

BERGEY'S MANUAL® OF
**Systematic
Bacteriology**
Second Edition

Volume Five
The *Actinobacteria*, Part A and B

BERGEY'S MANUAL® OF

Systematic Bacteriology

Second Edition

Volume Five

The *Actinobacteria*, Part A and B

**Michael Goodfellow, Peter Kämpfer, Hans-Jürgen Busse,
Martha E. Trujillo, Ken-ichiro Suzuki, Wolfgang Ludwig
and William B. Whitman**

EDITORS, VOLUME FIVE

William B. Whitman

DIRECTOR OF THE EDITORIAL OFFICE

Aidan C. Parte

MANAGING EDITOR

EDITORIAL BOARD

Fred A. Rainey, Chairman, **Peter Kämpfer**, Vice Chairman,
Paul De Vos, Jongsik Chun, Martha E. Trujillo and William B. Whitman

WITH CONTRIBUTIONS FROM 116 COLLEAGUES

 Springer

William B. Whitman
Bergey's Manual Trust
Department of Microbiology
527 Biological Sciences Building
University of Georgia
Athens, GA 30602-2605
USA

ISBN 978-0-387-95043-3 ISBN 978-0-387-68233-4 (eBook)
DOI 10.1007/978-0-387-68233-4
Springer New York Dordrecht Heidelberg London

Library of Congress Control Number: 2012930836

© 2012, 1984–1989 Bergey's Manual Trust

Bergey's Manual is a registered trademark of Bergey's Manual Trust.

All rights reserved. This work may not be translated or copied in whole or in part without the written permission of the publisher (Springer Science+Business Media, LLC, 233 Spring Street, New York, NY 10013, USA), except for brief excerpts in connection with reviews or scholarly analysis. Use in connection with any form of information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed is forbidden.

The use in this publication of trade names, trademarks, service marks, and similar terms, even if they are not identified as such, is not to be taken as an expression of opinion as to whether or not they are subject to proprietary rights.

Printed on acid-free paper.

Springer is part of Springer Science+Business Media (www.springer.com)

*This volume is dedicated to our colleagues
Michael Goodfellow and Peter H.A. Sneath.*

*Michael retired from the Board of Trustees of Bergey's Manual during preparation of this volume.
His tremendous efforts as an editor, author and officer of the Trust are truly appreciated.*

*Our late eminent colleague Peter H.A. Sneath (1923–2011) was a Trustee (1978–1994)
and Chairman of the Trust (1990–1994).*

*He also served as an editor of previous editions of The Manual and made many
other remarkable contributions to the systematics of prokaryotes.*

EDITORIAL BOARD AND TRUSTEES
OF BERGEY'S MANUAL TRUST

Fred A. Rainey, *Chairman*
Peter Kämpfer, *Vice Chairman*
Jongsik Chun
Paul De Vos
Martha E. Trujillo
William B. Whitman

Don J. Brenner, *Emeritus*
Richard W. Castenholz, *Emeritus*
George M. Garrity, *Emeritus*
Michael Goodfellow, *Emeritus*
John G. Holt, *Emeritus*
Noel R. Krieg, *Emeritus*
John Liston, *Emeritus*
James W. Moulder, *Emeritus*
R.G.E. Murray, *Emeritus*
Karl-Heinz Schleifer, *Emeritus*
James T. Staley, *Emeritus*
Joseph G. Tully, *Emeritus*

Preface to volume 5 of the second edition of *Bergey's Manual*[®] of *Systematic Bacteriology*

Prokaryotic systematics remains a vibrant and exciting field of study, one of challenges and opportunities, great discoveries and gradual advances. To honor one of the leaders of our field, the Trust presented the Bergey Award in recognition of outstanding contributions to the taxonomy of prokaryotes to Antonio Ventosa in 2010. The Bergey Medal, in recognition of life-long contributions to the field of systematic bacteriology, was also awarded to Michael Goodfellow, Zhiheng Liu, Ji-Sheng Ruan, and James Tiedje in 2011.

Volume 5 will be the last volume to be edited by Michael Goodfellow, who served on the Trust for many years and has continued to be active during his retirement. Mike contributed to volumes 2 and 4 of the first edition of *Bergey's Manual of Systematic Bacteriology* and has made an enormous contribution to the present volume as an author, editor, and mentor. As a leader in actinobacterial research for many decades, he is also directly responsible for much of the wealth of information about this fascinating group of microorganisms described in the current volume. Mike served as the Vice-Chairman of the Trust for many years and Chairman for the last 3 years. During his tenure, the Trust underwent important transitions for the future beyond the second edition. Adept at saying the most difficult things in the nicest way and a master of the telling omission, he was the right person at the right time.

Acknowledgements

The Trust is indebted to all of the contributors and reviewers, without whom this work would not be possible. The Editors are grateful for the time and effort that each has expended on behalf of the entire scientific community. We also thank the authors for their good grace in accepting comments, criticisms, and editing of their manuscripts.

The Trust recognizes its enormous debt to Dr Aidan Parte, whose enthusiasm and professionalism have made this *Manual* possible. The completion of the second edition is due in great measure to his dedication, good judgment, and hard work. His vision for excellent science has made the *Manual* more than it would have been.

We also recognize the special efforts of Dr Jean Euzéby in checking and correcting where necessary the nomenclature and etymology of every described taxon in this volume.

The Trust also thanks its Springer colleagues, especially Editorial Director Andrea Macaluso and Production Manager Susan Westendorf, for all of their efforts. As this will be the last volume of the *Manual* published in collaboration with Springer, the Trust also wishes to acknowledge the tremendous support and understanding that Springer has demonstrated over the last 13 years in helping us to publish this comprehensive synthesis of the systematics of prokaryotes.

In addition, we thank Amina Ravi, our manager at our typesetters, SPi, for her work in the proofing and production of this and the previous two volumes.

We thank our current copyeditors, proofreaders and other staff, including Susan Andrews, Joanne Auger, Hannah Berle, Robert Gutman, Judy Leventhal, Linda Sanders, Tyler Sgro, Dana Schneider, and Mohammed Waqar, without whose hard work and attention to detail the production of this volume would have been impossible. Lastly, we thank Dale Boyer and the other members of the Department of Microbiology at the University of Georgia for their unfailing support of this endeavor.

