Supplementary Material

The use of R in photosynthesis research

Yasi Liu[A], Xiangping Wang[A], Dayong Fan[B], and Jiangshan Lai[C,D,]*

[A]School of Ecology and Nature Conservation, Beijing Forestry University, Beijing 100083, China.

[B]College of Forestry, Beijing Forestry University, Beijing 100083, China.

[C]State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, The Chinese Academy of Sciences, Beijing 100093, China.

[D]University of Chinese Academy of Sciences, Beijing 100049, China.

[*]Correspondence to: Dayong Fan College of Forestry, Beijing Forestry University, Beijing 100083, China Email: dayong73fan@163.com Jiangshan Lai State Key Laboratory of Vegetation and Environmental Change, Institute of Botany, the Chinese Academy of Sciences, Beijing 100093, China Email: lai@ibcas.ac.cn

App. S1. The number of publications with "photosynthesis" in the title in journals from 2010 to 2019.

App. S2. Package and function information of the 248 articles that explicitly cited the use of R in their analyses.

App. S3. A brief description of the 109 R packages from the 248 articles that explicitly cited the use of R.

App. S4. Authors, citation sources and brief description of the 37 packages specific to photosynthesis research based on R-site search.

App. S5. Analysis on the 131 search results with "photosynthesis" in the title by R-site search engine, including classification, package name and description, models applied and references.

App. S6. Language use frequency in the photosynthesis discipline during 2013-2020, as searched by GitHub with the keyword "photosynthesis".

App. S7. Language use frequency in the in the journal "Photosynthesis research" during 2010-2020.

Appendix S1

Journal	Year	All Paper
Acta Physiologiae Plantarum	2010	1
Acta Physiologiae Plantarum	2011	2
Acta Physiologiae Plantarum	2012	2
Acta Physiologiae Plantarum	2013	4
Acta Physiologiae Plantarum	2014	4
Acta Physiologiae Plantarum	2015	3
Acta Physiologiae Plantarum	2016	2
Acta Physiologiae Plantarum	2017	6
Acta Physiologiae Plantarum	2018	2
Acta Physiologiae Plantarum	2019	1
Agricultural and Forest Meteorology	2011	1
Agricultural and Forest Meteorology	2012	2
Agricultural and Forest Meteorology	2013	1
Agricultural and Forest Meteorology	2014	1
Agricultural and Forest Meteorology	2015	1
Agricultural and Forest Meteorology	2017	1
Agricultural and Forest Meteorology	2018	2
Agricultural and Forest Meteorology	2019	1
Agricultural Water Management	2016	2
Agricultural Water Management	2017	1
Agricultural Water Management	2018	2
Agricultural Water Management	2019	1
Agriculture, Ecosystems and Environment	2011	1
Agronomy	2018	1
Agronomy	2019	5
Agronomy for Sustainable Development	2013	1
Agronomy Journal	2011	2
Agronomy Journal	2013	1
Agronomy Journal	2015	1
Agronomy Journal	2017	2
Algae	2012	1
Algae	2013	1
Algae	2015	1
Algae	2016	1
Algal Research	2016	1
Algal Research	2017	1
Algal Research	2019	1
Alpine botany	2015	1
American Journal of Botany	2010	2
American Journal of Botany	2014	1
American Journal of Botany	2015	1
American Journal of Botany	2018	2
American Journal of Botany	2019	1
Angewandte Chemie International Edition	2012	2
Angewandte Chemie International Edition	2013	2
Angewandte Chemie International Edition	2014	2
Angewandte Chemie International Edition	2015	1
Angewandte Chemie International Edition	2016	1
Angewandte Chemie International Edition	2017	1
Angewandte Chemie International Edition	2019	4
Annalen der Physik	2012	1
Annals of Botany	2010	4
Annals of Botany	2011	5
Annals of Botany	2012	2
Annals of Botany	2013	2
Annals of Botany	2014	3

Annals of Botany	2015	2
Annals of Botany	2016	3
Annals of Botany	2018	4
Annals of Botany	2019	1
Annual Review of Biochemistry	2013	1
Annual Review of Biochemistry	2014	1
Annual Review of Biochemistry	2015	1
Annual Review of Microbiology	2019	1
Annual Review of Plant Biology	2010	1
Annual Review of Plant Biology	2011	1
Annual Review of Plant Biology	2012	1
Annual Review of Plant Biology	2014	1
Annual Review of Plant Biology	2015	1
Annual Review of Plant Biology	2016	2
ANTIOXIDANTS & REDOX SIGNALING	2019	2
AoB PLANTS	2011	2
AoB PLANTS	2013	1
AoB PLANTS	2014	1
AoB PLANTS	2015	2
AoB PLANTS	2016	1
Applied and Environmental Microbiology	2012	2
Applied Biochemistry and Biotechnology	2013	1
Applied Catalysis B：Environmental	2010	1
Applied Catalysis B：Environmental	2013	1
Applied Catalysis B：Environmental	2016	2
Applied Catalysis B：Environmental	2017	1
Applied Microbiology & Biotechnology	2013	1
Applied Microbiology & Biotechnology	2019	1
Applied Physics Express	2013	1
Applied Surface Science	2019	1
Aquacultural Engineering	2010	1
Aquaculture	2019	1
Aquatic Botany	2010	1
Aquatic Botany	2014	1
Aquatic Botany	2018	1
Aquatic Microbial Ecology	2014	1
Aquatic Toxicology	2010	3
Aquatic Toxicology	2014	1
Aquatic Toxicology	2016	1
Aquatic Toxicology	2017	2
Aquatic Toxicology	2019	1
Archives of Environmental Contamination & Toxicology	2015	1
Arctic, Antarctic, and Alpine Research	2017	1
ASTROBIOLOGY	2010	1
ASTROBIOLOGY	2012	1
ASTROBIOLOGY	2014	1
Atmospheric Chemistry and Physics	2013	1
Atmospheric Chemistry and Physics	2015	2
Atmospheric Chemistry and Physics	2016	2
Atmospheric Chemistry and Physics	2017	1
Atmospheric Chemistry and Physics	2018	1
Atmospheric Environment	2011	3
Atmospheric Environment	2017	1
Australian Journal of Grape and Wine Research	2011	1
Australian Journal of Grape and Wine Research	2017	1
BBA - Bioenergetics	2017	1
BBA - Bioenergetics	2019	1
Beilstein Journal of Nanotechnology	2018	1

Biochemical and Biophysical Research Communications	2014	1
Biochemical and Biophysical Research Communications	2016	1
Biochemical Journal	2010	1
Biochemical Journal	2016	1
Biochemical Journal	2017	1
Biochemical Journal	2019	2
Biochemical Society Transactions	2015	1
Biochemical Society Transactions	2018	1
BIOCHEMISTRY (Moscow)	2014	3
Biochimica et Biophysica Acta	2011	2
Biochimica et Biophysica Acta	2012	1
Biochimica et Biophysica Acta	2013	1
Biochimica et Biophysica Acta	2014	2
Biochimica et Biophysica Acta	2016	5
Bioenergy Research	2017	1
Bioessays	2012	1
Biogeosciences	2010	1
Biogeosciences	2011	1
Biogeosciences	2012	4
Biogeosciences	2013	1
Biogeosciences	2014	1
Biogeosciences	2015	4
Biogeosciences	2016	1
Biogeosciences	2017	6
Biogeosciences	2018	2
Biogeosciences	2019	1
Bioinformatics	2015	1
Bioinformatics	2016	1
Biological Invasions	2012	1
Biological Journal of the Linnean Society	2011	1
Biological Research	2017	1
Biological Trace Element Research	2011	1
Biological Trace Element Research	2012	1
Biology Open	2018	1
Biomass and Bioenergy	2010	1
Biomass and Bioenergy	2012	1
Biomass and Bioenergy	2014	1
BioMed Research International	2014	2
Biometals	2012	1
Biophysical Journal	2010	1
Bioresource Technology	2010	1
Bioresource Technology	2011	1
Bioresource Technology	2012	1
Bioresource Technology	2013	1
Bioresource Technology	2014	1
Bioresource Technology	2015	1
Bioresource Technology	2016	1
Bioresource Technology	2017	2
Bioresource Technology	2019	1
Biosensors and Bioelectronics	2018	1
Biotechnology and Bioengineering	2013	1
Biotechnology and Bioengineering	2014	1
Biotechnology and Bioengineering	2016	1
Biotechnology and Bioengineering	2019	1
Biotechnology for Biofuels	2017	1
Biotropica	2017	1
BMC Genomics	2018	2
BMC Genomics	2019	1

BMC Plant Biology	2010	1
BMC Plant Biology	2011	1
BMC Plant Biology	2013	1
BMC Plant Biology	2019	3
Botanical Journal of the Linnean Society	2010	1
Botanical Journal of the Linnean Society	2013	1
Botanical Journal of the Linnean Society	2017	1
Boundary-Layer Meteorol	2011	1
Breeding Science	2011	1
Breeding Science	2018	1
Canadian Journal of Forest Research	2012	1
Catalysis Communications	2016	1
Cell	2013	1
Cell	2017	1
Cellular Microbiology	2012	1
Chem	2017	1
Chem	2019	1
ChemCatChem	2011	2
ChemCatChem	2012	1
ChemCatChem	2018	1
Chemical Communications	2019	2
Chemical Engineering Journal	2013	1
Chemical Engineering Science	2015	1
Chemical Geology	2016	1
Chemical Reviews	2014	2
Chemical Reviews	2018	1
Chemical Science	2011	1
Chemical Science	2017	2
Chemical Science	2019	1
Chemical Society Reviews	2017	1
Chemical Society Reviews	2019	1
Chemistry: A European Journal	2013	1
Chemistry: A European Journal	2014	2
Chemistry: A European Journal	2016	1
Chemistry: A European Journal	2018	2
Chemistry: A European Journal	2018	1
Chemosphere	2011	3
Chemosphere	2012	1
Chemosphere	2016	1
Chemosphere	2017	1
Chemosphere	2019	3
ChemPhysChem	2016	1
Chemsuschem	2011	2
Chemsuschem	2012	1
Chemsuschem	2013	1
Chemsuschem	2015	1
Chemsuschem	2017	7
Chemsuschem	2018	1
Chemsuschem	2019	1
Climatic Change	2014	1
Cold Spring Harbor perspectives in biology	2014	1
Computers and Electronics in Agriculture	2016	1
Conservation Physiology	2017	1
Coordination Chemistry Reviews	2012	1
Coordination Chemistry Reviews	2015	1
Coral Reefs	2019	1
Crop Ecology & Physiology	2013	1
Crop Ecology & Physiology	2015	3

Current Biology	2012	1
Current Biology	2013	1
Current Biology	2017	1
Current Biology	2018	1
Current Opinion in Biotechnology	2010	1
Current Opinion in Biotechnology	2012	1
Current Opinion in Biotechnology	2014	1
Current Opinion in Chemical Biology	2013	1
Current Opinion in Chemical Biology	2016	1
Current Opinion in Plant Biology	2012	1
Current Opinion in Plant Biology	2013	1
Current Opinion in Plant Biology	2016	2
Earth and Planetary Science Letters	2011	1
Earth and Planetary Science Letters	2013	1
Earth System Science Data	2018	1
Ecohydrology	2011	1
Ecohydrology	2019	1
Ecological Applications	2011	1
Ecological Applications	2015	1
Ecological Engineering	2011	2
Ecological Indicators	2012	1
Ecology	2019	1
Ecology and Evolution	2012	1
Ecology and Evolution	2015	1
Ecology and Evolution	2016	4
Ecology and Evolution	2017	1
Ecology and Evolution	2018	3
Ecology and Evolution	2019	1
Ecology Letters	2018	1
Ecosphere	2013	1
Ecosphere	2017	1
Ecosphere	2019	1
Ecotoxicology	2017	1
Ecotoxicology and Environmental Safety	2012	4
Ecotoxicology and Environmental Safety	2013	1
Ecotoxicology and Environmental Safety	2014	1
Ecotoxicology and Environmental Safety	2016	1
Ecotoxicology and Environmental Safety	2017	2
Ecotoxicology and Environmental Safety	2018	1
Ecotoxicology and Environmental Safety	2019	3
Electrocatalysis	2017	1
Electrophoresis	2015	1
Energy&Environmental Science	2011	1
Energy&Environmental Science	2013	1
Engineering in Life Sciences	2014	1
Entropy	2012	1
Environmental and Experimental Botany	2010	2
Environmental and Experimental Botany	2011	6
Environmental and Experimental Botany	2012	8
Environmental and Experimental Botany	2013	2
Environmental and Experimental Botany	2014	3
Environmental and Experimental Botany	2016	2
Environmental and Experimental Botany	2017	3
Environmental and Experimental Botany	2018	7
Environmental and Experimental Botany	2019	6
Environmental Chemistry	2019	1
Environmental Microbiology	2010	1
Environmental Microbiology	2011	1

