UNIVERSITY OF HOHENHEIM

Good Research Practice

3502-440 Methods of Scientific Working for Crop Science

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Background

- The **individual practice** of science: How do scientists actually do their work?
- The different **types of scientists** and scientific work: How does one become a scientist?
- The **organization** of the scientific enterprise: Who is funding, controlling and organizing scientific activities?

Key principles of good research practice

- Honesty
- Carefulness and efficiency
- Openness
- Credit
- Social/Community responsibilty
- Education
- Legality
- Sharing of findings
- Respect for subjects

See "Good Research Practice" by the Deutsche Forschungsgemeinschaft (DFG) `http://www.dfg.de/en/research_funding/principles_dfg_funding/good_scientific_practice/index.html`

Why good research practice?

- Establish common standards for research practice
- Numerous cases of science fraud and science scandals
- Numerous cases of bad science and “cargo cult science”
- Therefore, numbers of paper retractions are growing!
- Legal obligation to preserve your scientific record and data
- Bad research practice:
  - Data invention
  - Cherry-picking
  - Deliberate misuse of research tools (e.g., statistics)

What the scientific community/society needs:

Research results are reliable and value-free (no hidden agenda) so they can be an objective basis for choices and actions.

Largest science scandals in Germany

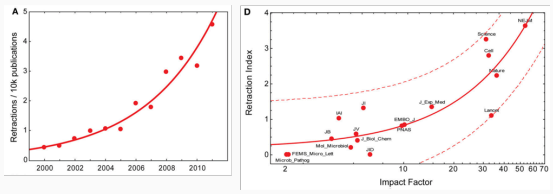
Friedhelm Herrmann and Marion Brach

- Cancer Researchers
- 97 Publications contained falsified data!
- They worked in the 1990s

Jan-Hendrik Schön

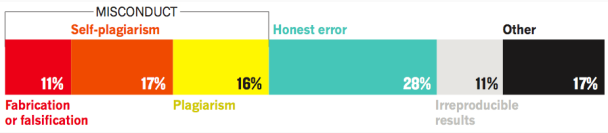
- Ph.D. in Physics (University of Konstanz)
- Published papers during his Ph.D. work each 8th day on average
- 17 papers appeared in Nature and Science
- Was offered a directorship for Max-Planck-Institute in Stuttgart
- Investigation in 2002: 17 Publications were falsified!

Rise in number of retracted papers



Source: Brembs et al. (2013) Frontiers in Human Neuroscience doi: 10.3389/fnhum.2013.00291

Reasons for retractions



RETRACTION

doi:10.1038/nature07645

The RNA-binding protein FCA is an abscisic acid receptor

Fawzi A. Razem, Ashraf El-Kereamy, Suzanne R. Abrams & Robert D. Hill

Nature **439**, 290–294 (2006)

Portions of the work repeated with respect to abscisic acid (ABA) binding have revealed errors in the calculations associated with Fig. 1, with the result that the molar ratio of ABA bound to FCA is substantially lower than claimed. There are also difficulties with the data in Fig. 2a, b that arose from the preparation of FY. We conclude that there is no effect of ABA on the FCA–FY interaction, and therefore requested to retract this paper on 14 July 2008. See the Brief Communication Arising in this issue[1].

1. Risk, J. M., Macknight, R. C. & Day, C. L. FCA does not bind abscisic acid. *Nature* doi:10.1038/nature07646 (this issue).

RETRACTION

doi:10.1038/nature09809

Mediation of pathogen resistance by exudation of antimicrobials from roots

Harsh P. Bais, Balakrishnan Prithiviraj, Ajay K. Jha, Frederick M. Ausubel & Jorge M. Vivanco

Nature **434,** 217–221 (2005)

The authors wish to retract this Letter after a key reference by Walker *et al.*[1] (ref. 9 in this Letter) was retracted from the scientific literature. The withdrawn paper[1] reported ten compounds exuded by *Arabidopsis thaliana* roots, which were used in this Letter to monitor the defence response in *Arabidopsis* seedlings. In this Letter, these ten compounds were shown to have antimicrobial activity against specific pathovars of the bacterial phytopathogen *Pseudomonas syringae* but not against the pathovar *Pseudomonas syringae* pv. *tomato* strain DC3000 that is a highly virulent pathogen of *Arabidopsis*. Moreover, wild-type *P. syringae* DC3000 suppressed the exudation of the ten compounds whereas a DC3000 *hrcC* mutant did not, leading to the conclusion that DC3000 type III effectors block the exudation or synthesis of the ten compounds. As a consequence of the retraction of the Walker *et al.*[1] paper, the validity of the use of the ten compounds as markers of the *Arabidopsis* defence response is now in doubt. Thus, the data in Fig. 3, Table 1, Supplementary Figs 5–8 and Supplementary Table 1 cannot be used to support the conclusions that *P. syringae* DC3000 is generally resistant to antimicrobial compounds exuded by *Arabidopsis* or that *P. syringae* DC3000 type III effectors block the exudation or synthesis of antimicrobial compounds.

