Hubertus P. Bell, Tim Feuerstein, Carlos E. Güntner, Sören Hölsken, J. Klaas Lohmann



What's Cooking in Chemistry?

How Leading Chemists Succeed in the Kitchen

WILEY-VCH

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WILEY-VCH Verlag GmbH & Co. KGaA

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Library of Congress Card No.:

applied for

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

Bibliographic information published by the Deutsche Nationalbibliothek

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <u>http://dnb.d-nb.de</u>.

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ISBN978-3-527-32621-1

Druck und Bindung: Ebner & Spiegel GmbH, Ulm **Cover:** Himmelfarb, Eppelheim, <u>www.himmelfarb.de</u> *Dedicated to our mentor Lutz Friedjan Tietze on the occasion of his 60th birthday*

Editorial

The passion for chemistry often goes together with a passion for good cuisine. Having this experience in mind, which resulted from the old tradition in our research group that everyone has to prepare an assortment of cakes for the others on the occasion of his birthday, we had the idea for this cookbook.

After inviting a number of well-known chemists from all around the world to participate in our project, we received the answers of some 60 professors who were inspired to send us a recipe, often together with some personal remarks about why they chose this particular one.

We are very grateful for their contributions that cover such different dishes as soups, meat, fish, sweet dishes, and even a punch. They are presented in this book together with short biographical and scientific sketches that might be interesting to read during the possible waiting times in the kitchen. Furthermore, we are indebted to M. Wöhr-mann, who supported us in the beginning of this project, and to S. Stewart, who helped us while struggling for the right words. To A. Kühn and S. Schliebitz we owe the careful proofreading of the manuscript and to S. Hellkamp the software support. Finally, we thank G. Walter (Wiley-VCH) for the fruitful cooperation.

We wish you a lot of pleasure with this book, citing Georg C. Lichtenberg (1742–1799), professor of physics at Göttingen University: "Wer nichts als Chemie versteht, versteht auch die nicht recht." ("He who knows nothing but chemistry does not know chemistry either").

Göttingen 2003

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Sören Hölsken

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Martin Banwell



was born on November 24, 1954, in Lower Hutt, New Zealand. He studied chemistry at the Victoria University of Wellington, where he received his B.Sc. Hons. (1st class) in 1977 and his Ph.D. in Organic Chemistry under the guidance of B. Halton in 1979. After a postdoctoral year with L. A. Paquette at the Ohio State University, Columbus, he returned to the University of Adelaide, South Australia, as a Senior Teaching Fellow at the Department of Organic Chemistry.

From 1993 to 1994 he was Associate Professor and Reader at the University of Melbourne. Since 1999 he has been Professor at the Australian National University in Canberra.

Among his fellowships and awards are the Rennie Medal of the Royal Australian Chemical Institute (1986), the Grimwade Prize in Industrial Chemistry (1992), and the Humboldt Research Award of the Alexander von Humboldt Foundation (2000). He was elected Fellow of the Royal Australian Chemical Institute in 1992, a Fellow of the Japan Society for the Promotion of Science in 1999, and an Honorary Fellow of the Royal Society of New Zealand in 2000. Moreover, he is a member of the Honorary Advisory Board of *Synlett* (since 1997), the International Advisory Editorial Board of the *New Journal of Chemistry* (since 1997), the Editorial Board of the Indian Journal of Chemistry, Section B (since 1999), and an Associate Editor of the Journal of the Chemical Society, Perkin Transaction I (since 1999) and of Methods in Organic Synthesis (since 1999).

He is author of approximately 150 papers in refereed journals; five patents have been issued to him.

Scientific Sketch

The research activities of Banwell's group are focused on developing new and efficient methodologies for the synthesis of target molecules ranging from biologically active natural products to compounds having unusual be exploited that could architectures for molecular recognition or materials science purposes. Natural products that have been targeted for synthesis include various antimitotic agents such as paclitaxel (Taxol[™]) (J. Chem. Soc., Chem. Commun. 1995, 1395) and lamellarin K (Fig. 1), an alkaloid isolated from a Pacific ascidian collected at the northeastern coast of Australia (I. Chem. Soc., Chem. Commun. 1997 ,2259).

<u>Figure 1</u>. Lamellarin K (1).