Environmental Microbiology	2012	1
Environmental Microbiology	2015	1
Environmental Microbiology	2017	1
Environmental Microbiology Reports	2012	1
Environmental Microbiology Reports	2013	1
Environmental Microbiology Reports	2019	1
Environmental Monitoring and Assessment	2016	1
Environmental Pollution	2011	1
Environmental Pollution	2014	1
Environmental Pollution	2017	2
Environmental Pollution	2019	3
Environmental Research Letters	2014	1
Environmental Science and Pollution Research	2012	1
Environmental Science and Pollution Research	2015	1
Environmental Science and Pollution Research	2016	4
Environmental Science and Pollution Research	2017	1
Environmental Science and Pollution Research	2019	2
Environmental Toxicology	2010	1
Environmental Toxicology	2014	1
Environmental Toxicology and Chemistry	2012	1
Environmental Toxicology and Chemistry	2014	1
Estuarine, Coastal and Shelf Science	2011	1
European Journal of Agronomy	2013	1
European Journal of Agronomy	2018	2
European Journal of Inorganic Chemistry	2014	1
European Journal of Inorganic Chemistry	2019	2
European Journal of Organic Chemistry	2017	1
European Journal of Phycology	2013	1
European Journal of Phycology	2014	1
European Journal of Phycology	2015	1
Evolution	2017	1
Evolutionary Applications	2010	1
Extremophiles	2013	1
Extremophiles	2019	1
Faraday Discussions	2015	1
FEBS Letters	2010	1
FEBS Letters	2012	1
FEMS Microbiology Ecology	2010	1
FEMS Microbiology Ecology	2019	2
FEMS Microbiology Reviews	2018	1
Field Crops Research	2011	1
Field Crops Research	2014	1
Field Crops Research	2016	2
Field Crops Research	2019	2
Food and Energy Security	2014	1
Food and Energy Security	2016	1
Food and Energy Security	2018	1
Forest Ecology and Management	2012	1
Forest Ecology and Management	2014	1
Forest Ecology and Management	2016	2
Forest Ecology and Management	2018	1
Forest Ecology and Management	2019	1
Forests	2014	1
Forests	2018	3
Forests	2019	6
Fortineau and Bancal Plant Methods	2018	1
Free Radical Biology and Medicine	2019	3
Freshwater Biology	2014	1

Freshwater Biology	2016	1
Freshwater Biology	2017	1
Freshwater Biology	2019	1
Frontiers in Chemistry	2014	1
Frontiers in Chemistry	2017	1
Frontiers in Chemistry	2019	1
Frontiers in Microbiology	2014	1
Frontiers in Microbiology	2015	3
Frontiers in Microbiology	2016	4
Frontiers in Microbiology	2017	3
Frontiers in Microbiology	2018	2
Frontiers in Microbiology	2019	2
Frontiers in Physiology	2015	1
Frontiers in Physiology	2017	3
Frontiers in Plant Science	2012	2
Frontiers in Plant Science	2013	6
Frontiers in Plant Science	2014	8
Frontiers in Plant Science	2015	6
Frontiers in Plant Science	2016	29
Frontiers in Plant Science	2017	25
Frontiers in Plant Science	2018	20
Frontiers in Plant Science	2019	17
FUNCTIONAL AND INTEGRATIVE GENOMICS	2011	1
Functional Ecology	2013	1
Functional Ecology	2017	2
Functional Plant Biology	2010	7
Functional Plant Biology	2011	4
Functional Plant Biology	2012	2
Functional Plant Biology	2013	1
Functional Plant Biology	2014	4
Functional Plant Biology	2015	7
Functional Plant Biology	2016	6
Functional Plant Biology	2017	3
Functional Plant Biology	2018	2
Functional Plant Biology	2019	1
GCB Bioenergy	2011	1
GCB Bioenergy	2012	1
GCB Bioenergy	2016	1
GCB Bioenergy	2017	3
GCB Bioenergy	2019	1
Gene	2019	1
Genes	2019	1
Genome Biology	2012	1
Genome Biology and Evolution	2010	1
Genome Biology and Evolution	2013	3
Genome Biology and Evolution	2015	1
Genome Biology and Evolution	2019	2
Geobiology	2018	1
Geobiology	2019	1
Geology	2019	1
Geophysical Research Letters	2012	1
Geophysical Research Letters	2014	1
Geophysical Research Letters	2015	3
Geophysical Research Letters	2016	1
Geophysical Research Letters	2017	2
Geophysical Research Letters	2018	1
Geophysical Research Letters	2019	1
Geoscientific Model Development	2015	1

Geoscientific Model Development	2018	1
Geoscientific Model Development	2019	1
GigaScience	2019	1
Global Biogeochemical Cycles	2012	1
Global Biogeochemical Cycles	2015	1
Global Biogeochemical Cycles	2019	1
Global Change Biology	2010	6
Global Change Biology	2011	1
Global Change Biology	2013	4
Global Change Biology	2014	1
Global Change Biology	2015	3
Global Change Biology	2016	2
Global Change Biology	2017	6
Global Change Biology	2018	5
Global Change Biology	2019	3
Gold Bull	2012	1
Green Chemistry	2019	1
Harmful Algae	2016	2
Hydrobiologia	2012	1
Hydrobiologia	2013	1
Hydrobiologia	2017	1
Hydrology and Earth System Sciences	2013	1
Hydrology and Earth System Sciences	2014	1
ICES Journal of Marine Science	2016	2
ICES Journal of Marine Science	2017	1
Industrial Crops and Products	2010	1
Industrial Crops and Products	2013	1
Insects	2019	1
Integrative and Comparative Biology	2010	1
Integrative and Comparative Biology	2019	1
International Journal of Climatology	2019	1
International Journal of Hydrogen Energy	2012	2
International Journal of Hydrogen Energy	2013	1
International Journal of Hydrogen Energy	2016	1
International Journal of Hydrogen Energy	2017	3
International Journal of Hydrogen Energy	2018	1
International Journal of Hydrogen Energy	2019	1
International Journal of Molecular Sciences	2010	1
International Journal of Molecular Sciences	2014	1
International Journal of Molecular Sciences	2015	1
International Journal of Molecular Sciences	2018	10
International Journal of Molecular Sciences	2019	8
IUBMB Life	2015	1
Journal of Advances in Modeling Earth Systems	2015	5
Journal of Agronomy and Crop Science	2010	3
Journal of Agronomy and Crop Science	2011	3
Journal of Agronomy and Crop Science	2012	2
Journal of Agronomy and Crop Science	2013	2
Journal of Agronomy and Crop Science	2014	1
Journal of Agronomy and Crop Science	2015	3
Journal of Agronomy and Crop Science	2016	3
Journal of Agronomy and Crop Science	2019	1
Journal of Applied Microbiology	2016	1
Journal of Applied Phycology	2013	1
Journal of Applied Phycology	2014	4
Journal of Applied Phycology	2015	2
Journal of Applied Phycology	2016	2
Journal of Applied Phycology	2017	3

Journal of Applied Phycology	2018	1
Journal of Applied Phycology	2019	1
Journal of Arid Environments	2019	1
Journal of Biotechnology	2010	1
Journal of Biotechnology	2014	1
Journal of Biotechnology	2017	1
Journal of Catalysis	2016	1
Journal of Chemical Ecology	2010	1
Journal of Chemical Ecology	2019	1
Journal of CO9 Utilization	2017	1
Journal of Controlled Release	2019	1
Journal of Ecology	2012	1
Journal of Ecology	2014	1
Journal of Ecology	2016	1
Journal of Environmental Management	2019	1
Journal of Environmental Sciences	2010	1
Journal of Environmental Sciences	2013	2
Journal of Eukaryotic Microbiology	2011	1
Journal of Experimental Biology	2017	1
Journal of Experimental Biology	2018	1
Journal of Experimental Botany	2010	6
Journal of Experimental Botany	2011	17
Journal of Experimental Botany	2012	9
Journal of Experimental Botany	2013	14
Journal of Experimental Botany	2014	20
Journal of Experimental Botany	2015	7
Journal of Experimental Botany	2016	16
Journal of Experimental Botany	2017	19
Journal of Experimental Botany	2018	7
Journal of Experimental Botany	2019	18
Journal of Experimental Marine Biology and Ecology	2011	2
Journal of Experimental Marine Biology and Ecology	2014	3
Journal of Experimental Marine Biology and Ecology	2019	2
Journal of Ginseng Research	2010	1
Journal of Great Lakes Research	2011	1
Journal of Great Lakes Research	2017	1
Journal of Hydrology	2012	1
Journal of Hydrometeorology	2017	1
Journal of Integrative Plant Biology	2010	5
Journal of Integrative Plant Biology	2011	1
Journal of Integrative Plant Biology	2014	1
Journal of Integrative Plant Biology	2016	1
Journal of Integrative Plant Biology	2018	1
Journal of Marine Systems	2017	1
Journal of Materials Chemistry A	2014	1
Journal of Materials Chemistry A	2016	1
Journal of Materials Chemistry A	2017	1
Journal of Molecular Evolution	2018	1
Journal of Molluscan Studies	2014	1
Journal of Nanomaterials	2016	1
Journal of Photochemistry and Photobiology,A: Chemistry	2016	1
Journal of Photochemistry and Photobiology,A: Chemistry	2018	1
Journal of Photochemistry and Photobiology,B: Biology	2011	2
Journal of Photochemistry and Photobiology,B: Biology	2014	4
Journal of Photochemistry and Photobiology,B: Biology	2015	1
Journal of Photochemistry and Photobiology,B: Biology	2016	2
Journal of Photochemistry and Photobiology,C: Photochemistry Reviews	2010	1
Journal of Phycology	2010	2

Journal of Phycology	2011	1
Journal of Phycology	2012	2
Journal of Phycology	2013	2
Journal of Phycology	2014	1
Journal of Phycology	2017	1
Journal of Phycology	2018	3
Journal of Phycology	2019	2
Journal of Physics: Condensed Matter	2016	1
Journal of Phytopathology	2012	1
Journal of Phytopathology	2013	1
Journal of Plankton Research	2010	1
Journal of Plankton Research	2013	1
Journal of Plankton Research	2014	1
Journal of Plant Biology	2010	1
Journal of Plant Biology	2012	1
Journal of Plant Biology	2014	1
Journal of Plant Biology	2016	1
Journal of Plant Biology	2019	2
Journal of Plant Ecology	2010	2
Journal of Plant Ecology	2012	1
Journal of Plant Ecology	2013	2
Journal of Plant Ecology	2014	1
Journal of Plant Ecology	2015	2
Journal of Plant Ecology	2019	2
Journal of Plant Growth Regulation	2012	1
Journal of Plant Growth Regulation	2014	3
Journal of Plant Growth Regulation	2015	1
Journal of Plant Growth Regulation	2017	1
Journal of Plant Growth Regulation	2018	2
Journal of Plant Growth Regulation	2019	1
Journal of Plant Interactions	2010	2
Journal of Plant Nutrition & Soil Science	2010	1
Journal of Plant Nutrition & Soil Science	2011	2
Journal of Plant Nutrition & Soil Science	2012	2
Journal of Plant Nutrition & Soil Science	2013	3
Journal of Plant Nutrition & Soil Science	2014	2
Journal of Plant Nutrition & Soil Science	2016	3
Journal of Plant Nutrition & Soil Science	2017	1
Journal of Plant Physiology	2011	6
Journal of Plant Physiology	2012	2
Journal of Plant Physiology	2013	1
Journal of Plant Physiology	2014	2
Journal of Plant Physiology	2015	1
Journal of Plant Physiology	2016	3
Journal of Plant Physiology	2017	3
Journal of Plant Physiology	2018	2
Journal of Plant Research	2016	1
Journal of Plant Research	2017	1
Journal of Plant Research	2018	2
Journal of Rare Earths	2011	1
Journal of Rare Earths	2014	1
Journal of Rare Earths	2019	1
Journal of Saudi Chemical Society	2013	1
Journal of Soils and Sediments	2011	1
Journal of Soils and Sediments	2017	1
Journal of the American Chemical Society	2014	1
Journal of the American Society for Horticultural Science	2012	2
Journal of the American Society for Horticultural Science	2013	1