William B. (Barney) Whitman

Contents

Preface to volume 5	ix
Contributors	xvii
On using the <i>Manual</i>	xxiii
Part A	
Road map of the phylum <i>Actinobacteria</i>	1
Taxonomic outline of the phylum <i>Actinobacteria</i>	29
Phylum XXVI. <i>Actinobacteria</i> phyl. nov.	33
Class I. <i>Actinobacteria</i>	34
Order I. <i>Actinomycetales</i>	35
Family I. <i>Actinomycetaceae</i>	36
Genus I. <i>Actinomyces</i>	42
Genus II. <i>Actinobaculum</i>	109
Genus III. <i>Arcanobacterium</i>	114
Genus IV. <i>Mobiluncus</i>	126
Genus V. <i>Varibaculum</i>	139
Order II. <i>Actinopolysporales</i> ord. nov.	162
Family I. <i>Actinopolysporaceae</i>	163
Genus I. <i>Actinopolyspora</i>	163
Order III. <i>Bifidobacteriales</i>	170
Family I. <i>Bifidobacteriaceae</i>	171
Genus I. <i>Bifidobacterium</i>	171
Genus II. <i>Aeriscardovia</i>	206
Genus III. <i>Alloiscardovia</i>	207
Genus IV. <i>Gardnerella</i>	208
Genus V. <i>Metiscardovia</i>	211
Genus VI. <i>Parascardovia</i>	213
Genus VII. <i>Scardovia</i>	214
Order IV. <i>Catenulisporales</i> ord. nov.	225
Family I. <i>Catenulisporaceae</i>	226
Genus I. <i>Catenulispora</i>	226
Family II. <i>Actinospicaceae</i>	232
Genus I. <i>Actinospica</i>	232
Order V. <i>Corynebacteriales</i> ord. nov.	235
Family I. <i>Corynebacteriaceae</i>	244
Genus I. <i>Corynebacterium</i>	245
Genus II. <i>Turicella</i>	289
Family II. <i>Dietziaceae</i>	301
Genus I. <i>Dietzia</i>	301
Family III. <i>Mycobacteriaceae</i>	312
Genus I. <i>Mycobacterium</i>	312

Family IV. <i>Nocardiaceae</i>	376
Genus I. <i>Nocardia</i>	376
Genus II. <i>Gordonia</i>	419
Genus III. <i>Millisia</i>	435
Genus IV. <i>Rhodococcus</i>	437
Genus V. <i>Skermania</i>	464
Genus VI. <i>Smaragdicoccus</i>	467
Genus VII. <i>Williamsia</i>	470
Family V. <i>Segniliparaceae</i>	497
Genus I. <i>Segniliparus</i>	497
Family VI. <i>Tsukamurellaceae</i>	500
Genus I. <i>Tsukamurella</i>	500
Order VI. <i>Frankiales</i> ord. nov.	509
Family I. <i>Frankiaceae</i>	512
Genus I. <i>Frankia</i>	512
Family II. <i>Acidothermaceae</i>	520
Genus I. <i>Acidothermus</i>	520
Family III. <i>Cryptosporangiaceae</i>	522
Genus I. <i>Cryptosporangium</i>	522
Genus <i>Incertae sedis</i> I. <i>Fodinicola</i>	525
Family IV. <i>Geodermatophilaceae</i>	528
Genus I. <i>Geodermatophilus</i>	528
Genus II. <i>Blastococcus</i>	531
Genus III. <i>Modestobacter</i>	536
Family V. <i>Nakamurellaceae</i>	539
Genus I. <i>Nakamurella</i>	540
Genus II. <i>Humicoccus</i>	542
Family VI. <i>Sporichthyaceae</i>	544
Genus I. <i>Sporichthya</i>	544
Order VII. <i>Glycomycetales</i> ord. nov.	546
Family I. <i>Glycomycetaceae</i>	547
Genus I. <i>Glycomyces</i>	547
Genus II. <i>Stackebrandtia</i>	553
Order VIII. <i>Jiangellales</i> ord. nov.	555
Family I. <i>Jiangellaceae</i>	557
Genus I. <i>Jiangella</i>	557
Genus II. <i>Haloactinopolyspora</i>	560
Order IX. <i>Kineosporiales</i> ord. nov.	561
Family I. <i>Kineosporiaceae</i>	562
Genus I. <i>Kineosporia</i>	562
Genus II. <i>Kineococcus</i>	565
Genus III. <i>Quadrisphaera</i>	567
Order X. <i>Micrococcales</i>	569
Family I. <i>Micrococcaceae</i>	571
Genus I. <i>Micrococcus</i>	571
Genus II. <i>Acaricomes</i>	577
Genus III. <i>Arthrobacter</i>	578
Genus IV. <i>Citricoccus</i>	624
Genus V. <i>Kocuria</i>	626
Genus VI. <i>Nesterenkonia</i>	636
Genus VII. <i>Renibacterium</i>	643
Genus VIII. <i>Rothia</i>	646
Genus IX. <i>Yaniella</i>	650
Genus X. <i>Zhihengliuella</i>	653

Family II. <i>Beutenbergiaceae</i>	667
Genus I. <i>Beutenbergia</i>	669
Genus II. <i>Miniimonas</i>	671
Genus III. <i>Salana</i>	673
Genus IV. <i>Serinibacter</i>	677
Family III. <i>Bogoriellaceae</i>	678
Genus I. <i>Bogoriella</i>	679
Genus II. <i>Georgenia</i>	681
Family IV. <i>Brevibacteriaceae</i>	685
Genus I. <i>Brevibacterium</i>	685
Family V. <i>Cellulomonadaceae</i>	701
Genus I. <i>Cellulomonas</i>	702
Genus II. <i>Incertae sedis Actinotalea</i>	710
Genus III. <i>Incertae sedis Demequina</i>	712
Genus IV. <i>Oerskovia</i>	713
Genus V. <i>Tropheryma</i>	717
Family VI. <i>Dermabacteraceae</i>	727
Genus I. <i>Dermabacter</i>	727
Genus II. <i>Brachybacterium</i>	730
Family VII. <i>Dermacoccaceae</i>	738
Genus I. <i>Dermacoccus</i>	738
Genus II. <i>Demetria</i>	742
Genus III. <i>Kytococcus</i>	744
Family VIII. <i>Dermatophilaceae</i>	748
Genus I. <i>Dermatophilus</i>	749
Genus II. <i>Kineosphaera</i>	752
Family IX. <i>Intrasporangiaceae</i>	754
Genus I. <i>Intrasporangium</i>	759
Genus II. <i>Arsenicicoccus</i>	761
Genus III. <i>Humihabitans</i>	764
Genus IV. <i>Janibacter</i>	765
Genus V. <i>Knoellia</i>	769
Genus VI. <i>Kribbia</i>	773
Genus VII. <i>Lapillicoccus</i>	774
Genus VIII. <i>Ornithinicoccus</i>	775
Genus IX. <i>Ornithinimicrobium</i>	777
Genus X. <i>Oryzihumus</i>	781
Genus XI. <i>Phycicoccus</i>	782
Genus XII. <i>Serinicoccus</i>	786
Genus XIII. <i>Terrabacter</i>	788
Genus XIV. <i>Terracoccus</i>	790
Genus XV. <i>Tetrasphaera</i>	792
Family X. <i>Jonesiaceae</i>	802
Genus I. <i>Jonesia</i>	802
Family XI. <i>Microbacteriaceae</i>	807
Genus I. <i>Microbacterium</i>	814
Genus II. <i>Agreia</i>	852
Genus III. <i>Agrococcus</i>	855
Genus IV. <i>Agromyces</i>	862
Genus V. <i>Clavibacter</i>	877
Genus VI. <i>Cryobacterium</i>	883
Genus VII. <i>Curtobacterium</i>	887
Genus VIII. <i>Frigoribacterium</i>	895
Genus IX. <i>Fron dih abitans</i>	898