1. Walker, T. S., Bais, H. P., Halligan, K. M., Stermitz, F. R. & Vivanco, J. M. Metabolic profiling of root exudates of Arabidopsis thaliana. *J. Agric. Food Chem.* **51,** 2548–2554 (2003).

The Séralini affair

- G.-E. Séralini: Molecular biologist at the University of Caen Lower Normandy
- Critic of GMO safety studies
- 2012: Séralini et al. "Long term toxicity of a Roundup herbicide and a Roundup-tolerant genetically modified maize" was published in the peer-reviewed journal Food and Chemical Toxicology `doi:10.1016/j.fct.2012.08.005`.
- In a long-term experiment with Sprague-Dawley rats which were fed Roundup-tolerant GMO maize, the authors claimed increased cancer rates.
- Release was accompanied by a book & film launch of Séralini about this topic. Journalists were given pre-information if they agreed not to discuss findings with other scientists. Publication featured pictures of cancerous rats, but no pictures of non-cancerous rats.

Source: Seralini et al., (2012) DOI:10.1016/j.fct.2012.08.005

The Séralini affair

Scientific criticism of Séralini et al. (2012):

- Too small samples
- Statistical methods
- General susceptibility of Sprague-Dawley rats to cancer
- Non-sharing of raw data with other scientists

The authors' response to criticism, also published in Food and Chemical Toxicology (`FoodandChemicalToxicology`):

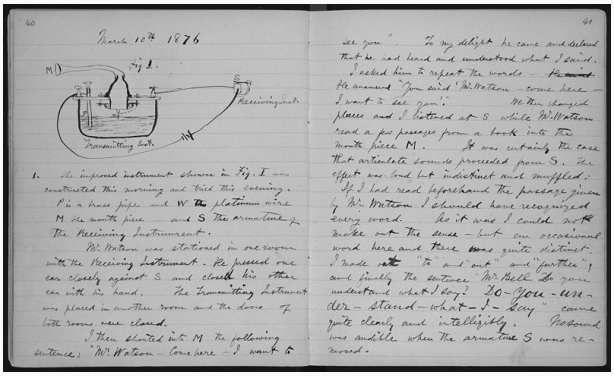
- Sharing of raw data if also pro-GMO studies share the raw data

The journal has retracted the publication eventually (which was also seen as unethical by a share of scientists).

Tools for good scientific working

- Project plan ⇒ Discuss with advisor!
- Laboratory notebook
- Good reference management
- Backup of data and writings
- Store analysis scripts
- Use scripts for statistical analysis (R, SAS) rather than a GUI-based program
- Describe your analysis well enough that it can be reproduced
- You finish your project: Archive your documents and materials.

Lab notebook of Graham Bell (1876)



Own good research practice and the scientific community

How can the scientific community check/help with good research practice?

- Peer reviews
- Replication of studies
- Critical check of results by other means

Reproducible research

Definition:

Not only the publication as the ultimate product of research is important, but also the tools (experimental protocols, computer code, statistical analysis scripts) and the data that are necessary for reproducing the research.

Release the complete material for reanalysis:

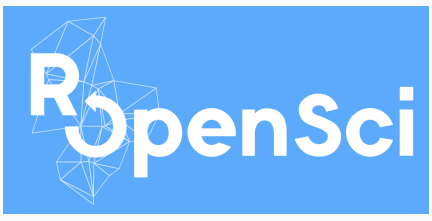
- **Publication**: Advertisement of scholarship
- **Data:** Basis of scholarship
- **Software and experimental tools used for analysis**: Core of scholarship; growing importance of computational analysis!
- `http://www.reproducibleresearch.net/`

Tools for good and reproducible research practice

- Paper-based lab notebook (laboratory)
- Electronic notebook: Wiki, RMarkdown (or Jupyter, Pluto.jl) notebook, Emacs org-mode
- Use version control systems like git
- Consider legal regulations for commercially relevant research (e.g., patents)
- Data storage and backup!
- Where to deposit data at the end of project?
- Public data stores like Dryad for publication (`http://www.datadryad.org`)

⇒ **Discuss this issue with your thesis advisor!**

Tools for open science: ROpenSci



`https://ropensci.org`

Further reading

- Richard van Noorden, The trouble with retractions, Nature 2011
  `http://www.ncbi.nlm.nih.gov/pubmed/21979026`
- Fang et al. (2012) - Describes the outcome of bad research practice

References i

Fang, F. C., Steen, R. G., and Casadevall, A. (2012). Misconduct accounts for the majority of retracted scientific publications. *Proceedings of the National Academy of Sciences*, 109(42):17028–17033.