Journal of the American Society for Horticultural Science	2014	2
Journal of the American Society for Horticultural Science	2015	1
Journal of the American Society for Horticultural Science	2017	1
Journal of the American Society for Horticultural Science	2018	1
Journal of the American Society for Horticultural Science	2019	1
Journal of the Science of Food and Agriculture	2016	1
Journal of Theoretical Biology	2012	1
Journal of Vegetation Science	2011	1
Journal of Vegetation Science	2016	1
Journal of Water and Climate Change	2018	1
Korean Journal of Chemical Engineering	2017	1
Limnology and Oceanography	2010	1
Limnology and Oceanography	2012	2
Limnology and Oceanography	2013	1
Limnology and Oceanography	2017	2
Limnology and Oceanography	2018	2
Limnology and Oceanography: Methods	2010	1
Limnology and Oceanography: Methods	2012	2
Marine and Freshwater Research	2018	1
Marine Biology	2012	1
Marine Biology	2013	1
Marine Biology	2014	2
Marine Drugs	2010	1
MARINE ECOLOGY PROGRESS SERIES	2011	2
MARINE ECOLOGY PROGRESS SERIES	2012	2
MARINE ECOLOGY PROGRESS SERIES	2013	1
MARINE ECOLOGY PROGRESS SERIES	2015	1
Marine Pollution Bulletin	2011	1
Marine Pollution Bulletin	2017	1
Marine Pollution Bulletin	2019	2
Materials	2011	1
Materials Research Bulletin	2018	1
Materials Research Innovations	2014	1
Mathematical Methods in the Applied Sciences	2018	1
Metabolic Engineering	2011	1
Metabolic Engineering	2018	1
Metabolic Engineering	2019	1
Microbes and Environments	2016	1
Microbial Ecology	2011	1
Microgravity Science and Technology	2017	1
Micron	2013	1
Molecular Biology & Evolution	2011	1
Molecular Biology & Evolution	2015	2
Molecular Biology & Evolution	2016	1
Molecular Biology & Evolution	2017	1
Molecular Biology & Evolution	2018	2
Molecular Genetics & Genomics	2017	1
Molecular Microbiology	2010	1
Molecular Plant	2016	1
Molecular Plant	2017	2
Molecular Plant Pathology	2018	1
Molecules	2010	1
Molecules	2011	2
Molecules	2012	1
Molecules	2014	1
Molecules	2017	2
Molecules	2018	2
Monthly Notices of the Royal Astronomical Society	2019	1

Mycorrhiza	2017	1
Nano Energy	2016	2
Nano Energy	2019	1
Nano Letters	2015	1
Nano Letters	2019	1
Nanomaterials	2019	1
Nanoscale	2015	1
National Science Review	2016	1
National Science Review	2018	1
Nature	2010	1
Nature	2014	1
Nature	2016	2
Nature	2018	1
Nature	2019	1
Nature Climate Change	2011	1
NATURE COMMUNICATIONS	2015	2
NATURE COMMUNICATIONS	2016	2
NATURE COMMUNICATIONS	2017	4
NATURE COMMUNICATIONS	2018	2
Nature Genetics	2019	1
Nature Plants	2016	1
Nature Plants	2017	1
Nature Plants	2018	2
New Biotechnology	2012	2
New Journal of Physics	2011	1
New Phytologist	2010	4
New Phytologist	2011	5
New Phytologist	2012	2
New Phytologist	2013	4
New Phytologist	2014	8
New Phytologist	2015	6
New Phytologist	2016	7
New Phytologist	2017	11
New Phytologist	2018	7
New Phytologist	2019	13
New Zealand Journal of Botany	2013	1
New Zealand Journal of Botany	2014	1
Nucleic Acids Research	2012	1
Ocean Science	2019	1
Oceanologia	2012	1
Oecologia	2010	1
Oecologia	2011	1
Oecologia	2012	3
Oecologia	2016	1
Oecologia	2017	2
Oikos: A Journal of Ecology	2015	1
Oikos: A Journal of Ecology	2018	1
OMICS-A Journal of Integrative Biology	2016	1
Origins of Life and Evolution of the Biosphere	2015	2
Paddy and Water Environment	2018	1
Palaeogeography, Palaeoclimatology, Palaeoecology	2012	1
Palaeontology	2015	1
Particle & Particle Systems Characterization	2018	1
Pedosphere	2011	1
Pedosphere	2017	1
Peer J	2016	1
Peer J	2019	5
Perspectives in Plant Ecology, Evolution and Systematics	2019	1

Journal	Year	Count
Pest Management Science	2010	1
Pest Management Science	2017	1
Pesticide Biochemistry and Physiology	2010	1
Pesticide Biochemistry and Physiology	2014	1
Pesticide Biochemistry and Physiology	2016	2
Photochemical&Photobiological Sciences	2014	1
Photochemistry and Photobiology	2010	4
Photochemistry and Photobiology	2011	1
Photochemistry and Photobiology	2013	2
Photochemistry and Photobiology	2015	2
Photochemistry and Photobiology	2016	1
Photosynthesis Research	2010	49
Photosynthesis Research	2011	43
Photosynthesis Research	2012	66
Photosynthesis Research	2013	50
Photosynthesis Research	2014	73
Photosynthesis Research	2015	82
Photosynthesis Research	2016	90
Photosynthesis Research	2017	81
Photosynthesis Research	2018	99
Photosynthesis Research	2019	100
PHOTOSYNTHETICA	2010	6
PHOTOSYNTHETICA	2011	17
PHOTOSYNTHETICA	2012	13
PHOTOSYNTHETICA	2013	16
PHOTOSYNTHETICA	2014	20
PHOTOSYNTHETICA	2015	15
PHOTOSYNTHETICA	2016	16
PHOTOSYNTHETICA	2017	14
PHOTOSYNTHETICA	2018	25
PHOTOSYNTHETICA	2019	39
Phycological Research	2013	3
Phycological Research	2014	1
Phycological Research	2015	2
Phycological Research	2016	1
Phycological Research	2017	2
Phycological Research	2018	2
Phycological Research	2019	1
PHysica A	2018	1
Physical Chemistry Chemical Physics	2014	1
Physiologia Plantarum	2010	6
Physiologia Plantarum	2011	2
Physiologia Plantarum	2012	6
Physiologia Plantarum	2013	5
Physiologia Plantarum	2014	7
Physiologia Plantarum	2015	3
Physiologia Plantarum	2016	1
Physiologia Plantarum	2017	7
Physiologia Plantarum	2018	4
Physiologia Plantarum	2019	12
Physiology & Molecular Biology of Plants	2013	1
Physiology & Molecular Biology of Plants	2017	1
Physiology & Molecular Biology of Plants	2019	1
Plant and Cell Physiology	2010	2
Plant and Cell Physiology	2011	1
Plant and Cell Physiology	2012	1
Plant and Cell Physiology	2013	3
Plant and Cell Physiology	2014	3

Plant and Cell Physiology	2016	6
Plant and Cell Physiology	2017	4
Plant and Cell Physiology	2018	3
Plant and Cell Physiology	2019	1
Plant Biology	2010	3
Plant Biology	2012	2
Plant Biology	2013	2
Plant Biology	2014	2
Plant Biology	2019	6
Plant Biotechnology Journal	2012	1
Plant Biotechnology Journal	2014	2
Plant Biotechnology Journal	2015	1
Plant Biotechnology Journal	2016	1
Plant Biotechnology Reports	2013	1
Plant Breeding	2019	1
Plant Cell Reports	2016	1
Plant Cell,Tissue&Organ Culture	2014	1
Plant Ecology	2011	1
Plant Ecology	2018	1
Plant Ecology & Diversity	2011	1
Plant Growth Regulation	2011	1
Plant Growth Regulation	2013	1
Plant Growth Regulation	2014	1
Plant Growth Regulation	2015	3
Plant Growth Regulation	2016	1
Plant Growth Regulation	2017	2
Plant Growth Regulation	2018	2
Plant Pathology	2013	1
Plant Pathology	2017	1
Plant Physiology	2010	4
Plant Physiology	2011	6
Plant Physiology	2012	1
Plant Physiology	2013	1
Plant Physiology	2014	5
Plant Physiology	2015	1
Plant Physiology	2016	5
Plant Physiology	2017	6
Plant Physiology	2018	4
Plant Physiology	2019	3
Plant Physiology and Biochemistry	2011	1
Plant Physiology and Biochemistry	2012	1
Plant Physiology and Biochemistry	2013	3
Plant Physiology and Biochemistry	2017	1
Plant Physiology and Biochemistry	2018	2
Plant Physiology and Biochemistry	2019	7
Plant Production Science	2015	1
Plant Production Science	2017	2
Plant Science	2010	1
Plant Science	2011	1
Plant Science	2012	4
Plant Science	2014	3
Plant Science	2016	2
Plant Science	2017	1
Plant Science	2019	3
Plant Signaling & Behavior	2018	1
Plant Signaling & Behavior	2019	1
Plant Soil	2010	2
Plant Soil	2011	1

Plant Soil	2014	1
Plant Soil	2019	1
Plant Species Biology	2015	1
Plant Systematics and Evolution	2015	1
Plant,Cell and Environment	2010	9
Plant,Cell and Environment	2011	5
Plant,Cell and Environment	2012	10
Plant,Cell and Environment	2013	11
Plant,Cell and Environment	2014	12
Plant,Cell and Environment	2015	6
Plant,Cell and Environment	2016	10
Plant,Cell and Environment	2017	9
Plant,Cell and Environment	2018	5
Plant,Cell and Environment	2019	8
Plant,Soil and Environment	2019	1
Planta	2010	1
Planta	2012	1
Planta	2013	1
Planta	2015	3
Planta	2016	1
Planta	2017	1
Planta	2019	1
Plos Genetics	2014	2
Plos Genetics	2019	1
PLOS ONE	2010	2
PLOS ONE	2011	2
PLOS ONE	2012	7
PLOS ONE	2013	12
PLOS ONE	2014	21
PLOS ONE	2015	16
PLOS ONE	2016	7
PLOS ONE	2017	7
PLOS ONE	2018	6
PLOS ONE	2019	6
PNAS	2011	1
PNAS	2012	6
PNAS	2013	3
PNAS	2014	2
PNAS	2015	1
PNAS	2016	1
PNAS	2017	2
PNAS	2018	1
PNAS	2019	4
Polar Biology	2010	1
Polar Science	2019	1
POLISH JOURNAL OF ENVIRONMENTAL STUDIES	2015	1
POLISH JOURNAL OF ENVIRONMENTAL STUDIES	2016	1
POLISH JOURNAL OF ENVIRONMENTAL STUDIES	2019	2
Poster presentations(Current Opinion in Biotechnology)	2013	1
Proceedings of the Steklov Institute of Mathematics	2019	1
Progress in Lipid Research	2013	1
Progress in Oceanography	2017	3
Progress in Oceanography	2019	1
Proteomics	2010	1
Protoplasma	2012	1
Protoplasma	2015	1
Protoplasma	2017	1
Protoplasma	2019	1

Pure & Applied Chemistry	2011	1
Pure & Applied Chemistry	2015	1
Rapid Communications in Mass Spectrometry	2011	1
Remote Sensing	2017	4
Remote Sensing	2018	5
Remote Sensing	2019	4
Remote Sensing of Environment	2011	1
Remote Sensing of Environment	2012	1
Remote Sensing of Environment	2014	1
Remote Sensing of Environment	2016	1
Remote Sensing of Environment	2017	2
Renewable and Sustainable Energy Reviews	2015	1
Renewable Energy	2010	1
Results In Physics	2016	1
revista brasileira de ciencia do solo	2013	1
Revista Brasileira de Farmacognosia Brazilian Journal of Pharmacognosy	2011	1
Rice Science	2017	1
RNA Biology	2013	1
RSC Advances	2015	3
RSC Advances	2016	2
RSC Advances	2018	1
RSC Advances	2019	1
Science	2017	2
SCIENCE ADVANCES	2017	1
Science of the Total Environment	2016	2
Science of the Total Environment	2018	2
Science of the Total Environment	2019	3
Scientia Horticulturae	2010	2
Scientia Horticulturae	2011	4
Scientia Horticulturae	2012	1
Scientia Horticulturae	2013	3
Scientia Horticulturae	2014	4
Scientia Horticulturae	2015	2
Scientia Horticulturae	2017	4
Scientia Horticulturae	2018	2
Scientia Horticulturae	2019	10
Scientific Reports	2013	2
Scientific Reports	2016	3
Scientific Reports	2017	10
Scientific Reports	2018	3
Scientific Reports	2019	3
Sensors	2019	1
Small	2016	1
Small	2018	1
Small	2019	2
Soil Research	2013	1
Soil Science and Plant Nutrition	2019	1
South African Journal of Botany	2012	1
South African Journal of Botany	2014	1
South African Journal of Botany	2016	2
South African Journal of Botany	2019	1
Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy	2018	1
Surface Science	2015	1
Sustainable Energy Fuels	2018	1
Symbiosis	2012	1
Symmetry	2014	1
Systematic Biology	2018	1
Taxon	2011	1