Genus X. <i>Gulosibacter</i>	900
Genus XI. <i>Humibacter</i>	904
Genus XII. <i>Labeledella</i>	906
Genus XIII. <i>Leifsonia</i>	907
Genus XIV. <i>Leucobacter</i>	923
Genus XV. <i>Microcella</i>	933
Genus XVI. <i>Microterricola</i>	934
Genus XVII. <i>Mycetocola</i>	936
Genus XVIII. <i>Okibacterium</i>	940
Genus XIX. <i>Phycicola</i>	942
Genus XX. <i>Plantibacter</i>	943
Genus XXI. <i>Pseudoclavibacter</i>	949
Genus XXII. <i>Rathayibacter</i>	953
Genus XXIII. <i>Rhodoglobus</i>	964
Genus XXIV. <i>Salinibacterium</i>	969
Genus XXV. <i>Subtercola</i>	973
Genus XXVI. <i>Yonghaparkia</i>	975
Family XII. <i>Promicromonosporaceae</i>	995
Genus I. <i>Promicromonospora</i>	995
Genus II. <i>Cellulosimicrobium</i>	1002
Genus III. <i>Isoptericola</i>	1006
Genus IV. <i>Myceligerans</i>	1010
Genus V. <i>Xylanibacterium</i>	1012
Genus VI. <i>Xylanimicrobium</i>	1015
Genus VII. <i>Xylanimonas</i>	1016
Family XIII. <i>Rarobacteraceae</i>	1019
Genus I. <i>Rarobacter</i>	1020
Family XIV. <i>Ruaniaceae</i>	1022
Genus I. <i>Ruania</i>	1024
Genus II. <i>Haloactinobacterium</i>	1025
Family XV. <i>Sanguibacteraceae</i>	1027
Genus I. <i>Sanguibacter</i>	1030

Part B

Order XI. <i>Micromonosporales</i> ord. nov.	1035
Family I. <i>Micromonosporaceae</i>	1035
Genus I. <i>Micromonospora</i>	1039
Genus II. <i>Actinocatenispora</i>	1057
Genus III. <i>Actinoplanes</i>	1058
Genus IV. <i>Asanoa</i>	1088
Genus V. <i>Catellatospora</i>	1090
Genus VI. <i>Catenuloplanes</i>	1092
Genus VII. <i>Couchioplanes</i>	1094
Genus VIII. <i>Dactylosporangium</i>	1096
Genus IX. <i>Krasilnikovia</i>	1106
Genus X. <i>Longispora</i>	1107
Genus XI. <i>Luedemannella</i>	1110
Genus XII. <i>Pilimelia</i>	1111
Genus XIII. <i>Polymorphospora</i>	1117
Genus XIV. <i>Salinispora</i>	1118
Genus XV. <i>Spirilliplanes</i>	1123
Genus XVI. <i>Verrucosispora</i>	1124
Genus XVII. <i>Virgisporangium</i>	1127
Order XII. <i>Propionibacteriales</i> ord. nov.	1137
Family I. <i>Propionibacteriaceae</i>	1138
Genus I. <i>Propionibacterium</i>	1138

Genus II. <i>Aestuariimicrobium</i>	1155
Genus III. <i>Brooklawnia</i>	1156
Genus IV. <i>Friedmanniella</i>	1159
Genus V. <i>Granulicoccus</i>	1165
Genus VI. <i>Luteococcus</i>	1166
Genus VII. <i>Microlunatus</i>	1168
Genus VIII. <i>Micropruina</i>	1173
Genus IX. <i>Propionicicella</i>	1174
Genus X. <i>Propionicimonas</i>	1175
Genus XI. <i>Propioniferax</i>	1177
Genus XII. <i>Propionimicrobium</i>	1179
Genus XIII. <i>Tessaracoccus</i>	1180
Family II. <i>Nocardioideae</i>	1189
Genus I. <i>Nocardioides</i>	1197
Genus II. <i>Actinopolymorpha</i>	1251
Genus III. <i>Aeromicrobium</i>	1258
Genus IV. <i>Kribbella</i>	1268
Genus V. <i>Marmoricola</i>	1284
Order XIII. <i>Pseudonocardiales</i> ord. nov.	1301
Family I. <i>Pseudonocardiaceae</i>	1302
Genus I. <i>Pseudonocardia</i>	1305
Genus II. <i>Actinoalloteichus</i>	1323
Genus III. <i>Actinokineospora</i>	1325
Genus IV. <i>Actinosynnema</i>	1331
Genus V. <i>Amycolatopsis</i>	1334
Genus VI. <i>Crossiella</i>	1359
Genus VII. <i>Goodfellowiella</i>	1363
Genus VIII. <i>Kibdelosporangium</i>	1366
Genus IX. <i>Kutzneria</i>	1371
Genus X. <i>Lechevalieria</i>	1375
Genus XI. <i>Lentzea</i>	1379
Genus XII. <i>Prauserella</i>	1384
Genus XIII. <i>Saccharomonospora</i>	1390
Genus XIV. <i>Saccharopolyspora</i>	1396
Genus XV. <i>Saccharothrix</i>	1415
Genus XVI. <i>Streptoalloteichus</i>	1419
Genus XVII. <i>Thermocrispum</i>	1423
Genus XVIII. <i>Umezawaea</i>	1427
Order XIV. <i>Streptomycetales</i> ord. nov.	1446
Family I. <i>Streptomycetaceae</i>	1446
Genus I. <i>Streptomyces</i>	1455
Genus <i>Incertae sedis</i> I. <i>Kitasatospora</i>	1768
Genus <i>Incertae sedis</i> II. <i>Streptacidiphilus</i>	1777
Order XV. <i>Streptosporangiales</i> ord. nov.	1805
Family I. <i>Streptosporangiaceae</i>	1807
Genus I. <i>Streptosporangium</i>	1811
Genus II. <i>Acrocarpospora</i>	1825
Genus III. <i>Herbidospora</i>	1827
Genus IV. <i>Microbispora</i>	1831
Genus V. <i>Microtetrastroma</i>	1838
Genus VI. <i>Nonomuraea</i>	1844
Genus VII. <i>Planobispora</i>	1861
Genus VIII. <i>Planomonospora</i>	1866
Genus IX. <i>Planotetrastroma</i>	1873
Genus X. <i>Sphaerisporangium</i>	1875
Genus XI. <i>Thermopolyspora</i>	1880

