

Environmental Assessments in the Okavango Region

2013
Biodiversity & Ecology 5



Biodiversity & Ecology

ISSN 1613-9801

Journal of the Division Biodiversity, Evolution and Ecology of Plants (BEE) of the Biocentre Klein Flottbek, the Herbarium Hamburgense, and the Botanical Garden, University of Hamburg
Chief Editor: Norbert Jürgens – Managing Editor: Jens Oldeland

Biodiversity & Ecology 5 (2013)

Environmental Assessments in the Okavango Region

Volume Editors:

Jens Oldeland, Hamburg
Cynthia Erb, Hamburg
Manfred Finckh, Hamburg
Norbert Jürgens, Hamburg

Layout and typesetting: C. Erb, J. Oldeland & D. Kühne

Cover layout: J. Wallenfang & M. Finckh

Cover photos: Front cover: Classification - Marion Stellmes et al. (Catchment Earth Observation) – Back cover (from top left to bottom right): Citrus plantation south of Menongue, Cuando Cubango Province; Cuito River south of Nankova, Cuando Cubango Province; horticulture in Nankova, Cuando Cubango Province; log paved path through peatlands at core site Cusseque; transhumant cattle at core site Caiundo; hunter at core site Caiundo; leached and dried Cassava at core site Cusseque (all photos: M. Finckh)

Published by:

BEE, Biocentre Klein Flottbek and Botanical Garden, University of Hamburg, Ohhorststr. 18, 22609 Hamburg, Germany

Printed by:

Isensee GmbH, Haarenstr. 20/ Burgstr. 17,
26122 Oldenburg, Germany

Circulation figure: 700

Free-access, online version:

http://www.biodiversity-plants.de/biodivers_ecol/

Biodiversity & Ecology publishes contributions on biodiversity, evolution, and ecology, with a focus on plants. It appears annually and replaces the former journals

- *Mitteilungen aus dem Institut für Allgemeine Botanik Hamburg* (ISSN 0344-5615): Volumes 15 (1977) – 30–32 (2002)
- *Mitteilungen aus dem Staatsinstitut für Allgemeine Botanik Hamburg* (ISSN 0374-9347): Volumes 11 (1957) – 14 (1973)
- *Mitteilungen aus dem Institut für Allgemeine Botanik in Hamburg* (ISSN 0344-5615): Volumes 1 (1914) – 10 (1939)
- *Mitteilungen aus den Botanischen Staatsinstituten in Hamburg*: Volumes 1901 (1902) – 1912 (1913)

Proposals for **Special Volumes/Features** should be discussed with the Chief Editor, Prof. Dr. Norbert Jürgens (norbert.juergens@uni-hamburg.de).

Submissions of papers following the Guidelines for authors (see back cover and journal homepage) should be made in electronic format to **editors.b-e@biodiversity-plants.de**.

Biodiversity & Ecology is currently received by approximately 400 scientific libraries around the world. If you are interested in subscribing or setting up an exchange agreement for a scientific journal published by your institution, please contact **editors.b-e@biodiversity-plants.de**.

Individual volumes of *Biodiversity & Ecology* can be ordered from **orders.b-e@biodiversity-plants.de**.

Previous volumes

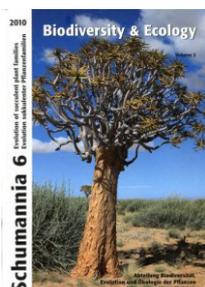
Biodiversity & Ecology 4 (2012)

Special Volume: Vegetation databases for the 21st century Edited by Jürgen Dengler (Bayreuth), Jens Oldeland (Hamburg), Florian Jansen (Greifswald), Milan Chytrý (Brno), Jörg Ewald (Freising), Manfred Finckh (Hamburg), Falko Glöckler (Berlin), Gabriela Lopez-Gonzalez (Leeds), Robert K. Peet (Chapel Hill) & Joop H.J. Schaminée (Wageningen). 447 pp.



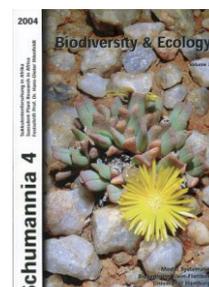
Biodiversity & Ecology 3 (2010)

Evolution of succulent plant families (also: Schumannia 6) Edited by Detlev Metzger (Oldenburg) & Norbert Jürgens (Hamburg). 296 pp.