Tetrahedron	2010	1
Tetrahedron	2017	1
The Astrophysical Journal	2018	1
The Chemical Record	2018	1
The Crop Journal	2017	1
The FEBS Journal	2012	1
The FEBS Journal	2018	1
The ISME Journal	2016	1
The ISME Journal	2018	1
THE JOURNAL OF BIOLOGICAL CHEMISTRY	2010	1
THE JOURNAL OF BIOLOGICAL CHEMISTRY	2011	1
THE JOURNAL OF BIOLOGICAL CHEMISTRY	2012	1
The Journal of Cell Biology	2016	1
The Journal of Eukaryotic Microbiology	2011	1
The Journal of Experimental Biology	2010	1
The Journal of Experimental Biology	2013	1
The Journal of Experimental Biology	2015	1
The Journal of Physical Chemistry	2017	1
The Plant Cell	2010	1
The Plant Cell	2011	4
The Plant Cell	2013	4
The Plant Cell	2014	1
The Plant Cell	2015	1
The Plant Cell	2016	1
The Plant Cell	2017	2
The Plant Cell	2018	1
The Plant Cell	2019	6
The Plant Journal	2010	1
The Plant Journal	2011	1
The Plant Journal	2012	3
The Plant Journal	2013	2
The Plant Journal	2014	2
The Plant Journal	2015	5
The Plant Journal	2016	1
The Plant Journal	2017	4
The Plant Journal	2019	4
The Plant Pathology Journal	2019	1
The Scientific World Journal	2012	2
The Scientific World Journal	2013	2
The Scientific World Journal	2014	2
Toxicon	2012	1
Toxins	2017	1
Tree Physiology	2010	6
Tree Physiology	2011	10
Tree Physiology	2012	4
Tree Physiology	2013	1
Tree Physiology	2014	4
Tree Physiology	2015	2
Tree Physiology	2016	5
Tree Physiology	2017	5
Tree Physiology	2018	5
Tree Physiology	2019	1
Trees	2015	1
Trees	2016	1
Trees	2018	1
Trees	2019	3
Trends in Biotechnology	2011	1
Trends in Genetics	2016	1

Appendix S2

Journal	Year	All Paper	Paper Using R	Package	Function
Acta Physiologiae Plantarum	2012	2	1	stats	nls
Agricultural and Forest	2012	2	1	lme4	
Agricultural and Forest	2014	1	1	mgcv,nlme,car	
Agricultural and Forest	2019	2	1		
Agricultural Water Management	2016	2	1		
Agronomy Journal	2011	2	1	nlme	
American Journal of Botany	2014	1	1	multcompView	
American Journal of Botany	2015	1	1	ape,phyloch	ace
American Journal of Botany	2018	2	1	stats,lme4,lmerTest	difflsmeans
Annals of Botany	2014	2	2	nlme	
Annals of Botany	2016	3	1	lsmeans	
Annals of Botany	2018	3	1		
AoB Plants	2015	2	1	stats	nls,lm
AoB Plants	2016	1	1	stats	lm,aov
Aquatic Microbial Ecology	2014	1	1	AquaEnv	
Aquatic Toxicology	2010	3	1	nlme	lme
Biogeosciences	2012	4	1	nlme	
Biogeosciences	2015	4	1		
Biogeosciences	2017	5	2	nlme	nlme
Biogeosciences	2018	2	2	lme4	
Biogeosciences	2019	1	1	FluxnetLSM	
Biomass and Bioenergy	2014	1	1		
Biophysical Journal	2010	1	1	timp	
BMC Genomics	2018	2	2	wgcna,minval,KEGGREST,g2f,Sybil,UniProt.ws,Biobase,exp2flux	
BMC Plant Biology	2011	1	1	limma	
Botanical Journal of the Linnean Society	2017	1	1	nlme,ape	
Cell	2013	1	1	coin	
Chemosphere	2011	3	1		
Computers and Electronics in Agriculture	2016	1	1		
Ecohydrology	2019	1	1		
Ecology	2019	1	1	StreamMetabolizer	
Ecology and Evolution	2015	1	1		
Ecology and Evolution	2016	4	2	ape,phytools,nlme	
Ecology Letters	2018	1	1	ape,ggtree	ace
Ecotoxicology	2017	1	1		
Environmental and Experimental Botany	2019	6	3	pcaMethods,pls,GenENT	prcomp
Environmental Microbiology	2019	1	1		
Environmental Pollution	2019	3	1	ggbiplot	
Environmental Science and Pollution Research	2016	4	1		
Evolution	2017	1	1	ape	
Field Crops Research	2016	2	1		
Forest Ecology and Management	2014	1	1		
Forest Ecology and Management	2016	2	1		
Forests	2018	3	1		
Freshwater Biology	2016	1	1		
Freshwater Biology	2019	1	1	stats	
Frontiers in Chemistry	2017	1	1	Plantecophys	

Journal	Year				
Frontiers in Plant Science	2016	29	2	corrplot,stats	cor,aov,hclust,p.adjust
Frontiers in Plant Science	2017	25	2	pheatmap	
Frontiers in Plant Science	2018	20	2	multcomp	
Frontiers in Plant Science	2019	17	2	lme4,NAM,CM-plot,bWGR	gwas2,reml,mcmcCV,emCV
Functional and Integrative	2011	1	1	affy	
Functional Plant Biology	2014	4	1	nlme	
GCB Bioenergy	2017	3	1	lsmeans	
GCB Bioenergy	2019	1	1	e1071	
Geophysical Research Letters	2017	2	1	stats	nls
Geoscientific Model Development	2015	1	1	rkt	
Global Change Biology	2013	4	1		
Global Change Biology	2015	3	2	lme4,MuMIn	
Global Change Biology	2018	5	2		
Global Change Biology	2019	3	1	nlme	
ICES Journal of Marine Science	2016	2	1	nlme,multcomp	glht
ICES Journal of Marine Science	2017	1	1	Seacarb	
Insects	2019	1	1	lme4,multcomp	
Integrative and Comparative	2019	1	1	Caper,phytools	brunch,pic
International Journal of Molecular Sciences	2019	8	2	stats,car,corrplot,edgeR,ggplots	
Journal of Agronomy and Crop Science	2015	3	1	sizer	
Journal of Applied Phycology	2013	1	1		
Journal of Applied Phycology	2015	2	1	EasyqPCR,SLqPCR	
Journal of Applied Phycology	2017	3	1	minpack.lm	
Journal of Applied Phycology	2019	1	1		
Journal of Chemical Ecology	2019	1	1	PCMCR	
Journal of Ecology	2014	1	1		
Journal of Ecology	2016	1	1	nlme	lme
Journal of Experimental Biology	2018	1	1	stats,LambertW	shapiro.test,test_normality,var.test
Journal of Experimental Botany	2012	9	1		
Journal of Experimental Botany	2014	20	3	limma	eBayes,topTable,lmFit
Journal of Experimental Botany	2015	7	1	lmerTest	difflsmeans
Journal of Experimental Botany	2016	16	3	stats,ape,nlme,geiger,phytools	spline
Journal of Experimental Botany	2017	19	3	RGBIF,FactoMineR,fdrtools	
Journal of Experimental Botany	2018	7	2	nlme,ape,lme4,plantecophys	lmer
Journal of Experimental Botany	2019	18	1	nlme,multcomp,rcompanion	lme,glht,transformTukey
Journal of Experimental Marine Biology and Ecology	2019	2	1	nlme	lme
Journal of Phycology	2013	2	1		
Journal of Phycology	2018	3	2	lme4,stats	lme,t.test
Journal of Phycology	2019	2	1		
Journal of Plant Nutrition & Soil Science	2014	2	1		
Journal of Plant Physiology	2017	3	1	agricolae,plantecophys,plyr,stats	lm,nls
Journal of Plant Physiology	2018	2	1	edgeR	
Journal of Plant Research	2017	1	1	Rcmdr	
Limnology and Oceanography:Methods	2010	1	1		

Journal	Year				
Limnology and Oceanography:Methods	2012	2	1	FME	modFit
Limnology and Oceanography	2012	2	1	stats	
Limnology and Oceanography	2018	2	1	nlme,stats	lme,anova
Marine Ecology Progress Series	2015	1	1		
Marine Pollution Bulletin	2019	2	1	Biostrings,vegan	
Micrgravity Science and Technology	2017	1	1	Rcmdr	
Molecular Biology and Evolution	2011	1	1	stats	lm
Molecular Biology and Evolution	2017	1	1	ape,stats	ace,lm
Molecular Biology and Evolution	2018	2	1	stats	lm
Molecular Plant	2017	2	1		
Nature Communications	2017	4	1	MuMln,gamm4	
New Phytologist	2010	4	1		
New Phytologist	2013	4	1		
New Phytologist	2015	6	1	rgbif,vegan	
New Phytologist	2016	7	3	stats,nlme,lsmeans, mgcv,plantecophys	cor,lme
New Phytologist	2017	11	5	quantreg,propagate ,maeswrap,stats,hmi sc,stats	nls,aov,TukeyHSD,l m,smooth,spline,rc orr
New Phytologist	2018	7	1	nls	varIdent
New Phytologist	2019	13	3	nlme,plantecophys,l me4,homonym,stats ,MuMln,smatr	nlme,fitacis,lmer,ga mm4,lm,dredge,m odel.sel,lme,varPo wer
Ocean Science	2019	1	1	uHMM,factoextra,g gplot2,stats	prcomp
Oecologia	2011	1	1		
Oikos: A Journal of Ecology	2015	1	1	nlme	
Photosynthesis Research	2010	49	2	nlme,affy,siggenes	sam
Photosynthesis Research	2011	43	1		
Photosynthesis Research	2012	66	0		
Photosynthesis Research	2013	50	3	pheatmap,multcom p,stats	lm
Photosynthesis Research	2014	73	1		
Photosynthesis Research	2015	82	2		
Photosynthesis Research	2016	90	2	DESeq2	
Photosynthesis Research	2017	81	3	Phangorn	
Photosynthesis Research	2018	99	7	stats,emmeans,stats, vegan,kohonen,min pack.lm,stats,timp	nls
Photosynthesis Research	2019	100	6	multcomp,stats,grap hics,timp	nls,contour
Photosynthetica	2013	16	1		
Photosynthetica	2019	39	2		
Phycological Research	2014	1	1		
Phycological Research	2016	1	1		
Physiologia Plantarum	2012	6	1	limma,gplots	hclust,heatmap.2
Physiologia Plantarum	2017	7	1	vegan	
Physiologia Plantarum	2018	4	1		
Physiologia Plantarum	2019	12	1		
Plant and Cell Physiology	2017	4	1	ggplot2	
Plant Biology	2012	2	1		
Plant Biology	2014	2	1		
Plant Breeding	2019	1	1		
Plant Pathology	2017	1	1		
Plant Physiology	2014	5	1	deSolve	

Journal	Year			Packages	
Plant Physiology	2016	5	3	lme4,pls,lme4,multcomp,smatr	plsr,lmer,glht
Plant Physiology	2017	6	2	smatr,FactoMineR,deSolve	
Plant Physiology	2018	4	1	GO.db,Genefilter,topGO	
Plant Physiology and Biochemistry	2019	7	3	nlme,ggplot2,plyr,reshape2,lubridate,cowplot,agricolae	
Plant,Cell and Environment	2011	5	1	nlme,gmodels,smatr	gls
Plant,Cell and Environment	2012	10	1		
Plant,Cell and Environment	2014	12	1		
Plant,Cell and Environment	2015	6	1		
Plant,Cell and Environment	2016	10	1	lme4,mgcv,multcomp	bootMer
Plant,Cell and Environment	2017	9	3	plantecophys,plantecophys,stats,Leaps	nls,lm,Photosyn,fitaci
Plant,Cell and Environment	2018	5	1		
Plant,Cell and Environment	2019	8	3	nlme,stats	nlme,prcomp
Planta	2010	1	1		
Plos Genetics	2014	2	1	limma	
Plos Genetics	2019	1	1	wgcna,MetaCycle,topGO	
Plos One	2013	12	1	Seacarb	
Plos One	2014	21	1		
Plos One	2015	16	1		
Plos One	2017	7	1	gplots	heatmap.2
Plos One	2018	6	1	plantecophys,nlme	lme
PNAS	2012	6	1	limma	
PNAS	2019	4	1		
Remote Sensing	2017	4	1	vegan	
Remote Sensing	2018	5	1	raster,hsdar	
Remote Sensing	2019	4	1		
Science of the Total Environment	2018	2	2	car,lattice,lme4,lsmeans,agricolae	
Science of the Total Environment	2019	3	1	drc	compPAR
Scientia Horticulturae	2014	4	1		
Scientific Reports	2017	10	2	car,lme4,lsmeans,stats	aov,levene,shapiro.test,lmer,lsmeans,cor,TukeyHSD,kruskal.test
Scientific Reports	2018	3	2	nlme,agricolae,mixOmics	
Scientific Reports	2019	3	1		
Soil Science and Plant Nutrition	2019	1	1		
Systematic Biology	2018	1	1	phytools,HyPhy	rerootingMethod
The FEBS Journal	2018	1	1		
The Plant Cell	2013	4	1	topGO,wgcna,nlme,gplots	heatmap.2,lme
The Plant Cell	2014	1	1		
The Plant Cell	2019	6	1	Rsubread,DESeq2,ggplot2,amap,VennDiagram	prcomp
The Plant Journal	2019	4	2	stats,FactoMineR,lattice,pcaMethods,pls	lm,anova,PCA
Tree Physiology	2011	10	1		
Tree Physiology	2014	4	2	mvpart,stats,nls,nls2,bbmle,glht	nls,nlm,lm

