

HUBERT SIMON (JIM) MARKL

17 August 1938 — 8 January 2015



Timothy Chiswick

HUBERT SIMON (JIM) MARKL

17 August 1938 — 8 January 2015

Elected ForMemRS 2002

BY AXEL MEYER^{1,*} AND JÜRGEN MITTELSTRAß²

¹*Department of Zoology, University of Konstanz, 78457 Konstanz, Germany*

²*Department of Philosophy, University of Konstanz, 78457 Konstanz, Germany*

Hubert (Jim) Markl was a zoologist and animal behavioural physiologist; but, beyond that, he was arguably the most influential figure in European science policy and the key person influencing the relationship between science and society in Germany. He uniquely served as president of both the Deutsche Forschungsgemeinschaft (German Science Foundation) and the Max Planck Gesellschaft. In these roles he was an outstanding and bold advocate for scientific research in Germany and throughout Europe, and his astute judgement, cogency and intellectual rigour commanded the respect of all his peers. His occupancy of the two most senior positions in German science policy followed from his earlier substantial scientific contributions to the emerging discipline of behavioural ecology, as well as his books on science, society and culture. Markl was a leading spokesperson in Germany on contested issues at the interface between science and society; for example, he was an eloquent advocate of stem cell research, speaking out against the political mainstream. He also strove to expose fully, and acknowledge, the Max Planck Society's responsibility for atrocities committed by the Kaiser Wilhelm Gesellschaft scientists during the Nazi era; Markl will be remembered as the president who oversaw a historical analysis of the involvement of the Kaiser Wilhelm Gesellschaft (the scientific society that legally preceded the Max Planck Gesellschaft), and in 2001 he apologized in the name of the Max Planck Society for the expulsion and deaths of Jewish scientists.

* Axel.Meyer@uni-konstanz.de

EARLY LIFE, 1938–1974

Markl was born on 17 August 1938 in the Bavarian city of Regensburg, where he attended the Albertus Magnus Gymnasium. As Bert Hölldobler, his life-long friend, reported in his obituary (Hölldobler 2015), Hubert Markl's friends at school called him Jim, and he was called this name by his friends ever after.

Markl's childhood years were not easy. His mother had to care for his father, who suffered from multiple sclerosis and disabilities from war injuries, while earning the family's living by working as a secretary. Markl's disdain for pseudoscience might be rooted in the early observation that his mother spent money on homeopathy in a desperate attempt to improve her sick husband's health. The young son and his sister helped their mother to the best of their abilities. An uncle, who substituted for his father, communicated to him the love of nature. According to Hölldobler (2015) Markl later wrote:

Him, more than anybody else, I have to thank for learning how to sit quietly in nature for hours, to wait, to watch, paying attention to everything. He was a passionate angler, and I was allowed to join him. If one has not learned to curb his liveliness outdoors and concentrate attentively one will never succeed in becoming a natural scientist. . . . In any event, I am sure that I would never have become a natural scientist, if this uncle had not taught me through fishing how much one can learn and experience, and how much success patience can bring.

The foundation for his future career as a natural scientist was laid—although perhaps not to the great pleasure of his mother since the young Markl collected snails, which had to be prepared at home.

Markl was a brilliant student and received a special fellowship from the State of Bavaria that enabled him to study biology, chemistry and geography at the Ludwig Maximilians University of Munich. It was while working there as a teaching assistant for laboratory courses that he met his wife, Eva-Maria, called Evi, who also studied biology and chemistry. They got married in 1963, and in 1971 their son Gregor was born, who has become an internationally known mineralogist and has been a professor at the University of Tübingen since 1999.

