The Geomagnetic Field and Solar Activity: Neglected Sources of Biological Variability ?

Christian Bartsch[1,2], Hella Bartsch[1,2], and Dieter Mecke[1]

[1]Center for Research in Medical and Natural Sciences, and
[2]Interfaculty Institute of Biochemistry, University of Tübingen, Tübingen, Germany

In our experiments to define the link between the pineal gland and cancer we repeatedly faced unexpected results. Initially, we detected seasonal variations of nocturnal plasma melatonin in laboratory rats with higher concentrations in spring than in winter, same as for the *in vitro* responsiveness of immune cells to different stimuli (1, 2). During 1990-2 very high plasma melatonin concentrations were observed in male rats during summer (3) and elevated nocturnal urinary excretion of 6-sulfatoxymelatonin (aMT6s: main melatonin metabolite), in four groups of untreated female rats (4, 5). During these years mammary tumors in inbred rats, induced by the same carcinogen dose of DMBA, developed faster in animals born in summer than in autumn (3). Finally, we found that the so-called Pineal Anti-Tumor Activity (PATA, low-molecular substances different from melatonin), exhibited annual changes with a peak in summer (6).

To explain these findings in animals kept under controlled laboratory conditions (including constant lighting regimens), we hypothesized that seasonal changes of the geomagnetic field may act as an additional *Zeitgeber* apart from light (4). In later experiments during 1993-1997 we were, however, surprised to see that seasonal melatonin rhythms were less pronounced or even absent (7). Furthermore, we had to observe that during 1997-2000 DMBA-induced mammary cancers showed divergent responsiveness to a mobile phone-signal although the same dose of the carcinogen was administered on corresponding days of consecutive years (8). To resolve these controversies we performed four long-term experiments (1997-2006) with female rats kept within the same room over at least 18 months in each case to see when seasonal rhythms may be present. Seasonal aMT6s-rhythmicity was found in one experiment only during 2002-2004 (9). Interestingly, overall variations of aMT6s occurred throughout these experiments which followed the number of sunspots during the 23rd solar cycle (1996-2008)) (9, 10) which were in turn abolished in animals chronically exposed to a pulsed high-frequency field (217 Hz, 900 MHz, mobile phone-like signal) (11). These observations led to a refinement of our initial hypothesis, namely that seasonal melatonin rhythms preferably develop during phases of very high solar activity (1990-2, 2002-4) which are known to profoundly affect the geomagnetic field (9, 10).

On this basis, a complete re-evaluation of our previous experiments was initiated and it is becoming apparent that even very basic physiological parameters, e.g. body weight, underlie both seasonal as well as solar cycle-related modulations (11). Furthermore, the development and responsiveness of spontaneous tumours appears to be influenced by different phases of the 11-years' sunspot cycle (3). In addition, spontaneous survival of female rats as well as the effects of chronic exposure to a weak mobile phone-related signal on survival depends on the month as well as year of birth of the animals concerned (12). This may have far-reaching implications for experimental studies dealing with possible biological effects of pulsed high-frequency fields used for mobile telecommunication. It is conceivable that the observed year-to-year variations of responsiveness of experimental animals may explain why findings in this field of research are highly contradictory and thus prevent reliable risk

assessments since the responsible mechanisms are widely unknown. Here we assume a central role of geomagnetic perceptive mechanisms which might be related to those involved in the ability of birds to orientate and navigate in the course of homing and migration (13, 14). Such perceptive mechanisms are known to be disturbed during days of high solar activity (15) and experimental studies indicate that the corresponding receptor molecules (cryptochrome, 16, and biomagnetite, 17) are affected by high frequency fields as well. Thus the presence of a complex electromagnetic perceptive system has to be postulated which responds to both static magnetic and high frequency fields. On this basis it appears plausible why both natural as well as anthropogenic electromagnetic fields of diverse types may substantially contribute to biological variability and prevent standardization of experimental studies on animals and perhaps even of diverse medical therapies in humans. There is a great need to define this electromagnetic perceptive system which could process both natural as well as anthropogenic signals in order to not only adequately estimate the risk of our man-made environment for ourselves (18, 19) but to perhaps understand why it might have been necessary for living organisms to develop such a system in the course of evolution. To answer such basic questions it will be necessary to initiate extensive multi-disciplinary research activities among life scientists and geo- as well as astrophysicists, particularly at a time when human beings are increasingly exploring outer space.

References

(1) Bartsch H., Bartsch C., Gupta D. (1990) Seasonal variations of endogenous defence mechanisms against cancer. In: Neuroendocrinology: New Frontiers. D. Gupta, H.A. Wollmann, M.B. Ranke (Eds.), Brain Research Promotion, London: Tübingen, 333-339.

(2) Bartsch H., Bartsch C., Mecke D., Lippert TH. (1993) The relationship between the pineal gland and cancer: seasonal aspects. In: Light and Biological Rhythms. L. Wetterberg (Ed). Pergamon Press, Oxford, 337-347.