Tree Physiology	2015	2	1	multcomp,MASS,ggplot2	
Tree Physiology	2016	5	2	lmerTest,lme4,lme4,nlme,DAAG	difflsmeans,lmer,lmer,nlme,vif
Tree Physiology	2017	5	3	corrplot,nls,nlme,smatr,plantecophys,YplantQMC	
Tree Physiology	2018	5	1	gam	
Tree Physiology	2019	1	1		
Trees	2019	3	1	multcomp,stats	glht,glm
Weed Research	2011	2	1		

Appendix S3

ID	Package	Function	Theoretical Model	Description
general statistics (numerical value/probability) and graph packages (category G)				
1	ade4	Not mentioned	1,2	Analysis of Ecological Data: Exploratory and Euclidean Methods in Environmental Sciences
2	amap	Not mentioned	7	Another Multidimensional Analysis Package
3	bbmle	Not mentioned	1,2,6	Tools for General Maximum Likelihood Estimation
4	bWGR	mcmcCV,emCV	8	Bayesian Whole-Genome Regression
5	car	levene	1,2,4,5,6,7	Companion to Applied Regression
6	coin	Not mentioned	8	Conditional Inference Procedures in a Permutation Test Framework
7	corrplot	Not mentioned	1,2,4,7,8	Visualization of a Correlation Matrix
8	cowplot	Not mentioned	2,3,6,7	Streamlined Plot Theme and Plot Annotations for 'ggplot2'
9	DAAG	vif	1,2	Data Analysis and Graphics Data and Functions
10	deSolve	Not mentioned	1,2,3,5,7	Solvers for Initial Value Problems of Differential Equations ('ODE', 'DAE', 'DDE')
11	drc	compPAR	7	Analysis of Dose-Response Curves
12	e1071	Not mentioned	7	Misc Functions of the Department of Statistics, Probability Theory Group (Formerly: E1071), TU Wien
13	emmeans	Not mentioned	4,7	Estimated Marginal Means, aka Least-Squares Means
14	factoextra	Not mentioned	4,7	Extract and Visualize the Results of Multivariate Data Analyses
15	FactoMineR	PCA	1,2,3,4,7,8	Multivariate Exploratory Data Analysis and Data Mining
16	fdrtools	Not mentioned	8	Estimation of (Local) False Discovery Rates and Higher Criticism
17	FME	modFit	1,7	A Flexible Modelling Environment for Inverse Modelling, Sensitivity, Identifiability and Monte Carlo Analysis
18	gam	Not mentioned	1,4,7	Generalized Additive Models
19	gamm4	Not mentioned	7	Generalized Additive Mixed Models using 'mgcv' and 'lme4'
20	ggbiplot	Not mentioned	1,2	An implementation of the biplot using ggplot2. Data Visualisations for PCA analysis
21	ggplot2	Not mentioned	1,2,3,4,6,7	Create Elegant Data Visualisations Using the Grammar of Graphics
22	ggplots	Not mentioned	7	Hierarchical clustering and volcano plot (Bioconductor)
23	glht	Not mentioned	1,2,6	conduct multi-comparison analysis
24	gmodels	Not mentioned	1,2,6	Various R Programming Tools for Model Fitting
25	gplots	hclust,heatmap.2	3,7	Various R Programming Tools for Plotting Data
26	graphics	contour	1	Implement some basic drawing functions

27	hmisc	rcorr	1,2,6,7	Contains many functions useful for data analysis, high-level graphics, utility operations, functions for computing sample size and power, simulation, importing and annotating datasets, imputing missing values, advanced table making, variable clustering, character string manipulation, conversion of R objects to LaTeX and html code, and recoding variables.
28	homonym	gamm4	1,2	Fit GAMMs
29	kohonen	Not mentioned	7	Supervised and Unsupervised Self-Organising Maps
30	LambertW	test_normality,var.test	7	Probabilistic Models to Analyze and Gaussianize Heavy-Tailed, Skewed Data
31	lattice	Not mentioned	1,2,4,7	Trellis Graphics for R
32	Leaps	Not mentioned	1,2,7	Regression Subset Selection
33	lme4	lme,lmer,bootMer	1,2,3,4,5,6,7,8	Linear Mixed-Effects Models using 'Eigen' and S4
34	lmerTest	difflsmeans	1,2,4,7	Tests in Linear Mixed Effects Models
35	lsmeans	lsmeans	1,2,3,4,5,6,7,8	Least-Squares Means
36	lubridate	Not mentioned	2,3,6,7	Data processing and statistical analysis
37	maeswrap	Not mentioned	1,5,7	Wrapper Functions for MAESTRA/MAESPA
38	MASS	Not mentioned	1,2	Support Functions and Datasets for Venables and Ripley's MASS
39	mgcv	Not mentioned	1,2,3,4,5,6	Mixed GAM Computation Vehicle with Automatic Smoothness Estimation
40	minpack.lm	Not mentioned	1,4,7	R Interface to the Levenberg-Marquardt Nonlinear Least-Squares Algorithm Found in MINPACK, Plus Support for Bounds
41	multcomp	glht	1,2,6,7,8	Simultaneous Inference in General Parametric Models
42	multcompView	Not mentioned	1,4	Visualizations of Paired Comparisons
43	MuMIn	dredge,model.s	1,2,4,7	Multi-Model Inference
44	mvpart	Not mentioned	1,2,4	Modifications of RPART by Glenn De'ath, including partitioning based on (1) multivariate numeric responses and (2) dissimilarity matrices. (removed from the CRAN repository)
45	nlme	nlme,lme,varPower,gls	1,2,3,4,5,6,7,8	Linear and Nonlinear Mixed Effects Models
46	nls	varIdent	1,2,6,7	A nonlinear least-squares package
47	nls.multstart	nls_multstart	1,2,7	Robust Non-Linear Regression using AIC Scores
48	nls2	Not mentioned	1,2,6	Non-linear regression with brute force
49	pcaMethods	Not mentioned	1,2,4,7	A collection of Principal component analysis (PCA) methods (Bioconductor)
50	PCMCR	Not mentioned	1,7	Separate rank-sum means via Conover post hoc analysis
51	pheatmap	Not mentioned	1,2,7,8	Pretty Heatmaps
52	pls	plsr	1,2,4,7	Partial Least Squares and Principal Component Regression
53	plyr	Not mentioned	1,2,3,6,7	Tools for Splitting, Applying and Combining Data
54	propagate	Not mentioned	3,7	Propagation of Uncertainty
55	quantreg	Not mentioned	3,7	Quantile Regression
56	raster	Not mentioned	1,2	Geographic Data Analysis and Modeling

57	Rcmdr	Not mentioned	1,2,9	A platform-independent basic-statistics GUI (graphical user interface) for R, based on the tcltk package.
58	rcompanion	transformTukey	1,2,7	Functions to Support Extension Education Program Evaluation
59	reshape2	Not mentioned	2,3,6,7	Flexibly Reshape Data: A Reboot of the Reshape Package
60	rkt	Not mentioned	4	Mann-Kendall Test, Seasonal and Regional Kendall Tests
61	sizer	Not mentioned	2	Significant Zero Crossings
62	smatr	Not mentioned	1,2,3,6,7	(Standardised) Major Axis Estimation and Testing Routines
63	stats	cor,nlm,lm,anova,aov,cor,hclust, p.adjust,prcomp, shapiro.test,spline,t.test,anova,TukeyHSD,kruskal.test,glm,smooth	1,2,3,4,5,6,7,8	The stats package contains functions for statistical calculations and random number generation.
64	uHMM	Not mentioned	4,7	Construct an Unsupervised Hidden Markov Model
65	VennDiagram	Not mentioned	7	Generate High-Resolution Venn and Euler Plots

photosynthesis special-purpose packages (category S)

66	agricolae	Not mentioned	1,2,3,6,7	Statistical Procedures for Agricultural Research
67	AquaEnv	Not mentioned	4,7	Integrated Development Toolbox for Aquatic Chemical Model Generation
68	FluxnetLSM	Not mentioned	5	A community tool for processing FLUXNET data for use in land surface modelling
69	g2f	Not mentioned	7	Find and Fill Gaps in Metabolic Networks
70	hsdar	Not mentioned	1,2,7	Manage, Analyse and Simulate Hyperspectral Data
71	minval	Not mentioned	7	MINimal VALidation for Stoichiometric Reactions
72	plantecophys	fitaci,fitacis,Photosyn	1,2,3,4,5,6,7	Modelling and Analysis of Leaf Gas Exchange Data
73	StreamMetabolizer	Not mentioned	7	StreamMetabolizer uses inverse modeling to estimate aquatic metabolism (photosynthesis and respiration) from time series data on dissolved oxygen, water temperature, depth, and light.
74	Sybil	Not mentioned	7	Efficient Constrained Based Modelling
75	timp	Not mentioned	7	Fitting Separable Nonlinear Models in Spectroscopy and Microscopy
76	YplantQMC	Not mentioned	1,2,6	Coupled photosynthesis-stomatal conductance model.

phylogenetic and evolutionary packages (category E)

77	affy	Not mentioned	1,2,7,8	Methods for Affymetrix Oligonucleotide Arrays (Bioconductor)
78	ape	ace	1,8	Analyses of Phylogenetics and Evolution
79	Biobase	Not mentioned	8	Base functions for Bioconductor (Bioconductor)

80	Biostrings	Not mentioned	8	Memory efficient string containers, string matching algorithms, and other utilities, for fast manipulation of large biological sequences or sets of sequences. (Bioconductor)
81	Caper	brunch	1,2,8	Comparative Analyses of Phylogenetics and Evolution in R
82	CM-plot	Not mentioned	8	Circle Manhattan Plot
83	DESeq2	Not mentioned	7,8	Differential gene expression analysis based on the negative binomial distribution (Bioconductor)
84	EasyqPCR	Not mentioned	8	EasyqpcR for low-throughput real-time quantitative PCR data analysis
85	edgeR	Not mentioned	7,8	Empirical Analysis of Digital Gene Expression Data in R (Bioconductor)
86	exp2flux	Not mentioned	8	Convert Gene EXPression Data to FBA FLUXes
87	geiger	Not mentioned	1,8	Analysis of Evolutionary Diversification
88	Genefilter	Not mentioned	7,8	methods for filtering genes from high-throughput experiments (Bioconductor)
89	GeneNT	Not mentioned	1,2,8	Calculate the correlation relationships using morphological and physiological traits
90	ggtree	Not mentioned	8	an R package for visualization of tree and annotation data (Bioconductor)
91	GO.db	Not mentioned	7,8	A set of annotation maps describing the entire Gene Ontology (Bioconductor)
92	HyPhy	Not mentioned	8	Macroevolutionary phylogentic analysis of species trees and gene trees
93	KEGGREST	Not mentioned	7,8	Client-side REST access to the Kyoto Encyclopedia of Genes and Genomes (KEGG) (Bioconductor)
94	limma	eBayes,topTable,lmFit	3,7,8	Limma is an R package that utilizes Linear Models for Microarray Data for the assessment of differential expression. (Bioconductor)
95	MetaCycle	Not mentioned	8	Evaluate Periodicity in Large Scale Data
96	mixOmics	Not mentioned	1,2,7,8	Omics Data Integration Project (Bioconductor)
97	NAM	gwas2,reml	8	Nested Association Mapping
98	Phangorn	Not mentioned	8	Phylogenetic Reconstruction and Analysis
99	phyloch	Not mentioned	8	various phylogenetic manipulations
100	phytools	pic,rerootingMethod	1,2,8	Phylogenetic Tools for Comparative Biology (and Other Things)
101	Rsubread	Not mentioned	8	Mapping, quantification and variant analysis of sequencing data (Bioconductor)
102	siggenes	sam	1,2,7,8	Multiple Testing using SAM and Efron's Empirical Bayes Approaches (Bioconductor)
103	SLqPCR	Not mentioned	8	Functions for analysis of real-time quantitative PCR data at SIRS-Lab GmbH (Bioconductor)
104	topGO	Not mentioned	7,8	Enrichment Analysis for Gene Ontology (Bioconductor)
105	UniProt.ws	Not mentioned	8	R Interface to UniProt (Universal Protein) Web Services (Bioconductor)
106	wgcna	Not mentioned	7,8	Weighted Correlation Network Analysis

other packages

107	rgbif	Not mentioned	2,9	Interface to the Global 'Biodiversity' Information Facility API
108	Seacarb	Not mentioned	1,4,9	Seawater Carbonate Chemistry
109	vegan	Not mentioned	1,2,4,5,7,9	Community Ecology Package

description of the theoretical models:

1	FvCB model/von Caemmerer model, temperature response of parameters of photosynthesis model, irradiance response of parameters of photosynthesis model
2	stomatal conductance models/mesophyll conductance models
3	sensitivity analysis models
4	light environment and energy balance models
5	large-scale vegetaion models
6	hydraulic models
7	spectral dynamics analysis models
8	phylogenetic and evolutionary analysis models
9	other models

ID	Package	Description	Authors	Release Date	Citation
general statistics (numerical value/probability) and graph packages (category G)					
1	abd	The abd package contains data sets and sample code for the book, The Analysis of Biological Data	Kevin M. Middleton, Randall Pruim	2015/7/3	Whitlock MC, Schluter D (2009) 'The Analysis of Biological Data'. (Roberts and Company Publishers, Greenwood Village, CO, USA.)
2	alr3	The abr3 package contains data sets and sample code for the book, The Analysis of Biological Data	Sanford Weisberg	2018/4/20	Whitlock MC, Schluter D (2009) 'The Analysis of Biological Data'. (Roberts and Company Publishers, Greenwood Village, CO, USA.)
3	BayesianTools	General-Purpose MCMC and SMC Samplers and Tools for Bayesian	Florian Hartig	2019/12/9	https://cran.r-project.org/web/packages/BayesianTools/index.html
4	deSolve	Solvers for Initial Value Problems of Differential Equations ('ODE', 'DAE', 'DDE')	Karline Soetaert , Thomas Petzoldt, R. Woodrow Setzer, Peter N. Brown, George D. Byrne, Ernst Hairer, Alan C. Hindmarsh, Cleve Moler, Linda R. Petzold, Youcef Saad,	2020/3/8	Soetaert K, Petzoldt T, Setzer RW (2010) Solving Differential Equations in R: Package deSolve. Journal of Statistical Software 33(9), 1-25
5	drc	Analysis of Dose-Response Curves	Christian Ritz, Jens C. Strebig	2016/8/30	Ritz C, Baty F, Streibig JC, Gerhard D (2015) Dose-Response Analysis Using R. PLoS ONE 10(12),
6	gpk	Collection of datasets as prepared by Profs. A.P. Gore, S.A. Paranjape, and M.B. Kulkarni of Department of Statistics, Poona	Prabhanjan Tattar	2013/7/14	https://cran.r-project.org/web/packages/gpk/index.html
7	lgrdata	A largish collection of example datasets, including several classics. Many of these datasets are well suited for regression, classification, and visualization.	Remko Duursma, Jeff Powell	2019/6/19	https://cran.r-project.org/web/packages/lgrdata/index.html

#	Package	Description	Author	Date	Reference
8	Maeswrap	A bundle of functions for modifying MAESTRA/MAESPA input files,reading output files, and visualizing the stand in 3D. Handy for running sensitivity analyses, scenario	Remko Duursma	2015/6/30	https://cran.r-project.org/web/packages/Maeswrap/index.html
9	nls.multstart	Robust Non-Linear Regression using AIC Scores	Daniel Padfield, Granville Matheson	2020/9/18	https://cran.r-project.org/web/packages/nls.multstart/index.html

photosynthesis special-purpose packages (category S)

#	Package	Description	Author	Date	Reference
10	bigleaf	Physical and Physiological Ecosystem Properties from Eddy Covariance Data	Juergen Knauer, Soenke Zaehle, Tarek El-Madany, Mirco Migliavacca, Thomas Wutzler	2019/6/8	Knauer J, El-Madany T, Zaehle S, Migliavacca M (2018) Bigleaf - An R package for the calculation of physical and physiological ecosystem properties from eddy covariance data. PLoS ONE 13(8), e0201114https://doi.org/10.1371/journal.pone.0201114.
11	flux	Functions for the calculation of greenhouse gas flux rates from closed chamber concentration measurements.	Gerald Jurasinski, Franziska Koebsch, Anke Guenther, Sascha Beetz	2014/4/25	https://cran.r-project.org/web/packages/flux/index.html
12	gunit	Converts Conductance Units, , converts conductance (e.g. stomatal conductance) to different units: m/s, mol/m^2/s, and umol/m^2/s/Pa.	Chris Muir	2019/5/3	https://cran.r-project.org/web/packages/gunit/index.html
13	LeafArea	Rapid Digital Image Analysis of Leaf Area	Masatoshi Katabuchi	2019/7/3	Katabuchi M (2015) LeafArea: an R package for rapid digital image analysis of leaf area. Ecological Reserach 30,1073-1077.
14	LeafR	Calculates the Leaf Area Index (LAD) and Other Related Functions	Danilo Roberti Alves de Almeida, Scott Christopher Stark, Carlos Alberto Silva, Caio Hamamura, Ruben Valbuena	2019/8/2	Almeida DRAD, Stark SC, Shao G, Schietti J, Nelson BW, Silva CA, Gorgens EB, Valbuena R, Papa DDA, Brancalion PHS (2019) Optimizing the remote detection of tropical rainforest structure with airborne lidar: Leaf area profile sensitivity to pulse density and spatial sampling. Remote Sensing 11,92

15	medfate	Mediterranean Forest Simulation	Miquel De Cáceres, Shengli Huang, Víctor Granda, Antoine Cabon, Jordi Martínez-Vilalta, Maurizio Mencuccini, Nicolas Martin-StPaul	2020/11/5	https://cran.r-project.org/web/packages/medfate/index.html
16	meteoland	Landscape Meteorology Tools	Miquel De Cáceres, Nicolas Martin, Víctor Granda, Antoine Cabon	2020/10/27	de Caceres M, Martin-StPaul N, Turco M, Cabon A, Granda V (2018) Estimating daily meteorological data and downscaling climate models over landscapes, Environmental Modelling and Software 108,186-
17	nlraa	Nonlinear Regression for Agricultural Applications	Fernando Miguez, José Pinheiro, Douglas Bates	2021/1/5	Archontoulis SV and Miguez FE (2015) Nonlinear regression models and applications in agricultural research. Agronomy Journal 107, 786-798.
18	photobiologyFilters	Spectral Transmittance and Spectral Reflectance Data	Pedro J. Aphalo, Titta K. Kotilainen, Tania de la Rosa, Riitta Tegelberg, Andreas Albert, SCHOTT AG, Midwest Optical Systems, Inc.	2020/10/5	Aphalo PJ (2015) The r4photobiology suite. UV4Plants Bulletin 2015(1), 21-29. doi: 10.19232/uv4pb.2015.1.14.
19	photobiologyInOut	Read Spectral and Logged Data from Foreign Files	Pedro J. Aphalo, Titta K. Kotilainen, Glenn Davis	2020/4/14	Aphalo PJ (2015) The r4photobiology suite. UV4Plants Bulletin 2015(1), 21-29. doi: 10.19232/uv4pb.2015.1.14.
20	photobiologyLamps	Spectral Irradiance Data for Lamps	Pedro J. Aphalo, Lasse Ylianttila	2019/6/14	Aphalo PJ (2015) The r4photobiology suite. UV4Plants Bulletin 2015(1), 21-29.
21	photobiologyLEDs	Spectral Data for Light-Emitting-Diodes	Pedro J. Aphalo, Shafiuddin Ahmed	2018/1/14	Aphalo PJ (2015) The r4photobiology suite. UV4Plants Bulletin 2015(1), 21-29.
22	photobiologyPlants	Plant Photobiology Related Functions and Data	Pedro J. Aphalo	2019/6/14	Aphalo PJ (2015) The r4photobiology suite. UV4Plants Bulletin 2015(1), 21-29.
23	photobiologySensors	Spectral Response Data for Light Sensors	Pedro J. Aphalo	2020/10/5	Aphalo PJ (2015) The r4photobiology suite. UV4Plants Bulletin 2015(1), 21-29.
24	photobiologySun	Data for Sunlight Spectra	Pedro J. Aphalo	2019/3/27	Aphalo PJ (2015) The r4photobiology suite. UV4Plants Bulletin 2015(1), 21-29.
25	photobiologyWavebands	Waveband Definitions for UV, VIS, and IR	Pedro J. Aphalo, Titta K. Kotilainen	2020/4/28	Aphalo PJ (2015) The r4photobiology suite. UV4Plants Bulletin 2015(1), 21-29.

26	photosynthesis	Tools for Plant Ecophysiology & Modeling	Joseph Stinziano, Cassaundra Roback, Demi Gamble, Bridget Murphy, Patrick Hudson, Chris	2020/9/12	Stinziano JR, Roback C, Gamble D, Murphy B, Hudson P, Muir CD (2020) "photosynthesis: tools for plant ecophysiology & modeling." R package version 2.0.1, https://CRAN.R-project.org/package=photosynthesi
27	phytotools	Phytoplankton Production Tools	Greg M. Silsbe, Sairah Y. Malkin	2015/2/14	https://cran.r-project.org/web/packages/phytotools/index.html
28	plantecophys	Modelling and Analysis of Leaf Gas Exchange Data	Remko Duursma	2019/3/13	Duursma RA (2015) Plantecophys - An R Package for Analysing and Modelling Leaf Gas Exchange Data. PLoS ONE 10(11), e0143346.
29	plantecowrap	Enhancing Capabilities of 'plantecophys'	Joseph Stinziano, Demi Gamble, Robert Sharwood, Warren Conaty	2020/4/3	Duursma RA (2015) Plantecophys - An R Package for Analysing and Modelling Leaf Gas Exchange Data. PLoS ONE 10(11), e0143346
30	rpmodel	P-Model,predicting acclimated parameters of the enzyme kinetics of C3 photosynthesis, assimilation, and dark respiration rates as a function of the environment (temperature, CO2, vapour pressure deficit, light, atmospheric pressure)	Benjamin Stocker	2019/12/4	Stocker B, Wang H, Smith N, Harrison S, Keenan T, Sandoval D, Davis T, Prentice C (2019) P-model v1.0: An optimality-based light use efficiency model for simulating ecosystem gross primary production. Geoscientific Model Development Discussions, 2019, 1–59.
31	SuessR	Suess and Laws Corrections for Marine Stable Carbon Isotope Data	Casey Clark, Mattias Cape, Mark Shapley, Franz Mueter, Bruce Finney, Nicole Misarti	2020/10/21	https://cran.r-project.org/web/packages/SuessR/index.html
32	tealeaves	Solve for Leaf Temperature Using Energy Balance	Chris Muir	2020/6/18	Muir CD (2019) tealeaves: an R package for modelling leaf temperature using energy budgets. AoB PLANTS 11, plz054.
33	VICmodel	Get or set global parameters of the VIC model.		?	?
34	YplantQMC	Coupled photosynthesis-stomatal conductance model.		?	has been removed since 2018.2.28

phylogenetic and evolutionary packages (category E)

| 35 | hisse | Sets up and executes a HiSSE model (Hidden State Speciation and Extinction) on a phylogeny and character sets to test for hidden shifts in trait dependent rates of | Jeremy Beaulieu, Brian O'Meara, Daniel Caetano, James Boyko | 2021/2/20 | Beaulieu JM, O'Meara BC (2016) Detecting hidden diversification shifts in models of trait-dependent speciation and extinction. Systematic Biology 65, 583-601. |

other packages

| 36 | phenofit | Extract Remote Sensing Vegetation Phenology | Dongdong Kong, Mingzhong Xiao, Yongqiang Zhang, Xihui Gu, Jianjian Cui | 2020/4/2 | Kong D. R package: A state-of-the-art Vegetation Phenology extraction package, phenofit version 0.2.3, <https://github.com/kongdd/phenofit> |
| 37 | phenopix | Process Digital Images of a Vegetation Cover | Gianluca Filippa, Edoardo Cremonese, Mirco Migliavacca, Marta Galvagno, Matthias Folker, Andrew D. Richardson, Enrico Tomelleri | 2020/9/3 | https://cran.r-project.org/web/packages/phenopix/index.html |