Among Markl's academic teachers were Karl von Frisch ForMemRS, Hansjochem Autrum, Konrad Lorenz, Erich von Holst, Feodor Lynen (ForMemRS 1975) and Martin Lindauer, who also served as his thesis advisor (ForMemRS 1964). When he received his doctoral degree (Dr. rer. nat.) with summa cum laude, Markl was only 24 years old. Soon afterwards (1963) Lindauer accepted an offer as full professor and director of the Zoological Institute of the Johann von Goethe University in Frankfurt, and he invited Markl to move with him to Frankfurt to become his scientific assistant (assistant professor). Markl received his 'habilitation' in zoology in 1967 from Frankfurt University.

His time in Frankfurt was interrupted by a year (1965/66) as a research fellow at Harvard University and Rockefeller University, where Donald Griffin was his host and made it possible for him to work at a tropical research station in Trinidad. During his time in the United States his American colleagues were so impressed by his presentations and brilliant discussions that he received offers for tenure track positions from both Cornell University and the University of California at Berkeley. Instead, he decided to stay in Germany and in 1968 he accepted a full professorship at the Technical University of Darmstadt, where he stayed for six years. Then in 1974 he moved on for a position as professor of zoology and animal physiology to the University of Konstanz, and—although he had attractive offers from other institutions,

including from his alma mater (the Ludwig Maximilians University in Munich) to succeed Hansjochem Autrum in the chair formerly held by Karl von Frisch—he decided to stay in Konstanz for the rest of his career. In 1997, one of us (Axel Meyer) succeeded Markl in his chair of zoology at the university.

Markl played an important role in the early history of the University of Konstanz, which had been founded just eight years before he moved there. But, similarly to other leading professors in Konstanz, he felt that his energy and influence were better used outside this small but highly regarded university in Germany's southwest, and so he became one of the crucial players on the national and the international stage.

FOUNDATIONS OF BEHAVIOURAL SENSORY ECOLOGY

Markl was an outstanding scientist. His meticulous morphological study of hair plate sensilla which function as proprioceptors in ants, bees and wasps, and the experimental demonstration of the significance of these trichoid sensilla for orientation with respect to gravity, still belong to the very best studies in insect sensory biology (1)*. Equally impressive was his detailed analysis of the peripheral nervous and muscular systems in the thorax of *Apis mellifera*, *Formica polyctena* and *Vespa vulgaris* (2); and the detailed analyses of vibrational cues and signals in animal orientation and communication are still scientific masterpieces (3). Although it has been recognized for more than 100 years that ants of the subfamily Ponerinae, Myrmicinae and Myrmeciinae can produce stridulous sounds by moving the sharp posterior rim of the third abdominal tergite over a fine-ribbed area on the front of the fourth abdominal tergite, not much was known about the physical quality of the sound that is produced nor the biological function. In a series of excellent experimental analyses, Markl brilliantly demonstrated that leaf cutting ant workers of the genus *Atta* stridulate whenever they are prevented from moving freely, that nest mates do not perceive the airborne stridulation sounds but instead are extremely sensitive to ground-conducted stridulation vibrations, and that in appropriate contexts these vibrations function as alarm signals (4). The analyses of the biomechanics of the production and the physical characterization of the stridulation signals combined with the determination of the sensitivity of signal reception in leaf cutting ants are truly milestones in the exploration of insect communication. Later, together with several students and postdocs, Markl investigated a broad spectrum of questions concerning production, reception and function of vibrational cues and signals in a variety of invertebrates (9), and even some vertebrates, such as communication in the electric fish piranha (5) and social systems in mice (11).

Although most of Markl's scientific work belongs to the domain of sensory and behavioural physiology, his true love was empirical sociobiology and behavioural ecology; his chapter on 'Manipulation, modulation, information, cognition: some of the riddles of communication' published in 1985 in a book dedicated in memoriam to Karl von Frisch is one of the most insightful and inspiring papers on animal communication (10). Today, more than 30 years later, with a long-term perspective on science in a time when often 'the wheel seems to rediscovered' again and again, it is worthwhile to re-read this stimulating chapter—Bert Hölldobler wrote in Markl's obituary (Hölldobler 2015) that its author was the first who clearly

* Numbers in this form refer to the bibliography at the end of the text.

conceived the concept of modulatory signals in animal communication. Markl and his students presented the first evidence in support of this concept, and the animal behaviour community greatly benefitted from that insight because it led to a better understanding of the function of multimodal signals in ant communication, which Hölldobler himself began to investigate in the early 1970s; Hölldobler collaborated with Markl to investigate the role of vibrational signals in *Novomessor* and *Pogonomyrmex* harvester ants during foraging and mating (6, 7, 8).