Family II. <i>Nocardiopsaceae</i>	1889
Genus I. <i>Nocardiopsis</i>	1891
Genus II. <i>Haloactinospora</i>	1907
Genus III. <i>Streptomonospora</i>	1908
Genus IV. <i>Thermobifida</i>	1914
Family III. <i>Thermomonosporaceae</i>	1929
Genus I. <i>Thermomonospora</i>	1931
Genus II. <i>Actinocorallia</i>	1935
Genus III. <i>Actinomadura</i>	1940
Genus IV. <i>Spirillospora</i>	1959
Order XVI. <i>Incertae sedis</i>	1967
Genus I. <i>Thermobispora</i>	1967
Class II. <i>Acidimicrobiia</i> class. nov.	1968
Order I. <i>Acidimicrobiales</i>	1969
Family I. <i>Acidimicrobiaceae</i>	1970
Genus I. <i>Acidimicrobium</i>	1970
Genus II. <i>Ferrimicrobium</i>	1972
Genus III. <i>Ferrithrix</i>	1973
Family II. <i>Iamiaceae</i>	1974
Genus I. <i>Iamia</i>	1975
Class III. <i>Coriobacteriia</i> class. nov.	1975
Order I. <i>Coriobacteriales</i>	1976
Family I. <i>Coriobacteriaceae</i>	1977
Genus I. <i>Coriobacterium</i>	1977
Genus II. <i>Atopobium</i>	1978
Genus III. <i>Collinsella</i>	1984
Genus IV. <i>Cryptobacterium</i>	1987
Genus V. <i>Denitrobacterium</i>	1988
Genus VI. <i>Eggerthella</i>	1990
Genus VII. <i>Olsenella</i>	1993
Genus VIII. <i>Slackia</i>	1995
Class IV. <i>Nitriliruptoria</i> class. nov.	2000
Order I. <i>Nitriliruptorales</i>	2001
Family I. <i>Nitriliruptoraceae</i>	2001
Genus I. <i>Nitriliruptor</i>	2001
Order II. <i>Euzebyales</i>	2002
Family I. <i>Euzebyaceae</i>	2003
Genus I. <i>Euzebya</i>	2003
Class V. <i>Rubrobacteria</i> class. nov.	2004
Order I. <i>Rubrobacterales</i>	2005
Family I. <i>Rubrobacteraceae</i>	2006
Genus I. <i>Rubrobacter</i>	2006
Class VI. <i>Thermoleophilia</i> class. nov.	2010
Order I. <i>Thermoleophilales</i>	2010
Family I. <i>Thermoleophilaceae</i>	2011
Genus I. <i>Thermoleophilum</i>	2011
Order II. <i>Solirubrobacterales</i>	2014
Family I. <i>Solirubrobacteraceae</i>	2015
Genus I. <i>Solirubrobacter</i>	2015
Family II. <i>Conexibacteraceae</i>	2018
Genus I. <i>Conexibacter</i>	2019
Family III. <i>Patulibacteraceae</i>	2024
Genus I. <i>Patulibacter</i>	2024
Author index	2029
Index of scientific names of <i>Archaea</i> and <i>Bacteria</i>	2031

Contributors

Hiroshi Akasaka

Creative Research Initiative “Sousei” (CRIS), Hokkaido University, Kita 21, Nishi 10, Kita-ku, Sapporo 001-0021, Japan

Vladimir N. Akimov

VKM – All-Russian Collection of Microorganisms, G.K. Skryabin Institute of Biochemistry and Physiology of Microorganisms, Russian Academy of Sciences, Pushchino, Moscow Region 142290, Russia
akimov@ibpm.pushchino.ru

Robin C. Anderson

Research Microbiologist/Lead Scientist, United States Department of Agriculture, Southern Plains Agricultural Research Center, Food and Feed Safety Research Unit, 2881 F&B Road, College Station, TX 77845, USA
robin.anderson@ars.usda.gov

Elena V. Ariskina

VKM – All-Russian Collection of Microorganisms, G.K. Skryabin Institute of Biochemistry and Physiology of Microorganisms, Russian Academy of Sciences, Pushchino, Moscow Region 142290, Russia
lena@ibpm.pushchino.ru

Brian Austin

Institute of Aquaculture, School of Natural Sciences, University of Stirling, Stirling FK9 4LA, Scotland, UK
brian.austin@stir.ac.uk

Undine Behrendt

Leibniz Centre for Agricultural Landscape Research (ZALF), Institute of Landscape Matter Dynamics, Eberswalder Straße 84, D-15374 Müncheberg, Germany
ubehrendt@zalf.de

Yoshimi Benno

Benno Laboratory, Innovation Center, RIKEN, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan
benno828@riken.jp

David R. Benson

Department of Molecular & Cell Biology, University of Connecticut, Storrs, CT 06269-3125, USA
david.benson@uconn.edu

Kathryn A. Bernard

National Microbiology Laboratory, Public Health Agency of Canada, 1015 Arlington Street, Winnipeg, Manitoba R3E 3R2, Canada
kathy.bernard@phac-aspc.gc.ca

Alison M. Berry

Department of Plant Sciences, One Shields Avenue, University of California, Davis, CA 95616, USA
amberry@ucdavis.edu

Bruno Biavati

Department of Agricultural Sciences, Bologna University, Viale Fanin 42, 40127 Bologna, Italy
bruno.biavati@unibo.it

Sandra Buczolits

Institut für Bakteriologie, Mykologie und Hygiene, Veterinärmedizinische Universität Wien, Veterinärplatz 1, A-1210 Wien, Austria
sandra.buczolits@vetmeduni.ac.at

Hans-Jürgen Busse

Institut für Bakteriologie, Mykologie und Hygiene, Veterinärmedizinische Universität Wien, Veterinärplatz 1, A-1210 Wien, Austria
hans-juergen.busse@vetmeduni.ac.at

W. Ray Butler

Division of Tuberculosis Elimination, National Center for HIV, STD and Tuberculosis Prevention, Centers for Disease Control and Prevention, Atlanta, GA, USA
wrb1@cdc.gov

Lorena Carro

Departamento de Microbiología y Genética, Edificio Departamental, Lab. 205, Campus Unamuno, Universidad de Salamanca, 37007 Salamanca, Spain
lcg@usal.es

Linda Cavaletti

Fondazione Istituto Insubrico di Ricerca per la Vita, via Robert Lepetit 34, 21040 Gerenzano, Italy
lindacavaletti@ricercaperlavita.it

Wen-Feng Chen

State Key Laboratories of Agrobiotechnology, College of Biological Sciences, China Agricultural University, Beijing 100193, P.R. China
chenwf@cau.edu.cn

Matthew D. Collins

The University of Reading, Whiteknights, Reading RG6 6AP, UK

Milton S. da Costa

Department of Life Sciences, University of Coimbra, 3001-401, Coimbra, Portugal
milton@ci.uc.pt

Xiao-Long Cui

Yunnan Institute of Microbiology, Yunnan University, Cuihu Beilu 2, Kunming, Yunnan 650091, P.R. China
xlcul@ynu.edu.cn

Ewald B. M. Denner

Institut für Bakteriologie, Mykologie und Hygiene, Veterinärmedizinische Universität Wien, Veterinärplatz 1, A-1210 Wien, Austria
ewald.denner@vetmeduni.ac.at

Floyd E. Dewhirst

Department of Molecular Genetics,
The Forsyth Institute, 245 First Street,
Cambridge, MA 02142, USA
fdewhirst@forsyth.org

Stefano Donadio

KtedoGen Srl and NAICONS Scrl, Via Fantoli 16/15,
20138 Milano, Italy
stefano.donadio@ktedogen.com, sdonadio@naicons.com

Lubov V. Dorofeeva

VKM – All-Russian Collection of Microorganisms,
G.K. Skryabin Institute of Biochemistry and Physiology
of Microorganisms, Russian Academy of Sciences,
Pushchino, Moscow Region 142290, Russia
dorofeeva@ibpm.pushchino.ru

Jean P. Euzéby

Ecole Nationale Veterinaire, 23 chemin des Capelles,
B.P. 87614, 31076 Toulouse cedex 3, France
jean.euzeby@gmail.com