Appendix S5

Number	Name	Classification	Description	Package	Models applied
1	R: Simulate C3 photosynthesis	f	Simulate C3 photosynthesis Description Usage Arguments Details Value Examples page for photosynthesis	photosynthesis	Farquhar et al., 1980;Bernacchi et al. 2002;Marshall and Biscoe 1980;Kruse et al. 2008;Medlyn et al.,2002;Hobbs et al. 2013;Kok 1956;Walker and Ort 2015;Yin et al. 2009;Yin et al. 2011;Harley et al. 1992;Koide et al. 2000;Tyree et al. 1972;Ogle et al. 2009;Pammenter et al. 1998
2	R: Photosynthesis submodel functions	f	Photosynthesis submodel functions Description Usage Arguments Details Value	medfate	
3	R: 'photosynthesis' package	p	Photosynthesis package Description Details page for photosynthesis-package	photosynthesis	Farquhar et al., 1980;Bernacchi et al. 2002;Marshall and Biscoe 1980;Kruse et al. 2008;Medlyn et al.,2002;Hobbs et al. 2013;Kok 1956;Walker and Ort 2015;Yin et al. 2009;Yin et al. 2011;Harley et al. 1992;Koide et al. 2000;Tyree et al. 1972;Ogle et al. 2009;Pammenter et al. 1998
4	Make lists of parameters for photosynthesis	f	Make lists of parameters for photosynthesis Description Usage Arguments Details Value References	photosynthesis	Buckley and Diaz-Espejo, 2015
5	Farquhar-von Caemmerer-Berry (FvCB) C3 photosynthesis model	f	Farquhar-von Caemmerer-Berry (FvCB) C3 photosynthesis model Description Usage Arguments Details Value References	photosynthesis	Buckley and Diaz-Espejo, 2015
6	R: Checking dependencies of photosynthesis	f	Checking dependencies of photosynthesis Description Usage Value Examples page for check_dependencies	photosynthesis	Farquhar et al., 1980;Bernacchi et al. 2002;Marshall and Biscoe 1980;Kruse et al. 2008;Medlyn et al.,2002;Hobbs et al. 2013;Kok 1956;Walker and Ort 2015;Yin et al. 2009;Yin et al. 2011;Harley et al. 1992;Koide et al. 2000;Tyree et al. 1972;Ogle et al. 2009;Pammenter et al. 1998
7	R: Tools for Plant Ecophysiology & Modeling	p	Simulate C3 photosynthesis using FvCB model, fit Aci,fit AQ,fit temperature responses,fit respiration in the light,fit mesophyll conductance,fit pressure-volume curves,fit hydraulic vulnerability curves,sensitivity anaylysis	photosynthesis	Farquhar et al., 1980;Bernacchi et al. 2002;Marshall and Biscoe 1980;Kruse et al. 2008;Medlyn et al.,2002;Hobbs et al. 2013;Kok 1956;Walker and Ort 2015;Yin et al. 2009;Yin et al. 2011;Harley et al. 1992;Koide et al. 2000;Tyree et al. 1972;Ogle et al. 2009;Pammenter et al. 1998
8	R: C4 Photosynthesis	f	An implementation of the A-Ci curve for C4 plants	plantecophys	von Caemmerer et al., 2000
9	R: self start for non-rectangular hyperbola	f	Fit AQ curves	nlraa	Archontoulis and Miguez, 2015
10	R: McCree's action spectra for whole-leaf photosynthesis.	d	McCree's action spectra for whole-leaf photosynthesis	photobiologyPlants	McCree,1972
11	R: Inhibition of photosynthesis	d	Inhibition of photosynthesis Description Usage Format Details Source Examples page for spinach	drc	Streibig,1998

12	R: Fits the Farquhar-Berry-von Caemmerer model of photosynthesis to measurements of	f	Fits the Farquhar-Berry-von Caemmerer model of photosynthesis	plantecophys	Farquhar et al., 1980
13	R: Photosynthesis in Neotropical Trees	d	9 females of Ocotea tenera	abd	Wheelwright and Logan, 2004
14	R: Coupled leaf gas exchange model	f	Coupled leaf gas exchange model Description Usage Arguments Details Value References See Also Examples	plantecophys	Duursma. 2015
15	Photosynthesis-DIN5031-10.txt	d	Evaluating Potential Spectral Impacts of Various Artificial Lights on Melatonin Suppression		
16	R: Bulk Canopy Photosynthetic Capacity (Vcmax and Jmax)	f	Bulk canopy maximum carboxylation rate (Vcmax25), and maximum electron transport rate (Jmax25) at 25 degrees Celsius from bulk intercellular CO2 concentration using the Farquhar et al. 1980 model for C3 photosynthesis.	bigleaf	Farquhar et al., 1980
17	R: Transpiration submodel functions	f	Set of high-level functions used in the calculation of stomatal conductance and transpiration.	medfate	Sperry et al., 2017
18	R: Mediterranean Forest Simulation	f	Functions to simulate Mediterranean forest functioning and dynamics using cohort-based description of	medfate	
19	R: Fitting ACi	f	Fitting ACi curves	photosynthesis	Gu et al., 2010
20	R: Estimating light respiration	f	fit_r_light_kok estimates light respiration using the Kok	photosynthesis	Kok 1956;Walk and Ort 2015; Yin et al., 2009; Yin et al., 2011
21	R: Calculates the Michaelis Menten coefficient for...	f	Calculates the Michaelis Menten coefficient of Rubisco-limited assimilation as a function of temperature and atmospheric pressure	rpmodel	
22	R: Fitting stomatal conductance	f	Fitting stomatal conductance models	photosynthesis	Ball et al., 1987; Leuning, 1995; and Medlyn et al., 2011
23	R: Stomatal conductance models	f	Stomatal conductance models	photosynthesis	Ball et al., 1987; Leuning, 1995; and Medlyn et al., 2011
24	R: Plots simulation results for one day	f	Plots simulation results for one day	medfate	
25	R: Fitting light responses of net CO2 assimilation	f	Fitting light responses of net CO2 assimilation	photosynthesis	Marshall B, Biscoe P. 1980
26	R: Fitting mesophyll conductance with the variable J method	f	Fitting mesophyll conductance with the variable J method	photosynthesis	Harley PC, Loreto F, Di Marco G, Sharkey TD. 1992
27	R: Fitting temperature responses	f	Fitting temperature responses	photosynthesis	Arrhenius 1915;Heskel et al,2016;Hobbs et al., 2013;Liang et al., 2018;Medlyn et al.,2012
28	R: Soil-plant water balance	f	Function spwb() is a water balance model that determines changes in soil moisture, soil water potentials, plant transpiration and drought stress at daily steps for a given forest stand during a period specified in the input climatic data	medfate	
29	R: Phytoplankton Production Tools	f	Calculates phytoplankton production by transposing modeled PE or RLC data to a water column with a user-defined theoretical in-situ irradiance field.	phytotools	

30	R: Printing graphs to system	f	Printing graphs to system	photosynthesis	
31	R: Temperature response functions	f	Fitting temperature responses	photosynthesis	Arrhenius 1915;Heskel et al,2016;Hobbs et al., 2013;Liang et al., 2018;Medlyn et al.,2012
32	R: J: Rate of electron transport (umol/m^2/s)	f	Calculate the rate of electron transport as a function of photosynthetic photon flux density	photosynthesis	
33	R: Running 2-parameter sensitivity analyses	f	Running 2-parameter sensitivity analyses	photosynthesis	
34	R: Non-rectangular hyperbolic model of light responses	f	Non-rectangular hyperbolic model of light responses	photosynthesis	Marshall and Biscoe,1980
35	R: Leaf parameter temperature responses	f	Leaf parameter temperature responses	photosynthesis	
36	R: Compiling outputs from lists	d	compile_data converts the outputs of fit_many into a form more readily usable for analysis	photosynthesis	
37	R: Computing measures of sensitivity	f	Computing measures of sensitivity	photosynthesis	
38	R: Fitting pressure-volume curves	f	Fitting pressure-volume curves	photosynthesis	Koide et al., 2000;Sack et al., 2003; Tyree and Hammel, 1972
39	R: Fitting hydraulic vulnerability curves	f	Fitting hydraulic vulnerability curves	photosynthesis	Ogle et al., 2009;Pammenter, Van der Willigen. 1998
40	R: Fitting many functions across groups	f	Fitting many functions across groups	photosynthesis	
41	R: Water use efficiency	f	Calculates water use efficiency (WUE)	medfate	
42	R: Get vector of parameter names	f	Get vector of parameter names	photosynthesis	
43	R: Convert pressure from PPM to Pascals	f	Convert pressure from PPM to Pascals	photosynthesis	
44	R: Reading in LiCor files	f	Returns a dataframe from raw LiCor files	photosynthesis	
45	R: CO2 supply and demand function (mol / m^2 s)	f		photosynthesis	
46	R: Conductance to CO2 (umol / (m^2 s Pa))	f		photosynthesis	
47	R: S3 class	f		photosynthesis	
48	R: S3 class baked	f		photosynthesis	
49	R: S3 class constants	f		photosynthesis	
50	R: S3 class enviro_par	f		photosynthesis	
51	R: Convert g_c (mumol CO2/m^2/s/Pa) to g_w (mumol H2O /m^2/s/Pa)	f		photosynthesis	
52	R: Inverse non-rectangular hyperbola for J_max calculation	f	Inverse non-rectangular hyperbola for J_max calculation	photosynthesis	
53	R: S3 class leaf_par	f		photosynthesis	
54	R: Light extinction and absortion functions	f	calculate the fraction of above-canopy irradiance (and the soil irradiance, respectively) reaching each vegetation layer	medfate	Anten and Bastiaans, 2016
55	R: Invokes a P-model function	f		rpmodel	

56	R: A Physiological Model of Unbalanced Algal Growth	f	A phytoplankton model with uncoupled carbon and nitrogen assimilation as a function of light and Dissolved Inorganic Nitrogen (DIN) concentration	deSolve	
57	R: Fit Ball-Berry type models of stomatal conductance	f	Fits one of three versions of the Ball-Berry type stomatal conductance models to observations of stomatal conductance (gs), photosynthesis (A), atmospheric CO2 concentration (Ca) and vapour pressure deficit (VPD).	plantecophys	Ball et al. 1987;Leuning, 1995; Medlyn et al., 2011; Duursma et al., 2013
58	R: FARquhar And Opti	f	The numerical solution of the optimal stomatal conductance model, coupled with the Farquhar model of	plantecophys	Buckley et al, 2014;Medlyn et al., 2011;Cowan and Farquhar, 1977
59	R: Farquhar-Ball-Berry coupled leaf gas exchange	f	Coupled photosynthesis-stomatal conductance model.	YplantQMC	
60	R: Displays simulation results	f	Function plot produces temporal graphs	medfate	
61	R: Optimization of root distribution	f	find optimum the species root distribution	medfate	Brodribb et al., 2010;Cabon et al., 2018;Eagleson 1982;Urli et al.,
62	R: Fit A-Ci curves with custom	f	Update version of "plantecophys"	plantecowrap	Bernacchi et al., 2001; Bernacchi et al., 2002; von Caemmerer 2000
63	R: Stomatal Slope Parameter "g1"	f	Estimation of the intrinsic WUE metric	bigleaf	Ball et al., 1987; Leuning, 1995; Medlyn et al., 2011
64	R: Modelling and Analysis of Leaf Gas Exchange Data	p		plantecophys	
65	R: Example metabolic thermal response curves	d	A dataset containing example data of rates of photosynthesis and respiration of the phytoplankton Chlorella vulgaris	multstart	
66	R: Default control parameters for models	f	The function returns a list with default parameters	medfate	
67	R: Forest growth	f	a forest growth model that calculates changes in leaf area, sapwood area and structural variables for all plant cohorts in a given forest stand during a period specified in the input climatic data.	medfate	
68	R: Nonlinear Regression for Agricultural Applications	p	Nonlinear Regression for Agricultural Applications	nlraa	
69	R: Calculates the instantaneous temperature response of Vcmax	f	Calculates its temperature-scaling factor following modified Arrhenius kinetics based on Kattge & Knorr (2007).	rpmodel	Kattge and Knorr 2007
70	R: Calculates the temperature dependence of the quantum yield	f	Calculates the temperature dependence of the quantum yield efficiency following the temperature dependence of the maximum quantum yield of photosystem II in light-adapted tobacco leaves, determined by Bernacchi et al. (2003)	rpmodel	Bernacchi et al., 2003
71	R: Very simple ecosystem model	f	The model determines the accumulation of carbon in the plant and soil from the growth of the plant via photosynthesis and senescence to the soil which respires carbon back to the atmosphere.	BayesianTools	