BEHAVIOURAL ECOLOGY AND SOCIOBIOLOGY 1976–1988

Markl and Hölldobler knew each other for 50 years and soon after their first meeting, at a scientific conference in Graz (Austria), became life-long friends. Both were ‘scientific assistants’ in the Department of Zoology chaired by Martin Lindauer at the University of Frankfurt and shared many mutual scientific interests, and their close friendship continued after their academic paths parted. Even after Hölldobler emigrated to the United States to accept a professorship at Harvard University they stayed in close academic and personal contact. It was in 1975 that Markl first joined him for ants fieldwork in Arizona, and Markl returned to Arizona to study ants into the 1980s (figure 1).

Hölldobler (2015) writes:

It was in July or August 1975, when Jim joined me for field work in Arizona. We were sitting on the porch of our cottage in Cave Creek Ranch in Portal and discussing the need for a new journal that covered the rapidly growing fields of Behavioral Ecology and Sociobiology. We tossed around several tentative titles for such a new journal, and finally decided for the double name [*Behavioral Ecology and Sociobiology*], the acronym of which is BES. We already had explored whether Springer Verlag would be interested to be the publisher of such a new journal and indeed the response was very encouraging. Markl agreed to serve as managing editor, John Crook, Hans Kummer, Edward O. Wilson and myself functioned as co-editors. Karl von Frisch [v. Frisch 1976] wrote a gracious foreword for the first issue of BES published in 1976, in which he states: “We do not have to worry about the future of the new child . . . , the editorial responsibility lies in the best hands.” Indeed, it is almost entirely due to Jim’s vision and tremendous efforts that this journal became one of the leading journals in behavioral biology. He served as managing editor from 1976 to 1988.

SCIENCE MANAGEMENT 1977–2015

Early, maybe too early, this highly original and enormously gifted scientist decided to give up experimental science and began to focus his energies on his other superb talent: science management and science politics. All of science in Europe, maybe the world, but particularly science in Germany benefitted tremendously from this decision. Markl was one of the most significant and effective science organizers in Germany, and his impact on science politics was recognized and admired worldwide. First, he was a member of the senate of the German Science Foundation (Deutsche Forschungsgemeinschaft, DFG). Then he became vice president of the DFG in 1977, at the age of 39, and from 1986 to 1991 he served as its president and simultaneously as vice president of the Alexander von Humboldt Foundation. In 1993, shortly after Germany’s reunification, he became the founding president (until 1995) of the Berlin-Brandenburg Academy of Sciences and Humanities. Also, from 1993 to 1994 he was the chair of the Gesellschaft Deutscher Naturforscher und Ärzte. Nobody else has ever



Figure 1. Hubert Markl during fieldwork in Arizona with Thomas Eisner (ForMemRS 1997) (photograph kindly provided by Bert Hölldobler). (Online version in colour.)

held so many crucial positions in Germany's science realm, and, importantly, he played these key roles soon after the reunification of the two Germanys in 1989.