Lyudmila I. Evtushenko

VKM – All-Russian Collection of Microorganisms,
G.K. Skryabin Institute of Biochemistry and Physiology
of Microorganisms, Russian Academy of Sciences, Pushchino,
Moscow Region 142290, Russia
evtushenko@ibpm.pushchino.ru

José F. Fernández-Garayzábal

Departamento de Sanidad Animal,
Facultad de Veterinaria, Universidad Complutense,
28040 Madrid, Spain
garayzab@vet.ucm.es

Christopher Franco

Department of Medical Biotechnology, School of Medicine,
Flinders University, Bedford Park, South Australia 5042,
Australia
chris.franco@flinders.edu.au

Guido Funke

Department of Medical Microbiology & Hygiene,
Gärtner & Colleagues Laboratories, Elisabethenstrasse 11,
D-88212 Ravensburg, Germany
ldg.funke@t-online.de

George M. Garrity

Department of Microbiology, Michigan State University,
6162 Biomedical and Physical Sciences Building,
East Lansing, MI 48824-4320, USA
garrity@msu.edu

Olga Genilloud

Fundación MEDINA, Avda del Conocimiento 3,
Parque Tecnológico Ciencias de la Salud, 18100 Armilla,
Granada, Spain
olga.genilloud@medinaandalucia.es, olga_genilloud@wanadoo.es

Michael Goodfellow

School of Biology, Ridley Building, University of Newcastle,
Newcastle upon Tyne NE1 7RU, UK
m.goodfellow@newcastle.ac.uk

Anthony C. Greene

Microbial Gene Research and Resources Facility,
School of Biomolecular and Physical Sciences,
Griffith University, Brisbane, Queensland 4111,
Australia
t.greene@griffith.edu.au

Ingrid Groth

Molekulare und Angewandte Mikrobiologie,
Leibniz-Institut für Naturstoff-Forschung
und Infektionsbiologie e. V., Hans-Knöll-Institut,
Beutenbergstrasse 11a, D-07745 Jena, Germany
ingrid.groth@gmx.net

Val Hall

Anaerobe Reference Unit, Public Health Wales Microbiology,
University Hospital of Wales, Cardiff CF14 4XW, UK
hallv@cardiff.ac.uk

Satoshi Hanada

Institute for Biological Resources and Functions,
National Institute of Advanced Industrial Science
and Technology (AIST), Tsukuba Central 6, 1-1-1 Higashi,
Tsukuba 305-8566, Japan
s-hanada@aist.go.jp

Lesley Hoyles

Microbial Ecology & Health Group,
Department of Food & Nutritional Sciences,
University of Reading, Whiteknights Campus, Reading, UK
lesley_hoyles@hotmail.com

Wael N. Hozzein

Botany Department, Faculty of Science, Beni-Suef University,
Beni-Suef, Egypt
hozzein29@yahoo.com

Ying Huang

State Key Laboratory of Microbial Resources,
Institute of Microbiology, Chinese Academy of Sciences,
No. 1 West Beichen Road, Chaoyang District, Beijing 100101,
P.R. China
huangy@im.ac.cn

Paul R. Jensen

Scripps Institution of Oceanography, University of California
San Diego, La Jolla, CA 92093-0204, USA
pjensen@ucsd.edu

Amanda L. Jones

Department of Biology, Food and Nutritional Sciences,
School of Life Sciences, A314 Ellison Building, Northumbria
University, Newcastle upon Tyne NE1 8ST, UK
amanda.l.jones@northumbria.ac.uk

Akiko Kageyama

Kitasato Institute for Life Sciences, Kitasato University,
5-9-1 Shirokane, Minato-ku, Tokyo 108-8641, Japan
kageyama@nihs.go.jp

Peter Kämpfer

Institut für Angewandte Mikrobiologie,
Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring
26-32 (IFZ), D-35392 Giessen, Germany
peter.kaempfer@umwelt.uni-giessen.de

Hiroaki Kasai

Marine Biotechnology Institute, 3-75-1, Heita, Kamashi,
Iwate 026-0001, Japan
hkasai@kitasato-u.ac.jp

Ellen M. Kerr

Science and Advice for Scottish Agriculture,
Roddinglaw Road, Edinburgh, EH12 9FJ, Scotland, UK

Seung Bum Kim

Department of Microbiology and Molecular Biology,
Chungnam National University, 220 Gung-dong, Yuseong,
Daejeon 305-764, Republic of Korea
sbk01@cnu.ac.kr

Helmut König

Institute of Microbiology and Wine Research,
Johannes Gutenberg University, Becherweg 15,
55128 Mainz, Germany
hkoenig@uni-mainz.de

Valentina I. Krausova

VKM – All-Russian Collection of Microorganisms,
G.K. Skryabin Institute of Biochemistry and Physiology
of Microorganisms, Russian Academy of Sciences, Pushchino,
Moscow Region 142290, Russia
vikrau_z@mail.ru

Noel R. Krieg

617 Broce Drive, Blacksburg, VA 24060-2801, USA
nrk@vt.edu

Takuji Kudo

Japan Collection of Microorganisms, RIKEN, Hirosawa, Wako,
Saitama 351-0198, Japan
kudo@jcm.riken.jp

Yashawant Kumar

NCIMB Ltd, Ferguson Building,
Craibstone Estate, Bucksburn, Aberdeen AB21 9YA,
Scotland, UK

David P. Labeda

National Center for Agricultural Utilization Research,
U.S. Department of Agriculture, Peoria, IL 61604-3999, USA
david.labeda@ars.usda.gov

Paul A. Lawson

Department of Botany and Microbiology, George Lynn
Cross Hall, 770 Van Vleet Oval, The University of Oklahoma,
Norman, OK 73019-0245, USA
paul.lawson@ou.edu

Soon Dong Lee

School of Biological Sciences and Research Center
for Molecular Microbiology, Seoul National University,
Republic of Korea, Seoul, Korea
sdlee@cheju.ac.kr

Wen-Jun Li

Key Laboratory of Microbial Diversity in Southwest China,
Ministry of Education and Laboratory for Conservation
and Utilization of Bio-Resources, Yunnan Institute
of Microbiology, Yunnan University, Kunming 650091,
P.R. China
wjli@ynu.edu.cn, liact@hotmail.com

Zhi-Heng Liu

Institute of Microbiology, Chinese Academy of Sciences,
P.O. Box 2714, Beijing 100190, P.R. China
zhliu@sun.im.ac.cn

Nicole Ladders

Institut für Angewandte Mikrobiologie,
Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring
26-32 (IFZ), D-35392 Giessen, Germany
nicole.ladders@umwelt.uni-giessen.de

Wolfgang Ludwig

Lehrstuhl für Mikrobiologie, Technische Universität
München, Emil-Ramann-Str. 4, D-85350 Freising, Germany
ludwig@mikro.biologie.tu-muenchen.de

John G. Magee

HPA Microbiology Services Newcastle Laboratory,
Level 2, Freeman Hospital High Heaton,
Newcastle upon Tyne NE7 7DN, UK
john.magee@hpa.org.uk

Matthias Maiwald

Department of Pathology and Laboratory Medicine,
KK Women's and Children's Hospital,
100 Bukit Timah Road, Singapore 229899
matthias.maiwald@flinders.edu.au, matthias_maiwald@yahoo.com

