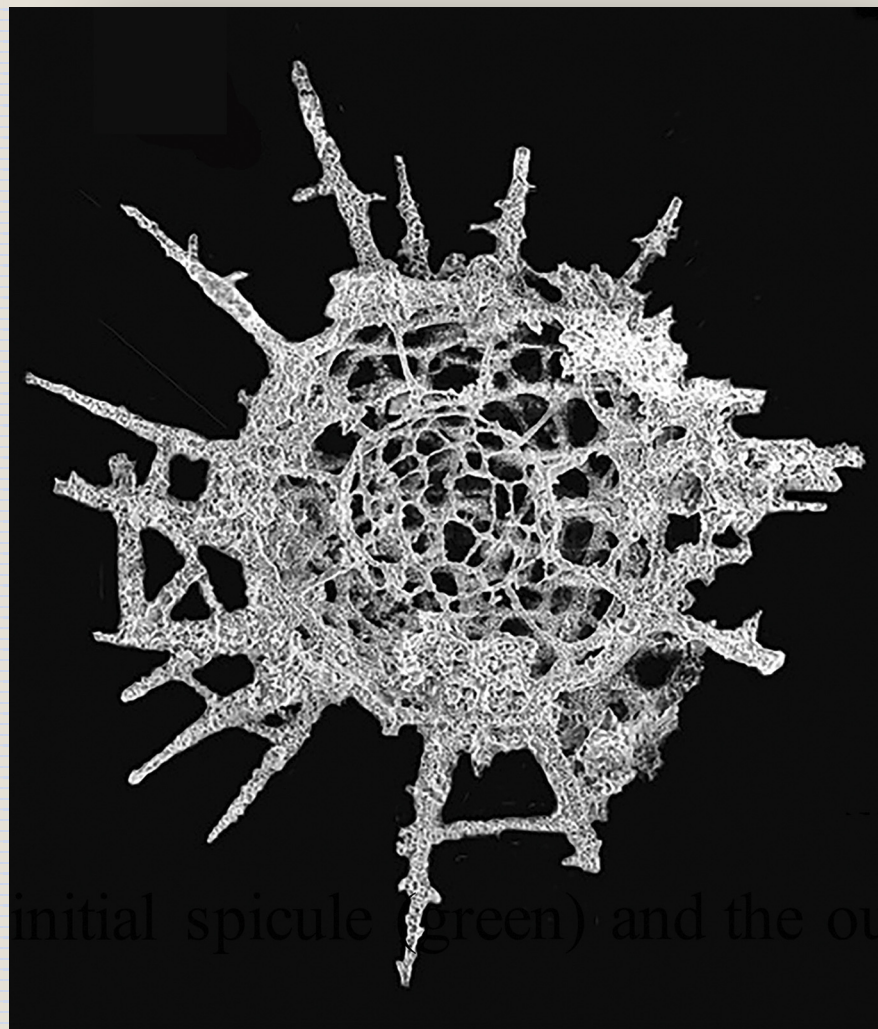


JOURNAL of PALEONTOLOGY



VOL 95 | NO 5 | SEPTEMBER 2021



initial spicule (green) and the ou

CAMBRIDGE
UNIVERSITY PRESS



OFFICERS AND EDITORS OF THE PALEONTOLOGICAL SOCIETY



President

WILLIAM DiMICHELE,
Smithsonian Institution
president@paleosoc.org

President-Elect

ANNE RAYMOND,
Texas A&M
presidentelect@paleosoc.org

Past President

BRUCE MacFADDEN,
Florida Museum of Natural History
pastpresident@paleosoc.org

Secretary

CLAUDIA JOHNSON,
Indiana Univ.
secretary@paleosoc.org

Treasurer

JONATHAN R. HENDRICKS,
Paleontological Research Institution
treasurer@paleosoc.org

JP Editor-in-Chief

BRENDA R. HUNDA,
Cincinnati Museum Center
BHunda@cincymuseum.org

JP Co-Editors

JISUO JIN,
Univ. of Western Ontario
jjin@uwo.ca

HANS-DIETER SUES,
Smithsonian Institution
suesh@si.edu

ELLEN CURRANO,
Univ. of Wyoming
ecurrano@uwyo.edu

JP Associate Editors

BJORN BERNING,
Upper Austrian State Museum

JOSEPH BOTTING,
Nanjing Institute of Geology
and Paleontology,
Chinese Academy of Sciences

CHENYANG CAI,
Nanjing Institute of Geology and
Palaeontology,
Chinese Academy of Sciences

TOM CRONIN,
U.S. Geological Survey

WILLIAM A. DiMICHELE,
Smithsonian Institution

JAN OVE EBBESTAD
Museum of Evolution,
Uppsala Univ.