PRESIDENT OF THE MAX PLANCK SOCIETY 1996–2002

In 1995 Markl was offered the position of *Rektor* (president) of the University of Konstanz, but decided to decline the offer in order to become the president of the Max Planck Society (1996–2002) instead. Markl, a charismatic, albeit formal, and demanding university teacher, cared deeply for his students, and his concern for the next generations of scientists was also crucial for his agenda as president of the Society. He urged his Society colleagues to get involved in undergraduate teaching at neighbouring universities and he founded the programme of the Max Planck Society called the International Max Planck Research School (IMPRS) as a mechanism to link German universities that can grant degrees with the much better funded Max Planck Society, which, like other extra-university research institutions, cannot confer academic degrees. The IMPRS programme also aims to attract international scientific talent to Germany as PhD students.

With almost 20 000 employees and an annual budget in the neighbourhood of two billion euros, the Max Planck Society is the most important extra-university research institution in the basic sciences in Germany. Markl was the only president of the Max Planck Society ever recruited from outside its ranks—which made his job more difficult. At the Society he initiated many innovations and new institutes, especially in the former East Germany. In a statement published by the Max Planck Society, Markl is characterized ‘as a man who never

took the easy way out, who made his feelings known with wit and eloquence' (Hölldobler 2015). He took the helm of the Max Planck Society six years after German reunification. In order to invest in and establish new research institutions in the former East Germany, funds for existing Max Planck institutes in the West had to be cut—during his presidency, the Society closed several institutes in Germany, such as the Max Planck Institute for Biology in Tübingen, and he even attempted to close the Max Planck Institute for Animal Behavioral Physiology in Seewiesen, where Konrad Lorenz worked, but a special deal that this institute had with the State of Bavaria prevented this bold move from going ahead. This, his personal line of research, was only revived in 2020 in the form of the Max Planck Institute for Animal Behavior in Konstanz, and the former Max Planck Institute in Seewiesen became the Max Planck Institute for Ornithology, which grew out of the *Vogelwarte* (ringing station) Radolfzell—it is quite unusual for a rather mundane institute for bird ringing to transform into a Max Planck Institute. The Max Planck Society recalls: 'In a tremendous act of will, the new President reduced or closed departments and institutes, but he was able to set new courses in research with the appointment of 153 Directors' (Hölldobler 2015); 153 new directors out of 266 in total is very large percentage. Markl's successor as president of the Max Planck Society, Peter Gruss, characterized Markl's forceful moves 'as an impressive push towards rejuvenation for the Max Planck Society' (Hölldobler 2015).

At the Max Planck Society, Markl will probably be most remembered as the president who oversaw a historical analysis of the involvement of the Kaiser Wilhelm Society (KWS; Kaiser Wilhelm Gesellschaft, the scientific society that legally preceded the Max Planck Gesellschaft from 1911 to 1946) in Nazi Germany. When Markl took the helm of the Society he realized that this distinguished organization had not come to terms with its past. In 1999 he appointed an independent presidential committee of historians to investigate the involvement of the KWS in medical experiments undertaken in Nazi concentration camps. Midway through this investigation, it was shockingly obvious that some scientists of the KWS were involved in the expulsion of Jewish colleagues, and the historians had produced hard evidence that, as Markl expressed it, 'proves beyond the shadow of a doubt that directors and employees at the KWS co-masterminded and sometimes even actively participated in the crimes of the Nazi regime' (Hölldobler 2015). In 2001, on behalf of the Max Planck Society, Markl asked for forgiveness from the victims and for the expulsion and deaths of Jewish scientists and 'a lack of willingness on the part of (some) inside and outside the Max Planck Society to face up to their historical responsibility' (Hölldobler 2015).

THE PUBLIC INTELLECTUAL: THE CITIZEN ('BÜRGER') AND THE BIOLOGIST

Markl was much more than a zoologist—he was a free-thinking, liberal and, at times, belligerent spirit, a superbly eloquent speaker and a writer who wanted to know everything, and seemed to strive towards the ideal of a Humboldtian '*Universalgelehrter*'. He truly was a Renaissance man who masterfully bridged the two cultures in academia and society and had deep knowledge of history, of philosophy and of the humanities more broadly. Unlike the UK, Germany does not have a strong tradition of public outreach by scientists. Markl was a notable exception; there was no topic on which it was too controversial for him to express his view in his famously eloquent speeches or sharply argued essays published in leading newspapers, scientific journals or books. Given the high political level Markl worked at, it was even more



Figure 2. German President Johannes Rau (left) with Hubert Markl in 2001 in Berlin (© the Max Planck Society).

admirable how unwavering was his conscience and his bravery to speak out with politically unpopular opinions.