Luis A. Maldonado

Instituto de Ciencias del Mar y Limnología (ICMyL),
Universidad Nacional Autónoma de México (UNAM),
04510 Mexico, DF, Mexico
lamaldo@icmyl.unam.mx

Célia Manaia

Escola Superior de Biotecnologia, Universidade Católica
Portuguesa, R. Dr António Bernardino de Almeida,
4200-072 Porto, Portugal
cmmanaia@esb.ucp.pt

Eustoquio Martínez-Molina

Departamento de Microbiología y Genética,
Edificio Departamental, Lab. 209, Universidad de Salamanca,
Salamanca, Spain
emm@usal.es

Abdul M. Maszenan

Environmental Engineering Research Centre,
School of Civil and Environmental Engineering,
Nanyang Technological University, 639798, Singapore
emaszenan@ntu.edu.sg

Pedro F. Mateos

Departamento de Microbiología y Genética,
Edificio Departamental, Campus Unamuno,
Universidad de Salamanca, 37007 Salamanca, Spain
pfmg@usal.es

Atsuko Matsumoto

Kitasato Institute for Life sciences, Kitasato University,
5-9-1 Shirokane, Minato-ku, Tokyo 108-8641, Japan
amatsu@lisci.kitasato-u.ac.jp

Paola Mattarelli

Department of Agricultural Sciences, Bologna University,
Viale Fanin 42, 40127 Bologna, Italy
paola.mattarelli@unibo.it

Anne L. McCartney

Microbial Ecology and Health Group, Department
of Food and Nutritional Sciences, University of Reading,
Whiteknights, P.O. Box 226, Reading, RG6 6AP, UK
a.l.mccartney@reading.ac.uk

Andrew McDowell

Centre for Infection and Immunity, School of Medicine,
Dentistry and Biomedical Sciences, Queen's University Belfast,
Medical Biology Centre, 97 Lisburn Road, Belfast BT9 7BL, UK
a.mcdowell@qub.ac.uk

Simon J. McIlroy

Biotechnology Research Centre, La Trobe University,
P.O. Box 199, Bendigo, Victoria 3550, Australia
s.mcilroy@latrobe.edu.au

Patricia Messenberg Guimarães

Embrapa Genetic Resources and Biotechnology,
PqEB Final W3 Norte, P.O. Box 02372, 70770-900 Brasília-DF,
Brazil
messenbe@cenargen.embrapa.br

William M. Moe

Department of Civil and Environmental Engineering,
Louisiana State University, Baton Rouge, LA 70803, USA
moemwil@lsu.edu

Paolo Monciardini

KtedoGen srl, via Fantoli 16/15, 20138 Milano, Italy
paolo.monciardini@ktedogen.com

Kazunori Nakamura

Institute for Biological Resources and Functions,
 National Institute of Advanced Industrial Science
 and Technology (AIST), Tsukuba, Ibaraki, Japan
k.nakamura@aist.go.jp

Futoshi Nakazawa

Department of Oral Microbiology, School of Dentistry,
 Health Sciences University of Hokkaido,
 1757 Kanazawa, Tobetsu-Ishikari, Hokkaido, 061-0293,
 Japan
nakazawa@hoku-iryo-u.ac.jp

Olga I. Nedashkovskaya

Pacific Institute of Bioorganic Chemistry,
 of the Far-Eastern Branch of the Russian
 Academy of Sciences, Pr. 100 let Vladivostoku 159,
 690022, Vladivostok, Russia
olganedashkovska@piboc.dvo.ru, olganedashkovska@yahoo.com

Balbina Nogales

Area de Microbiologia, Dept. Biologia,
 Universitat de les Illes Balears, Crtra. Valldemossa km 7.5,
 07122 Palma de Mallorca, Spain
bnogales@uib.es

Philippe Normand

IFR41 CNRS Ecologie Genetique Evolution, UMR 5557
 CNRS Ecologie Microbienne, Université Claude-Bernard
 Lyon1, Bat G. Mendel, 43 Blvd du 11 novembre 1918,
 69622 Villeurbanne Cedex, France
normand@biomserv.univ-lyon1.fr

Paul R. Norris

School of Life Sciences, University of Warwick,
 Coventry CV4 7AL, UK
p.r.norris@warwick.ac.uk

Olga C. Nunes

LEPAE-Departamento de Engenharia Química,
 Faculdade de Engenharia, Universidade do Porto,
 R. Dr Roberto Frias, Porto, 4200-465, Portugal
opnunes@fe.up.pt

Cristina Pascual

National Documentation Centre, 48 Vas. Constantinou
 Avenue, GR11635 Athens, Greece
cpascual@ekt.gr, cristina_93@hotmail.com

Bharat K. C. Patel

Microbial Discovery Research Unit, School of Biomolecular
 and Physical Sciences, Griffith University, Nathan Campus,
 Kessels Road, Brisbane, Queensland 4111, Australia
b.patel@griffith.edu.au

Sheila Patrick

Centre for Infection and Immunity, School of Medicine,
 Dentistry and Biomedical Sciences, Queen's University Belfast,
 Medical Biology Centre, 97 Lisburn Road, Belfast BT9 7BL,
 UK
sheila.patrick@qub.ac.uk

Jerome J. Perry (Deceased)

3125 Eton Road, Raleigh, NC 27608, USA

Rüdiger Pukall

DSMZ – Deutsche Sammlung von Mikroorganismen
 und Zellkulturen, Inhoffenstraße 7 B, 38124 Braunschweig,
 Germany
rpu@dsmz.de

Erika T. Quintana

Instituto Politécnico Nacional (IPN), Escuela Nacional
 de Ciencias Biológicas (ENCB), Department of Microbiology,
 General Microbiology Laboratory, Prolongación de Carpio
 y Plan de Ayala s/n, Col. Santo Tomás, Deleg. Miguel Hidalgo,
 C.P. 11340, Mexico City, Mexico
erika_quintana@hotmail.com

Fred A. Rainey

Department of Biological Sciences, University of Alaska
 Anchorage, Providence Drive, Anchorage, AK 99508, USA
farainey@gmail.com

David A. Relman

Departments of Medicine, and of Microbiology
 & Immunology, Stanford University School of Medicine,
 Stanford, CA 94305-5124, USA
relman@stanford.edu

Raúl Rivas

Departamento de Microbiología y Genética,
 Edificio Departamental, Lab. 209, Campus Unamuno,
 Universidad de Salamanca, 37007 Salamanca, Spain
raulbrg@usal.es

Gerard S. Saddler

Science and Advice for Scottish Agriculture, Roddinglaw Road,
 Edinburgh, EH12 9FJ, Scotland, UK
gerry.saddler@sasa.gsi.gov.uk

Klaus P. Schaal

Institut für Medizinische Mikrobiologie,
 Immunologie und Parasitologie, Universitätsklinikum Bonn,
 Sigmund-Freud-Strasse 25, D-53105 Bonn, Germany
schaal@microbiology-bonn.de, kpschaal@t-online.de

Jenny Schäfer

Bundesanstalt für Arbeitsschutz und Arbeitsmedizin,
 "Biologische Arbeitsstoffe", Nöldnerstrasse 40–42,
 10317 Berlin, Germany
schaefer.jenny@baua.bund.de