The former compound is used clinically for the treatment of ovarian and breast cancers, while the latter shows great potential for combating multidrug-resistant cancers. The group's recently completed and highly convergent synthesis of compound $\mathbf{1}$ is now being adapted to the solid-phase to allow the generation of analogue libraries. Such libraries will

be used to probe the structure/activity profile of this class of natural products and to construct novel hybrids with the colchicinoid class of anti-mitotic agents. In collaboration with Australian companies, Banwell is also engaged in developing concise syntheses of the polyketide herbicide herboxidiene (*Pure Appl. Chem.* **2000,** 72, 1631) and various analogues of the anti-influenza drug GG-167.

A second research focus involves compounds of the general structure shown in Fig. 2 which are obtained in multi-gram quantities and enantiomeric excesses of more than 99.8% by microbial oxidation of the corresponding aromatic.

Figure 2. *cis*-Dihydrocatechols **2** obtained by microbial oxidation.



cis-1,2-dihyrocatechols These embody unusual combinations of functionalities, and they are used as starting materials for the synthesis of a wide range of compounds including (+)- and (-)-steroids, (+)- and (-)taxoids, pyrethroids, carbohydrates (e.g., vitamin C), and triguinoid natural products (J. Chem. Soc., Perkin Trans. 1 2002, 2439). Another broad area of activity is concerned with exploiting ring-fused gem-dihalogenocyclopropanes in chemical syntheses. These compounds, which are readily obtained via di-halocarbene addition to the corresponding cyclo-alkene, serve as a useful starting material for the synthesis of various natural products (J. Org. Chem. 2000, 65, 4241). In addition, Banwell and coworkers have recently discovered that such compounds underao а novel dimerization reaction, which allows the construction of molecular clefts possessing convergent functional groups. Certain of these clefts have shown an ability to "recognize"

carbohydrates and are now "tuned" to optimize this recognition process. The longer term objective is to develop systems that might be used for diagnostic/analytical purposes. Furthermore, these clefts may serve as catalysts for various cycloaddition reactions.

Marinade for BBQ Kangaroo

Starting materials (serves 4):

2 tbsp soy sauce

1 tbsp "Blue Gum" honey (almost any honey will suffice)

1 tbsp light virgin olive oil

1 tbsp tomato sauce

1 piece (ca. 10 g) peeled root ginger

2 cloves garlic

500 g kangaroo loin (or fillet of beef)

Add the soy sauce, honey, oil, tomato sauce, and diced ginger to a generous-sized plastic container, then squeeze in the juice from the garlic cloves. "Striploin" fillet of kangaroo cut into small to medium portions is then added to the marinade and the mixture is stirred thoroughly so as to ensure that the entire surface of the meat is covered. Seal the container and store in the refrigerator for approximately 7–10 hours with occasional shaking.

The meat is removed from the marinade and immediately cooked on a BBQ (or in a fry pan) with a hot flame until (in the case of kangaroo, at least) rare to medium rare. The residual marinade can be used to baste the meat while it is cooking.

Serve the meat with a fresh green salad, corn on the cob, and a red wine (a McLaren Vale Shiraz from South Australia is especially appropriate).

«Kangaroo is a very lean, popular, and readily available meat in Australia. The marinade can also

be used with beef. Using eucalyptus (gum tree) leaves and twigs as part of the BBQ fuel imparts an additional quality to the meat that many people enjoy.»

Martin Banwell

Robert G. Bergman



was born in Chicago on May 23, 1942. After completing his undergraduate studies in chemistry at Carleton College in 1963, he received his Ph.D. at the University of Wisconsin in 1966 under the direction of J. A. Berson. While at Wisconsin he was awarded a National Institutes of Health (NIH) Predoctoral Fellowship. Bergman spent 1966 and 1967 as a NATO Fellow in R. Breslow's laboratories at Columbia, and following that went to the California Institute of Technology as a Noves Research Instructor. He was promoted to assistant professor in 1969, associate professor in 1971, and full professor in 1973. He accepted an appointment as Professor of Chemistry at the University of California, Berkeley, in 1977, where he was appointed Gerald E. K. Branch Distinguished Professor in 2002. During his long scientific career, Bergman has received many awards and honors, which include the ACS Award in Organometallic Chemistry (1986), the Arthur C. Cope Scholar Award (1987), the E. F. Smith Award (1990), the I. Remsen Award (1990), a MERIT Award from the NIH (1991), the E. O. Lawrence Award in Chemistry from the U.S. Department of Energy (1994), the ACS Arthur C. Cope Award (1996), a Guggenheim

Fellowship (1999), the American Institute of Chemists Chemical Pioneer Award (1999), the E. Leete Award for Teaching and Research in Organic Chemistry (2001), and a number of visiting professorships. He will soon receive the 2003 ACS James Flack Norris Award in Physical Organic Chemistry. Bergman is a member of the National Academy of Sciences (since 1984) and the American Academy of Arts and Sciences (since 1984) and the American Academy of Arts and Sciences (since 1984) and has served on many academic and administrative committees and review boards. He has been or is currently a member of the Editorial Advisory Boards of several scientific journals (*e.g., Journal of Organic Chemistry, Organometallics, Chemical Reviews, International Journal of Chemical Kinetics, Synlett,* and *Organic Letters*).