In the now famous ‘Bürger Markl speech’ (figure 2) at the 2001 annual meeting of the Max Planck Society in Berlin, Markl addressed the German president not as president but as ‘Bürger Rau’, telling him ‘Bürger to Bürger’ what he thought German law should do about abortion (addressing the question when human life begins: at implantation of the zygote in the uterus) and protection of embryos and research on them. In the *Frankfurter Allgemeine Zeitung*, the publisher, Frank Schirrmacher, called this speech historic and also sharply criticized Markl for subscribing to a relativistic image of the human being and for being too glib about the distinction between a scientific and a cultural perspective (2001, 47). Rau, a quite religious man, had given a speech on the limits of genetic engineering not long before and poignantly left the audience during Markl’s speech (supposedly due to scheduling conflicts, as Markl said after the speech). Markl’s ‘Zivilcourage’, inadequately translated as moral courage, was as exemplary on that occasion as for his mandate to investigate the KWS during the Nazi regime. This is well remembered and still commands respect.

Although a man of conservative character and way of life, in scientific and science policy matters (e.g. his indefatigable commitment to the freedom of research) Markl always espoused progressive and liberal positions, at the same time trusting in the humane nature of science. It was his great confidence in science as a guarantor of a humane world that was his distinguishing feature as scientist and science facilitator. For him, science and creative

thinking guided by knowledge and curiosity always should have the last word. At the same time, his work and interests spanned a hugely impressive array of fields and areas, reaching from intelligent design and evolution, bioethics, philosophy and history of science to neurobiology and human genetics (such as pre-implantation diagnostics). He also wrote cogently about controversial topics in brain research (such as consciousness), stem cells, eugenics and abortion. And Markl wrote about man in a world which is his creation. In his books on science and society he discussed the impact of science on modern society, not merely in the usual journalistic way, but engaged deeply with the debates of the relevant disciplines. In particular, he looked for an anthropological and philosophical understanding. He was a scientist who knew how to think in philosophical categories. One could even say that he was a gifted philosopher among the scientists. Not in the technical sense of a philosopher of science dealing with theoretical and methodological problems of scientific knowledge creation, but as a scientist who was able – and determined – to combine scientific practice with philosophical reflection. In his striving for scientific knowledge and in his thinking about man in his world, he closed the famous gap between the two cultures.

Markl wrote or edited at least a dozen books. Their titles demonstrate the breadth and depth of his interests and expertise in the nature of humans: aggression and altruism, behavioural physiology, biophysics, evolution and genetics, the history of scientific conception and research, the conflict of scientific knowledge versus exploitation, the philosophy of science past and future, and the freedom and the responsibility of scientific research. These topics also show his personal evolution from a ‘pure scientist’ to one of the most important cheerleaders, politicians and facilitators of science in Germany. It is no wonder that Markl received numerous prizes and medals and seven honorary degrees.

Hubert Markl died on 8 January 2015 in Konstanz, aged 76.