Biodiversity & Ecology 2 (2004)

Succulent plant research in Africa Festschrift Prof. Dr. Hans-Dieter Ihlenfeldt (also: Schumannia 4) Edited by Joachim Thiede (Hamburg), Maik Veste (Hamburg) & Detlev Metzger (Oldenburg). 250 pp.



Contents

EDITORIAL

Norbert Jürgens

How can scientific information on the Okavango Region be made useful for decision making? – An integrated compilation of the first products of the project “The Future Okavango”..... 7

Authors’ general acknowledgements..... 9

INTRODUCTION TO THE OKAVANGO BASIN AND CORE RESEARCH SITES: FACT SHEETS

Okavango Basin:..... 11

Jan Wehberg & Thomas Weinzierl

Okavango Basin - Physicogeographical setting 11

Torsten Weber

Okavango Basin - Climate 15

Thomas Steudel, Hendrik Göhmann, Edwin. Mosimanyana, Manuel Quintino, Wolfgang-Albert Flügel & Jörg Helmschrot

Okavango Basin - Hydrology 19

Marion Stellmes, David Frantz, Manfred Finckh, Rasmus Revermann

Okavango Basin - Earth Observation..... 23

Rasmus Revermann & Manfred Finckh

Okavango Basin - Vegetation 29

Stephanie Domptail & Oliver Mundi

Okavango Basin - Relative Importance of Ecosystem Services (ESS) Among Stakeholders..... 37

Core site: Cusseque (Angola) 43

Alexander Gröngröft, Jona Luther-Mosebach, Lars Landschreiber, Rasmus Revermann, Manfred Finckh & Annette Eschenbach

Cusseque - Landscape 43

Torsten Weber

Cusseque - Climate 45

Rasmus Revermann & Manfred Finckh

Cusseque - Micro-climatic Conditions..... 47

Alexander Gröngröft, Jona Luther-Mosebach, Lars Landschreiber & Annette Eschenbach

Cusseque - Soils 51

| | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Anne Schneibel, Marion Stellmes, David Frantz, Manfred Finckh & Rasmus Revermann Cusseque - Earth Observation | 55 |
| Rasmus Revermann, Francisco Maiato, Amandio Gomes, Fernanda Lages & Manfred Finckh Cusseque - Vegetation | 59 |
| Friederike Richter Cusseque - Biodiversity of Birds | 65 |
| Ana Filipa Piedade Cusseque - Use of Woody Plants | 69 |
| Stephanie Domptail, Laura Marlene Große, Benjamin Kowalski & João Baptista Cusseque/Cacuchi - The People | 73 |
| Miguel Sachilula Hilario Cusseque - Para-ecologist Miguel Sachilula Hilario | 81 |
| Core site: Caiundo (Angola) | 83 |
| Alexander Gröngröft, Jona Luther-Mosebach, Lars Landschreiber, Rasmus Revermann, Manfred Finckh & Annette Eschenbach Caiundo - Landscape | 83 |
| Torsten Weber Caiundo - Climate | 85 |
| David Frantz, Anne Schneibel, Marion Stellmes, Rasmus Revermann & Manfred Finckh Caiundo - Earth Observation | 87 |
| Rasmus Revermann & Manfred Finckh Caiundo - Vegetation | 91 |
| Friederike Richter Caiundo - Biodiversity of Birds | 97 |
| Core site: Mashare (Namibia) | 101 |
| Alexander Gröngröft, Jona Luther-Mosebach, Lars Landschreiber, Rasmus Revermann, Manfred Finckh & Annette Eschenbach Mashare - Landscape | 101 |
| Torsten Weber Mashare - Climate | 103 |
| Alexander Gröngröft, Jona Luther-Mosebach, Lars Landschreiber & Annette Eschenbach Mashare - Soils | 105 |
| Katharina Huber, Pia Wüst, Janne Grönemeyer, Claudia Burbano, Barbara Reinhold-Hurek & Jörg Overmann Mashare - Microbiology | 109 |