ROBERT J. ELIAS,
Univ. of Manitoba

NADIA FRÖBISCH,
Museum für Naturkunde

PETER J. HARRIES,
North Carolina State

MICHAEL HAUTMANN,
Univ. of Zurich

MARTIN J. HEAD,
Brock Univ.

THOMAS HEGNA,
SUNY Fredonia

SAMANTHA HOPKINS,
Univ. of Oregon

BRIAN HUBER,
Smithsonian Institution

NIGEL HUGHES,
Univ. of California

NATHAN JUD,
Univ. of Florida

MICHAEL KAMINSKI
King Fahd University of Petroleum and
Minerals

DANIEL KSEPKA,
Bruce Museum

MARCUS KEY,
Dickinson College

JAMES LAMSDALL,
West Virginia Univ.

MAX LANGER,
Universidade de São Paulo

BERTRAND LEFEBVRE,
Lyon Univ.

STEPHEN A. LESLIE,
James Madison Univ.

BRUCE LIEBERMAN,
Univ. of Kansas

ALEX LIU,
Univ. of Cambridge

STEVEN LoDUCA,
Eastern Michigan Univ.

RICK LUPIA,
Univ. of Oklahoma

GABRIELA MÁNGANO,
Univ. of Saskatchewan

GREG McDONALD,
Bureau of Land Management

RICHARD MOOI,
California Academy of Sciences

ALISON MURRAY,
Univ. of Alberta

GALINA NESTELL,
Univ. of Texas at Arlington

PAULA NOBLE,
Univ. of Nevada

ANDRZEJ PISERA,
Polish Academy of Sciences

BRIAN PRATT,
Univ. of Saskatchewan

SIMON SCHNEIDER,
CASP

CRAIG SCOTT,
Royal Tyrrell Museum of Paleontology

MARY SILCOX,
Univ. of Toronto Scarborough

COLIN SPROAT,
Univ. of Saskatchewan

PAUL TAYLOR,
Natural History Museum London

DAVID VARRICCHIO,
Montana State Univ.

STEVE WESTROP,
Oklahoma Museum

DAVID M. WORK,
Maine State Museum

MARGARET M. YACOBUCCI,
Bowling Green State Univ.

SAMUEL ZAMORA,
Geological Survey of Spain

RENBIN ZHAN,
Nanjing Institute of Geology and
Palaeontology,
Chinese Academy of Sciences

SHUNXIN ZHANG,
Canada-Nunavut Geoscience Office

ZHIFEI ZHANG,
Northwest Univ.

Paleobiology Editor-in-Chief
MARK PATZKOWSKY,
Penn State Univ.

Paleobiology Co-Editors
NADIA FRÖBISCH,
Museum für Naturkunde

KEVIN BOYCE,
Stanford Univ.

WOLFGANG KIESSLING,
Universitat Erlangen

JAMES CRAMPTON,
GNA Science

Managing Editor
JESSICA KASTIGAR,
JournalofPaleontology@cambridge.org
Paleobiology@cambridge.org

Communications Officer
TAORMINA LEPORE,
Univ. of California, Berkeley
tlepore@berkeley.edu

Program Coordinator
MATTHEW CLAPHAM,
Univ. of California, Santa Cruz
mclapham@ucsc.edu

