Greenhouse gas emissions from integrated urban drainage systems: Where do we stand?

As sources of greenhouse gas (GHG) emissions, integrated urban drainage systems (IUDSs) (i.e., sewer systems, wastewater treatment plants and receiving water bodies) contribute to climate change. This paper, produced by the International Working Group on Data and Models, which works under the IWA/IAHR Joint Committee on Urban Drainage, reviews the state-of-the-art and modelling tools developed recently to understand and manage GHG emissions from IUDS. Further, open problems and research gaps are discussed and a framework for handling GHG emissions from IUDSs is presented. The literature review reveals that there is a need to strengthen already available mathematical models for IUDS to take GHG into account.
Dynamic mechanical characterization with respect to temperature, humidity, frequency and strain in mPOFs made of different materials

This paper presents a dynamic mechanical analysis (DMA) of polymer optical fibers (POFs) to obtain their Young modulus with respect to the variation of strain, temperature, humidity and frequency. The POFs tested are made of polymethyl methacrylate (PMMA), Topas grade 5013, Zeonex 480R and Polycarbonate (PC). In addition, a step index POF with a core composed of Topas 5013 and cladding of Zeonex 480R is also analyzed. Results show a tradeoff between the different fibers for different applications, where the Zeonex fiber shows the lowest Young modulus among the ones tested, which makes it suitable for high-sensitivity strain sensing applications. In addition, the fibers with Topas in their composition presented low temperature and humidity sensitivity, whereas PMMA fibers presented the highest Young modulus variation with different frequencies. The results presented here provide guidelines for the POF material choice for different applications and can pave the way for applications involving the combination of different polymer materials.

General information

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Authors: Leal-Junior, A. (Ekstern), Frizera, A. (Ekstern), Pontes, M. J. (Ekstern), Fasano, A. (Intern), Woyessa, G. (Intern), Bang, O. (Intern), Marques, C. A. (Ekstern)
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Type-2 fuzzy elliptic membership functions for modeling uncertainty

Whereas type-1 and type-2 membership functions (MFs) are the core of any fuzzy logic system, there are no performance criteria available to evaluate the goodness or correctness of the fuzzy MFs. In this paper, we make extensive analysis in terms of the capability of type-2 elliptic fuzzy MFs in modeling uncertainty. Having decoupled parameters for its support and width, elliptic MFs are unique amongst existing type-2 fuzzy MFs. In this investigation, the uncertainty distribution along the elliptic MF support is studied, and a detailed analysis is given to compare and contrast its performance with existing type-2 fuzzy MFs. Furthermore, fuzzy arithmetic operations are also investigated, and our finding is that the elliptic MF has similar features to the Gaussian and triangular MFs in addition and multiplication operations. Moreover, we have tested the prediction capability of elliptic MFs using interval type-2 fuzzy logic systems on oil price prediction problem for a data set from 2nd Jan 1985 till 25th April 2016. Throughout the simulation studies, an extreme learning machine is used to train the interval type-2 fuzzy logic system. The prediction results show that, in addition to their various advantages mentioned above, elliptic MFs have comparable prediction results when compared to Gaussian and triangular MFs. Finally, in order to test the performance of fuzzy logic controller with elliptic interval type-2 MFs, extensive real-time experiments are conducted for the 3D trajectory tracking problem of a quadrotor. We believe that the results of this study will open the doors to elliptic MFs’ wider use of real-world identification and control applications as the proposed MF is easy to interpret in addition to its unique features.
Learning-by-doing: experience from 20 years of teaching LCA to future engineers

