



Forschungsinstitut am Goetheanum

Natural Science Section

Annual report 2021



Goetheanum

2021 Annual Report

Research Institute at the Goetheanum

Editorial

Dear Readers

As in life, not everything can be planned in advance at the Section. At the beginning of the year Matthias Rang was occupied for several weeks setting up a station with experts for measuring water quality. In the immediate vicinity of the “Feuchtgelände”, a small nature reserve behind the Glashaus and former open-air laboratory of the Research Institute, an extensive residential construction project had begun. Now the springs that originally supplied the site with water dried up and often, as a result of the concrete work, polluted water with a pH value far exceeding permissible limits flowed into the area. After tough negotiations and remedial work, the biggest problems have been alleviated; however, long-term damage cannot yet be assessed.

We organised a memorable Memorial Colloquium for Jochen Bockemühl. Due to Corona measures only the speakers could meet on site, but the event was accessible online for participants from all over the world. The varied contributions showed just how widely and fruitfully Jochen’s work lives on, in and through former students and participants in seminars worldwide.

The successful digitisation of our journal “Elemente der Naturwissenschaft” is attracting great interest, reflected in the number of new subscribers. Following the example of “Elemente der Naturwissenschaft”, the “Jahrbuch für Goetheanismus” (Yearbook for Goetheanism) has now been digitised as well by the Freie Hochschule Stuttgart in cooperation with our Institute and should be accessible online before the end of 2022.

We continue to work on our research projects in cooperation with partners and institutions. The topics range from projects on saving forest bee colonies and breeding suitable varieties of *Artemisia annua* and St. John’s wort, to the correlation of brain physiology with the moment of decision, and the development of a sensitive detector for measuring ultra-weak bioluminescence. In addition, the effect of different coloured light spectra on the shape and smell of selected plants was investigated and in a dissertation project, a botanical garden based on Goethe’s ideas was created for botany lessons at Waldorf schools (p. 8).

The scientific nature of anthroposophy is under scrutiny. In our small team we are working to make the Goethean anthroposophical research method visible and comprehensible in the vast arena of academic natural sciences. If its content can unfold in conversation, its significance as a complementary science becomes clear. In modern natural science, an explanation always requires functions and mechanisms while the phenomena in which they appear are degraded to placeholders of physical, chemical or biological laws. The Goethean method puts scientists at eye level with the phenomena and seeks to recognise these phenomena in their larger overall context. One could say that modern natural science decodes the grammar, our method the drama of the world. The former seeks a description that is independent of human beings, the latter – in the observation of inner experiences – finds an understanding that depicts the real effectiveness of thoughts and ideas.

The ambitious plan to make this extended field of research comprehensible does not spring from the veneration of Goethe or Steiner, but is a current and urgently necessary task to demonstrate an inner perspective through which the creative but also the moral

forces in the world can be discovered. It is the endeavour to bring science, art and religion – which were not experienced separately in the original project of becoming human – together again.

Two images of the future emerge from this. The first is the realisation of the immanent spirit in nature and in man. The second is the promise, which has yet to be fulfilled, that in non-human nature lies a key to the constitution of social life.

Mara Born, Ruth Richter, Matthias Rang & Johannes Wirz

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Part I.

Current Research Projects

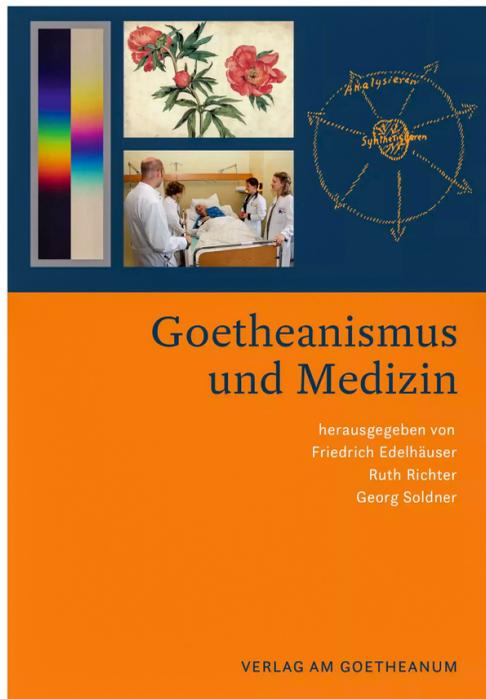
Goetheanism and Medicine – In Search of the Lost Context

Ruth Richter

What is the contribution of Goetheanism to the future of medicine? This question – at the interface between the Medical and Natural Science Sections – has given rise to a joint project: the publication of contributions by Goetheanistic researchers who have addressed this question. The authors come from two generations: scientists who have worked out quite individual approaches along the paths of Goethe’s method and their students who are increasingly entering into dialogue with modern natural science.

A common tenor unites the different perspectives. In addition to aesthetic competence, the Goethean method trains a way of thinking that creates coherences as a complement to an analytical scientific attitude which, despite a wealth of valuable individual results, has largely lost touch with the complex reality of life.

The arc of suspense spans from the fundamental, consciously graspable connection between perception and concept in Peter Heusser’s contribution, to the fruitful effect that a concept such as “polarity”, read from phenomena, can have on the development of science in the richly illustrated contribution from historian of science Olaf Müller. In between, readers experience an exemplary view of the Goethean type from Armin Husemann, a differentiated development of the term “Goetheanism” from Wolfgang Schad and a path to inner seeing via various modes of perception from Jochen Bockemühl. The methodological application of the element concept and the conceptual significance of Goetheanism in genetics and anthropology are additional topics – not all authors can be mentioned here. Those whose curiosity has been peaked can have a look at the book. It was published in February 2022 by the “Verlag am Goetheanum” and



aims to stimulate a discourse that addresses not only subject-specific content but also the ethical side of scientific knowledge formation.

Goethe Garden and Botany at the Rudolf Steiner School, Zürcher Oberland, Wetzikon ZH

João Felipe Toni

My name is João Felipe Toni. I am a biologist and educator with a Master's degree in Botany and Ecology from the University of Basel and I am a researcher in the field of Didactics of Biology at the Friederich-Schiller-University in Jena (DE). I have been a visiting researcher at the Nature Institute (USA) and the Royal Botanic Gardens Edinburgh, Scotland. My main research interests are Goethe's morphology and Steiner's epistemology applied to the study of metamorphosis and evolution of flowering plants; and botanical education in Waldorf schools and academia. I am currently a research associate at the Natural Science Section at the Goetheanum in Dornach, Switzerland, a member of the FLO-RE-S International Network on Floral Morphology and a science and biology teacher at the Rudolf Steiner Zurich Oberland School in Wetzikon, Switzerland.

