https://buergeruni.hhu-blog.de/index.php/2025/03/31/warum-vielfalt-und-grundlagenforschung-so-wichtig-sind-und-was-das-mit-einem-kleinen-kreuzbluetler-zu-tun-hat/

Why diversity and basic research are so important – and what this has to do with a small cruciferous plant

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In English, there is this wonderful expression ‘Blast from the past!’ I had such a sudden, unexpected memory from the past the other day when I was visiting the old town centre of Monheim am Rhein. Suddenly I spotted a poster of Wolf Maahn[1], who actually gave a concert in Monheim on 8 March 2025 (Figure 1).

Figure 1: An advertising poster for Wolf Maahn's concert in Monheim am Rhein (23 February 2025; photo by B. A. Walther).

When I was a teenager, our German rock heroes were Herbert Grönemeyer, Heinz-Rudolf Kunze, Marius Müller-Westernhagen and ... Wolf Maahn. Wolf Maahn's first record was ‘Irgendwo in Deutschland’ (well, who remembers records?) and is actually a classic in German rock history. Songs

like the title track ‘Rosen im Asphalt’ and ‘Nur auf der Durchreise’ are lyrically and musically totally awesome. But why am I mentioning this in a blog about plant research?

Because the last track on the record has the following chorus[2]:

‘Yes, we're so free, what's the big deal, we'll do it anywhere,’ although of course they don't explain what they're doing. That is left to your own imagination.

And our target plants are doing the same everywhere at the moment! A few weeks ago, only the rosettes were recognisable, but now millions of thale cress, common shepherd's purse and four-man's-foam are sprouting and flowering all over Germany (Figure 2). And we would like you to send us some of them by taking part in the PUKI collection. It really doesn't take more than 15-20 minutes to collect a plant, and with a little experience it can be done even quicker[3].

Figure 2: In front of a house wall, a dense stand of thale cress grows on top of the areas with open soil, and directly below it, numerous hairy bittercress grow on the area covered with grasses (Düsseldorf, 17 March 2025; photo by B. A. Walther). Thus within one metre, there are two slightly different microhabitats with different plant communities. Further examples of our target plants doing it everywhere at the moment are attached below (Figures 4-9).

And there you have my stream of consciousness à la James Joyce or Marcel Proust. The poster reminded me of Wolf Maahn, it reminded me of his first record, it reminded me of the song ‘Überall’, and then I thought, that fits exactly with what our target plants are doing at the moment.

And that's the unique thing: everyone has different thoughts, associations and preferences. And that's why we shouldn't celebrate unity, but diversity, whether in our society or in nature. That's why protecting minorities is just as important as protecting the diversity of genes, species and

ecosystems. It is now also scientifically proven that diversity protects and strengthens the stability and productivity of ecosystems[4], just as a diverse economic system is much more stable against fluctuations than a one-sided system (e.g., countries that live mainly from the extraction of raw materials[5]). However, instead of protecting and preserving biodiversity at all levels, we are destroying it at an ever-increasing rate. Most scientists agree that we are already in the midst of a mass extinction[6], just like the extinction of the dinosaurs 66 million years ago! This will have a grave impact on human prosperity and well-being[7].

Research into species and ecosystem diversity is carried out by other scientific groups in Germany[8], while our research group specialises in genetic diversity[9]. We investigate how the genetic differences between individual plants affect their chance to survive and reproduce. An exemplary study[10] was published last year, which I would like to present to you here.

The thale cress (*Arabidopsis thaliana*) is found in almost all of Europe, large parts of Asia and Africa. And there are a large number of different populations that are regionally adapted to their environmental conditions by having different genomes, i.e. a large genetic diversity. The first author Gregor Schmitz noticed that the thale cress grew in a relatively small area in the south of Cologne in locations with very different environmental conditions (Figure 3). These included places with a low water and nutrient supply, such as small pavement cracks, but also heavily disturbed habitats, such as frequently mown meadows along busy roads.

Thereupon, Gregor Schmitz collected plants from different locations to investigate whether these plants differ genetically and whether these differences are related to the living conditions at the locations.

