



SCIENCE DILIMAN is published semi-annually (June and December) by the University of the Philippines Diliman through the Office of the Vice Chancellor for Research and Development. The journal features articles of pure and applied sciences.

Editorial Board

Editor in Chief

Carlos Primo C. David, Ph.D.

Associate Editors

Jose Maria P. Balmaceda, Ph.D.

University of the Philippines Diliman

Louis Angelo M. Danao, Ph.D.

University of the Philippines Diliman

Marlon T. Conato, Ph.D.

University of the Philippines Diliman

Christian N. Della, Ph.D.

University of Glasgow Singapore

Arnold M. Guloy, Ph.D.

University of Houston

Marie Antonette J. Meñez, Ph.D.

University of the Philippines Diliman

Dennis I. Merino, Ph.D.

Southeastern Louisiana University

Brian S. Santos, Ph.D.

University of the Philippines Diliman

Terence P. Tumolva, D.Eng.

University of the Philippines Diliman

Casiana Blanca J. Villarino, Ph.D.

University of the Philippines Diliman

Managing Editor

Conchitina R. Cruz, Ph.D.

University of the Philippines

Editorial Assistant

Narita E.C. de las Alas

Layout Artist

Miriam M. Velasco

Copyeditor

Mart Cyrel M. Geronia

Manuel Justin G. Custado

On the Cover:

Philippine Cockatoo *Cacatua haematuropygia*.

Photo by Peter Widmann of KATALA Foundation, Inc.,
Puerto Princesa City, Palawan, Philippines.

Contents of this journal may not be reproduced without the publisher's written permission except for fair use, i.e., for personal, educational and research purposes, in accordance with copyright law. Reprinting and republication in any other journal or compilation is likewise prohibited except as provided in the Publication Agreement when the author reprints his/her article for inclusion in any publication where he/she is the author or editor, subject to giving proper credit to the original publication of the article in the journal.

The views expressed in the articles are those of the authors and do not necessarily reflect the views of the publisher and the editors.

INTERNATIONAL ADVISORY BOARD

Teofilo A. Abrajano, Jr., Ph.D.

King Abdullah University of Science and Technology
Kingdom of Saudi Arabia

Rigoberto C. Advincula, Ph.D.

Case School of Engineering
Case Western Reserve University, USA

Kenneth A. Buckle, Ph.D.

Professor Emeritus
School of Chemical Engineering
The University of New South Wales, Australia

Jose B. Cruz, Jr., Ph.D.

Professor Emeritus
University of Illinois, USA
University of California, Irvine, USA
The Ohio State University, USA

John P. Encarnacion, Ph.D.

Department of Earth and Atmospheric Sciences
Saint Louis University, USA

Mihali A. Felipe, Ph.D.

Gerstein Lab, Bioinformatics
Yale University, USA

Robert J. Howell, Ph.D.

Department of Mechanical Engineering
The University of Sheffield, United Kingdom

Jeanmaire E. Molina, Ph.D.

Department of Biology
Long Island University, Brooklyn, USA

Rudolf A. Roemer, Ph.D.

Department of Physics
University of Warwick, United Kingdom

Raul K. Suarez, Ph.D.

Professor Emeritus
University of California, Sta. Barbara, USA

Myra O. Villareal, Ph.D.

Life and Environmental Sciences
Graduate School
University of Tsukuba, Japan