Peter Schumann

DSMZ – Deutsche Sammlung von Mikroorganismen
 und Zellkulturen, Inhoffenstraße 7 B, 38124 Braunschweig,
 Germany
psc@dsmz.de

Susmitha Seshadri

Department of Microbiology, University of Georgia,
 527 Biological Sciences Building, Cedar Street, Athens,
 GA 30602, USA
ssusmitha@uga.edu

Robert J. Seviour

Biotechnology Research Centre, La Trobe University,
 P.O. Box 199, Bendigo, Victoria 3550, Australia
r.seviour@latrobe.edu.au

Peter P. Sheridan

Department of Biological Sciences, Idaho State University,
 P.O. Box 8007, Pocatello, ID 83209, USA
sherpete@isu.edu

Jacques A. Soddell

Cajid Media, 21 Wirth Street, Bendigo, Victoria 3550,
 Australia
jacques@cajid.com

Cathrin Spröer

DSMZ – Deutsche Sammlung von Mikroorganismen
 und Zellkulturen, Inhoffenstraße 7 B, 38124 Braunschweig,
 Germany
ckc@dsmz.de

Erko Stackebrandt

40 Rue des Ecoles, 75005 Paris, France
erko@dsmz.de

Thaddeus B. Stanton

Agricultural Research Service – Midwest Area,
 National Animal Disease Center, United States Department
 of Agriculture, P.O. Box 70, 1920 Dayton Avenue,
 Building 24, Ames, IA 50010-0070,
 USA
thad.stanton@ars.usda.gov

Virginie Storms

Lab. voor Microbiologie en Microbiele Genetica,
 Faculteit Wetenschappen, Universiteit of Gent,
 K.L. Ledeganckstraat 35, B-9000 Ghent, Belgium
virginie.storms@ugent.be

Ken-ichiro Suzuki

NITE Biological Resource Center (NBRC),
 National Institute of Technology and Evaluation,
 2-5-8, Kazusakamatari 2-chome, Kisarazu-shi, Chiba 292-0818,
 Japan
suzuki-ken-ichiro@nite.go.jp

Yōko Takahashi

Kitasato Institute for Life Sciences, Kitasato University,
 5-9-1 Shirokane, Minato-ku, Tokyo 108-8641, Japan
ytakaha@lisci.kitasato-u.ac.jp

Mariko Takeuchi

Takeda Chemical Industries, 17-85, Juso-honmachi, 2-chome,
 Yodogawa-ku, Osaka 532-8686, Japan

Tomohiko Tamura

NITE Biological Resource Center (NBRC),
 National Institute of Technology and Evaluation,
 2-5-8, Kazusakamatari, Kisarazu-shi,
 Chiba 292-0818, Japan
tamura-tomohiko@nite.go.jp

Geok Yuan Annie Tan

Microbiology Division, Institute of Biological Sciences,
 University of Malaya, 50603 Kuala Lumpur, Malaysia
gyatan@um.edu.my

Shu-Kun Tang

The Key Laboratory for Microbial Resources of the Ministry
 of Education, P.R.China, and Laboratory for Conservation
 and Utilization Bio-Resources, Yunnan Institute of
 Microbiology, Yunnan University, Kunming 650091,
 P.R. China

Tian-shen Tao

College of Life Sciences, Wuhan University, Wuhan 430072,
 Hubei Province, P.R. China
taotianshen@126.com

Martha E. Trujillo

Departamento de Microbiología y Genética,
 Edificio Departamental, Lab. 205, Campus Unamuno,
 Universidad de Salamanca, 37007 Salamanca,
 Spain
mett@usal.es

Takanori Tsukamoto

Plant Protection Division, Food Safety and
 Consumer Affairs Bureau, Ministry of Agriculture,
 Forestry and Fisheries (MAFF) 1-2-1 Kasumigaseki,
 Chiyoda-ku, Tokyo 100-8950, Japan
tsukamotot@pps.maff.go.jp

Atsuko Ueki

Faculty of Agriculture, Yamagata University,
 Wakaba-machi 1-23, Tsuruoka 997-8555, Japan
uatsuko@tds1.tr.yamagata-u.ac.jp

Katuji Ueki

Faculty of Agriculture, Yamagata University,
 Wakaba-machi 1-23, Tsuruoka 997-8555, Japan
kueki@tds1.tr.yamagata-u.ac.jp

Andreas Ulrich

Institute of Landscape Matter Dynamics, Leibniz-Centre
 for Agricultural Landscape Research (ZALF) e.V.,
 Eberswalder Strasse 84, D-15374 Müncheberg, Germany
aulrich@zalf.de

Peter Vandamme

Laboratorium voor Microbiologie, Faculteit Wetenschappen,
 Universiteit Gent, Ledeganckstraat 35, B-9000 Gent, Belgium
peter.vandamme@ugent.be

Encarna Velázquez

Departamento de Microbiología y Genética, Lab 209,
 Edificio Departamental, Universidad de Salamanca,
 Campus Miguel de Unamuno, 37007 Salamanca, Spain
evp@usal.es

António Veríssimo

Centro de Neurociências e Biologia Celular and Department
 of Life Sciences, University of Coimbra, Apartado 3046,
 3001-401 Coimbra, Portugal
averissimo@uc.pt

Gernot Vobis

Departamento de Botánica, Centro Regional Universitario
 Bariloche, Universidad Nacional del Comahue, Quintral,
 1250 8400 San Carlos de Bariloche, Prov. de Río Negro,
 Argentina
agavobis@bariloche.com.ar

William G. Wade

Microbiology, King's College London Dental Institute,
 Floor 17, Tower Wing, Guy's Campus, London SE1 9RT, UK
william.wade@kcl.ac.uk

Alan C. Ward

School of Biology, University of Newcastle upon Tyne,
 Newcastle upon Tyne NE1 7RU, UK
alan.ward@ncl.ac.uk

William B. Whitman

Department of Microbiology, University of Georgia,
 527 Biological Sciences Building, Cedar Street, Athens,
 GA 30602-2605, USA
whitman@uga.edu

Monika Wieser

Institut für Bakteriologie, Mykologie und Hygiene,
 Veterinärmedizinische Universität Wien, Veterinärplatz 1,
 A-1210 Wien, Austria
monika.wieser@vetmeduni.ac.at

Atteyet F. Yassin

Institut für Medizinische Mikrobiologie und Immunologie
 der Universität Bonn, Sigmund-Freud-Straße 25, 53127 Bonn,
 Germany
yassin@mibi03.meb.uni-bonn.de, atteyet-alla.yassin@ukb.uni-bonn.de

Akira Yokota

Institute of Molecular and Cellular Biosciences,
 The University of Tokyo, 1-1-1, Yayoi, Bunkyo-Ku,
 Tokyo 113-0032, Japan
uayoko@gmail.com

Jung-Hoon Yoon

Laboratory of Microbial Function, Korea Research
Institute of Bioscience and Biotechnology (KRIIBB),
P.O. Box 115, Yusong, Taejon,
South Korea
jhyoon@kribb.re.kr

Xiao-Yang Zhi

The Key Laboratory for Microbial Resources of the Ministry
of Education, P.R.China, and Laboratory for Conservation
and Utilization Bio-Resources, Yunnan Institute of
Microbiology, Yunnan University, Kunming 650091,
P.R. China

On using the *Manual*

NOEL R. KRIEG AND GEORGE M. GARRITY

Citation

The *Systematics* is a peer-reviewed collection of chapters, contributed by authors who were invited by the Trust to share their knowledge and expertise of specific taxa. Citations should refer to the author, the chapter title, and inclusive pages rather than to the editors.