Figure 3: Thale cress at three different locations in Cologne (photos by J. Floret).

Together with his colleagues, he then discovered that (1) even within a city there is great genetic diversity and (2) this genetic diversity actually correlates with the living conditions at the locations. Gregor Schmitz commented: 'The genetic diversity that we find in the city is not randomly distributed, but corresponds to the specific differences in the urban environment.' These differences contributed to the plants surviving in habitats that differed mainly in (1) how much and how often they were disturbed by human activities such as weeding or mowing and (2) the nutrient content of the soil. Plants that were threatened by early weeding or mowing flowered very quickly after germination while other plants were able to take more time and therefore had different genes.

'This process, known as 'environmental filtering', was already known: It determines which plant species establish and persist in specific locations. It is fascinating to see that exactly the same process also works for different lineages within a species,' explained co-author Anja Linstädter.

This result is similar to the known genetic differences in humans: for example, people of African origin generally have darker skin[11] and higher immunity to malaria than people of Eurasian origin. What is surprising is that such clear genetic differences in thale cress can occur between populations growing just a few metres apart, e.g., in a pavement crack and in an adjacent meadow.

But does this research have practical applications? On the one hand, I always emphasise that basic research such as this on the Cologne thale cress can often lead to unexpected but important applications that cannot be anticipated in advance. A prime example is Alexander Fleming's[12] discovery of penicillin: he studied the growth of bacteria without the slightest intention of finding a cure for bacterial diseases. It simply happened because he was able to concentrate on basic research. And that is just one example of thousands[13].

On the other hand, the challenges that these plants face in urban environments reflect on a small scale the challenges that plants will have to face in the coming decades as a result of global environmental changes. Cities often have even higher temperatures and drier climates than their surroundings. They are, so to speak, laboratories of the future when it comes to the consequences of climate change. If we can understand how thale cress can cope with these at times extreme conditions, then this could have important practical applications, e.g., in agriculture and forestry, in nature conservation and renaturalisation projects, and in the creation of green cities. Which tree species can we plant in Germany's forests that will still be able to withstand climate change in a hundred years' time[14]? What characteristics do plants need in order to green cities[15]? What skills do crops need to cope with changing conditions so that we can continue to feed humanity in the future[16]?

PUKI invites interested people to participate in this research with a small or even a larger contribution, but also to find out more about our research. This blog post is therefore another information offer from us to you. If you are interested in other topics, please send us a suggestion.

Please send all questions and suggestions to: **Bruno Walther**, Heinrich-Heine-Universität Düsseldorf, Gebäude 26.14, Raum 01.067, Universitätsstr. 1, 40225 Düsseldorf, Tel: 0211-81-13427, Email: Bruno.Walther@hhu.de

Further information can be found here:

1) https://de.wikipedia.org/wiki/Wolf_Maahn

2) https://www.youtube.com/watch?v=5mqLMa_zibs

3) https://www.puki.hhu.de/mach-mit

4) Vielfalt schützt: Biologische Vielfalt hilft Ökosystemen klimatische Extremereignisse abzufedern. https://www.pflanzenforschung.de/de/pflanzenwissen/journal/vielfalt-schuetzt-biologische-vielfalt-hilft-oekosystem-10513, Ökosystemforschung: Pflanzenvielfalt fördert Stabilität von Nahrungsnetzen. https://www.anl.bayern.de/publikationen/anliegen/doc/an42119offenberger_2020_oekosystemforschung.pdf, Artenvielfalt schützt das Klima. https://www.mpg.de/9151504/artenvielfalt-klima, Artenreiche Ökosysteme sind produktiver als artenarme. https://www.ufz.de/index.php?de=36336&webc_pm=4/2016; auch weitere Faktoren sind wichtig: Artenvielfalt allein macht Ökosysteme nicht stabil. https://www.sonnenseite.com/de/umwelt/artenvielfalt-allein-macht-oekosysteme-nicht-stabil/

