



Cover image: Pictured is a peregrine falcon (*Falco peregrinus*) overlooking Chicago. Paul R. Martin and Frances Bonier found that dominant, urban-adapted bird species were more widespread than subordinate species in cities where they coexist, and that this pattern was absent in countries with developing economies. The results suggest that direct competitive interactions reduce the ability of urban-adapted, subordinate bird species to persist in cities, and that increased economic development may heighten the effects of competition on subordinate species, thereby reducing urban species diversity. See the article by Martin and Bonier on pages E11495–E11504. Image courtesy of Derek Zaraza (photographer).

From the Cover

- E11495 Urban adaptation and competition
- 12429 Underestimating environmental concerns
- 12471 Speciation in tropical mountains
- 12501 Mucus clearance failure in lungs
- 12525 Brain omega-3 fatty acid metabolism

Contents

THIS WEEK IN PNAS

- 12319 In This Issue

LETTERS (ONLINE ONLY)

- E11429 **Incorrect policy interpretation affects conclusion on SO₂ emissions by coal-fired power plants in China**
Ye Qi and Changgui Dong
- E11430 **Reply to Qi and Dong: Policy clarification and robustness of effects**
Valerie J. Karplus, Shuang Zhang, and Douglas Almond
- E11432 **Penicillins' defined daily doses must be changed**
Florent Charra, Philippe Berthelot, and Frédérique Bergheau
- E11433 **Reply to Charra et al.: Global longitudinal assessment of 2019 changes in defined daily doses**
Eili Y. Klein, Katie K. Tseng, Simon A. Levin, Herman Goossens, and Ramanan Laxminarayan

OPINION—Leading scientists discuss current issues

- 12321 **Flood-risk reduction: Structural measures and diverse strategies**
Z. W. Kundzewicz, D. L. T. Hegger, P. Matczak, and P. P. J. Driessen

RETROSPECTIVE

- 12326 **The varied careers of Kenneth L. Bowles**
M. Granger Morgan, Mark Overgaard, and Ann E. Bowles

COMMENTARIES

- 12331 **Interspecific conflict structures urban avian assemblages**
Alexander Charles Lees
→ See companion article on page E11495
- 12334 **Environmentalism, norms, and identity**
Thomas Dietz and Cameron T. Whitley
→ See companion article on page 12429

- 12337 Janzen's mountain passes hypothesis is comprehensively tested in its fifth decade**
M. Alex Smith
→ See companion article on page 12471
- 12340 What it takes for a cough to expel mucus from the airway**
Burton F. Dickey
→ See companion article on page 12501
- 12343 ACSL6 is critical for maintaining brain DHA levels**
Raphaël Chouinard-Watkins and Richard P. Bazinet
→ See companion article on page 12525

PNAS PLUS

- 12346 Significance Statements**
Brief statements written by the authors about the significance of their papers.

INAUGURAL ARTICLE

- 12349 Detecting and explaining why aquifers occasionally become degraded near hydraulically fractured shale gas wells**
Josh Woda, Tao Wen, David Oakley, David Yoxtheimer, Terry Engelder, M. Clara Castro, and Susan L. Brantley

PHYSICAL SCIENCES

APPLIED PHYSICAL SCIENCES

- 12359 Differential growth and shape formation in plant organs**
Changjin Huang, Zilu Wang, David Quinn, Subra Suresh, and K. Jimmy Hsia
- 12365 Mesoscale structure, mechanics, and transport properties of source rocks' organic pore networks**
Jeremie Berthonneau, Amaël Obliger, Pierre-Louis Valdenaire, Olivier Grauby, Daniel Ferry, Damien Chaudanson, Pierre Levitz, Jae Jin Kim, Franz-Josef Ulm, and Roland J.-M. Pellenq
- 12371 Oscillating path between self-similarities in liquid pinch-off**
Antoine Lagarde, Christophe Josserand, and Suzie Protière

BIOPHYSICS AND COMPUTATIONAL BIOLOGY

- E11455 Design and in vitro realization of carbon-conserving photorespiration**
Devin L. Trudeau, Christian Edlich-Muth, Jan Zarzycki, Marieke Scheffen, Moshe Goldsmith, Olga Khersonsky, Ziv Avizemer, Sarel J. Fleishman, Charles A. R. Cotton, Tobias J. Erb, Dan S. Tawfik, and Arren Bar-Even
- 12377 Cats use hollow papillae to wick saliva into fur**
Alexis C. Noel and David L. Hu
- 12453 Probabilistic control of HIV latency and transactivation by the Tat gene circuit**
Youfang Cao (曹又方), Xue Lei (雷雪), Ruy M. Ribeiro, Alan S. Perelson, and Jie Liang (梁杰)