Editor, Special Publications

COLIN SUMRALL,
Univ. of Tennessee, Knoxville
csumrall@utk.edu

Education/Outreach Coordinator

ROWAN LOCKWOOD,
College of William & Mary
rxlock@wm.edu

Diversity and Inclusion Coordinator

DENA SMITH,
Univ. of Colorado
dena.smith@colorado.edu

Amateur/Avocational Liaison

LINDA McCALL,
NC Fossil Club Past-President
lndmccall02@yahoo.com

Representatives At Large

DANITA BRANDT,
Michigan State Univ.
brandt@msu.edu

PHOEBE COHEN,
Williams College
pac3@williams.edu

Student Representatives

ANNAKA CLEMENT,
North Dakota State Univ.
annaka.clement@ndsu.edu

JEANETTE PIRLO,
Univ. of Florida
jpirlo@flmnh.ufl.edu

Section Chairs

Cordilleran:
CARLIE PIETSCH,
San Jose State Univ.
carlie.pietsch@sjsu.edu

North Central:
CARRIE SCHWEITZER,
Kent State Univ.
cshweit@kent.edu

Northeastern:
JACALYN WITTMER
MALINOWSKI,
SUNY Geneseo
malinowski@geneseo.edu

Rocky Mountain:
BROOKE LONG-FOX,
S. Dakota School of Mines & Tech.
brooke.long@mines.sdsmt.edu

South Central:
VICTORIA CHRAIBI,
Tarleton State Univ.
chraibi@tarleton.edu

Southeastern:
TOM TOBIN,
Univ. of Alabama
ttobin@ua.edu

Cover illustration: SEM image of *Nyfriedlandia* sp. aff. *N. complicate*, a Middle Ordovician radiolarian from the Table Cove Formation, Piccadilly Quarry, Newfoundland, Canada. Kachovich et al., Fig. 7.4.

SUBSCRIPTION INFORMATION

The Journal of Paleontology [ISSN 0022-3360] is published bimonthly (January, March, May, July, September, and November) by Cambridge University Press (One Liberty Plaza, 20th Floor, New York, NY 10006) for the Paleontological Society. Members of the Paleontological Society automatically receive electronic subscriptions to the *Journal of Paleontology* and *Paleobiology* as a benefit of membership. Institutional subscriptions can be purchased direct from Cambridge University Press or through any major subscription agent. Print-only, online-only, and bundled print and online prices are all available, and subscription prices are tiered according to institution type and size.

Please contact Cambridge University Press for further details:

For customers in North America

Email: subscriptions_newyork@cambridge.org; Phone: (800) 872-7423, option 4

For customers outside of North America

Email: journals@cambridge.org;

Phone: +44 (0)1223-32-6070; Fax: +44 (0)1223-32-5150

Downloads of individual articles are available on <https://www.cambridge.org/core/journals/journal-of-paleontology>.

Reprints of individual articles may be ordered. For information on reprints, please contact Cambridge University Press.

Archives of previous issues are available on <https://www.cambridge.org/core/journals/journal-of-paleontology>.

Permissions All rights reserved. Permissions and reproduction policies, request forms, and contacts are available at: <http://www.cambridge.org/about-us/rights-permissions/>

ADVERTISING

To advertise in the journal please contact M. J. Mrvica Associates, 2 West Taunton Avenue, Berlin, NJ 08009; Phone: 856-768-9360; Fax: 856-753-0064; Email: mjmrvica@mrvica.com

ABSTRACTING AND INDEXING

Abstracting and indexing information for the *Journal of Paleontology* is available at: <https://www.cambridge.org/core/journals/journal-of-paleontology/information/abstracting-and-indexing>.

POSTAL INFORMATION

Periodicals postage rate paid at New York, NY, and at additional mailing offices. POSTMASTER: Send address changes in the USA, Canada, and Mexico to: *Journal of Paleontology*, Cambridge University Press, Journals Fulfillment Department, One Liberty Plaza, 20th Floor, New York, NY 10006. Send address changes elsewhere to the *Journal of Paleontology*, Cambridge University Press, Journals Fulfillment Department, UPH, Shaftesbury Road, Cambridge CB2 8BS, England.

Copyright © 2021 The Paleontological Society. All rights reserved.

Printed in the United States of America

Lane

PALEONTOLOGY

SPECIMEN CABINETS



- * All steel construction
- * Powder paint finish
- * Durable door seal
- * No adhesives
- * Reinforced for easy stacking
- * Sturdy steel trays

LANE SCIENCE EQUIPMENT CORP.

136 Madison Avenue
5th Floor
New York, NY 10016

Tel: 212-563-0663
Fax: 212-465-9440
www.lanescience.com