(3) Bartsch C., Bartsch H. (2007) Die Bedeutung des Melatonins in der Wechselbeziehung zwischen Zirbeldrüse und Krebs – eine Übersicht mit neuen Resultaten. Abhandlungen der Sächsischen Akademie der Wissenschaften zu Leipzig – Mathematisch-naturwissenschaftliche Klasse, Bd. 64 Heft 4: Endokrinologie III. E. Peschke (Ed.), Hirzel, Stuttgart/Leipzig, 139-174.

(4) Bartsch H., Bartsch C., Mecke D., Lippert TH. (1994) Seasonality of pineal melatonin production in the rat: possible synchronization by the geomagnetic field. Chronobiol. Int. 11, 21-26.

(5) Bartsch H., Bartsch C., Deerberg F., Mecke D. (2001) Seasonal rhythms of 6-sulphatoxymelatonin (aMT6s) excretion in female rats are abolished by growth of malignant tumors. J. Pineal Res. 31, 57-61

(6) Bartsch H., Bartsch C., Gupta D. (1990) Tumor-inhibiting activity in the rat pineal gland displays a circannual rhythm. J. Pineal Res. 9, 171-178

(7) Bartsch H., Bartsch C., (unpublished results).

(8) Bartsch H., Bartsch C., Seebald E., Deerberg F. Dietz K., Vollrath L., Mecke D. (2002) Chronic exposure to a GSM-like signal (mobile phone) does not stimulate the development of DMBA-induced mammary tumors in rats: results of three consecutive studies. Rad. Res. 157, 183-190.

(9) Bartsch H., Mecke D., Probst H., Küpper H., Seebald E., Salewski, Stehle T., Bartsch C. (2012) Search for seasonal rhythmicity of pineal melatonin in rats under constant laboratory conditions: spectral chronobiological analysis, and relation to solar and geomagnetic variables. Chronobiol. Int. 29(8), 1048-1061.

(10) Bartsch H., Mecke D., Probst H., Küpper H., Seebald E., Herget I., Peschke E., Salewski, Stehle T., Bartsch C. Longitudinal melatonin production in female laboratory rats during 1997-2006: possible modulatory effects of changing solar activity. Current Aging Sci. 2012 Dec. 4 [Epub ahead of print].

(11) Bartsch H., Küpper H., Seebald E., Salewski L., Probst H., Mecke D., Stehle T., Bartsch C. (2012) Longitudinal nocturnal melatonin production in female laboratory rats with and without chronic exposure to a low-intensity GSM-like signal (mobile phone): Results of four experiments during Solar Cycle 23. Abstract of lecture S 1-3 held at the International Congress on Chronobiology at the University of Delhi (October 3-7, 2012) as printed in the book of abstracts on p. 15.

(12) Bartsch H., Küpper H., Scheurlen U, Deerberg F., Seebald E, Dietz K., Mecke D. Probst H., Stehle T., Bartsch C. (2010) Effect of chronic exposure to a GSM-like signal (mobile phone) on survival of female Sprague-Dawley rats: modulatory effects by month of birth and possibly stage of the solar cycle. Neuro Endocrinol. Lett. 31(4), 457-473.

(13) Wiltschko W, Wiltschko R. (2005). Magnetic orientation and magnetoreception in birds and other animals. J. Comp. Physiol. 191, 675–693.

(14) Winklhofer M. (2010). Magnetoreception. J. Royal Soc. Interface 7, S131–S134.

(15) Moore FR. (1977) Geomagnetic disturbance and the orientation of nocturnally migrating birds. Science 196, 682-684

(16) Müller P., Ahmad M. (2011) Light-activated cryptochrome reacts with molecular oxygen to a flavin superoxide radical pair consistent with magnetoreception. J. Biol. Chem. 286, 21033-21040.

(17) Fleissner G, Fleissner G, Stahl B, Falkenberg G. (2007). Iron-mineral based magnetoreception in birds: the stimulus conducting system. J. Ornithol. 148 (Suppl. 2), S643–S648.

(18) Bartsch C., Bartsch H. (2006) The anti-tumor activity of pineal melatonin and cancer enhancing life styles in industrialized societies. Cancer Causes Control 17,559-571.

(19) Bartsch C., Bartsch H., Peschke E. (2009) Light, melatonin and cancer: current results and future perspectives. Biol. Rhythm Res. 40, 17-35

Address for correspondence and supply of PDFs of our publications:

PD Dr. Christian Bartsch
Center for Research in Medical and Natural Sciences
University of Tübingen
Ob dem Himmelreich 7
D-72074 Tübingen, Germany

Tel. ++49-7071-29 735 53

christian.bartsch@uni-tuebingen.de

This pdf was circulated in the ISWI Newsletter on 17 Dec 2012. (Volume 4, Number 124)