Purpose: In support of the sustainable development of our societies, future engineers should have elementary knowledge in sustainability assessment and use of life cycle assessment. Publications on pedagogical experience with teaching life cycle assessment (LCA) in high-level education are however scarce. Here, we describe and discuss 20 years of experience in teaching LCA at MSc level in an engineering university with the ambition to share our insights and inspire teaching of LCA as part of a university curriculum. Methods: We detail the design of an LCA course taught at the Technical University of Denmark since 1997. The course structure relies on (i) a structured combination of theoretical teaching, practical assignments and hands-on practice on LCA case studies, and (ii) the conduct of real-life LCA case studies in collaboration with companies or other organisations. Through the semester-long duration of the course, students from different engineering backgrounds perform full-fledged LCA studies in groups, passing through two iterations—a screening LCA supporting a more targeted LCA. Results and discussion: The course design, which relies on a learning-by-doing principle, is transparently described to inspire LCA teachers among the readers. Historical evolution and statistics about the course, including its 192 case studies run in collaboration with 105 companies and institutions, are analysed and serve as basis to discuss the benefits and challenges of its different components, such as the theory acquisition, the assignment work, the LCA software learning, the conduct of case studies, the merits of industrial collaborations and grading approaches. Conclusions: We demonstrate the win-win situation created by the setting of the course, in which the students are actively engaged and learn efficiently how to perform an LCA while the collaborating companies often get useful insights into their analysed case studies. The course can also be an eye opener for companies unfamiliar with LCA, who get introduced to life cycle thinking and the potential benefits of LCA. We have no hesitation in recommending industries and LCA teachers to engage into such collaborations even in the fundamental teaching of LCA techniques.
Environmentally friendly treatment of highly potent pharmaceuticals in hospital wastewater - Mermiss


Den traditionelle metode til rensning af spildevand er baseret på aktivt slam. Metoden er effektiv overfor letnedbrydelige lægemidler, men ineffektiv overfor middelsvære og svært nedbrydelige lægemidler.

Teknologien med biofilm er testet i laboratorieskala og i pilot-skala på dets råspildevand med koncentreret indhold af lægemidler fra en kræftafdeling, dets blandet råspildevand fra et hospital, dets almindeligt råspildevand fra Herning Vand, og dets på udløbsvand fra Viby renseanlæg. Over 95% af den samlede belastning med lægemidler i miljøet kommer i dag fra almindeligt husspildevand, både fra håndkøbsmedicin og fra patienter i ambulant behandling.

Projektet gennemførte således en benchmarking af lægemiddelfjernelse på forskellige typer af spildevand, og kunne på den baggrund demonstrere, at en biofilm-baseret teknologi er langt mere effektiv end den konventionelle aktiv slam behandling, som bruges i dag. Bl.a. viser projektet, at teknologien med fordel kan anvendes til at efterpolere allerede renset spildevand, og at driftsomkostningerne til teknologien er relativt lave.

Resultaterne af projektet er så lovende, at de allerede er anvendt til at starte et nyt MUDP-projekt, MerEff, der tester teknologien til at efterpolere renset spildevand i større skala på Herning Vands renseanlæg.

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Fast Inscription of Long Period Gratings in Microstructured Polymer Optical Fibers
We demonstrate 20 dB long period grating (LPG) fast inscription in microstructured polymer optical fibers (mPOFs) using a point-by-point technique obtaining an LPG total length of 25 mm. Two 248 nm UV laser pulses of 15 ns duration have been employed for every inscription point, which means a time reduction by over 21 times compared with the fastest inscription time already reported in literature. The device has been fabricated in a single-mode mPOF with a core that has been doped with benzyl dimethyl ketal for photosensitivity enhancement. Moreover, we characterize the strain and temperature responses and the stability of the fabricated gratings response under different conditions in order to assess the viability for different applications.

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Direct whole-genome sequencing of Plasmodium falciparum specimens from dried erythrocyte spots

Background: Plasmodium falciparum malaria remains a major health burden and genomic research represents one of the necessary approaches for continued progress towards malaria control and elimination. Sample acquisition for this purpose is troublesome, with the majority of malaria-infected individuals living in rural areas, away from main infrastructure and the electrical grid. The aim of this study was to describe a low-tech procedure to sample P. falciparum specimens for direct whole genome sequencing (WGS), without use of electricity and cold-chain. Methods: Venous blood samples were collected from malaria patients in Bandim, Guinea-Bissau and leukocyte-depleted using Plasmodipur filters, the enriched parasite sample was spotted on Whatman paper and dried. The samples were stored at ambient temperatures and subsequently used for DNA-extraction. Ratios of parasite:human content of the extracted DNA was assessed by qPCR, and five samples with varying parasitaemia, were sequenced. Sequencing data were used to analyse the sample content, as well as sample coverage and depth as compared to the 3d7 reference genome. Results: qPCR revealed that 73% of the 199 samples were applicable for WGS, as defined by a minimum ratio of parasite:human DNA of 2:1. WGS revealed an even distribution of sequence data across the 3d7 reference genome, regardless of parasitaemia. The acquired read depths varied from 16 to 99×, and coverage varied from 87.5 to 98.9% of the 3d7 reference genome. SNP-analysis of six genes, for which amplicon sequencing has been performed previously, confirmed the reliability of the WGS-data. Conclusion: This study describes a simple filter paper based protocol for sampling P. falciparum from malaria patients for subsequent direct WGS, enabling acquisition of samples in remote settings with no access to electricity.
Dried blood spots, Dried erythrocyte spots, Leukocyte depletion, Malaria, Plasmodium falciparum, Sub-Saharan Africa, Whole-genome sequencing