Arrangement of the *Manual*

As in the previous volumes of this edition, the *Manual* is arranged in phylogenetic groups based upon the analyses of the 16S rRNA presented in the introductory chapter “Road map of the phylum *Actinobacteria*”. This phylum has been substantially modified since the publication of volume 1 in 2001, reflecting both the availability of more experimental data and a different method of analysis. Since volume 5 includes only the phylum *Actinobacteria*, taxa are arranged by class, order, family, genus and species. Within each taxon, the nomenclatural type is presented first. Other taxa are presented in alphabetical order without consideration of degrees of relatedness.

Articles

Each article dealing with a bacterial genus is presented wherever possible in a definite sequence as follows:

a. Name of the genus. Accepted names are in boldface, followed by “defining publication(s)”, i.e. the authority for the name, the year of the original description, and the page on which the taxon was named and described. The superscript AL indicates that the name was included on the Approved Lists of Bacterial Names, published in January 1980. The superscript VP indicates that the name, although not on the Approved Lists of Bacterial Names, was subsequently validly published in the *International Journal of Systematic and Evolutionary Microbiology* (or the *International Journal of Systematic Bacteriology*). Names given within quotation marks have no standing in nomenclature; as of the date of preparation of the *Manual* they had not been validly published in the *International Journal of Systematic and Evolutionary Microbiology*, although they may have been “effectively published” elsewhere. Names followed by the term “nov.” are newly proposed but will not be validly published until they appear in a Validation List in the *International Journal of Systematic and Evolutionary Microbiology*. Their proposal in the *Manual* constitutes only “effective publication”, not valid publication.

b. Name of author(s). The person or persons who prepared the Bergey’s article are indicated. The address of each author can be found in the list of Contributors at the beginning of the *Manual*.

c. Synonyms. In some instances a list of some synonyms used in the past for the same genus is given. Other synonyms can be found in the *Index Bergeyana* or the *Supplement to the Index Bergeyana*.

d. Etymology of the name. Etymologies are provided as in previous editions, and many (but undoubtedly not all) errors have been corrected. It is often difficult, however, to determine why a particular name was chosen, or the nuance intended, if the details were not provided in the original publication. Those authors who propose new names are urged to consult a Greek and Latin authority before publishing in order to ensure grammatical correctness and also to ensure that the meaning of the name is as intended.

e. Salient features. This is a brief resume of the salient features of the taxon. The most important characteristics are given in boldface. The DNA G+C content is given.

f. Type species. The name of the type species of the genus is also indicated along with the defining publication(s).

g. Further descriptive information. This portion elaborates on the various features of the genus, particularly those features having significance for systematic bacteriology. The treatment serves to acquaint the reader with the overall biology of the organisms but is not meant to be a comprehensive review. The information is normally presented in the following sequence:

- Colonial morphology and pigmentation
- Growth conditions and nutrition
- Physiology and metabolism
- Genetics, plasmids, and bacteriophages
- Phylogenetic treatment
- Antigenic structure
- Pathogenicity
- Ecology

h. Enrichment and isolation. A few selected methods are presented, together with the pertinent media formulations.

i. Maintenance procedures. Methods used for maintenance of stock cultures and preservation of strains are given.

j. Procedures for testing special characters. This portion provides methodology for testing for unusual characteristics or performing tests of special importance.

k. Differentiation of the genus from other genera. Those characteristics that are especially useful for distinguishing the genus from similar or related organisms are indicated here, usually in a tabular form.

l. Taxonomic comments. This summarizes the available information related to taxonomic placement of the genus and indicates the justification for considering the genus a distinct taxon. Particular emphasis is given to the methods of molecular biology used to estimate the relatedness of the genus to other taxa, where such information is available. Taxonomic information regarding the arrangement and status of the various species within the genus follows. Where taxonomic controversy exists, the problems are delineated and the various alternative viewpoints are discussed.

m. Further reading. A list of selected references, usually of a general nature, is given to enable the reader to gain access to additional sources of information about the genus.

n. Differentiation of the species of the genus. Those characteristics that are important for distinguishing the various species within the genus are presented, usually with reference to a table summarizing the information.

o. List of species of the genus. The citation of each species is given, followed in some instances by a brief list of objective synonyms. The etymology of the specific epithet is indicated. Descriptive information for the species is usually presented in tabular form, but special information may be given in the text. Because of the emphasis on tabular data, the species descriptions are usually brief. The type strain of each species is indicated, together with the collection(s) in which it can be found. (Addresses of the various culture collections are given in the article in volume I entitled *Culture Collections: An Essential Resource for Microbiology*.) The 16S rRNA gene sequence used in phylogenetic analysis and placement of the species into the taxonomic framework is given, along with the GenBank (or other database) accession number. Additional comments may be provided to point the reader to other well-characterized strains of the species and any other known DNA sequences that may be relevant.

p. Species *incertae sedis*. The List of Species may be followed in some instances by a listing of additional species under the heading “Species *Incertae sedis*” or “Other organisms”, etc. The taxonomic placement or status of such species is questionable, and the reasons for the uncertainty are presented.

q. References. All references given in the article are listed alphabetically at the end of the family chapter

Tables

In each article dealing with a genus, there are generally three kinds of table: (a) those that differentiate the genus from

similar or related genera, (b) those that differentiate the species within the genus, and (c) those that provide additional information about the species (such information not being particularly useful for differentiation). The meanings of symbols are as follows:

- +, 90% or more of the strains are positive
- d, 11–89% of the strains are positive
- , 90% or more of the strains are negative
- D, different reactions occur in different taxa (e.g., species of a genus or genera of a family)
- v, strain instability (NOT equivalent to “d”)
- w, weak reaction.
- nd, not determined or no data.
- nr, not reported.

These symbols, and exceptions to their use, as well as the meaning of additional symbols, are given in footnotes to the tables.

Use of the *Manual* for determinative purposes

Many chapters have keys or tables for differentiation of the various taxa contained therein. For identification of species, it is important to read both the generic and species descriptions because characteristics listed in the generic descriptions are not usually repeated in the species descriptions.

The index is useful for locating the articles on unfamiliar taxa or in discovering the current classification of a particular taxon. Every bacterial name mentioned in the *Manual* is listed in the index. In addition, an up-to-date outline of the taxonomic framework is provided in the introductory chapter “Road map of the phylum *Actinobacteria*”.

Errors, comments, and suggestions

As in previous volumes, the editors and authors earnestly solicit the assistance of all microbiologists in the correction of possible errors in *Bergey’s Manual of Systematic Bacteriology*. Comments on the presentation will also be welcomed as well as suggestions for future editions. Correspondence should be addressed to:

Editorial Office
 Bergey’s Manual Trust
 Department of Microbiology
 University of Georgia
 Athens, GA 30602-2605, USA
 Tel: +1-706-542-4219; fax +1-706-542-6599
 e-mail: bergeys@uga.edu