Johann Wolfgang von Goethe came to Weimar in 1775. After moving into his new domicile at the gates of the city in the Ilm-Aue, he devoted himself with growing intensity to garden design and botany. A few years later, when he moved into a prestigious residence on Weimar's Frauenplan, another garden plot came into his possession. Both gardens, together with the botanical garden of the University of Jena, provided illustrative material for his botanical research on living plants. The aim of my PhD project is to re-examine Goethe's dynamic view of the diversity of plants in the context of the didactics of botany and environmental education. How can the history and philosophy of science be used in science teaching? This will be tested within the framework of the project as well as the planning and creation of a Goethean garden as a didactic implementation of the topic "Metamorphosis of Plants". High school students can use both visual thinking and manual work to learn about topics such as Goethean floral morphology and ecology, evolution of plant development (Evo-Devo), plant systematics, taxonomy, and botanical illustration. In addition, the project aims to generate



Students working in the Goethe Garden at the Rudolf Steiner School Zürich Oberland, Wetzikon.

experience in school-community interaction with science in general and Goethe's morphological approach in particular.

“We want to regard this institution as a harbinger of peace and look forward to it for the best”.

— Goethe in a letter to Batsch on the occasion of the founding of the Botanical Garden of Jena.

Readiness Potential (RP) and Intentional Movement Reference

Carolin Schürer, Tiffany Huber, Siegward M. Elsas & Matthias Rang

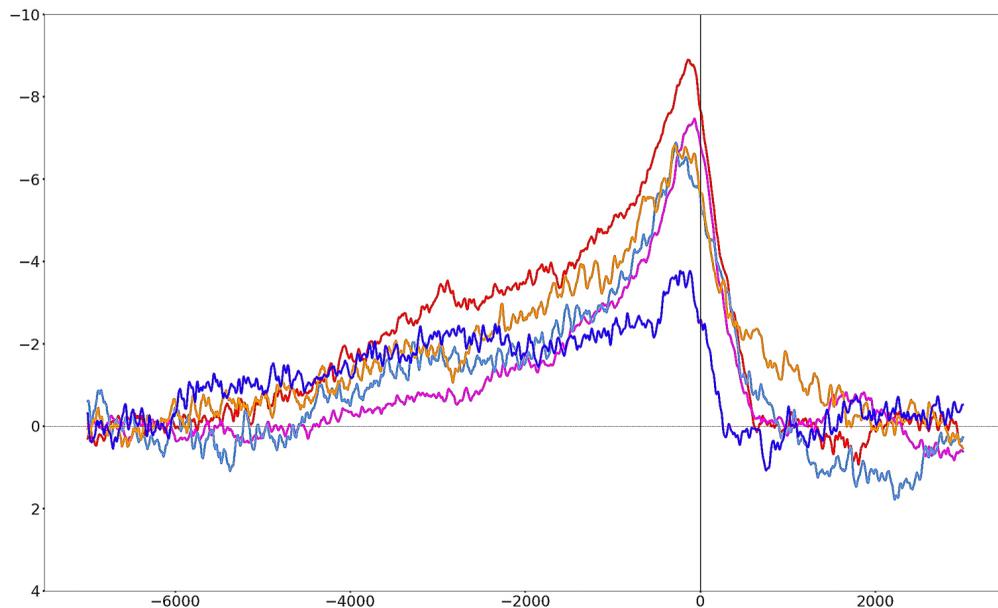
The project on brain physiology and freedom of will could be continued and completed thanks to renewed support from the Mahle Foundation, the Rudolf Steiner Fonds and the Dr. Hauschka Foundation. A publication for “Frontiers of Neuroscience” will soon be ready for submission.

The statistical analysis of the EEG data on the readiness potential (RP) was successfully carried out with the help of a “mixed model” algorithm. This procedure (Laird & Ware, 1982) is tailored to the problem that often arises in studies dealing with different subjects: the change in a variable is observed over time and this is done repeatedly for each subject. Particularly influential and at the same time difficult to objectify is the individual nature of the subjects and their individual performance of the tasks. This subjective factor is included as a “random effect” so that the inter-subjective “actual effects” that are asked for in the experimental design become more visible. In this way, individual differences no longer stand in the way of the question about the significance of inter-subjective effects.

The results of the statistical analysis show that the differences in experimental variants (see Annual Report 2020) only turn out to be significant at less than 250 milliseconds (ms) before the subjectively stated decision point, i.e., much later than the onset of the RP increase. This suggests that anything that takes place earlier has the character of general preparation for an action.

As a method of interpreting the results in terms of the mental correlate of RP, the different RP variants were arranged in a morphological series. The “intentional movement reference” emerged as the decisive factor for the form of the readiness potential (an imagined movement also has a movement reference). The stronger this movement reference, the more pronounced the RP.

Even if the Libet experiment was motivated by the question of freedom and consciousness, our results suggest, instead, that the essential element for the emergence of a RP is the existence of the “intentional movement reference”. But how does an intentional movement impulse arise in us in the first place? This is described by Rudolf Steiner in “Anthroposophy, a Fragment” as a phenomenon connected with the astral body. According to this indication, the impulses for movement are to be sought in the human inner life – by no means always as impulses of the



Readiness potentials from different test variants averaged over several subjects. The vertical line at time 0 marks the moment that the subjects indicated as the moment of decision.

“I-person” but, rather, instinctively as impulses of the “astral human being”. A process takes place that begins with the perception of an image, proves effective in a desire according to the judgement of the “I-person” and then lives on in the actual movement. According to our observations, precisely these processes of image perception and desire are depicted in the slowly increasing RP; in contrast, a neuronal effect of the emerging decision of the “I-person” – for or against an actual movement – only becomes apparent in the last 250 ms before the indicated time of the decision.

Communicating about Bees – Following the Example of the Bee

Johannes Wirz

An important form of communication in the beehive is the so-called “waggle dance”. With them, forager bees indicate to their sisters the direction, distance, and quality of the nectar source. Without this form of communication, a colony could not survive.

In 2020 I spent about eight weeks working with introductory courses in biodynamic beekeeping, online events with bee friends in the USA, UK and Portugal, article writing, the English translation of the book on biodynamic beekeeping (with Norbert Poeplau), conferences, lectures, guided tours and individual consultations, and bee visits. Like the bees, I hope I have been able to communicate directionally, with realistic assessments of the length of the road towards bee-friendly, spiritual beekeeping, and with the necessary passion for it.

I would like to highlight three moments in particular. The first was a seminar with employees of a medium-sized carpentry company for exhibition stands, catering equipment and kitchen construction. The managing director had asked me to practise decision-making with the participants, just like bees in a swarm do when choosing a new home. This includes diligence, full transparency of all available information, assessments of all participants, renunciation of “lobbying” and a quorum decision of 70 %. For the first time, the development department, the manufacturers, the logisticians, and the finance people met for a joint discussion – and were happy to be able to discuss the complex processes in each area and find forms of a structured decision. This event was a highlight.

The second happy event was the guidance of a meditation entitled “The Earth is our Sun”, which was offered online because due to Corona the seminar “Bees and Spirituality” could not be held as a face-to-face event. With about 50 participants, despite the digital technology, it was possible to create a kind of resonance space and silence that touched people deeply, with people from all over Europe.