5) https://de.wikipedia.org/wiki/Ressourcenfluch

6) Eine Million Arten betroffen: Das sechste Massenaussterben ist in vollem Gange. https://www.geo.de/natur/nachhaltigkeit/21267-rtkl-un-report-eine-million-arten-betroffen-das-sechste-massenaussterben#:~:text=Das%20sechste%20Massenaussterben%20hat%20begonnen,Asteriod%20auf%20der%20Erde%20einschlug, Das größte Massensterben seit 66 Millionen Jahren. https://www.deutschlandfunkkultur.de/biodiversitaet-artensterben-folgen-100.html, Ökozid: Wettlauf mit dem Tod. https://www.focus.de/earth/titel-wettlauf-mit-dem-tod_id_137449207.html, Menschliche Eingriffe verringern Biodiversität. https://science.orf.at/stories/3229492/, Global Assessment Report on Biodiversity and Ecosystem Services. https://www.ipbes.net/global-assessment, Accelerated modern human–induced species losses: Entering the sixth mass extinction. https://www.science.org/doi/pdf/10.1126/sciadv.1400253?trk=public_post_comment-text, Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. https://www.pnas.org/doi/epdf/10.1073/pnas.1922686117, The Sixth Mass Extinction: fact, fiction or speculation? https://onlinelibrary.wiley.com/doi/epdf/10.1111/brv.12816, ”There is a mass extinction of plants.” https://www.su.se/english/news/there-is-a-mass-extinction-of-plants-1.612339, 40% of world’s plant species at risk of extinction. https://www.theguardian.com/environment/2020/sep/30/world-plant-species-risk-extinction-fungi-earth, Hunderte Pilzarten vom Aussterben bedroht. https://science.orf.at/stories/3229511/,

7) Wird die Menschheit das sechste große Massenaussterben überleben? https://www.nationalgeographic.de/umwelt/2017/03/wird-die-menschheit-das-sechste-grosse-massenaussterben-ueberleben, Fokus Biodiversität: Naturverlust als Bedrohung für Wohlstand und Überleben. https://www.gdv.de/resource/blob/186740/ccd6d60ea62c81528495afbfe788e18c/economics-and-finance-flash-01-25-download-data.pdf, Massensterben der Arten - Gefahr auch für die Menschheit. https://www.dw.com/de/das-massensterben-der-arten-eine-der-gr%C3%B6%C3%9Ften-gefahren-f%C3%BCr-die-menschheit/a-61674077, The Economics of Ecosystems & Biodiversity. https://teebweb.org/, Ecological disruptions are a risk to national security. https://theconversation.com/ecological-disruptions-are-a-risk-to-national-security-248754

8) https://www.senckenberg.de/de/institute/sbik-f/, https://www.ipbes.net/, https://www.fona.de/de/themen/biodiversitaet.php, https://www.mpg.de/biodiversitaet, https://www.feda.bio/wp-content/uploads/2024/05/2024-05_FEdA-Broschuere_DE-web.pdf

9) https://trr341.uni-koeln.de/

10) Die Ackerschmalwand in Köln ist an ihre städtische Umgebung angepasst. https://uni-koeln.de/universitaet/aktuell/meldungen/meldungen-detail/die-ackerschmalwand-in-koeln-ist-an-ihre-staedtische-umgebung-angepasst

11) https://de.wikipedia.org/wiki/Hautfarbe

12) https://de.wikipedia.org/wiki/Alexander_Fleming

13) Nobel laureate: Basic science research is critical for medical progress. https://www.aamc.org/news/nobel-laureate-basic-science-research-critical-medical-progress

14) Baumartenwahl im Klimawandel. https://www.kiwuh.de/service/wissenswertes/wissenswertes/baumartenwahl-im-klimawandel, Klimaresiliente Wälder durch Migration besser angepasster Baumarten. https://www.swr.de/wissen/assistierte-migration-klimaresiliente-waelder-durch-besser-angepasste-baumarten-100.html, Wie Wälder dem Klimawandel trotzen können. https://www.deutschlandfunk.de/deutschlands-gruene-lungen-wie-waelder-dem-klimawandel-100.html, Klimaresiliente Baumarten finden! https://www.hlnug.de/stadtgruen-im-klimawandel/klimaresiliente-baumarten-finden