CHEMISTRY

- 12383 Receptor selectivity from minimal backbone modification of a polypeptide agonist**
Shi Liu, Ross W. Cheloha, Tomoyuki Watanabe, Thomas J. Gardella, and Samuel H. Gellman
- 12389 Elastic and Li-ion-percolating hybrid membrane stabilizes Li metal plating**
Quan Pang, Laidong Zhou, and Linda F. Nazar

- 12395 Structural analysis of transient reaction intermediate in formic acid dehydrogenation catalysis using two-dimensional IR spectroscopy**
Yufan Zhang, Xin Chen, Bin Zheng, Xunmin Guo, Yupeng Pan, Hailong Chen, Huaifeng Li, Shixiong Min, Chao Guan, Kuo-Wei Huang, and Junrong Zheng

COMPUTER SCIENCES

- 12435 Bots increase exposure to negative and inflammatory content in online social systems**
Massimo Stella, Emilio Ferrara, and Manlio De Domenico

EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

- E11436 Nanomagnetic properties of the meteorite cloudy zone**
Joshua F. Einsle, Alexander S. Eggeman, Ben H. Martineau, Zineb Saghi, Sean M. Collins, Roberts Blukis, Paul A. J. Bagot, Paul A. Midgley, and Richard J. Harrison
- 12401 Change in household fuels dominates the decrease in PM_{2.5} exposure and premature mortality in China in 2005–2015**
Bin Zhao, Haotian Zheng, Shuxiao Wang, Kirk R. Smith, Xi Lu, Kristin Aunan, Yu Gu, Yuan Wang, Dian Ding, Jia Xing, Xiao Fu, Xudong Yang, Kuo-Nan Liou, and Jiming Hao
- 12407 Potential shift from a carbon sink to a source in Amazonian peatlands under a changing climate**
Sirui Wang, Qianlai Zhuang, Outi Lähteenoja, Frederick C. Draper, and Hinsby Cadillo-Quiroz
- 12413 Large changes in biomass burning over the last millennium inferred from paleoatmospheric ethane in polar ice cores**
Melinda R. Nicewonger, Murat Aydin, Michael J. Prather, and Eric S. Saltzman
- ENVIRONMENTAL SCIENCES**
- 12349 Detecting and explaining why aquifers occasionally become degraded near hydraulically fractured shale gas wells**
Josh Woda, Tao Wen, David Oakley, David Yoxtheimer, Terry Engelder, M. Clara Castro, and Susan L. Brantley
- 12419 Smoke radiocarbon measurements from Indonesian fires provide evidence for burning of millennia-aged peat**
Elizabeth B. Wiggins, Claudia I. Czimczik, Guaciara M. Santos, Yang Chen, Xiaomei Xu, Sandra R. Holden, James T. Randerson, Charles F. Harvey, Fuu Ming Kai, and Liya E. Yu

SOCIAL SCIENCES

ECONOMIC SCIENCES

- E11446 Contrasting temporal difference and opportunity cost reinforcement learning in an empirical money-emergence paradigm**
Germain Lefebvre, Aurélien Nioche, Sacha Bourgeois-Gironde, and Stefano Palminteri
- 12425 Dynamic effects of enforcement on cooperation**
Roberto Galbiati, Emeric Henry, and Nicolas Jacquemet

ENVIRONMENTAL SCIENCES

- 12429 Diverse segments of the US public underestimate the environmental concerns of minority and low-income Americans**
Adam R. Pearson, Jonathon P. Schuldt, Rainer Romero-Canyas, Matthew T. Ballew, and Dylan Larson-Konar
→ See Commentary on page 12334

SOCIAL SCIENCES

- 12435** **Bots increase exposure to negative and inflammatory content in online social systems**
Massimo Stella, Emilio Ferrara, and Manlio De Domenico
- 12441** **Generalizability of heterogeneous treatment effect estimates across samples**
Alexander Coppock, Thomas J. Leeper, and Kevin J. Mullin