The third highlight was the visits to the apiaries, where a small group or individuals were able to get a glimpse of the inside of a bee colony, often for the first time. Even after more than 20 years of experience, I still find immersion in this peaceful world of busy bee activity combined with scents and warmth impressions is part of the magic of beekeeping. Children often have the most fun. After some initial hesitation, they like to scoop out a bit of honey with their finger



Snow-white honeycombs built in the darkness of the hive always arouse amazement and awe in visitors and are a sign of the vitality of young bee colonies.

from a honeycomb filled with bees. One lively girl was rebuked by a bee with a sting. Crying, she called out to me, “Now I’ll never go to the bees with you again!” A few minutes later she was standing at the open hive again asking: “Can I have a bit of honey again?”

Further Development of Fluorescence Excitation Spectroscopy

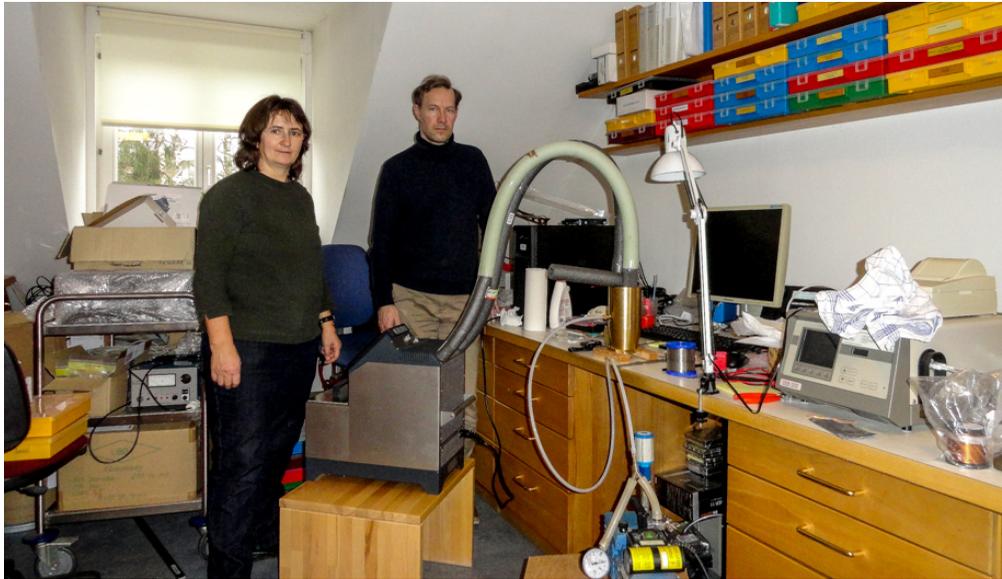
Philipp Bokatius, Gudrun Mende, Matthias Rang & Peter Stolz

Project status after the second project year

Fluorescence excitation spectroscopy was developed as a quality research method by Jürgen Strube in the 1990s. Since then, this method has been applied at the KWALIS gGmbH research institute for various types of samples such as seeds and fruits, but also liquids, such as oils, milk or water. Since 2019, we have been working on the further development of fluorescence excitation spectroscopy and in particular on the construction of a second measuring apparatus in a collaborative project between the KWALIS gGmbH Research Institute and the Research Institute at the Goetheanum. In last year's annual report, we reported on the construction of the new detection unit. The development of the mechanical construction of the new unit with the creation of CAD models for all components was the main focus in the second year.

Design difficulties arose from design decisions that had been made early on, based on previous experience with the existing plant. These included, in particular, the functional unbundling of the measuring unit and the measuring chamber so that the measuring chamber can be replaced in the future without having to change the measuring unit. The implementation requires spatial configuration of the two detection units with their photomultipliers, the mechanical shutter blades (similar to a camera shutter) and the advanced filter wheels, as well as the sample illumination by light guides with the mechanical shutter blades belonging to them and additional sensors in a measuring head. Since the photomultipliers have to be accommodated in evacuated housings and cooled to temperatures of about $-30\text{ }^{\circ}\text{C}$ by a cooling circuit for noise suppression, the spatial construction is densely packed and very demanding.

But we are convinced that this design decision will pay off in the future. Not only will other designs of the measuring chamber be possible, for example for larger samples, but for the first time both photomultipliers will measure the same side of the sample and liquids can be measured on their air side (and not just through a cuvette).



Photomultiplier housing (left) and next to it a part of the inner workings (right). A newly manufactured PMT measuring head (cylinder on the tabletop) in the vacuum and cooling test of the detector interior at $-30\text{ }^{\circ}\text{C}$. The vacuum pump can be seen on the lower right and the cooling unit with the curved cooling hoses on the left.

Project perspectives

At the moment we are building the system and, in particular, working on the programming. The cooperation with Prof. Dr. Johannes Grebe-Ellis from the University of Wuppertal is helpful as it allows us to manufacture some parts in the workshop of the Physics Institute there. After setting up the system, the main focus will be on programming the control and measurement software, setting up a new database and troubleshooting. The whole system has to be extensively tested and characterised. Furthermore, a very careful modernisation of the first plant is planned.

Effects of Different Colour Spectra on Plant Growth

Torsten Arncken

In the following, I would like to present a project that was begun in 2021:

With LED technology it is possible to emphasize different light spectra, from ultraviolet to blue and red to infrared, in white light, roughly corresponding to four ranges of sunlight. In doing so, I am looking for ways to detect the effects of the ether types on plant growth.

The effects of the modified light on the shape, scent, and taste of plants grown under each respective influence are investigated phenomenologically. As a methodical extension, the “symbolizing of pure perception” of scent and taste is used to enable extrasensory observations of the light effects.

In the first two examples with Paprika (sweet pepper), I would like to show that light has a formative effect on the seedlings from very early on, and that this tendency is then maintained. In the seedlings we already see that the plants illuminated with a stronger infrared component (far right) are more long-stemmed and are the tallest plants of all variants. With blue illumination (second from left) leaves and stems are shorter. With red illumination (second from right), the leaf blades are larger and the plants appear more relaxed. With the addition of UV to the light (far left), the leaves stay green longer and the plants appear more densely shaped.

Artemisia annua, in the final example, shows the same effects in the shape of the plants. With greater UV in the lighting, the plant appears fresh green and harmoniously formed. With blue light the plant is stocky: the leaves are green but they remain near the ground. With red, the leaves are lighter green and continue up the stem. With the addition of infrared light, the plants stretch upward and the leaves go even higher.

Other projects

In cooperation with Weleda, I support their “Actives” and “Galenics” research departments where new cosmetic products are developed. My task is to observe the qualities of plant substances and to work out their effect on humans. For example, the prickly pear (*Opuntia*) product line – for the care of dry skin – was developed in collaboration with anthroposophically working dermatologists.

In addition, I have other areas of research that I work on to the extent of half a day per week. For example, since 2013 I have been working with Carsten Gründemann, assistant professor for



From left to right: ultraviolet, blue, red, infrared. Paprika seedlings after one week of illumination.



From left to right: ultraviolet, blue, red, infrared. Paprika after four weeks of illumination.