HONOURS AND AWARDS

1984	Lorenz Oken Medal of the Gesellschaft Deutscher Naturforscher und Ärzte
1984	Karl Vossler Prize
1990	Bundesverdienstkreuz first class of the Republic of Germany
1990	Cross of Merit (with Star) of the Republic of Poland
1991	Karl-Winnacker Prize
1992	Großes Verdienstkreuz des Verdienstordens der Bundesrepublik Deutschland
1992	Honorary Degree of the University of the Saarland
1994	Cicero Speakers Award
1995	Ernst-Robert-Curtius Prize
1996	Erasmus Medal of the Academia Europaea
1997	Medal of Merit of the State of Baden-Württemberg
1997	Honorary Member of the Gesellschaft Deutscher Naturforscher und Ärzte
1997	Honorary Degree of the University of Dublin
1999	Leibniz Ring of the City of Hannover
1999	Großes Verdienstkreuz mit Stern der Bundesrepublik Deutschland
1999	Honorary Degree of the University of Potsdam
2000	Honorary Degree of the Jewish Theological Seminary
2000	Foreign Member of the Polish Academy of Sciences
2001	Order of Merit of the State of Bavaria

- 2001 Honorary Degree of the University of Tel Aviv
- 2001 Honorary Degree of the Hebrew University of Jerusalem
- 2002 Bayerische Verfassungsmedaille in Silver Pro meritis scientiae et litterarum
- 2002 Honorary Degree of the Weizmann Institute of Science
- 2004 Honorary Ring of the Eduard Rhein Foundation
- 2004 Harnack Medal of the Max Planck Society
- 2005 Hanns Martin Schleyer Prize

Markl was an elected member of several national and international academies, among them the Heidelberg Academy of Sciences, the Bavarian Academy of Sciences, the Berlin-Brandenburg Academy of Science and Humanities, the German National Academy of Sciences Leopoldina, the Academia Europaea, the Indian Academy of Sciences, the Polish Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society and, as a Foreign Member, the Royal Society.

ACKNOWLEDGEMENTS

We wish to thank Bert Hölldobler for his input and thoughts on this obituary, much of which was based on the obituary that he had written for his long-time friend published in *Behavioral Ecology and Sociobiology* (Hölldobler 2015), the journal that Markl and he founded.

The frontispiece photograph was taken in 1997 by Wolfgang Filser, and is © the Max Planck Society.

AUTHOR PROFILES

Professor Axel Meyer



Axel Meyer received his PhD in zoology in 1988 from the University of California (UC) in Berkeley. In his formative years he was influenced by Allan C. Wilson FRS, with whom he worked during his last year as a PhD student and then as a postdoc (1988–1990) in the Biochemistry Department at UC-Berkeley. He first used the then recently discovered polymerase chain reaction for work on molecular evolution of cichlid fishes of Lake Victoria, and asked whether the coelacanth or lungfish is our closest living relative among the fishes—the answer is lungfish (whose giant genome Meyer helped to sequence in 2021). Ernst Mayr (ForMemRS 1988) became a grandfatherly mentor to him following their meeting during a year at Harvard University (when he lived in Mayr's house in Cambridge, MA, 1986–1987). Mayr

also encouraged Meyer to return to Germany, which, belonging to a generation that still listens to old men, he did and became the successor to Hubert Markl at the University of Konstanz in 1997. He remained in Konstanz, and is an evolutionary biologist whose wide interests span several layers of biological organization. Meyer has made a number of contributions to molecular systematics and genomics of vertebrates but focuses mostly on cichlid fishes, studying everything about them, from feeding behaviour, phenotypic plasticity and adaptations to, more recently, genomics of speciation.

Professor Jürgen Mittelstraß



After obtaining his PhD on the history of an ancient research principle (*Die Rettung der Phänomene* [Saving the appearances]) in 1962, Jürgen Mittelstraß was professor of philosophy at the University of Constance, Germany (1970–2005) and also director of the Center for Philosophy of Science from 1990. His research interests are in philosophy and history of science, epistemology and philosophy of language. His publications include *Mind, brain, behavior: the mind-body problem and the philosophy of psychology* (1991, with Martin Carrier) and *Theoria: chapters in the philosophy of science* (2018), and he was the editor of the *Enzyklopädie Philosophie und Wissenschaftstheorie* (in four volumes, 1980–1996; 2nd edition in eight volumes, 2005–2018).