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Determining Biodegradation Kinetics of Hydrocarbons at Low Concentrations: Covering 5 and 9 Orders of Magnitude of Kow and Kaw

A partitioning-based experimental platform was developed and applied to determine primary biodegradation kinetics of 53 hydrocarbons at ng/L to μg/L concentrations covering C8-C20, 11 structural classes, and several orders of magnitude in hydrophobicity and volatility: (1) Passive dosing from a loaded silicone donor was used to set the concentration of each hydrocarbon in mixture stock solutions; (2) these solutions were combined with environmental water samples in gastight auto sampler vials for 1-100 days incubation, and (3) automated solid phase microextraction (SPME) coupled to GC-MS was applied directly on these test systems for measuring primary biodegradation relative to abiotic controls. First order biodegradation kinetics were obtained for 40 hydrocarbons in activated sludge filtrate, 18 in seawater, and 21 in lake water. Water phase half-lives in seawater and lake water were poorly related to hydrophobicity and volatility but were, with a few exceptions, within a factor of 10 or shorter than BioHCwin predictions. The most persistent hydrocarbons, 1,1,4,4,6-pentamethyldecalin, perhydropyrene, 1,2,3,6,7,8-hexahydropyrene, and 2,2,4,4,6,8,8-heptamethylnonane, showed limited or inconsistent degradation in all three environmental media. This biodegradation approach can cover a large chemical space at low substrate concentrations, which makes it highly suited for optimizing predictive models for environmental biodegradation.
Prevalence and risk factors for CTX-M gram-negative bacteria in hospitalized patients at a tertiary care hospital in Kilimanjaro, Tanzania

Emergence and spread of extended spectrum beta-lactamase (ESBL)-producing gram-negative bacteria, mainly due to CTX-M, is a major global public health problem. Patients infected with ESBL-producing gram-negative bacteria have an increased risk of treatment failure and death. We investigated the prevalence and risk factors for CTX-M gram-negative bacteria isolated from clinical specimens of patients hospitalized at a tertiary care hospital in Kilimanjaro, Tanzania. Isolated gram-negative bacteria from inpatients admitted at Kilimanjaro Christian Medical Centre (KCMC) between August 2013 and August 2015 were fully genome sequenced. The prevalence of ESBL-producing gram-negative bacteria was determined based on the presence of blaCTX-M. The odds ratio (OR) and risk factors for ESBL-producing gram-negative bacteria due to CTX-M were assessed using logistic regression models. The overall CTX-M prevalence (95% CI) was 13.6% (10.1–18.1). Adjusted for other factors, the OR of CTX-M gram-negative bacteria for patients previously hospitalized was 0.26 (0.08–0.88), p = 0.031; the OR for patients currently on antibiotics was 4.02 (1.29–12.58), p = 0.017; the OR for patients currently on ceftriaxone was 0.14 (0.04–0.46), p = 0.001; and the OR for patients with wound infections was 0.24 (0.09–0.61), p = 0.003. The prevalence of ESBL-producing gram-negative bacteria due to CTX-M in this setting is relatively low compared to other previous reports in similar settings. However, to properly stop further spread in the hospital, we recommend setting up a hospital surveillance system that takes full advantage of the available next-generation sequencing facility to routinely screen for all types of bacterial resistance genes.
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Authors: Sonda, T. (Ekstern), Kumburu, H. (Ekstern), van Zwetselaar, M. (Ekstern), Alifrangis, M. (Ekstern), Mmbaga, B. T. (Ekstern), Lund, O. (Intern), Møller Aarestrup, F. (Intern), Kibiki, G. (Ekstern)
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Upconversion detector for range-resolved DIAL measurement of atmospheric CH₄