From left to right: ultraviolet, blue, red, infrared. Artemisia.

translational complementary medicine at the University of Basel. Currently, we are conducting experiments to investigate how different plant species deal with heat. The aim is to arrive at internal images from concrete observations of how the plant's heat system behaves. How does external heat transform into the internal heat of an organism? This plays a role in understanding the immune system and the intervention of the ego organization in the organism.

Part II.

Teaching and Events

In Conversation: Section and Public Relations Work

Since we still hold to the old academic ideal that teaching and research are twins, all Section staff members are on the road every year with lectures, courses, and seminars.

The Corona pandemic has also kept us busy in 2021. There has been an increased demand for livestream lectures and online seminars. Add to that all the Zoom conferences and we're probably more present in public outreach than we were before the crisis.

The challenges of online events are considerable. First of all, it's noticeable that the atmospheric togetherness that we appreciate in face-to-face events is almost completely absent. We have learned to deal with shorter concentration spans on the computer: presentations are limited to a maximum of one hour and work in small virtual groups is much appreciated.

The great advantage of the internet is its range of influence. Whereas in face-to-face events there are often thirty or less on-site attendees, we found that there are sometimes over 100 online participants. We experienced an impressive example of this with the presentations at our Evolving Science 2021 conference in October. We were happy to welcome 66 attendees in person and another 30 for the online broadcast of the presentations. The conference brought together experts who demonstrated the importance of complementary research methods in many ways. To our delight, it was the first contact with the Goetheanum for about a third of the contributors and participants.

At the Memorial Colloquium for Jochen Bockemühl in March that brought together former students of his both on-site and online, we experienced how they continue to carry on and individually develop his endeavours all over the world. Bockemühl, together with his colleague Georg Maier, described such work as endeavours working in further education ("menschenbildende Hochschultätigkeit").

Another beautiful and often challenging task is our collaboration in the course offerings of the "Goetheanum Studies", which took place despite Corona with participants from six nations (see p. 27) in addition to an online international special course in anthroposophy. Whether we like it or not, the virtual formats will remain indispensable even after the (hopefully) upcoming

end of the Corona crisis. We all must learn to use this format adequately, assess what can and cannot be disseminated virtually, learn how to convey the sensory experiences and phenomena so important in Goethean science, and determine what inner, personal work is needed to ennoble the medium of the internet – an expression Rudolf Steiner once used in reference to the invention of printing.

In addition to the events of the Section at the Research Institute, the staff members had the opportunity by invitation to give impulses for Goetheanist work in various other places. These were our activities during the Corona Year 2021:

External Events 2021

Local, regional and online breeder training, topic: “Environment – Plant – Genotype”, Jan 5–7. (Ruth Richter)

Online lecture for organic beekeepers in Vienna, Jan 22. (Johannes Wirz)

Bee seminar at the Dottenfelderhof, Jan 27. (Johannes Wirz)

Online working group at the agricultural conference, Feb 11–14. (Matthias Rang, Johannes Wirz)

Physicists group online meetings, various dates. (Carolin Schürer, Johannes Kühl, Matthias Rang)

Online course in genetics for HFHS students, Mar 4. (Johannes Wirz)

Day seminar at HELIA AG: “What businesses can learn from bees”, Oberkirch, 25 Mar. (Johannes Wirz)

Physics lessons at Birseckschule Waldorf School, Apr 12–May 21. (Johannes Kühl)

Online experimental lecture for the “Colors and Cultures – couleurs et cultures” conference of the Université de Haute Alsace, Mulhouse, Apr 14. (Matthias Rang)

Online lecture: “Elements and ethers”, Zweig Chicago, Apr 17. (Johannes Kühl)

Online lecture: “What is an electron?”, Zweig Chicago, May 8. (Johannes Kühl)

Introductory course on Goethe's theory of colours for students of the Freie Hochschule Stuttgart, Jun 7–11. (Matthias Rang)

Breeder training, face-to-face event at Sativa Rheinau, topic: "Environment – Plant – Genotype", Jun 17–18. (Ruth Richter)

Online lectures for the "Sociedade Antroposofia" and the section group in Brazil, Jun 17–18. (Matthias Rang, Johannes Wirz)

Practical day for the Working Group for Natural Beekeeping (AGNI), Jun 20. (Johannes Wirz)

Presentation of the Section to students of the Freie Hochschule Stuttgart, Jul 12. (Matthias Rang)

Lectures on the Faust Festival, Jul 16–18. (Matthias Rang, Johannes Wirz)

Workshop: "From Sensory Perception to Imagination", Young Physicians Conference, Herdecke, Aug 16. (Torsten Arncken)

Course on *Echinacea angustifolia* and *E. purpurea*, Rüttihubelbad, Aug 21. (Ruth Richter, Kaspar Jaggi)

Lecture to beekeepers' association, Marbach, Sep 7. (Johannes Wirz)

Lecture: "Learning from Plants: Dynamic Thinking", Freie Pädagogische Vereinigung Bern, Sep 8. (Ruth Richter)

Lecture on subnature for the "Kolloquium Technik und Transhumanismus" of the Section for the Literary Arts and Humanities, Sep 18. (Matthias Rang)

Online lecture on Guenther Wachsmuth, Zweig Chicago, Sep 20. (Johannes Kühl)

Workshop: "Opuntia", Weleda in Schwäbisch Gmünd, Sep 22. (Torsten Arncken)

Annual meeting, AGNI, Sep 25. (Johannes Wirz)

Lecture to beekeepers' association, Lörrach, Oct 13. (Johannes Wirz)

Lecture, Michael-Zweig, Zürich, Oct 18. (Johannes Kühl)

Lectures at the quantum physics meeting of the section group in the Netherlands, den Haag, Nov 5. (Matthias Rang, Johannes Kühl)

Online participation in the annual conference of the NWS UK, Nov 6–7. (Johannes Wirz)

Lecture, AAG, Tübingen, Nov 8. (Johannes Wirz)

Online lectures: Color Theory, Slovenia, Nov 12, 19 + 26. (Johannes Kühl)

Lecture: “Atmospheric Colors”, Bauernzweig, Dornach, Nov 13. (Johannes Kühl)

Bee Seminar in Spain, Nov 19–21. (Johannes Wirz)

Lecture: “Willensfreiheit”, Munich, Nov 27. (Carolin Schürer)

Online workshop, Weleda Curriculum, Dec 6. (Torsten Arncken)

Teaching color theory at Birseckschule Waldorf School, Dec 14–16. (Johannes Kühl)

Regular external events

Monthly online meetings with NWS USA colleagues (Matthias Rang, Johannes Wirz)

Monthly online meetings with beekeeping colleagues from UK, Portugal, USA (Johannes Wirz)

Attendance, physicians’ working group, topic: “Vegetabilized Metals” (Torsten Arncken)

Attendance, physicians’ working group, topic: “Plants for Body Care” (Torsten Arncken)

Online meetings, working group for Goetheanistic Botany (Torsten Arncken)

Goetheanistic plant observation at the Weleda Garden (fortnightly) (Torsten Arncken)

Six Institute colloquia

On-site study in anthroposophy at the Goetheanum (nine weeks, daily classes) (Matthias Rang)

Online study in anthroposophy (four weeks, four classes per week) (Matthias Rang)

Weekly work on “Philosophy of Freedom” with eurythmy students (Carolin Schürer)

Monthly work on Rudolf Steiner’s “Warmth Course” with natural scientists / students (Carolin Schürer)

Approaching Process Design with Fluid Thinking

Ruth Richter

Microbes have the longest history in evolution and the scientists who study them also have real staying power: for the 40th time, the Microbiology Working Group of the Natural Science Section met in the Glashaus on September 24–25, 2021.

