Karl Peter Hadeler and the rise of Mathematical Biology
By Odo Diekmann

1. Introduction

During the opening session of the 2018 ECMTB in Lisbon, I presented a Tribute to K.P. Hadeler to commemorate the life (1936-2017) and work of a pioneer who has been instrumental in placing Mathematical Biology on the map of science. This text is, in essence, a written version of the tribute (with minor updates and additions).

2. Journals

Visionary scientists often start a new journal in order to promote their dreams. The Bulletin of Mathematical Biology was created as early as 1939 by Nicolas Rashevsky (under the name Bulletin of Mathematical Biophysics). In 1967 Richard Bellman (best known for developing Dynamic Programming) started Mathematical Biosciences. The Journal of Mathematical Biology was founded in 1974 by H.J. Bremermann, F.A. Dodge and K.P. Hadeler with the credo "The creation of this journal is a vote of confidence in the future of mathematical biology". From 1976 on, K.P. Hadeler and S.A. Levin served as Managing Editors and they managed in such a way that the journal became the predominant medium for publication of papers introducing high level mathematical methodology to tackle biologically motivated problems. For many PhD students and postdocs in the last quarter of the previous century, the journal, together with the Springer Lecture Notes in Biomathematics, of which S.A. Levin was the Managing Editor, defined the landscape in which they had to find their way.

3. Oberwolfach Meetings

Every week of every year there is a math meeting at the Mathematisches Forschungsinstitut Oberwolfach (https://www.mfo.de/) in Germany's Black Forest. If a sub-field of mathematics has a certain prestige, there is, very

K.P. Hadeler at the Bauer-Jacobs-Kolloquium Erlangen, Oberwolfach, 1988.
Oberwolfach Photo Collection

likely, an Oberwolfach meeting devoted to the topic at (ir)regular intervals.

Under the title "Mathematische Modelle in der Biologie" meetings were held in the years listed below, with the listed persons as the organizers:

1971 W. Bühler, J. Gani

1975 K.P. Hadeler, W. Jäger, H. Werner

1978 K.P. Hadeler, W. Jäger, S.A. Levin

1981 K.P. Hadeler, W. Jäger

1984 K.P. Hadeler, W. Jäger

1987 K.P. Hadeler, W. Jäger

1990 W. Alt, K.P. Hadeler, U. an der Heiden

1993 K.P. Hadeler, P.K. Maini, L.A. Segel

1996 W. Alt, O. Diekmann

1999 O. Diekmann, K.P. Hadeler

2003 W. Alt, O. Diekmann, D.A. Rand

2009 E. DiBenedetto, B. Perthame, A. Stevens

The Mathematisches Forschungsinstitut Oberwolfach (MFO, Oberwolfach Research Institute for Mathematics, `https://www.mfo.de/`).

After a long gap, a meeting on "Differential equations arising from organizing principles in biology" took place in September 2018. It was organized by J.A. Carrillo, A. Lorz, A. Marciniak-Czochra and B. Perthame.

In 1989 K. Dietz, K.P. Hadeler and H.W. Hethcote organized a meeting on "Mathematical Models for Infectious Diseases" and in 1995 this was repeated, with H.R. Thieme replacing H.W. Hethcote. Then there was a name switch to "Design and analysis of infectious disease data" with at first N. Becker, K. Dietz and N. Keiding as organizers and later M. Eichner, M.E. Halloran and Ph. O'Neill, and meetings in 1999, 2004, 2009, 2013 and 2018.

The 1978 meeting was the first I attended and, without exaggeration, I can say that it opened my eyes. In a double way. First, I became aware of the richness of the subject (for instance, by a 16 mm movie that Günther Gerisch brought from Basel; in those days, it took some effort of the staff to make the projector work, but once that was accomplished, the miracle of Dicty's self-organization was shown in glorious black and white detail). Second, it proved that authors of papers did really exist and were human beings one could talk to (in Oberwolfach I met for the first time Simon Levin, Lee Segel, Hans Othmer, John Rinzel, Michael Mackey, Masayasu Mimura, Art Winfree, Don Ludwig and many others).

A practitioner of Mathematical Biology aims to act as a trait d'union between the two pillars "Mathematics" and "Biology" and hence risks to be pulled apart by opposing forces. To see how others deal with certain dilemmas helps to keep courage. The Oberwolfach meetings did help a lot in this respect, they showed paragons in action.

Specialization is as unavoidable in math bio as it is in other fields of science. But to get truly new ideas, one needs to look beyond one's 'comfort' zone. The Oberwolfach meetings offered a very comfortable and stimulating way to do exactly that. Moreover, they were instrumental in catalyzing contacts beyond geographical/continental borders. So I (and, I am sure, many others from my generation) am most grateful to Karl Hadeler and Willi Jäger for being for so many years the driving force of these Oberwolfach meetings!

4. ESMTB

In June 1988, KP (as Karl was often nicknamed) and Wolfgang Alt produced and distributed the first Biomathematics Newsletter in order to catalyze the formation of a European community of researchers active in this relatively new area. A little later, Enzo Capasso and Jacques Demongeot took the initiative for the First European Conference on Mathematics Applied to Biology and Medicine, which took place in l'Alpes d'Huez in 1991. During this meeting the ESMTB was formed. The first board consisted of Jim Murray (president), Vin-

cenzo Capasso, Jacques Demongeot, Karl Peter Hadeler and Willi Jäger. The list of presidents so far is:

1991-1993 James D. Murray

1994-1996 Karl Peter Hadeler

1997-1999 Jacques Demongeot

2000-2002 Vincenzo Capasso

2003-2005 Mats Gyllenberg

2006-2008 Wolfgang Alt

2009-2011 Carlos Braumann

2012-2014 Andrea Pugliese

2015-2017 Roeland Merks

2018-2020 Andrea de Gaetano

5. A first conclusion

A journal, series of meetings, a newsletter and a society, these formed the outfit of the scientific youngster 'Mathematical Biology'. And for sure KP Hadeler was among the designers, the trend setters, the shining examples, ...