BIOLOGICAL SCIENCES

BIOCHEMISTRY

- E11455** **Design and in vitro realization of carbon-conserving photorespiration**
Devin L. Trudeau, Christian Edlich-Muth, Jan Zarzycki, Marieke Scheffen, Moshe Goldsmith, Olga Khersonsky, Ziv Avizemer, Sarel J. Fleishman, Charles A. R. Cotton, Tobias J. Erb, Dan S. Tawfik, and Arren Bar-Even
- E11465** **Single nucleotide polymorphisms alter kinase anchoring and the subcellular targeting of A-kinase anchoring proteins**
F. Donelson Smith, Mitchell H. Omar, Patrick J. Nygren, Joseph Sougayer, Naoto Hoshi, Ho-Tak Lau, Calvin G. Snyder, Tess C. Branon, Debapriya Ghosh, Lorene K. Langeberg, Alice Y. Ting, Luis F. Santana, Shao-En Ong, Manuel F. Navedo, and John D. Scott

- 12447** **SIR proteins create compact heterochromatin fibers**
Sarah G. Swygert, Subhadip Senapati, Mehmet F. Bolukbasi, Scot A. Wolfe, Stuart Lindsay, and Craig L. Peterson

BIOPHYSICS AND COMPUTATIONAL BIOLOGY

- E11475** **Molecular dynamics simulations of nucleotide release from the circadian clock protein KaiC reveal atomic-resolution functional insights**
Lu Hong, Bodhi P. Vani, Erik H. Thiede, Michael J. Rust, and Aaron R. Dinner

- 12359** **Differential growth and shape formation in plant organs**
Changjin Huang, Zilu Wang, David Quinn, Subra Suresh, and K. Jimmy Hsia

- 12453** **Probabilistic control of HIV latency and transactivation by the Tat gene circuit**
Youfang Cao (曹又方), Xue Lei (雷雪), Ruy M. Ribeiro, Alan S. Perelson, and Jie Liang (梁杰)

CELL BIOLOGY

- E11485** **Ubiquitin 2 modulates ALS/FTD-linked FUS-RNA complex dynamics and stress granule formation**
Elizabeth J. Alexander, Amirhossein Ghanbari Niaki, Tao Zhang, Jaya Sarkar, Yang Liu, Raja Sekhar Nirujogi, Akhilesh Pandey, Sua Myong, and Jiou Wang

ECOLOGY

- E11495** **Species interactions limit the occurrence of urban-adapted birds in cities**
Paul R. Martin and Frances Bonier
→ See Commentary on page 12331
- 12459** **Partitioning mortality into growth-dependent and growth-independent hazards across 203 tropical tree species**
James S. Camac, Richard Condit, Richard G. FitzJohn, Lachlan McCalman, Daniel Steinberg, Mark Westoby, S. Joseph Wright, and Daniel S. Falster

EVOLUTION

- E11505** **Loss of protein synthesis quality control in host-restricted organisms**
Sergey V. Melnikov, Antonia van den Elzen, David L. Stevens, Carson C. Thoreen, and Dieter Söll

- 12465** **Testing the retroelement invasion hypothesis for the emergence of the ancestral eukaryotic cell**
Gloria Lee, Nicholas A. Sherer, Neil H. Kim (김현일), Ema Rajic, Davneet Kaur, Niko Urriola, K. Michael Martini, Chi Xue, Nigel Goldenfeld, and Thomas E. Kuhlman

- 12471** **Narrow thermal tolerance and low dispersal drive higher speciation in tropical mountains**
Nicholas R. Polato, Brian A. Gill, Alisha A. Shah, Miranda M. Gray, Kayce L. Casner, Antoine Barthelet, Philipp W. Messer, Mark P. Simmons, Juan M. Guayasamin, Andrea C. Encalada, Boris C. Kondratieff, Alexander S. Flecker, Steven A. Thomas, Cameron K. Ghalambor, N. LeRoy Poff, W. Chris Funk, and Kelly R. Zamudio
→ See Commentary on page 12337