The working group was founded in 1981 by Norbert Pfennig, Professor of Microbiology and Limnology at the University of Konstanz, and Jochen Bockemühl. The working group uses the methods of anthroposophical natural science not as an alternative, but as an expanded approach that seeks to understand the essence and the context of the world of microorganisms. One goal of the annual meetings is to integrate the findings of anthroposophical science into a comprehensive reality horizon in which substances and phenomena of the physical world are not seen as causes but as the results of processes.

Expanded concept of the organism

This topic was pursued in this year's meeting by reading the book "Mikrobiom und Mensch"¹ by Thomas Hardtmuth, who is a member of the working group himself. In Chapter 5 he examines the modern findings of microbiology, genetics and microbiome research in the context of spiritual science. When dealing with these disciplines, it becomes clear that the dynamics of living things are primarily interactive activities that cannot be derived from properties of the substance – explanations from the interactions of atoms and molecules can at best serve as static auxiliary ideas.

It was discussed whether the idea of the Goethean type, which locates "inner nature" as an active agent within each living being, is tenable. Norbert Pfennig had already pointed out that the idea that only organisms visible to the human eye can be called living beings should be expanded with microbial research. Microorganisms are macroscopically visible only in their effects. They themselves, in their enormous plasticity, can only be perceived as fluid process shapes. This is in polar opposition to the formation of stable forms, just as the seed of a plant embodies a vast variety of possible forms that are only fixed in a specific growth habit when manifesting at a specific location.

¹Thomas Hardtmuth: Mikrobiom und Mensch. Berlin 2021

Studies of the genome of microorganisms in seawater show that even outside microbial cells we are dealing with an incalculably large number of viruses, chemical compounds derived from microbial metabolism, DNA fragments, proteins and messenger substances that are exchanged in a complex network of interconnected unicellular organisms. Here, metabolism and gene transfer occur not only between cells of one microbial species but also between cells of different species. This suggests an expanded concept of the organism, in which the individual species of microorganisms are thought of in a comprehensive organismic context.

The boundary between inside and outside is also blurred in the human body: the microbiome – the totality of all microorganisms living within and on us – forms a living fluid that is part of our organism and the environment at the same time. It forms the biological context of our immune system, which, like the brain, is a lifelong learning system. Contact with viruses and bacteria enables it to have experiences that it “digests” in the same highly individual way as we give our perceptions an individual character through our thinking activity. This sheds light on Rudolf Steiner’s statement that the brain is a compact immune system.

Interactions

In the professional exchange on current projects of the participants, practical questions were also addressed. Simon Sauer has extended his investigations of the microbiome of medicinal plants to the mother tinctures produced from them by fermentation. How do the microbial communities change during production and storage? Meinhard Simon, who has headed the working group for more than 20 years, reported on research conducted by his group that – in a hitherto unique way – once again brought to light the complex interactions in bacterial communities: two bacterial strains can only produce vitamin B12 together, through the mutual exchange of metabolic intermediates.

Falk Zucker was able to describe two new subfamilies of bacteriophages through genome sequence analyses of a recently isolated virus from the North Sea. Bacteriophages are viruses that infect bacteria. These so-called “bacterial eaters” are a manifest example of a thesis held by many virologists and cited by Thomas Hardtmuth: that viruses are the genetic regulators not only of ecosystems but also of the human, animal, and plant microbiome.

Powerful thinking

In their macroscopically imperceptible “process form”, microorganisms are very close to life processes and form a connection to the sphere of the living, to the etheric world. This cannot be understood and experienced with objective thinking oriented towards the material world. For this, thinking must be brought to life – as Rudolf Steiner formulated it in the leading thoughts letter on the Michael Way: “It is Michael’s mission to bring into human etheric bodies the forces through which the thought-shadows may regain life.”²

Evolving Science: “100 Years of Life Research”

Wolfgang Held, Johannes Wirz, Ruth Richter

“Evolving Science 2021” was the title of the Natural Science Section Autumn Conference that was also a celebration of the centennial of the Section’s Research Institute.

According to Johannes Kühl’s historical review, Guenther Wachsmuth and Ehrenfried Pfeiffer had initially inquired as to whether there was a reagent that could be used to detect the living. This led to the first picture-forming method, copper crystallization, and the beginning of the Section’s work. Hermann Poppelbaum, biologist, led the Section next. He saw his task as critically questioning, supplementing and transforming the biology and evolutionary theory of his time. His animal science in particular found a wide resonance in the anthroposophical field. As an academic, he wanted to bring Goethean ideas into science. He was followed by Jochen Bockemühl who, according to Johannes Wirz, recognized that the reagents of life are the living beings themselves and concluded from this that one belongs to them oneself. That turned the entire work upside down. Johannes Wirz remarked “When I came to the Section, Jochen told me that as a scientist one should talk only about what one has experienced” because – if we follow Goethe’s approach – “inner nature”, i.e. its laws, can only appear in man: inner experiences become objects of empirical research. However, one can only adequately connect the sensory world with the world of thought in cognition if one knows their own part in what appears inwardly. Accordingly, scientists have to transform themselves into a methodological

²Anthroposophical Leading Thoughts: The way of Michael and what preceded it (p. 69). Rudolf Steiner Press. GA 26.



2021 Autumn conference – *Evolving Science: “100 years of life research”*. Left: Johannes Wirz. Right: Matthias Rang

instrument in order to become aware of the conditions under which the inner experience appears in self-knowledge.

This includes a human-educating component of Goetheanism that, having started at the Research Institute, has been practiced in many educational contexts. It was also the theme of the first two days of the “Evolving Science” conference. In the last 25 years, the exchange with academic science has grown among the students and followers of Jochen Bockemühl and Georg Maier as part of the life of the Institute. Any approach that broadens the perspective on an object of research enriches the picture of the whole. This view leads to a pluralism of scientific approaches, a topic addressed by the historian of science Hasok Chang on the evening of the second day of the conference.

The third day focused on the disciplines of evo-devo, ecology, and microbiology, whose research is directed toward understanding relations and interactions. They call for and encourage contextual and processual thinking, as Goethe suggested for the knowledge of the living. Their findings, such as the intimate interactions between the microbiome and humans or between environmental factors and gene expression, have led many scientists to search for new concepts that go beyond traditional reductionist theories. Goethe’s idea of type, which describes living beings in permanent development with manifold possibilities of expression and offers a high explanatory value for topical issues, was explored on the last day of the conference.

From the point of view that the crisis of the earth is at the same time the crisis of man – and therefore the ecological crisis and the current pandemic are two sides of the same coin – the two

new Section leaders illuminated the connection between our mental “deeds” and the processes in nature.