Scientific Sketch

Research in the Bergman group centers on organic and organometallic reactions that take place in homogeneous solution. Bergman's early work in physical organic chemistry led to the discovery of the so-called "Bergman cyclization." In this process, cis-enediynes cyclize when heated to generate 1,4-benzenoid diradicals (Fig. 1), which then abstract hydrogen or halogen atoms to give stable aromatic products (Acc. Chem. Res. **1973**, **6**,25).

Figure I. Thermal cyclization/aromatization of cis-hex-3ene-1,5-diyne.

In his more recent studies, Bergman has focused on organometallic chemistry and homogeneous catalysis. Bergman's primary goals are to develop new stoichiometric and catalytic processes and to gain fundamental understanding of their mechanisms. One major effort is directed toward carbon-hydrogen (C-H) bond activation reactions. This involves the development and study of metal complexes that undergo intermolecular oxidative addition with the normally inert C-H bonds in alkanes and other organic molecules.

Figure 2. Ring-closure reactions catalyzed by Rh(I) that employ a C-H-activation step.



This process holds potential for converting methane and other hydrocarbons into useful functionalized organic molecules. Recent efforts have yielded directed catalytic C-H activation reactions that lead to efficient cyclization of a variety of organic substrates (Fig. 2, J. Am. Chem. Soc. **2001**, *123*, 2685).

A second major area of investigation involves the study of the mechanisms of metal-mediated atom- and grouptransfer processes using organometallic complexes having metal-oxygen, -nitrogen, and -sulfur bonds. Recent efforts in this area have yielded early transition metal imido (M=NR) complexes that undergo highly enantioselective cycloaddition reactions between metal-nitrogen multiple bonds and substituted allenes, (Fig. 3, Angew. Chem. Int. Ed. **2000,** 39, 2339) and the discovery of complexes with exceptionally basic nitrogen ligands.

Figure 3. The use of enantioresolved imido complexes in the kinetic resolution of chiral allenes.



These reactions are being applied to the development of efficient catalytic carbon-nitrogen bond-forming processes such as carbon-carbon multiple bond hydroamination reactions. Other projects in the group are directed at the design and synthesis of novel ligands for transition metal centers, and heterobinuclear complexes, that should provide entries to new and more selective catalytic transformations. Density functional theory is being used to supplement understanding obtained from mechanistic experiments and to help determine the direction of new experimental work.

Potato Latkes (Potato Pancakes): A Traditional Jewish Chanukah Dish

Starting materials:

- 6 large potatoes
- 1 small onion
- 2 eggs
- 3 tbsp flour
- ¹/₄ tsp pepper
- 1 tsp salt
- 1 tsp baking soda

Peel the potatoes and store them in a bowl of cold water to keep them from oxidizing. Grate the potatoes and onion as

quickly as possible. Separate the liquid. Add the other ingredients and mix well. The consistency should be somewhat thick; add more flour if it seems too runny. Pour 60 mL oil into heated frying pan. When the oil bubbles, spoon pancake-sized portions onto a hot, pre-greased skillet. Turn when golden brown. Be sure to add fresh oil as needed so the potatoes do not burn. When both sides are golden brown, remove the latkes with a slotted spatula so that the oil will drain off, and layer on a plate between paper towels, which will absorb more oil. Continue until all of the potato batter is used. Serve hot with applesauce or sour cream.

«In the second century B.C., the inhabitants of Judea joined a rebellion against the kingdom of Antiochus IV under the leadership of a country priest named Mattathais and his five sons (of whom ludah became the most famous. known as "the hammer" or Maccabee). The Maccabees and their followers used guerrilla tactics to win the first national liberation struggle in recorded history. In 165 B.C. they retook Jerusalem, purified and rededicated the Temple, which had been vandalized and desecrated, and rekindled the eternal light, which is always to be kept burning. They had only a small amount of oil, but the holiday of Chanukah (which means "dedication") was established to commemorate the legend that this small amount of oil kept the eternal light burning for eight days.