We demonstrate a robust, compact, portable and efficient upconversion detector (UCD) for a differential absorption lidar (DIAL) system designed for range-resolved methane (CH₄) atmospheric sensing. The UCD is built on an intracavity pump system that mixes a 1064 nm pump laser with the lidar backscatter signal at 1646 nm in a 25-mm long periodically poled lithium niobate crystal. The upconverted signal at 646 nm is detected by a photomultiplier tube (PMT). The UCD with a noise equivalent power around 127 fW/Hz₁/₂ outperforms a conventional InGaAs based avalanche photodetector when both are used for DIAL measurements. Using the UCD, CH₄ DIAL measurements have been performed yielding differential absorption optical depths with relative errors of less than 11% at ranges between 3 km and 9 km.
Multiplex PCR for detection of plasmid-mediated colistin resistance determinants, mcr-1, mcr-2, mcr-3, mcr-4 and mcr-5 for surveillance purposes

Background and aim: Plasmid-mediated colistin resistance mechanisms have been identified worldwide in the past years. A multiplex polymerase chain reaction (PCR) protocol for detection of all currently known transferable colistin resistance genes (mcr-1 to mcr-5, and variants) in Enterobacteriaceae was developed for surveillance or research purposes.

Methods: We designed four new primer pairs to amplify mcr-1, mcr-2, mcr-3 and mcr-4 gene products and used the originally described primers for mcr-5 to obtain a stepwise separation of ca 200 bp between ampli-cons. The primer pairs and amplification conditions allow for single or multiple detection of all currently described mcr genes and their variants present in Enterobacteriaceae. The protocol was validated testing 49 European Escherichia coli and Salmonella isolates of animal origin. Results: Multiplex PCR results in bovine and porcine isolates from Spain, Germany, France and Italy showed full concordance with whole genome sequence data. The method was able to detect mcr-1, mcr-3 and mcr-4 as singletons or in different combinations as they were present in the test isolates. One new mcr-4 variant, mcr-4.3, was also identified. Conclusions: This method allows rapid identification of mcr-positive bacteria and overcomes the challenges of phenotypic detection of colistin resistance. The multiplex PCR should be particularly interesting in settings or laboratories with limited resources for performing genetic analysis as it provides information on the mechanism of colistin resistance without requiring genome sequencing.
Experimentally validated dispersion tailoring in a silicon strip waveguide with alumina thin-film coating

We propose a silicon strip waveguide structure with alumina thin-film coating in-between the core and the cladding for group-velocity dispersion tailoring. By carefully designing the core dimension and the coating thickness, a spectrally-flattened near-zero anomalous group-velocity dispersion within the telecom spectral range is obtained, which is predicted to significantly broaden the bandwidth of four-wave mixing. We validate this by characterizing the wavelength conversion in a waveguide sample by atomic layer deposition technology, which to our best knowledge is the first experimental demonstration of the proposed structure. Due to the alumina thin-film coating, the wavelength conversion bandwidth reaches $58\sim\mathrm{nm}$, an increase by a factor of 1.3 compared to the corresponding structure without coating. This method can also be applied to other material platforms and applications requiring accurate group-velocity dispersion control.
Mid-IR hyperspectral imaging for label-free histopathology and cytology

Mid-infrared (MIR) imaging has emerged as a valuable tool to investigate biological samples, such as tissue histological sections and cell cultures, by providing non-destructive chemical specificity without recourse to labels. While feasibility studies have shown the capabilities of MIR imaging approaches to address key biological and clinical questions, these techniques are still far from being deployable by non-expert users. In this review, we discuss the current state of the art of MIR technologies and give an overview on technical innovations and developments with the potential to make MIR imaging systems more readily available to a larger community. The most promising developments over the last few years...
are discussed here. They include improvements in MIR light sources with the availability of quantum cascade lasers and supercontinuum IR sources as well as the recently developed upconversion scheme to improve the detection of MIR radiation. These technical advances can substantially speed up data acquisition of multispectral or hyperspectral datasets thus providing the end user with vast amounts of data when imaging whole tissue areas of many mm². Therefore, effective data analysis is of tremendous importance, and progress in method development is discussed with respect to the specific biomedical context.