With 66 participants on site and about 30 people online, “Evolving Science 2021” thus moved the past, present and future perspectives of Goetheanistic thinking developed at the Research Institute by means of specific content-related suggestions.

This is an expanded version of the article in Goetheanum Wochenschrift No. 43, Oct. 22, 2021.

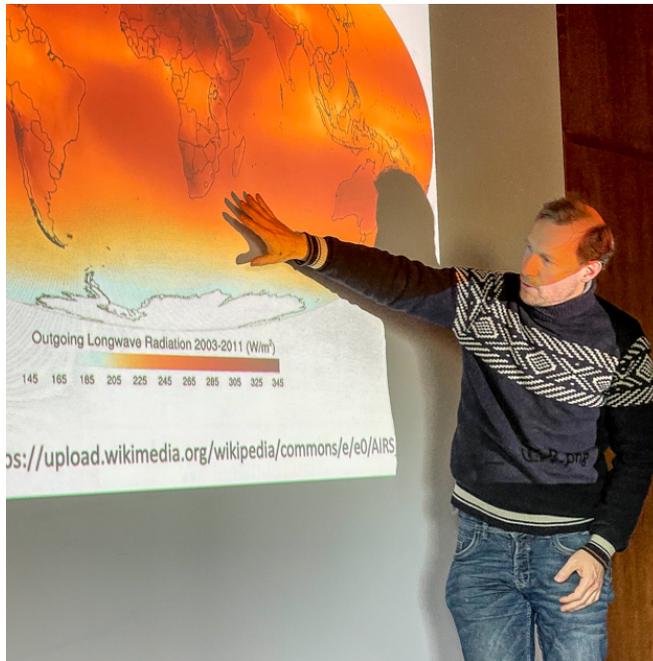
Restarting the In-service Goetheanistic Natural Sciences Course

Are we making a religion out of science? Certainty of knowledge through limitation

Ruth Richter

The subtitle of the entry-level course on October 15–16, 2021 can be taken as a political advertisement for Corona measures: even though we know little about the virus, let’s pretend it’s the truth. But when this topic was planned in the fall of 2019, there was no talk yet of Corona. In 2020, few people dared to sign up for our weekend-long courses because implementation was so uncertain. After some experience with online events, it was up for debate in 2021 whether to hold the training weekends in virtual mode or not. But after almost two years of deprivation of face-to-face contact with students, we decided to prioritize presence and continuity over economic considerations. Even though only seven people were registered, we wanted to hold the weekends with two instructors in personal contact with the participants, while still observing the necessary safety measures.

The topic planned for the course’s first weekend, “Are we making a religion out of science?”, was intended to draw attention to the change in status that natural science has acquired in society over the course of its history. Whereas in Newton or Darwin’s time the social environment was still strongly embedded in a religious context that was granted the authority to determine what was true or false for human life, religion has become less and less important in the 20th cen-



In-service course in natural sciences – weekend with Matthias Rang (photo) and Johannes Kühl.

ture. Today, when we want to emphatically state an opinion as true, we say, “it is scientifically proven.”

Natural science claims this certainty of knowledge with a certain justification, arising from the fact that we know exactly how a result of natural science came about. The conditions and prerequisites for the proposition found are part of the result. The first problem in communicating scientific results in society is that the limiting conditions are not mentioned. The impression is given that the result is also valid in other contexts or even generally, although under these conditions it has lost its certainty of knowledge. In this abbreviated approach, scientific results appear like a kind of revelation that meets the human desire for unconditional certainty of



knowledge. Particularly in existentially threatening situations, the desire for firm footing is great, as it used to be found in faith. Science today is supposed to substitute the religious foundations of faith. We can observe that the opinion of certain scientists is given a privileged hearing. The way deviating results in politics and the media are handled is reminiscent of the treatment of heretics in the church. We are no longer dealing with the struggle for certainty of knowledge but with questions of opinion or belief.

By analysing excerpts from scientific papers and corresponding media releases, the participants immersed themselves in this problem and became curious about how the Goethean scientific approach can contribute to its solution. The prospect of developing contextual thinking as can be practiced, for example in intensive observation of a living plant, indicated that such a method can also be used to pursue the reintegration of individual scientific results into the social context.

Events of the Natural Science Section at the Goetheanum 2021

- Mar 13–Mar 14 **Memorial Colloquium Jochen Bockemühl**, Natural Science Section (de)
- Apr 17–Oct 16 **Impulse Bee Colony – Practice and Background to Nature-Appropriate Beekeeping**, additional dates: May 8, Jun 19, Aug 21, Oct 16 (de)
- Apr 21–Apr 24 **Working Days for Physicists and Physics Teachers**, Natural Science Section (de) (*postponed due to Corona, original dates were: Feb 17–20, 2021*)
- May 28–May 30 **“Mental Observation Results According to the Scientific Method”**, Colloquium on Meditation & Natural Sciences, Natural Science Section (de)
- Jun 18–Nov 12 **Beekeepers Meeting**, additional dates: Aug 13, Sep 17, Oct 15, Nov 12 (de)
- Sep 24–Sep 25 **Working Days for Microbiologists**, Natural Science Section (de)
- Oct 7–Oct 10 **“Evolving Science 2021”** Autumn Conference, Natural Science Section (de/en)
- Oct 15–Oct 16 **“Are We Making a Religion Out of Science? Certainty of Knowledge Through Limitation”**, In-service Natural Sciences Course I, Natural Science Section and Goetheanum Studies (de) (*postponed due to Corona, original dates were: Nov 13–14, 2020*)
- Nov 12–Nov 13 **“Characters of the Planets – A Path from Sensory Experience to Imagination?”**, In-service Natural Sciences Course II, Natural Science Section and Goetheanum Studies (de) (*postponed due to corona, original dates were: Oct 16–17, 2020*)

Events of the Natural Science Section at the Goetheanum 2022

- Jan 21–Jan 22 **“The Cover of the Earth and the Climate – Elements and Ethers. How do We Gain a Moral Relationship to the World?”**, In-service Natural Sciences Course III, Natural Science Section and Goetheanum Studies (de) (*postponed due to Corona, original dates were: Jan 22–23, 2021*)
- Feb 11–Feb 13 **Workshop**, Bellis Working Group for Goethean Plant Knowledge (de), online event (*postponed due to Corona, original dates were: Jan 31–Feb 1, 2021*)
- Mar 11–Mar 12 **“From the Phenomenon of Electricity to Understanding Modern Technology. In Search of a Responsible Approach”**, In-service Natural Sciences Course IV, Natural Science Section and Goetheanum Studies (de) (*postponed due to Corona, original dates were: Mar 5–6, 2021*)
- Mar 12–Oct 15 **Impulse Bee Colony – Practice and Background to Nature-Appropriate Beekeeping**, additional dates: Apr 16, May 14, Jun 18, Aug 20, Oct 15 (de)
- Mar 25–Nov 11 **Beekeepers Meeting**, other dates during the year for a total of about 6 Fridays (de)
- Apr 27–Apr 30 **Working Days for Physicists and Physics Teachers**, Natural Science Section (de)
- May 6–May 7 **“Bees and Flowers – A Love Affair Put to the Test”**, In-service Natural Sciences Course V, Natural Science Section and Goetheanum Studies (de) (*postponed due to Corona, original dates were: May 7–8, 2021*)
- Jun 10–Jun 11 **“How Do We Extend Science into the Realm of the Living? The Contribution of Goetheanism”**, In-service Natural Sciences Course VI, Natural Science Section and Goetheanum Studies (de) (*postponed due to Corona, original dates were: Jun 11–12, 2021*)
- Sep 23–Sep 24 **Working Days for Microbiologists**, Natural Science Section (de)
- Oct 6–Oct 9 **Autumn Conference**, Natural Science Section (de/en)

Part III.