| | |
|------------------------------------------------------------------------------------------------------|-----|
| Achim Röder, Anne Schneibel, Marion Stellmes & David Frantz | |
| Mashare - Earth Observation | 113 |
| Vera De Cauwer | |
| Mashare - Woody Vegetation | 117 |
| Benjamin Kowalski, Nadege Azebaze, Stephanie Domptail, Laura Marlene Große & Michael Pröpper | |
| Mashare - The People | 121 |
| Robert Mukuya | |
| Mashare - Para-ecologist Robert Mukuya | 129 |
| Core site: Seronga (Botswana) | 131 |
| Alexander Gröngröft, Jona Luther-Mosebach, Lars Landschreiber, Rasmus Revermann & Annette Eschenbach | |
| Seronga - Landscape | 131 |
| Torsten Weber | |
| Seronga - Climate | 133 |
| Alexander Gröngröft, Jona Luther-Mosebach, Lars Landschreiber & Annette Eschenbach | |
| Seronga - Soils | 135 |
| Anne Schneibel, Marion Stellmes, David Frantz, Rasmus Revermann & Manfred Finckh | |
| Seronga - Earth Observation | 139 |
| Mike Murray-Hudson, Manfred Finckh & Rasmus Revermann | |
| Seronga - Vegetation | 143 |
| Laura Marlene Große, Benjamin Kowalski, Stephanie Domptail & Amanda Eigner | |
| Seronga - The People | 147 |
| Meshack Kwamovo | |
| Seronga - Para-ecologist Meshack Kwamovo | 159 |
| Luca Marazzi | |
| Okavango Delta - Biodiversity of Microalgae, precious invisible plants | 161 |
| Factsheet author affiliations | 165 |

THE FUTURE OKAVANGO CONCEPTUAL ARTICLES

| | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Achim Röder, Marion Stellmes, Stephanie Domptail, Annette Eschenbach, Manfred Finckh, Alexander Gröngröft, Jörg Helmschrot, Michael Pröpper, Anne Schneibel & Johannes Stoffels | |
| Cumulative effects of policy and management actions on ecosystem services. Challenges and methodological approaches in The Future Okavango project. | 167 |
| Stephanie Domptail, Ernst-August Nuppenau, Nadege Azebaze, Lawrence Brown, Thomas Falk, Manfred Finckh, Laura Große, Benjamin Kowalski, Michael Pröpper, Marion Stellmes & Jörg Overmann | |
| Using trade-offs and synergies in ecosystem services in resource management | 185 |

Laura Schmidt, Stephanie Domptail, Patrik Klintonberg, Martin Gruber, Ute Schmiedel, Ibo Zimmermann & Thomas Falk
Transdisciplinary research and stakeholder involvement. A review of the TFO approach 195

Sven Kralisch , Franziska Zander & Wolfgang-Albert Flügel
OBIS - a Data and Information Management System for the Okavango Basin 213

RESEARCH ARTICLES

Jan Wehberg, Michael Bock, Thomas Weinzierl, Olaf Conrad, Jürgen Böhner, Marion Stellmes & Lars Landschreiber
Terrain-based Landscape Structure Classification in Relation to Remote Sensing Products and Soil Data for the Okavango Catchment..... 221

Thomas Weinzierl, Olaf Conrad, Jürgen Böhner & Jan Wehberg
Regionalization of Baseline Climatologies and Time Series for the Okavango Catchment – Methods, Results and Limitations..... 235

Thomas Steudel, Hendrik Göhmann, Wolfgang-Albert Flügel & Jörg Helmschrot
Assessment of hydrological dynamics in the upper Okavango River Basins 247

Donald L. Kgathi, Gagoitsepe Mmopelwa, Cornelis Vanderpost, Piotr Wolski & Moseki R. Motsholapheko
Impacts of desiccation on ecosystem services and household adaptation in the Okavango Delta, Botswana..... 263

Alexander Gröngröft, Jona Luther-Mosebach, Lars Landschreiber & Benjamin Kowalski
A method for yield assessment on rainfed dryland agricultural fields 279

Jann Grönemeyer, Dirk Berkelmann, Tabo Mubyana-John, Daniel Haiyambo, Percy Chimwamurombe, Bruce Kasaona, Thomas Hurek & Barbara Reinhold-Hurek
A survey for plant-growth-promoting rhizobacteria and symbionts associated with crop plants in the Okavango region of Southern Africa 287

Tabo Mubyana-John, Lawrence Tarupiwa, Wellington R. L Masamba & Susan Ringrose
Mechanisms of phosphate solubilisation associated with some rhizobacteria in floodplains, as exemplified by the Okavango Region of Seronga, Botswana..... 295

Cornelia Gwatidzo, Wellington Riach Liamba Masamba & Tabo Mubyana-John
Variations in soil physicochemical characteristics in some soil profiles of Okavango Delta’s Panhandle region, Botswana 303