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Cryogenic Preamplifiers for Magnetic Resonance Imaging

Pursuing the ultimate limit of detection in magnetic resonance imaging (MRI) requires cryogenics to decrease the thermal noise of the electronic circuits. As cryogenic coils for MRI are slowly emerging cryogenic preamplifiers are required to fully exploit their potential. A cryogenic preamplifier operated at 77 K is designed and implemented for C imaging at 3 T (32.13 MHz), using off-the-shelves components. The design is based on a high electron mobility transistor (ATF54143) in a common source configuration. Required auxiliary circuitry for optimal cryogenic preamplifier performance is also presented consisting of a voltage regulator (noise free supply voltage and optimal power consumption), switch, and trigger (for active detuning during transmission to protect the preamplifier). A gain of 18 dB with a noise temperature of 13.7 K is achieved. Performing imaging experiments in a 3 T scanner showed an 8% increased signal-to-noise ratio from 365 to 399 when lowering the temperature of the preamplifier from 296 to 77 K while keeping the coil at room temperature. This paper thus enables the merger of cryogenic coils and preamplifiers in the hopes of reaching the ultimate limit of detection for MRI.
Column leaching from a Danish forest soil amended with wood ashes: fate of major and trace elements

Application of wood ashes onto two Danish forest soil horizons (A- and O-horizons) was investigated through a series of column experiments for ash dosages of 3, 9 and 30 Mg ha\(^{-1}\). Developments in the composition of the percolating soil solutions were investigated both in a short- (below 0.5 m\(^3\) m\(^{-2}\) of infiltrating water) and long-term perspective (until 2.0 m\(^3\) m\(^{-2}\) of infiltrating water). The higher the ash dosage, the higher the percolation of readily soluble elements (K, Cl, Mg and S) occurred within a short-term perspective. This initial washout of soluble elements resulted in the exchange of ions in the soil, thereby causing other soil bound elements to be released and the pH to decrease temporarily. Wood ash application also promoted an increase in the long-term leaching of As, Cu, K, P and Si beyond the O-horizon layer (until \(\sim 2.0 \text{ m}^3 \text{ m}^{-2}\)), while the migration of trace elements through this soil horizon appeared to be of limited concern compared with Danish groundwater quality criteria. Relatively similar effects were observed for both the use of 3 and 9 Mg ha\(^{-1}\) dosages on the composition of the percolating soil solutions. Low mobility of Cd, Co, Cr, Cu, Mo, Ni, Pb, Se, V and Zn was observed. The released amounts were generally limited to a few percentage points of their total contents in the columns. The potential accumulation of trace elements within the forest soil should be evaluated with respect to the specific case, if high ash dosages are intended for spreading.

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Occurrence of cyclic imines in European commercial seafood and consumers risk assessment

Cyclic imines constitute a quite recently discovered group of marine biotoxins that act on neural receptors and that bioaccumulate in seafood. They are grouped together due to the imino group functioning as their common pharmacore, responsible for acute neurotoxicity in mice. Cyclic imines (CIs) have not been linked yet to human poisoning and are not regulated in the European Union (EU), although the European Food Safety Authority (EFSA) requires more data to perform conclusive risk assessment for consumers. Several commercial samples of bivalves including raw and processed samples from eight countries (Italy, Portugal, Slovenia, Spain, Ireland, Norway, The Netherlands and Denmark) were obtained over 2 years. Emerging cyclic imine concentrations in all the samples were analysed on a LC-3200QTRAP and
LC-HRMS QExactive mass spectrometer. In shellfish, two CIs, pinnatoxin G (PnTX-G) and 13-desmethylspirolide C (SPX-1) were found at low concentrations (0.1–12 µg/kg PnTX-G and 26–66 µg/kg SPX-1), while gymnodimines and pteriatoxins were not detected in commercial (raw and processed) samples. In summary, SPX-1 (n: 47) and PnTX-G (n: 96) were detected in 9.4% and 4.2% of the samples, respectively, at concentrations higher than the limit of quantification (LOQ), and in 7.3% and 31.2% of the samples at concentrations lower than the LOQ (25 µg/kg for SPX-1 and 3 µg/kg for PnTX-G), respectively. For the detected cyclic imines, the average exposure and the 95th percentile were calculated. The results obtained indicate that it is unlikely that a potential health risk exists through the seafood diet for CIs in the EU. However, further information about CIs is necessary in order to perform a conclusive risk assessment.