Institute and Staff

Institute for Contextual Science (ICS)

Johannes Kühl & Johannes Wirz

The Intention

At the Research Institute we work for the scientific expansion and deepening of the Section work of the School of Spiritual Science at the Goetheanum. Collaboration with other sections and other institutions is desirable and takes place whenever possible.

We are convinced that active research with the methodological foundations of anthroposophy is needed to do justice to present-day problems and tasks in the anthroposophical fields of life. In our view, research is an essential part of the tasks of the Goetheanum and its sections. The Goetheanum location is unique in terms of its interdisciplinary potential and ability to host visitors from all over the world.

Methodology

Based on the scientific work of Goethe and the spiritual science of Rudolf Steiner, a set of phenomenological methods has been developed and tested over the last decades. Nevertheless, in our projects we always strive to redevelop the research method and to adapt it to the object of research, i.e. to find the appropriate approach in each case.

The apparent contradiction – to develop a method for an object of research prior to researching it – is characteristic of our way of working. Science, conceived as a process, requires constant oscillation back and forth, a kind of breathing, between scientific investigation and reflection on methods. A concept is brought as a request to the phenomenon, inquiring as to whether the phenomenon accepts it. Thereby the scientist remains open to be instructed by the “object”.

Various points of view can be taken. In “Cognitive Holism” (McClamrock 1989, Caruana 2000, Leiber 2008), approaches to experience ranging from analytics, to idea-oriented or appearance-oriented phenomenology, to meditative practices are considered and integrated “into the whole”. In this sense, Goethe’s Theory of Colours was already multi-perspectival and a science of contexts (“contextual science”). Research of this kind is not limited to literature work but depends on observations and experiments. It is immanent in the approach that all results receive their meaning only in the concrete relationship to the human being: “wholeness” arises in the human being and yet belongs to the object.

Projects

The main focus at the Research Institute is basic research. Current research questions and the way they are treated are related to anthroposophy in a way that is usually not possible at other institutes because of external circumstances. The aim is not so much oriented at direct applications or “scientific proof” of anthroposophical content, but towards a specific “knowledge of the essence” of the matter – the development of approaches to nature and anthroposophy that can do justice to a scientific consciousness.

Depending on the task, we cooperate with other institutes and universities: our work should serve the further development of anthroposophical fields of life as well as contribute to the general culture of science.

Training

In addition to the trainings and courses listed on previous pages, we organize a variety of conferences, exhibitions, seminars and colloquia. There were fewer events in 2021 due to Corona but at the end of the year, in addition to the normal conference program, the “In-service Natural Sciences Courses” began again (on October 15, 2021) in collaboration with the “Goetheanum Studies”: <https://science.goetheanum.org/veranstaltungen/berufsbegleitende-ausbildung>

Organization

The Institute is managed by the leaders of the Natural Science Section: Dr. Johannes Wirz and Dr. Matthias Rang. Together or individually, by arrangement, they represent the Institute.

The staff of the Natural Science Section contributes to and shapes the Institute through regular conferences and colloquia. The Section for Agriculture withdrew its active participation in the Institute as of the end of 2019 until a new, more concrete form of cooperation could be found.

Personnel changes at the Institute

We are happy to have found Vesna Forštnerič Lesjak to succeed Johannes Wirz in the Section leadership. As a pharmacist, she brings experience in Goethean research, which forms the basis for developing new remedies. She also grows medicinal plants on her Demeter farm in Slovenia. Vesna Forštnerič Lesjak will take on leadership of the Section along with Matthias Rang at the beginning of 2023. She is already familiarizing herself with the tasks of the Section through regular attendance and participation.

In Conclusion

This year, once again, we would like to express our heartfelt gratitude to all those who have made our work possible and continue to support it:

First of all, there are the members of the Anthroposophical Society. Through their membership fees they ensure that we can work in a warm house – the most beautiful one on campus! – that our computers work, and they also contribute almost 20 % of our budget.

Then there are several private donors who have supported our work with large and small donations. We would like to thank them all very much for this decision!

Finally, most of our projects are supported, often in large part, by a number of companies and foundations. We would like to express our immense gratitude to them. In 2021 these were:

- Dr. Hauschka Stiftung, Bad Boll
- Ellen M. and Ebbe Roberts Fond, Denmark
- Fondation la Bruyère Blanche, Vaduz
- Humanus Stiftung, Basel
- Mahle Stiftung GmbH, Stuttgart
- Mellifera e.V., Rosenfeld
- Pädagogische Forschungsstelle beim Bund der Freien Waldorfschulen, Stuttgart
- Rudolf Steiner Fonds, Nürnberg
- Software AG Stiftung, Darmstadt
- Stiftung Forschungsförderung der Anthroposophischen Gesellschaft in Germany
- Universitätsklinikum Freiburg, Unizentrum Naturheilkunde, Freiburg
- Verein Hortus Officinarum, Rheinfelden
- Wala Heilmittel GmbH, Bad Boll
- Weleda AG, Arlesheim

Annual Financial Statement of the Natural Science Section 2021

This statement is subject to correction after revision of the Goetheanum's financial statements.

Expenses (in CHF):		Income (in CHF):	
Personnel costs	538,000	General Anthroposophical Society	195,000
Administration costs	7,000	Earmarked donations	346,000
Travel expenses	2,000	Dissolution of reserves	30,000
Conferences, studies	35,000	Conferences, studies	30,000
Publications	20,000	Publications	10,000
Project material, technical literature	8,000		
Contribution to institutions	1,000		
TOTAL:	611,000	TOTAL:	611,000

What we need

Costs are increasing all over the world and the Natural Science Section is not exempt from this. But the basic funding of the Section and the Research Institute has been decreasing for years. About ten years ago we had a basic funding contribution from the Goetheanum of a little over three hundred thousand Swiss francs. Last year this amount was still about two hundred thousand francs and in the coming year it will probably be about one hundred and twenty thousand francs. This compares with a current expenditure of over half a million francs. This is a challenge that cannot be solved by third-party funding applications for research projects but requires us to develop new financing models and channels.