IMMUNOLOGY AND INFLAMMATION

- E11513** **The CD4⁺CD8⁻ MAIT cell subpopulation is a functionally distinct subset developmentally related to the main CD8⁺ MAIT cell pool**
Joana Dias, Caroline Boulouis, Jean-Baptiste Gorin, Robin H. G. A. van den Biggelaar, Kerri G. Lal, Anna Gibbs, Liyen Loh, Muhammad Yaaseen Gulam, Wan Rong Sia, Sudipto Bari, William Y. K. Hwang, Douglas F. Nixon, Son Nguyen, Michael R. Betts, Marcus Buggert, Michael A. Eller, Kristina Broliden, Annelie Tjernlund, Johan K. Sandberg, and Edwin Leeansyah

- E11523** **Excessive endosomal TLR signaling causes inflammatory disease in mice with defective SMCR8-WDR41-C9ORF72 complex function**
William McAlpine, Lei Sun, Kuan-wen Wang, Aijie Liu, Ruchi Jain, Miguel San Miguel, Jianhui Wang, Zhao Zhang, Braden Hayse, Sarah Grace McAlpine, Jin Huk Choi, Xue Zhong, Sara Ludwig, Jamie Russell, Xiaoming Zhan, Mihwa Choi, Xiaohong Li, Miao Tang, Eva Marie Y. Moresco, Bruce Beutler, and Emre Turer

- 12477** **Biological sex affects vaccine efficacy and protection against influenza in mice**
Ashley L. Fink, Kyrra Engle, Rebecca L. Ursin, Wan-Yee Tang, and Sabra L. Klein

- 12483** **MARCH3 attenuates IL-1 β -triggered inflammation by mediating K48-linked polyubiquitination and degradation of IL-1RI**
Heng Lin, Deng Gao, Ming-Ming Hu, Man Zhang, Xiao-Xia Wu, Lu Feng, Wen-Hua Xu, Qing Yang, Xuan Zhong, Jin Wei, Zhi-Sheng Xu, Hong-Xia Zhang, Ze-Min Song, Qian Zhou, Wen Ye, Ying Liu, Shu Li, and Hong-Bing Shu

MEDICAL SCIENCES

- 12489** **Targeted exon skipping of a CEP290 mutation rescues Joubert syndrome phenotypes in vitro and in a murine model**
Simon A. Ramsbottom, Elisa Molinari, Shalabh Srivastava, Flora Silberman, Charline Henry, Sumaya Alkanderi, Laura A. Devlin, Kathryn White, David H. Steel, Sophie Saunier, Colin G. Miles, and John A. Sayer

- 12495 **Redox dysregulation as a link between childhood trauma and psychopathological and neurocognitive profile in patients with early psychosis**



Luis Alameda, Margot Fournier, Ines Khadimallah, Alessandra Griffa, Martine Cleusix, Raoul Jenni, Carina Ferrari, Paul Klauser, Philipp S. Baumann, Michel Cuenod, Patric Hagmann, Philippe Conus, and Kim Q. Do

- 12501 **Roles of mucus adhesion and cohesion in cough clearance**

Brian Button, Henry P. Goodell, Eyad Atieh, Yu-Cheng Chen, Robert Williams, Siddharth Shenoy, Elijah Lackey, Nathan T. Shenkute, Li-Heng Cai, Robert G. Dennis, Richard C. Boucher, and Michael Rubinstein

→ See Commentary on page 12340

MICROBIOLOGY

- 12507 **Model metabolic strategy for heterotrophic bacteria in the cold ocean based on *Colwellia psycherythraea* 34H**

Jeffrey J. Czajka, Mary H. Abernathy, Veronica T. Benites, Edward E. K. Baidoo, Jody W. Deming, and Yinjie J. Tang

- 12513 **Artemisinin resistance phenotypes and K13 inheritance in a *Plasmodium falciparum* cross and *Aotus* model**

Juliana M. Sá, Sarah R. Kaslow, Michael A. Krause, Viviana A. Melendez-Muniz, Rebecca E. Salzman, Whitney A. Kite, Min Zhang, Roberto R. Moraes Barros, Jianbing Mu, Paul K. Han, J. Patrick Mershon, Christine E. Figan, Ramoncito L. Caleon, Rifat S. Rahman, Tyler J. Gibson, Chanaki Amaratunga, Erika P. Nishiguchi, Kimberly F. Breglio, Theresa M. Engels, Soundarapandian Velmurugan, Stacy Ricklefs, Judith Straimer, Nina F. Gnädig, Bingbing Deng, Anna Liu, Ababacar Diouf, Kazutoyo Miura, Gregory S. Tullo, Richard T. Eastman, Sumana Chakravarty, Eric R. James, Kenneth Udenze, Suzanne Li, Daniel E. Sturdevant, Robert W. Gwadz, Stephen F. Porcella, Carole A. Long, David A. Fidock, Marvin L. Thomas, Michael P. Fay, B. Kim Lee Sim, Stephen L. Hoffman, John H. Adams, Rick M. Fairhurst, Xin-zhuan Su, and Thomas E. Wellemes