Anne Schneibel, Marion Stellmes, Rasmus Revermann, Manfred Finckh, Achim Röder & Joachim Hill
Agricultural expansion during the post-civil war period in southern Angola based on multi-temporal Landsat data 311

Ben J. Strohbach
Vegetation of the Okavango river valley in Kavango West, Namibia..... 321

| | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Gaolathe Tsheboeng & Mike Murray-Hudson Spatial variation of riparian tree species population structure in the Okavango Delta, Botswana | 341 |
| Marion Stellmes, David Frantz, Manfred Finckh, Rasmus Revermann, Achim Röder & Jochaim Hill Fire frequency, fire seasonality and fire intensity within the Okavango Catchment derived from MODIS fire products | 351 |
| Björn Herold, Laura M. Grosse, Stephanie Domptail, Donald L. Kgathi, Thomas Falk, Nadege Azebaze & Benjamin Kowalski Livelihood diversification in a rural community of the Okavango Delta, Botswana. – Results from a Socio-Economic Baseline Survey..... | 363 |
| Michael Pröpper, Thomas Falk, Stephanie Domptail, Laura Marlene Große & Benjamin Kowalski Partly subsistent household economies and modern consumerism in the Namibian Kavango: Assets, income, expenditure and socio-economic stratification..... | 379 |
| João Afonso Baptista “Everything”: Towards an Ecology of Land Utilization | 393 |
| Manfred O. Hinz <i>Makongoro are the Hafumu of water and we respect them, or the ethno-philosophical foundation of customary water law in the Kavango Region of Namibia.....</i> | 407 |

Guidelines for authors (for complete up-to-date version, see http://www.biodiversity-plants.de/biodivers_ecol/)

Biodiversity & Ecology publishes research papers as well as reviews, forum papers, and reports on **biodiversity, evolution and ecology of plants**. The core foci lie on flora and vegetation of Africa and dryland biodiversity. Connected to the research portfolio of the publishing institutions, also contributions on change of global biodiversity, ecosystem functions and services, eco-informatics, lichens, flora and vegetation of Northern Germany, and topics related to herbaria and botanical gardens are welcome.

The journal often publishes **Special Volumes or Special Features** dedicated to specific themes, and contributions to these are normally solicited. The topics of forthcoming Special Volumes/Features are announced on the journal homepage or may be requested from the **Chief Editor, Prof. Dr. Norbert Jürgens (norbert.juergens@uni-hamburg.de)**, who is also open for proposals. If you are considering contributing an article to a future Special Volume/Feature, you are kindly asked to contact the respective Guest Editors prior to submission, who will specify the submission deadline and other details.

Ordinary submissions within the scope of the journal should be made electronically to editors.b-e@biodiversity-plants.de. For each submission, the Managing Editor (Jens Oldeland: jens.oldeland@uni-hamburg.de) and/or the Guest Editors will assign one Co-ordinating Editor. Contributions are normally reviewed by two peers, upon whose comments the Co-ordinating Editor will decide on article acceptance, acceptance with necessary revisions, or rejection.

Publication ethics

By a submission, the corresponding author confirms that all persons listed as co-authors have read the final version of the manuscript and given their consent for submission. All persons listed as co-authors must have made a significant scientific contribution to designing or carrying out the study and/or writing the manuscript; conversely, no person who has made such a significant scientific contribution to the paper shall be denied author rights. Further, the authors must ensure proper recognition (usually through means of citation) when they make use of the intellectual property of other persons.

Preparation of the manuscript

Manuscripts should be written either in British or American English throughout. If you are not a native speaker of English, you are kindly asked to have the language of the manuscript edited by an experienced native speaker prior to submission. There are no page limits as long as the length is justified by the content. Submissions should be made in a single document file (*.doc, *.docx or *.rtf), with pages and lines numbered consecutively.

The **title** of the manuscript should be brief and circumscribe the main content of the manuscript. It is followed by the full **names of all authors**. An **abstract** of 100–300 words should briefly present the salient points regarding the aim, location, methods, results, and conclusions. Then, up to ten **keywords** that do not repeat title words should be provided in alphabetical order. After that, sections on **nomenclatural references** for taxa, syntaxa, or other classifications (entitled Nomenclature) and definitions of all **abbreviations** that do not belong to standard English (entitled Abbreviations) follow if applicable.