6. Research

After doing a double 'master' in biology and mathematics, KP followed his heart and chose to do a PhD in mathematics under Lothar Collatz (yes, indeed, the one of the conjecture, see `https://en.wikipedia.org/wiki/Collatz_conjecture`). His first two papers, in 1964, were written in Russian (!) which he learned while staying a year in Moscow, and the next twenty or so in German. They were devoted to Operator Theory, Spectral Theory, Linear Algebra and Numerical Analysis. See [5] for a recent account of how some of this work relates to population dynamical models.

KP was an omnivore with very broad interests (let me mention, incidentally, that KP had an encyclopedic knowledge based on an exceptional memory; he had a staggering knowledge of languages, history, geography, field biology and many other subjects). Much of his subsequent work deals, in some way, with Dynamical Systems Arising in Biology. A noncomplete list of bio topics: population genetics, spatial ecology, lateral inhibition, eco-epi

interaction, demo-epi interaction, vaccination, core group, vector transmitted, animal orientation, mimicry, plasmids, cardiovascular function, proteasomal cleavage, quiescence. A noncomplete list of math topics: travelling fronts, (neutral) delay equations, backward bifurcation, cross diffusion, parameter identification. A bit more physical: nonlinear Schrödinger, cellular automata (his book [4] with Johannes Müller appeared in 2017), granular matter. For sure KP was a multi-methodologist (by which I mean the mathematical version of what in music is called a multi-instrumentalist). Major topics:

– macroparasite load as a structuring variable (with Klaus Dietz, see [1] for a survey)

– hyperbolic submodels for movement (correlated random walks, reaction-telegraph/transport equations, see [3])

– pair formation in STD context; homogeneous differential equations (see [5])

– the impact of quiescence (diapause, temporary change of either behaviour, physiology or habitat, see [3])

7. Teaching

In 1971 the Universität Tübingen appointed KP Hadeler at the Lehrstuhl für Biomathematik in the Biology Department and in 1973 this appointment was extended to the Mathematics Department, making him a trait d'union in a very literal sense. (With the earlier noted side effect of being subject to opposing forces.) In 1974 Hadeler's text book Mathematik für Biologen was published as one of the Heidelberger Taschenbücher by Springer.

In the 1979 CIME Summerschool 'Mathematics of Biology' in Cortona, organized by Mimmo Iannelli, Hadeler lectured about 'Diffusion Equations in Biology' (the other lecturers were K.L. Cooke, J.M. Cushing, S. Hastings, F.C. Hoppensteadt and S-O Londen, so various forms of delay equations received ample attention). Many years later, in 1997, and in a different part of Italy (Martina

Franca in Puglia) Hadeler lectured about 'Reaction Transport Systems in Biological Modelling' during the CIME school 'Mathematics Inspired by Biology' organized by V. Capasso and myself (the other lecturers were R. Durrett, P.K. Maini, H.L. Smith and myself). Somewhere in between there has been a DMV (Deutsche Mathematiker-Vereinigung) Seminar in the small town Blaubeuren near Ulm with lectures on mathematical methods for the study of biological systems by KP Hadeler, Horst Thieme and myself. And there must have been many more such schools in which Hadeler gave a series of lectures...

Remarkably, after his Tübingen retirement KP Hadeler rejuvenated and moved part-time to the new world for a second youth as Research Professor at Arizona State University in Phoenix during the period 2005-2011. The material of many of his lectures (at both the School of Life Sciences and the School of Mathematical and Statistical Sciences) is collected in his book [3] 'Topics in Mathematical Biology' that appeared in 2017 in the Springer Series 'Lecture Notes on Mathematical Modelling in the Life Sciences'. During his time at ASU, Hadeler very actively assisted Carlos Castillo-Chavez in the sympathetic endeavour of providing research opportunities for underrepresented groups.

My impression is that KP Hadeler was a warm mentor for his many students, often like a father figure (thus, perhaps, promoting the puberal urge for independence and freedom in some?). He had more than 30 students and of these, Mirjam Kretzschmar, Johannes Müller, Thomas Hillen, Christina Kuttler and Frithjof Lutscher are presently most active in math bio research.

8. Conclusion

While once a naturalist observed and classified, the present day naturalist urges the government to protect an endangered species. Likewise a theoretical biologist once aspired to uncover the mechanisms underlying a certain phenomenon, while the present day theoretical biologist ad-

vises the government about Covid-19 control. The world has changed. But we build on what has been achieved by the predecessors.

KP Hadeler has been instrumental in building up Mathematical Biology

– both organizationally and regarding content
– especially in Europe
– especially at the math side
– notably by pointing the way to young talent

He was a very versatile researcher, a prolific writer and a master in inventing clever tricks that made hopeless looking problems suddenly amenable to analysis. His stimulating influence and his charming personality are sorely missed by his many old friends. Hopefully this short note informs the younger among us about the pioneer that helped shape the world in which they now live, work and move on.

PS

– Please also see the special issue [2].
– It is a pleasure to thank Enzo Capasso for helping out with ESMTB history reconstruction, Klaus Dietz for providing information about the later Oberwolfach meetings on infectious disease epidemiology and Susanne Ditlevsen for editorial and text editing help!

References

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