- 12519 **The *Pseudomonas aeruginosa* T6SS-VgrG1b spike is topped by a PAAR protein eliciting DNA damage to bacterial competitors**

Panayiota Pissaridou, Luke P. Allsopp, Sarah Wettstadt, Sophie A. Howard, Despoina A. I. Mavridou, and Alain Filloux

NEUROSCIENCE

- E11532 **Genetic deletion of vesicular glutamate transporter in dopamine neurons increases vulnerability to MPTP-induced neurotoxicity in mice**



Hui Shen, Rosa Anna M. Marino, Ross A. McDevitt, Guo-Hua Bi, Kai Chen, Graziella Madeo, Pin-Tse Lee, Ying Liang, Lindsay M. De Biase, Tsung-Ping Su, Zheng-Xiong Xi, and Antonello Bonci

- 12525 **Acyl-CoA synthetase 6 enriches the neuroprotective omega-3 fatty acid DHA in the brain**

Regina F. Fernandez, Sora Q. Kim, Yingwei Zhao, Rachel M. Foguth, Marcus M. Weera, Jessica L. Counihan, Daniel K. Nomura, Julia A. Chester, Jason R. Cannon, and Jessica M. Ellis

→ See Commentary on page 12343

- 12531 **Arc/Arg3.1 mediates a critical period for spatial learning and hippocampal networks**

Xiaoyan Gao, Sergio Castro-Gomez, Jasper Grendel, Sabine Graf, Ute Süsens, Lars Binkle, Daniel Mensching, Dirk Isbrandt, Dietmar Kuhl, and Ora Ohana

PLANT BIOLOGY

- E11542 **Interlinked regulatory loops of ABA catabolism and biosynthesis coordinate fruit growth and ripening in woodland strawberry**



Xiong Liao, Mengsi Li, Bin Liu, Miaoling Yan, Xiaomin Yu, Hailing Zi, Renyi Liu, and Chizuko Yamamuro

- E11551 **Resistance protein Pit interacts with the GEF OsSPK1 to activate OsRac1 and trigger rice immunity**

Qiong Wang, Yuying Li, Kazuya Ishikawa, Ken-ichi Kosami, Kazumi Uno, Shingo Nagawa, Li Tan, Jiamu Du, Ko Shimamoto, and Yoji Kawano

CORRECTION (ONLINE ONLY)

MEDICAL SCIENCES

- E11561 **Papaverine and its derivatives radiosensitize solid tumors by inhibiting mitochondrial metabolism**

Martin Benej, Xiangqian Hong, Sandip Vibhute, Sabina Scott, Jinghai Wu, Edward Graves, Quynh-Thu Le, Albert C. Koong, Amato J. Giaccia, Bing Yu, Shih-Ching Chen, Ioanna Papandreou, and Nicholas C. Denko

SI CORRECTIONS (ONLINE ONLY)

SUSTAINABILITY SCIENCE

- E11562 **Payments for environmental services supported social capital while increasing land management**

Jennifer M. Alix-Garcia, Katharine R. E. Sims, Victor H. Orozco-Olvera, Laura E. Costica, Jorge David Fernández Medina, and Sofía Romo Monroy

NEUROSCIENCE

- E11563 **Coiled-coil structure-dependent interactions between polyQ proteins and Foxo lead to dendrite pathology and behavioral defects**

Min Jee Kwon, Myeong Hoon Han, Joshua A. Bagley, Do Young Hyeon, Byung Su Ko, Yun Mi Lee, In Jun Cha, Seung Yeol Kim, Dong Young Kim, Ho Min Kim, Daehee Hwang, Sung Bae Lee, and Yuh Nung Jan

PLANT BIOLOGY

- E11564 **Transcriptome landscape of a bacterial pathogen under plant immunity**

Tatsuya Nobori, André C. Velásquez, Jingni Wu, Brian H. Kvitko, James M. Kremer, Yiming Wang, Sheng Yang He, and Kenichi Tsuda