Potato latkes (potato pancakes) are a dish that Jews traditionally serve during the Chanukah holiday. It is certainly not clear that potatoes were available in ancient times, so the dish was probably developed in eastern Europe. The latkes are cooked in oil, another means of commemorating the eternal light legend.»

Robert G. Bergman

Dale L. Boger



was born on August 22, 1953 in Hutchinson, Kansas. He received his B.Sc. in chemistry from the University of Kansas, Lawrence, Kansas (1975, with highest distinction and honors in chemistry), and his Ph.D. in chemistry from Harvard University (1980) under the direction of E. J. Corey. He returned to the University of Kansas as a member of the faculty in the Department of Medicinal Chemistry (1979-1985), moved to the Department of Chemistry at Purdue University (1985–1991), and joined the faculty in the newly created Department of Chemistry at The Scripps Research Institute (1991-present) as the Richard and Alice Cramer Professor of Chemistry. Among Dale Boger's numerous awards and honors are the ACS Arthur C. Cope Scholar Award (1988), the American Cyanamide Academic Award (1989), the ISCH Katritzky Award in Heterocyclic Chemistry (1997), the Aldrich ACS Award for Creativity in Organic Synthesis (1999), the A. R. Day Award (2000), and the Paul Janssen Award for Creativity in Organic Synthesis (2002). Since 1990 he has been editor of *Bioorganic and Medicinal* Chemistry Letters and a member of the advisory board of the Journal of Organic Chemistry.

Scientific Sketch

The research interests of Boger's group include the total synthesis of biologically active natural products, the development of new synthetic methods, heterocyclic chemistry, bioorganic and medicinal chemistry, combinatorial chemistry, the study of DNA-agent interactions, and the chemistry of antitumor antibiotics. Boger places a special emphasis on investigations to define the structure-function relationships of natural or designed agents in an effort to understand the origin of their biological properties.

As new synthetic methodologies, the Boger group has developed acyl radical reactions, which are useful tools in natural product total synthesis. Selenyl ketones are used as precursors of acyl radicals. The radical, which is formed after reaction with the double/triple-bond, can be saturated with Bu₃SnH (Fig. 1, *J. Am. Chem. Soc.* 1990, *112*, 4003).

Figure 1. Cyclization of acyl radicals.



The enantiomer of roseophilin, an antitumor antibiotic, was synthesized in Boger's group recently. It possesses a topologically unique pentacyclic skeleton, and its complex structure is a challenge for an organic chemist. The key steps are a heterocyclic azadiene *Diels-Alder* reaction, a ring-closing metathesis, and a stereoselective acyl radical cyclization. (Fig. 2, J. Am. Chem. Soc. 2001, 123, 8515).

Figure 2. Total synthesis of ent-(-)-roseophilin.



Another important research topic is the biology and chemistry of CC-1065 and the duocar-mycins and their derivatives. These natural products bind in the minor groove of the double helix and alkylate DNA bases irreversibly according to the mechanism displayed in Fig. 3.

Figure 3. Mechanism for the alkylation of DNA bases by duocarmycin SA.



Cannole Shells

Starting materials (makes 25):

450 mL unsifted, regular all-purpose flour

 $\frac{1}{2}$ tsp salt

- 2 tbsp granulated sugar
- 1 egg, slightly beaten
- 2 tbsp firm butter, cut into small pieces

about 60 mL dry Sauterne 1 egg white, slightly beaten shortening or salad oil for deep-frying ricotta filling (see below) powered sugar chopped sweet chocolate

<u>Ricotta filling</u>:

1 kg (1 L) ricotta cheese 375 mL powdered sugar 4 tsp vanilla 60 mL sweet chocolate

Fluffy ricotta filling:

500 g (500 mL) ricotta cheese

200 g powdered sugar

2 tsp vanilla

30 mL sweet chocolate

250 mL heavy cream

Sift flour with salt and granulated sugar. Make a well in the center; in it, place the egg and butter. Stir with a fork, working from the center out, to moisten the flour mixture. Add the wine, one tablespoon at a time, until the dough begins to cling together. Use your hands to form the dough into a ball. Cover it and let it stand for 15 minutes.

Roll dough out on a floured board about 2 mm thick, cut into three 1.3-cm circles. With a rolling pin, roll the circle into ovals. Wrap them around hollow metal cannoli forms and seal the edge with egg white. Turn out the ends of the dough and flare them slightly. Fry two or three at a time in deep hot fat (180 °C) for about 1 minute or until lightly golden. Remove them with tongs to a paper towel to drain; let them cool about 5 seconds, then slip them out of the cannoli form, holding the shell carefully. Cool the shells