Since the Goetheanum is in a similar position with a structural deficit, it is clear that we need to build our own funding strategy at the Section. In the past, we pursued the ideal of being able to contribute at least a small portion of the Goetheanum's funds to research projects. Ultimately, these covered only the infrastructure costs associated with the workplace and possibly the laboratory or greenhouse. In the future, we will have to include overheads for these services in research proposals.

Because of this we will not be able to completely close the funding gap of the Section and the Institute, because the basic funding is no longer sufficient to finance the minimal Section work with leadership, assistance, their communication tasks, various collaborations at the Goetheanum and travel activities for the Society. There are currently seven staff members working in the Section, amounting to 5.2 full-time positions.

The basic funding from the Goetheanum covers about one third of the Section's budget of approximately 195,000 Swiss francs that includes staff salaries as well as services such as the publication of the "Elemente der Naturwissenschaft" journal. Four staff members are fully financed through third-party funds.

Every year we are happy to have a balanced annual account, but we have to admit that it can only be achieved through great effort and many overtime hours. What we would urgently like to see is more solid basic funding for the Section's non-project services, which would allow us to concentrate on our substantive concerns.

We are very grateful for any suggestions and hints! Of course donations gladly earmarked for individual projects also help us. If you have any questions or suggestions, please contact Mara Born, Matthias Rang or Johannes Wirz at any time (see p. 40/41).

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BIC RAIFCH22

Important: Payment reference: NWS 1100 for grants to the Natural Science Section.

Website

The website of the Research Institute and the Natural Science Section at www.science.goetheanum.org/en (also accessible via www.forschungsinstitut.ch) provides additional information about our work, including:

- a list of all publications since 2000
- up-to-date information on our conferences, seminars, public Institute colloquium and the Summer University
- research reports and project descriptions
- a bibliography of Goethean Natural Science

- information about “Elemente der Naturwissenschaft”
- links to other institutions, notes on their events, and various texts for downloading
- references to newly published books with short descriptions
- topic pages that briefly explain basic aspects of our work
- information on individual staff members and their respective areas of work and publications

Elemente der Naturwissenschaft

The Natural Science Section publishes the “Elemente der Naturwissenschaft” journal with contributions from all areas of natural science and image-creating methods. Issues are published twice a year.

All articles can also now be found online: www.elementedernaturwissenschaft.org/en

Editorial office

Ruth Richter (chief editor), Johannes Kühl, Matthias Rang and Mara Born

Editorial address and subscription orders

Naturwissenschaftliche Sektion am Goetheanum

Elemente der Naturwissenschaft

P.O. Box

CH-4143 Dornach

Email: science@goetheanum.ch

We will gladly send you a sample issue!



Institute outing in 2021 to the “Institut für Strömungswissenschaften” in Herrischried (from left to right): Helga Köhl, Carolin Schürer, Tiffany Huber, Mara Born, Johannes Köhl, Johannes Wirz, Michael Jacobi, Susanne Böttge, Matthias Rang, Elisabeth Rang, Ruth Richter. Missing: Torsten Arncken, João Felipe G. Toni.

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Current Publications of the Natural Science Section

- [1] Ginefra Toni, João Felipe; Abarca-Rojas, Betsabé & Matamala-Gajardo, Gabriela (2021): Taking Living Forms Seriously: A Goethean Approach to Floral Morphology and Anatomy of Two Chilean Loasa. *Elemente der Naturwissenschaft* 114, p. 52–65.
- [2] Kühl, Johannes (2021): Elemente und Ätherarten. *Das Goetheanum* 8, p. 10–13.
- [3] Kühl, Johannes (2021): Die Freie Hochschule für Geisteswissenschaft Goetheanum. Zur Orientierung und Einführung. In: Haid, Christiane; Kaliks, Constanza; Kühl, Johannes & Röh, Claus-Peter (Hrsg.).
- [4] Rang, Matthias (2021): Machen wir aus der Naturwissenschaft eine Religion? In: Hurter, Ueli & Wittich, Justus (Hrsg.): *Coronazeit. Zur geistigen Signatur der Gegenwart*, p. 157–172.
- [5] Rang, Matthias (2021): Are we making a religion out of science? In: Hurter, Ueli & Wittich, Justus (eds): *The Spiritual Signature of our Time in Era of Coronavirus*. p. 111–120.
- [6] Richter, Ruth; Söll, Nicole & Ellenberger, Andreas (2021): Pflanzliche Unterstützung im Virendilemma. *Anthrosana* 242: Epidemien und Immunität, p. 35–42.
- [7] Richter, Ruth (2021): *Artemisia annua* – A Traditional Plant Brought to Light. *Elemente der Naturwissenschaft* 114, p. 69–75.
- [8] Richter, Ruth (2021): Das unsichtbare Leben. *Das Goetheanum* 46, p. 4–5.
- [9] Richter, Ruth (2021): *Echinacea angustifolia* im Vergleich mit *Echinacea purpurea*. *Hortus officinarum Rundbrief* Nr. 21. <https://www.hortus-officinarum.org/index.php?cID=360>
- [10] Richter, Ruth (2021): Johanniskraut – Licht für dunkle Tage. Interview mit Stella Bünger. *Infobrief Saatgutfonds* 2, p. 1–2.



- [11] Wirz, Johannes & Poeplau, Norbert (2021): Keeping Bees Simply and Respectfully: Apiculture with the Golden Hive. IBRA and Northern Bee Book, 172 Seiten.
- [12] Wirz, Johannes & Dettli, Martin (2021): Mit den Bienen auf Augenhöhe – wesensgemäss durchs Bienenjahr. Schweizerische Bienen-Zeitung 2, p. 41–43.
- [13] Wirz, Johannes & Dettli, Martin (2021): Mit dem Schwarmtrieb arbeiten. Schweizerische Bienen-Zeitung 4, p. 30–32.
- [14] Wirz, Johannes & Dettli, Martin (2021): Der körpereigene Wabenbau. Schweizerische Bienen-Zeitung 6, p. 44–46.

- [15] Wirz, Johannes & Dettli, Martin (2021): Den Bienen Gutes tun. Schweizerische Bienen-Zeitung 8, p. 28–34.
- [16] Wirz, Johannes & Dettli, Martin (2021): Artgerecht und wesensgemäss – was ist der Unterschied? Schweizerische Bienen-Zeitung 10, p. 26–27.
- [17] Wirz, Johannes (2021): Weshalb die Artenvielfalt leidet. Elemente der Naturwissenschaft 115, p. 76–78.
- [18] Wirz, Johannes (2021): Partnerschaft mit der Natur. Das Goetheanum 50, p. 4–5.
- [19] Wirz, Johannes (2021): Goetheanistische Aspekte zum Umgang mit Covid-19. In: Hurter, Ueli & Wittich, Justus (Hrsg.): Coronazeit. Zur geistigen Signatur der Gegenwart, p. 173–188.
- [20] Wirz, Johannes (2021): Goetheanistic aspects in dealing with Covid-19. In: Hurter, Ueli & Wittich, Justus (eds): The Spiritual Signature of our Time in Era of Coronavirus. p. 121–134.

A complete list of all staff publications from 2000 onwards, can be found on the Section's website at www.science.goetheanum.org.