15) Stadtgrün wirkt! https://gruen-in-der-stadt.de/uploads/files/28092023_Stadtgru%CC%88nWirkt_getaggt_NEU_final-1.pdf, Quo vadis Biodiversitätsschutz? Einheimische Stadtbäume im Klimawandel. https://www.anl.bayern.de/publikationen/anliegen/doc/an43106interview_2021_boell_zehm.pdf, Wir brauchen in Zukunft eine breite Palette von Baumarten. https://33prozentmagazin.de/wir-brauchen-in-zukunft-eine-breite-palette-von-baumarten/, "Stadtgrün 2021+" : Neue Bäume braucht das Land! https://www.lwg.bayern.de/landespflege/urbanes_gruen/085113/index.php, Stadtbäume müssen Hitze und Trockenheit verkraften. https://www.ardalpha.de/wissen/natur/pflanzen/wald-waelder-bayern-baum-baeume-klimawandel-stadtbaeume-100.html

16) Hotter, drier, CRISPR: editing for climate change. https://www.sciencedaily.com/releases/2021/03/210301112331.htm, SciDevNet: Forschende in Afrika setzen auf Gentechnik für klimaresistente Nutzpflanzen. https://www.kooperation-international.de/aktuelles/fuer-sie-entdeckt/detail/info/scidevnet-forschende-in-afrika-setzen-auf-gentechnik-fuer-klimaresistente-nutzpflanzen, ntwicklung einer neuen Generation von klimaresistenten Anbaupflanzen. https://cordis.europa.eu/article/id/442178-creating-a-new-generation-of-climate-resilient-crops/de, Können wir bald klimafeste Nutzpflanzen anbauen? https://de.euronews.com/green/2022/07/18/konnen-wir-bald-klimafeste-nutzpflanzen-anbauen, Züchtung klimaresistenter Kulturpflanzen für den Biolandbau. https://cordis.europa.eu/article/id/442657-breeding-climate-resilient-crops-for-organic-agriculture/de, Pflanzenzucht mit Genschere? https://www.dw.com/de/klimaresistente-pflanzen-durch-die-genschere/video-64161208, Reiche Ernten in heißen Zeiten. https://www.pflanzenforschung.de/de/pflanzenwissen/journal/reiche-ernten-heissen-zeiten, Studie: Klimastress gefährdet unsere Ernten stärker als gedacht. https://www.swr.de/wissen/klimawandel-einfluss-landwirtschaft-studie-100.html, Mit den neuen Gentechnikverfahren dem Klimawandel trotzen? https://www.kritischer-agrarbericht.de/fileadmin/Daten-KAB/KAB-2021/KAB_2021_300_305_Kawall.pdf

Further examples of the many different microhabitats in which our target plants are currently growing and flowering:

Figure 4. Close-up of a thale cress from the stand shown in Figure 2 (Düsseldorf, 23 March 2025; photos by B. A. Walther).

Figure 5. Detailed photos of a hairy bittercress from the stand shown in Figure 2 (Düsseldorf, 23 March 2025; photos by B. A. Walther).

Figure 6. A dense stand of hairy bittercress within a somewhat damp meadow, with a typical accompanying fauna of ribwort plantain and numerous grasses (Düsseldorf, 23 March 2025; photo by B. A. Walther).

Figure 7. Close-up of a hairy bittercress within a somewhat damp meadow, with a typical accompanying fauna of daisies, clover and numerous grasses (Düsseldorf, 23 March 2025; photo by B. A. Walther).

Figure 8. A shepherd's purse and a hairy bittercress within a somewhat damp meadow (Düsseldorf, 23 March 2025; photo by B. A. Walther).

Figure 9. A stand of thale cress on a dry meadow on a sun-exposed, south-facing slope (Düsseldorf, 23 March 2025; photo by B. A. Walther).