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Aberrant intestinal microbiota in individuals with prediabetes

Aims/hypothesis: Individuals with type 2 diabetes have aberrant intestinal microbiota. However, recent studies suggest that metformin alters the composition and functional potential of gut microbiota, thereby interfering with the diabetes-related microbial signatures. We tested whether specific gut microbiota profiles are associated with prediabetes (defined as fasting plasma glucose of 6.1–7.0 mmol/l or HbA1c of 42–48 mmol/mol [6.0–6.5%]) and a range of clinical biomarkers of poor metabolic health. Methods: In the present case–control study, we analysed the gut microbiota of 134 Danish adults with prediabetes, overweight, insulin resistance, dyslipidaemia and low-grade inflammation and 134 age- and sex-matched individuals with normal glucose regulation. Results: We found that five bacterial genera and 36 operational taxonomic units (OTUs) were differentially abundant between individuals with prediabetes and those with normal glucose regulation. At the genus level, the abundance of Clostridium was decreased (mean log2 fold change −0.64 (SEM 0.23), \( p_{\text{adj}} = 0.0497 \)), whereas the abundances of Dorea, [Ruminococcus], Sutterella and Streptococcus were increased (mean log2 fold change 0.51 (SEM 0.12), \( p_{\text{adj}} = 5 \times 10^{-4} \); 0.51 (SEM 0.11), \( p_{\text{adj}} = 1 \times 10^{-4} \); 0.60 (SEM 0.21), \( p_{\text{adj}} = 0.0497 \); and 0.92 (SEM 0.21), \( p_{\text{adj}} = 4 \times 10^{-4} \), respectively). The two OTUs that differed the most were a member of the order Clostridiales (OTU 146584) and Akkermansia muciniphila, which both displayed lower abundance among individuals with prediabetes (mean log2 fold change −1.74 (SEM 0.41), \( p_{\text{adj}} = 2 \times 10^{-3} \) and −1.65 (SEM 0.34), \( p_{\text{adj}} = 4 \times 10^{-4} \), respectively). Faecal transfer from donors with prediabetes or screen-detected, drug-naive type 2 diabetes to germfree Swiss Webster or conventional C57BL/6 J mice did not induce impaired glucose regulation in recipient mice.

Conclusions/interpretation: Collectively, our data show that individuals with prediabetes have aberrant intestinal microbiota characterised by a decreased abundance of the genus Clostridium and the mucin-degrading bacterium A. muciniphila. Our findings are comparable to observations in overt chronic diseases characterised by low-grade inflammation.
Linking secondary metabolites to gene clusters through genome sequencing of six diverse Aspergillus species

The fungal genus of Aspergillus is highly interesting, containing everything from industrial cell factories, model organisms, and human pathogens. In particular, this group has a prolific production of bioactive secondary metabolites (SMs). In this work, four diverse Aspergillus species (A. campestris, A. novofumigatus, A. ochraceoroseus, and A. steynii) have been whole-genome PacBio sequenced to provide genetic references in three Aspergillus sections. A. taichungensis and A. candidus also were sequenced for SM elucidation. Thirteen Aspergillus genomes were analyzed with comparative genomics to determine phylogeny and genetic diversity, showing that each presented genome contains 15–27% genes not found in other sequenced Aspergilli. In particular, A. novofumigatus was compared with the pathogenic species A. fumigatus. This suggests that A. novofumigatus can produce most of the same allergens, virulence, and pathogenicity factors as A. fumigatus, suggesting that A. novofumigatus could be as pathogenic as A. fumigatus. Furthermore, SMs were linked to gene clusters based on biological and chemical knowledge and analysis, genome sequences, and predictive algorithms. We thus identify putative SM clusters for aflatoxin, chlorflavonin, and ochrindol in A. ochraceoroseus, A. campestris, and A. steynii, respectively, and novofumigatonin, ent-cycloechinulin, and epiaszonalenins in A. novofumigatus. Our study delivers six fungal genomes, showing the large diversity found in the Aspergillus genus; highlights the potential for discovery of beneficial or harmful SMs; and supports reports of A.
novofumigatus pathogenicity. It also shows how biological, biochemical, and genomic information can be combined to identify genes involved in the biosynthesis of specific SMs.

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