Manuscripts should be subdivided into non-numbered **sections** of up to three levels. Please indicate the section hierarchy clearly. You may deviate from the standard structure Introduction – Methods – Results – Discussion when appropriate. You may give **Acknowledgements** (including an authors' contribution statement) before the reference list. **No footnotes** will be printed.

Scientific names of taxa (all ranks!) and syntaxa as well as **expressions in foreign languages** and **mathematical symbols** should be formatted in italics. When cited in the text for the first time, scientific names should be written in full. Taxonomic authorship should be given according to the most recent versions of ICBN, ICPN, or equivalent codes and be included only once in the manuscript (at first mention in the text or in a tabular overview).

References in the text should be cited as follows: As shown by Adams (2002) ...; has been verified (Schmidt 1997, 2002, Schmidt & Meyer 1998, Schmidt et al. 2000, Adams 2002). If there is more than one source by the same author(s) in one year, these are differentiated by the addition of small letters (Smith 2000a, 2000b). References to specific pages in a source are given as (Muller 1975: 234). Author names are printed in lower-case letters. Please ensure that author names from foreign languages are spelled correctly with all diacritical marks.

The **Reference list** (entitled References) at the end of the paper has the following form:

- Chytrý, M. (2007) [Ed.]: Vegetace České republiky – 1. Travinná a keříčková vegetace (Vegetation of the Czech Republic – 1. Grassland and heathland vegetation) [with English summary]. – Praha: Academia.
- Crawley, M.J., Harral, J.E. (2001): Scale dependence in plant biodiversity. – *Science* **291**: 864–868.
- Desmet, P., Cowling, R. (2004): Using the species-area relationship to set baseline targets for conservation. – *Ecology & Society* **9(2)**: Article 11. URL: <http://www.ecologyandsociety.org/vol9/iss2/art11>.
- Faucon, P. (2002): Succulents scientific and common names. – URL: <http://www.desert-tropicals.com/plants/succulents.htm> [accessed on 2006-05-21].
- Gurevitch, J., Scheiner, S.M., Fox, G.A. (2006): The ecology of plants. 2nd ed. – Sunderland, Mass.: Sinauer.
- Kadereit, J.W. [Ed.]: Flowering plants – dicotyledons: *Lamiales* (except *Acanthaceae* including *Avicenniaceae*). – In: Kubitzki, K. [Ed.]: The families and genera of flowering plants **7**. Berlin: Springer.
- Röwer, I.U. (2009): Small-scale vegetation and biodiversity patterns of termitaria (heuweltjies) under different grazing pressures in the communal area of Soebatsfontein, South Africa. – Diplom thesis in Biology, University of Hamburg [deposited at the University Library of Hamburg].
- van Andel, J., Aronson, J. (2006) [Eds.]: Restoration ecology. – Malden, Mass.: Blackwell.

Note that all authors are to be given (even if there are many co-authors) and journal titles have to be provided in full. Title words should not be capitalized (except for English journal titles) unless required by the orthographic rules (e.g. proper names). Titles in languages other than English, German, French, Spanish, or Latin, should be accompanied by a translation into English (see example Chytrý 2007 above). The publisher and place of publication should be provided for books and volumes within series. Only the first town/city should be given when a publisher is based in several.

At the **end of the manuscript**, the full names, affiliations, addresses, and e-mail addresses of all authors should be given, with the corresponding author be marked with *.

Tables and figures should be prepared in such a way that they fit one-column width (5.4 cm), two-column width (11.3 cm), or three-column width (17.2 cm), and that they are not higher than 24.7 cm. Take care that all parts of tables and figures are clearly and easily legible after scaling to print format. Avoid vertical lines and use horizontal lines only above and below the headline and at the bottom of tables. **plant details**. **Appendices** to be printed after the reference list are possible for long tables, mathematical derivations, nomenclatural issues, or similar items that are only relevant for a minority of readers. If you plan to include other elements in your article, such as **boxes** or loose **supplements** (e.g. for large vegetation tables), you should seek the consent of the Co-ordinating Editor prior to submission.

Production of accepted manuscripts

Page proofs will be sent in PDF format to the corresponding author before printing, and you are asked to check them carefully within the set time frame. Articles will be published both as **print and free access online publication**. After print publication, the corresponding author will receive a PDF file of his/her article and a free copy of the respective volume. There are no page charges.