He was president of the German Philosophical Association (1997–1999), the Academia Europaea (2002–2007) and the Austrian Science Council (2005–2015). He began his friendship with Hubert Markl in 1974, when Markl came to Constance and joined him in many philosophical, science policy and organizational activities.

REFERENCES TO OTHER AUTHORS

- Hölldobler, B. 2015 Hubert (Jim) Markl 1938–2015. *Behav. Ecol. Sociobiol.* **69**, 519–521. (doi:10.1007/s00265-015-1881-5)
- Schirmacher, F. 2001 Bürger Markl: Der Präsident der Max-Planck-Gesellschaft treibt Kultur. *Frankfurter Allgemeine Zeitung*, 26 June, p. 7. (https://fazarchiv.faz.net/document/FAZ_FD1N20010626961987?offset=&all=)
- von Frisch, K. 1976 Geleitwort. *Behav. Ecol. Sociobiol.* **1**, 1–2. (doi:10.1007/BF00299950)

BIBLIOGRAPHY

The following publications are those referred to directly in the text. A full bibliography is available as electronic supplementary material at <https://doi.org/10.6084/m9.figshare.c.5560222>.

- (1) 1962 Borstenfelder an den Gelenken als Schweresinnesorgane bei Ameisen und anderen Hymenopteren. *Z. Vergl. Physiol.* **69**, 475–569. [In German.] (doi:10.1007/BF00342998)
- (2) 1965 Ein neuer Propriozeptor am Coxa-Trochanter-Gelenk der Honigbiene. *Naturwissenschaften* **52**, 460. (doi:10.1007/BF00627075)
- (3) Stridulation in leaf-cutting ants. *Science* **149**, 1392–1393. (doi:10.1126/science.149.3690.1392)
- (4) 1967 Die Verständigung durch Stridulationssignale bei Blattschneiderameisen - I. Die biologische Bedeutung der Stridulation [Communication by stridulatory signals in leaf cutting ants. I: The biological function of stridulation]. *Z. Vergl. Physiol.* **57**, 299–330. [In German with an abstract in English.] (doi:10.1007/BF00303001)
- (5) 1971 Schallerzeugung bei Piranhas (Serrasalminae, Characidae) [Sound production in piranhas (Serrasalminae, Characidae)]. *Z. Vergl. Physiol.* **74**, 39–56. [In German with an abstract in English.] (doi:10.1007/BF00297789)
- (6) 1977 (With B. Hölldobler & T. Hölldobler) Mating behavior and sound production in harvester ants (*Pogonomyrmex*, Formicidae). *Insectes Sociaux* **24**, 191–212. (doi:10.1007/BF02227171)

- (7) 1978 (With B. Hölldobler & R. C. Stanton) Recruitment and food-retrieving behavior in *Novomessor* (Formicidae, Hymenoptera). I: Chemical signals. *Behav. Ecol. Sociobiol.* **4**, 163–181. (doi:10.1007/BF00354978)
- (8) (With B. Hölldobler) Recruitment and food-retrieving behavior in *Novomessor* (Formicidae, Hymenoptera). II: Vibration signals. *Behav. Ecol. Sociobiol.* **4**, 183–216. (doi:10.1007/BF00354978)
- (9) 1981 (With W. M. Masters) Vibration signal transmission in spider orb webs. *Science* **213**, 363–365. (doi:10.1126/science.213.4505.363)
- (10) 1985 Manipulation, modulation, information, cognition: some of the riddles of communication. In *Experimental behavioral ecology and sociobiology* (eds B. Hölldobler & M. Lindauer), pp. 163–194. Stuttgart, Germany: Gustav Fischer.
- (11) 1987 (With B. König) Maternal care in house mice. I: The weaning strategy as a means for parental manipulation of offspring quality. *Behav. Ecol. Sociobiol.* **20**, 1–9. (doi:10.1007/BF00292161)