

SPECIAL SECTION

Breakthrough of the Year

WINNER

1520 Cosmic convergence

RUNNERS-UP

1522 A new great ape species

1523 Life at the atomic level

1523 Biology preprints take off

1524 Pinpoint gene editing

1524 A cancer drug's broad swipe

1525 Earth's atmosphere 2.7 million years ago

1526 Deeper roots for *Homo sapiens*

1526 Gene therapy triumph

1527 A tiny detector for the shiest particles

BREAKDOWNS OF THE YEAR

1528 Trump and scientists: an epic estrangement

1529 A bad year for cetaceans

1529 #MeToo: sexual harassment in science

SEE ALSO

► PODCAST; VIDEO; EDITORIAL P. 1504; NEUTRON STAR MERGER SECTION P. 1554

ON THE COVER



Illustration of two neutron stars spiraling into each other. On 17 August 2017, detectors in the United States and Italy spotted gravitational

waves from such an event. Seconds later, a satellite detected a gamma-ray burst, and more than 70 observatories subsequently studied the aftermath in every wavelength. This scientific bonanza (see page 1554) is *Science's* 2017 Breakthrough of the Year (see page 1520). *Illustration: Álvaro Valiño*

NEWS

IN BRIEF

1510 News at a glance

IN DEPTH

1513 SATURN'S RINGS ARE SOLAR SYSTEM NEWCOMERS

Cassini data point to a cataclysmic collision in the past few hundred million years *By P. Voosen*

1514 SAFETY CONCERNS DERAIL DENGUE VACCINATION PROGRAM

Other vaccine candidates likely to face increased scrutiny *By D. Normile*

1515 DEEP PACIFIC COOLED BY 'LITTLE ICE AGE' WATERS

Cold waters from centuries ago may still be taking up modern heat *By P. Voosen*

1516 DEADLY VIRUS THREATENS EUROPEAN PIGS AND BOAR

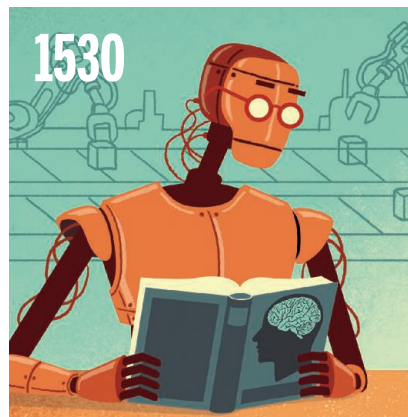
African swine fever outbreak alarms wildlife biologists and veterinarians *By E. Stokstad*

1518 WERE NOMADS THE WORLD'S FIRST TRADERS?

Researchers spar over whether pastoralists sparked the rise of urban civilization *By A. Lawler*

1519 BLOCKADE HARMS QATARI SCIENCE

Rift with neighbors has strangled collaborations and shut Qatari researchers out of regional meetings *By J. Kaiser*



INSIGHTS

POLICY FORUM

1530 WHAT CAN MACHINE LEARNING DO? WORKFORCE IMPLICATIONS

Profound change is coming, but roles for humans remain

By E. Brynjolfsson and T. Mitchell

PERSPECTIVES

1535 A NEW WORLD OF PLANTS

A searchable database collates information on all known vascular plants in the Americas *By T. J. Givnish*

► REPORT P. 1614

1536 HOW SEISMIC WAVES LOSE ENERGY

Energy loss varies with frequency in the lithosphere but not in the asthenosphere

By C. A. Dalton

► REPORT P. 1593

1538 HOW LAND PLANT LIFE CYCLES FIRST EVOLVED

Fossils and developmental genetics reveal early changes in the plant life cycle

By P. Kenrick

1540 THE RISE OF NEAR-ZERO-INDEX TECHNOLOGIES

Materials with designed electromagnetic response have a wide range of exotic applications *By I. Liberal and N. Engheta*

1541 THE QUEST FOR DURABLE RESISTANCE

A milestone for preventing the worldwide spread of wheat rusts has been reached

By M. J. Moscou and H. P. van Esse

► REPORTS PP. 1604 & 1607

DEPARTMENTS

1504 EDITORIAL

Science, big and small

By Jeremy Berg

► BREAKTHROUGH OF THE YEAR SECTION P. 1520; NEUTRON STAR MERGER SECTION P. 1554

1658 WORKING LIFE

My second-chance Ph.D.

By Shekhar Chandra

Science Staff	1505
AAAS News & Notes	1550
New Products	1628
Science Careers	1629



CONTENTS

22 DECEMBER 2017 • VOLUME 358 • ISSUE 6370

1543 SUPERCOOLED WATER REVEALS ITS SECRETS

Experiments provide evidence for two liquid phases in supercooled water droplets *By P. Gallo and H. E. Stanley*

► REPORT P. 1589

1544 COMPLEX REGULATION OF PLANT SEX BY PEPTIDES

How the pollen tube is regulated to deliver sperm cells to produce seeds is characterized

By M. Stegmann and C. Zipfel

► REPORTS PP. 1596 & 1600

BOOKS ET AL.

1546 THE SECRET LIFE OF HEDY LAMARR

A new documentary reveals the underappreciated intellectual contributions of the 1940s film star

By R. Blackburn

1547 TAKING THE LEAD

Faced with government inaction, private firms emerge as major players in climate change mitigation *By D. G. Victor*

LETTERS

1548 MANAGING QUANTITIES OF ANTIMICROBIALS

By D. Moran

1548 RESPONSE

By T. Van Boeckel and R. Laxminarayan

1548 TECHNICAL COMMENT ABSTRACTS

1549 RETRACTION ADDENDUM

1549 ERRATA

1549 ONLINE BUZZ: CONTINUE U.S.-CUBAN SCIENCE DIPLOMACY

RESEARCH

IN BRIEF

1551 From *Science* and other journals

RESEARCH ARTICLE

1588 IMMUNOLOGY

Recurrent infection progressively disables host protection against intestinal inflammation *W. H. Yang et al.*

RESEARCH ARTICLE SUMMARY; FOR FULL TEXT: dx.doi.org/10.1126/science.aao5610

REPORTS

1589 WATER THERMODYNAMICS

Maxima in the thermodynamic response and correlation functions of deeply supercooled water *K. H. Kim et al.*

► PERSPECTIVE P. 1543

1593 GEOPHYSICS

Determination of intrinsic attenuation in the oceanic lithosphere-asthenosphere system *N. Takeuchi et al.*

► PERSPECTIVE P. 1536

PLANT SCIENCE

1596 *Arabidopsis* pollen tube integrity and sperm release are regulated by RALF-mediated signaling *Z. Ge et al.*

1600 RALF4/19 peptides interact with LRX proteins to control pollen tube growth in *Arabidopsis* *M. A. Mecchia et al.*

► PERSPECTIVE P. 1544

PLANT SCIENCE

1604 Variation in the *AvrSr35* gene determines *Sr35* resistance against wheat stem rust race Ug99 *A. Salcedo et al.*

1607 Loss of *AvrSr50* by somatic exchange in stem rust leads to virulence for *Sr50* resistance in wheat *J. Chen et al.*

► PERSPECTIVE P. 1541

1610 ECONOMICS

Asylum applications respond to temperature fluctuations *A. Missirian and W. Schlenker*

1614 FLORISTICS

An integrated assessment of the vascular plant species of the Americas *C. Ulloa Ulloa et al.*

► PERSPECTIVE P. 1535

1617 CHEMICAL BIOLOGY

Synthetic transcription elongation factors license transcription across repressive chromatin *G. S. Erwin et al.*

1622 SINGLE-CELL GENOMICS

Spatial reconstruction of immune niches by combining photoactivatable reporters and scRNA-seq *C. Medaglia et al.*

Neutron star merger

INTRODUCTION

1554 An illuminating cosmic collision

RESEARCH ARTICLES

1556 Swope Supernova Survey 2017a (SSS17a), the optical counterpart to a gravitational wave source *D. A. Coulter et al.*

1559 Illuminating gravitational waves: A concordant picture of photons from a neutron star merger *M. M. Kasliwal et al.*

1565 *Swift* and *NuSTAR* observations of GW170817: Detection of a blue kilonova *P. A. Evans et al.*

1570 Light curves of the neutron star merger GW170817/SSS17a: Implications for r-process nucleosynthesis *M. R. Drout et al.*

1574 Early spectra of the gravitational wave source GW170817: Evolution of a neutron star merger *B. J. Shappee et al.*

1579 A radio counterpart to a neutron star merger *G. Hallinan et al.*

1583 Electromagnetic evidence that SSS17a is the result of a binary neutron star merger *C. D. Kilpatrick et al.*

► EDITORIAL P. 1504; BREAKTHROUGH OF THE YEAR SECTION P. 1520

Downloaded from <http://science.sciencemag.org/> on June 20, 2018

CREDITS: (TOP TO BOTTOM) V. ALTOUNIAN/SCIENCE; DANA BERRY/HARVARD-SMITHSONIAN CFA

SCIENCE (ISSN 0036-8075) is published weekly on Friday, except the last week in December, by the American Association for the Advancement of Science, 1200 New York Avenue, NW, Washington, DC 20005. Periodicals mail postage (publication No. 484460) paid at Washington, DC, and additional mailing offices. Copyright © 2017 by the American Association for the Advancement of Science. The title SCIENCE is a registered trademark of the AAAS. Domestic individual membership and subscription (51 issues): \$165 (\$74 allocated to subscription). Domestic institutional subscription (51 issues): \$1659; Foreign postage extra; Mexico, Caribbean (surface mail) \$55; other countries (air assist delivery) \$89. First class, airmail, student, and emeritus rates on request. Canadian rates with GST available upon request. GST #R1254 88122. Publications Mail Agreement Number 1069624. Printed in the U.S.A. Change of address: Allow 4 weeks, giving old and new addresses and 8-digit account number. Postmaster: Send change of address to AAAS, P.O. Box 96178, Washington, DC 20090-6178. Single-copy sales: \$23.00 current issue, \$28.00 back issue prepaid includes surface postage; bulk rates on request. Authorization to photocopy material for internal or personal use under circumstances not falling within the fair use provisions of the Copyright Act is granted by AAAS to libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that \$35.00 per article is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923. The identification code for Science is 0036-8075. Science is indexed in the Reader's Guide to Periodical Literature and in several specialized indexes.

Science

358 (6370)

Science **358** (6370), 1504-1658.

ARTICLE TOOLS

<http://science.sciencemag.org/content/358/6370>

PERMISSIONS

<http://www.sciencemag.org/help/reprints-and-permissions>

Use of this article is subject to the [Terms of Service](#)

Science (print ISSN 0036-8075; online ISSN 1095-9203) is published by the American Association for the Advancement of Science, 1200 New York Avenue NW, Washington, DC 20005. 2017 © The Authors, some rights reserved; exclusive licensee American Association for the Advancement of Science. No claim to original U.S. Government Works. The title *Science* is a registered trademark of AAAS.