72	R: Leaf gas exchange at the EucFACE	d	Measurements of leaf net photosynthesis at the EucFACE experiment, on leaves of different trees growing in ambient and elevated CO_2	lgrdata	
73	R: Biochemical Energy	f	Radiant energy absorbed in photosynthesis or heat release by respiration calculated from net ecosystem exchange of CO2 (NEE).	bigleaf	Meyers and Hollinger, 2004;Nobel, 1974; Blanken et al., 1997
74	R: An example A-Ci curve	d		plantecophys	
75	R: An example dataset with multiple A-Ci curves	f	CO2 response of leaf photosynthesis, as measured with a Licor6400, for multiple leaves.	plantecophys	
76	R: Modelling and Analysis of Leaf Gas Exchange Data	p	Coupled leaf gas exchange model, A-Ci curve simulation and fitting, Ball-Berry stomatal conductance models, leaf energy balance using Penman-Monteith, Cowan-Farquhar optimization, humidity unit	plantecophys	Duursma, 2015
77	R: Get or set global parameters of the VIC model.	f	Get or set global parameters of the VIC model.Variable Infiltration Capacity land surface	VICmodel	Bras 1990;Addison-Wesley et al., 1999;Liang and Lettenmaier, 1999; Nijssen et al., 2001
78	R: Fit PE or RLC data to Eilers and Peeters 1988	f	Phytoplankton Production Tools:Calculates photosynthetic-irradiance (PE) parameters (alpha, eopt, ps) and fit statistics for PE or RLC data using the model of Eilers and Peeters 1988.	phytotools	Eilers and Peeters, 1988
79	R: Fit PE or RLC data to Jassby and Platt 1976	f	Phytoplankton Production Tools:R: Fit PE or RLC data to Jassby and Platt 1976	phytotools	Jassby and Platt, 1976
80	R: Fit PE or RLC data to Platt, Gallegos and Harrison 1980	f	Phytoplankton Production Tools:Calculates photosynthetic-irradiance (PE) parameters (alpha, beta, ps) and fit statistics for PE or RLC data using the model of Platt, Gallegos and	phytotools	Platt et al., 1980
81	R: R_abs: total absorbed radiation (W / m^2)	f	Solve for Leaf Temperature Using Energy Balance	tealeaves	Okajima et al., 2012
82	R: Fine fitting	f	Fine curve fitting function is used to fit vegetation time-series in every growing season.	phenofit	Beck et al., 2006; Elmore et al., 2012;Gu et al., 2009
83	R: Calculate Suess and Laws corrections for stable carbon...	f	Generates region-specific Suess, Laws, and net (Suess + Laws) corrections for stable carbon isotope data δ13C data input by the user.	SuessR	
84	R: Skye-Instruments Sensors	d	Spectral response data for broadband ultraviolet and visible radiation sensors.	photobiologyS ensors	
85	R: Data tables with species parameter values for Mediterranean...	d	A data sets of species parameter values, resulting from bibliographic search, fit to empirical data or expert-based guesses.	medfate	
86	R: Input for simulation models	f		medfate	
87	R: self start for Collatz temperature	f		nlraa	
88	R: Solar radiation utility functions	f	Set of functions used in the calculation of incoming solar radiation and net radiation.	meteoland	

89	R: Character-free State Speciation and Extinction Searching...	f	Executes a set of MiSSE models (Missing State Speciation and Extinction) on a phylogeny, varying the number of parameters for turnover and extinction fraction and stopping when models stop being very	hisse	
90	CRAN Task View: Hydrological Data and Modeling	p	This Task View contains information about packages broadly relevant to hydrology , defined as the movement, distribution and quality of water and water resources over a broad spatial scale of landscapes. Packages are broadly grouped according to their function; however, many have functionality that spans multiple categories. We also highlight other, existing resources that have related functions	A summary of Packages related to hydrology	
91	R: P-Model	f	predicting acclimated parameters of the enzyme kinetics of C3 photosynthesis, assimilation, and dark respiration rates as a function of the environment	rpmodel	Stocker et al., 2019
92	R: Calculates the CO2 compensation point	f	Calculates the photorespiratory CO2 compensation point in absence of dark respiration, Γ*	rpmodel	Farquhar, 1980
93	R: Fitting the temperature responses of Vcmax and Jmax	f	Fitting the temperature responses of Vcmax and Jmax	plantecowrap	
94	R: Fitting multiple temperature response curves	f	Fitting multiple temperature response curves	plantecowrap	
95	R: Fitting the peaked Arrhenius temperature response model	f	Fitting the peaked Arrhenius temperature response model	plantecowrap	
96	R: Fitting the Topt temperature response model	f		plantecowrap	Medlyn et al. 2002
97	R: Constructor of PAR waveband	f	photobiologyWavebands	photobiology Wavebands	
98	R: A function that extracts phenological thresholds	f	This function extracts phenological thresholds according to different methods.	phenopix	Gu et al., 2009; Klosterman et al., 2014;Zhang et al., 2003
99	R: A function to extract phenological thresholds	f		phenopix	Gu et al., 2009
100	R: A function to fit a curve and extract thresholds from...	f	This is a wrapper function that calls fitting functions and threshold functions and returns an object of class phenopix.	phenopix	
101	R: A package to process images of a vegetation cover	p	The package provides functions to process digital images, depict greennes index trajectories and extract relevant phenological stages.	phenopix	Gu et al., 2009
102	R: A function to fit a double logisitic function to a vector...	f		phenopix	Gu et al., 2009

103	R: A function to fit a double logisitic function to a vector...	f		phenopix	
104	R: Plant Photobiology Related Functions and Data	d	Provides functions for quantifying visible (VIS) and ultraviolet (UV) radiation in relation to the photoreceptors Phytochromes, Cryptochromes, and UVR8 which are present in	photobiologyPlants	
105	R: Energy-Use Efficiency (EUE)	f	Fraction of net radiation fixed by primary productivity.	bigleaf	
106	R: (Modified) Arrhenius Temperature Response Function	f	(Modified) Arrhenius function describing the temperature response of biochemical parameters.	bigleaf	Johnson et al., 1942;Kattge and Knorr, 2007
107	R: Coupled leaf gas exchange model with energy	f	As Photosyn, but calculates the leaf temperature based on the leaf's energy balance.	plantecophys	
108	R: Coupled leaf gas exchange model with Tuzet stomatal...	f	An implementation of the coupled photosynthesis - stomatal conductance model, using the Tuzet et al. (2003) model of stomatal conductance.	plantecophys	Tuzet et al. 2003
109	R: Lake zooplankton diversity	d	These data give the number of known crustacean zooplankton species for 69 world lakes.	alr3	
110	R: Lake zooplankton	d		alr3	
111	R: The Analysis of Biological Data	p	The abd package contains data sets and sample code for the book, The Analysis of Biological Data	alr3	Michael C. Whitlock and Dolph Schluter,2009
112	R: Run a simulation over a day with YplantQMC	f	Interface to daily simulations with YplantQMC. Two objects are required to run the simulation: a plant3d object, containing the plant structure information, and a met object, containing weather data, solar position, and number of	YplantQMC	
113	R: Non-rectangular hyperbola	f	A simple light response function that predicts leaf photosynthesis from absorbed PAR.	YplantQMC	
114	R: A single simulation of YplantQMC	f	Runs the YplantQMC model for one timestep. Runs the QuasiMC raytracer to estimate absorbed PAR for every leaf on the plant, given diffuse and direct radiation (set by fbeam, see below), the position of the sun, and reflectance and transmittance of the foliage	YplantQMC	
115	R: Generate a weather object	f	To run Yplant, a weather object needs to be constructed, that contains solar position data, radiation, air temperature, and so on.	YplantQMC	
116	R: Make a leaf physiology object	f	Constructs an object of class 'ypphy', which contains a function that calculates leaf photosynthesis and transpiration (and possibly other variables), from weather data (air temperature, humidity, etc.), and	YplantQMC	

117	R: Functions for MAESPA batch runs	f	Functions for running MAESTRA/MAESPA with parameters read from a .csv file.Maespa is a model of forest canopy radiation absorption, photosynthesis and water	Maeswrap	Wang and Jarvis. 1990
118	R: Analysis of Dose-Response Curves	f	Analysis of dose-response data is made available through a suite of flexible and versatile model fitting and after-fitting	drc	
119	R: Fit PE data to Webb et al. 1974	f	Calculates photosynthetic-irradiance (PE) parameters (alpha, ek) and fit statistics for PE or rapid light curve data using the model of Webb et al. 1974.	phytotools	Webb et al. 1974
120	R: Simulate photosynthetic active radiaton (PAR)	f	Derives and simulates PAR over a defined period for a given location.	phytotools	
121	R: Computes surface reflectance	f	The fraction of surface reflectance at the air-water interface is calculated as a function of solar zenith angle following Kirk (2011).	phytotools	Kirk 2011
122	R: Modeling Genotypic variation in photosynthetic competence of...	d	A data frame with 33 observations on the following 58 variables.	gpk	
123	R: Predict fluxes from GPP and Reco models and prepare for...	f	The functions predict fluxes from GPP and R_eco models and prepare the data for summing them up to budgets including feeding in set.back positions and values	flux	
124	Spectral 'transmittance' data for frequently used filters and similar materials. Plastic sheets and films; photography filters; theatrical gels; machine-vision filters; various types of window glass; optical glass and some laboratory plastics and glassware. Spectral reflectance data for frequently encountered materials.	d	Spectral 'transmittance' data for frequently used filters and similar materials. Plastic sheets and films; photography filters; theatrical gels; machine-vision filters; various types of window glass; optical glass and some laboratory plastics and glassware. Spectral reflectance data for frequently encountered materials.	photobiologyFilters	

125	Functions for reading, and in some cases writing, foreign files containing spectral data from spectrometers and their associated software, output from daylight simulation models in common use, and some spectral data repositories. As well as functions for exchange of spectral data with other R packages.	p	Functions for reading, and in some cases writing, foreign files containing spectral data from spectrometers and their associated software, output from daylight simulation models in common use, and some spectral data repositories. As well as functions for exchange of spectral data with other R packages.	photobiologyInOut
126	Spectral emission data for some frequently used lamps excluding led emitting diodes (LEDs) available as electronic components.	d	Spectral emission data for some frequently used lamps excluding led emitting diodes (LEDs) available as electronic components.	photobiologyLamps
127	Spectral emission data for some frequently used light emitting	d	Spectral emission data for some frequently used light emitting diodes.	photobiologyLEDs
128	Data for the extraterrestrial solar spectral irradiance and ground level solar spectral irradiance and irradiance.	d	Data for the extraterrestrial solar spectral irradiance and ground level solar spectral irradiance and irradiance.	photobiologySun
129	Constructors of waveband objects for commonly used biological spectral weighting functions (BSWFs) and for different wavebands describing named ranges of wavelengths in the ultraviolet (UV), visible (VIS) and infrared (IR) regions of the electromagnetic spectrum.	f	Constructors of waveband objects for commonly used biological spectral weighting functions (BSWFs) and for different wavebands describing named ranges of wavelengths in the ultraviolet (UV), visible (VIS) and infrared (IR) regions of the electromagnetic spectrum.	photobiologyWavebands
130	An interface for the image processing program 'ImageJ', which allows a rapid digital image analysis for particle sizes. This package includes function to write an 'ImageJ' macro which is optimized for a leaf area analysis by default.	f	An interface for the image processing program 'ImageJ', which allows a rapid digital image analysis for particle sizes. This package includes function to write an 'ImageJ' macro which is optimized for a leaf area analysis by default.	LeafArea

| 131 | A set of functions for analyzing the structure of forests based on the leaf area density (LAD) and leaf area index (LAI) measures calculated from Airborne Laser Scanning (ALS), i.e., scanning lidar (Light Detection and Ranging) data. | f | A set of functions for analyzing the structure of forests based on the leaf area density (LAD) and leaf area index (LAI) measures calculated from Airborne Laser Scanning (ALS), i.e., scanning lidar (Light Detection and Ranging) data. | LeafR |

f	functions
p	packages
d	data

Reference

1   Anten NPR, Bastiaans L (2016) The use of canopy models to analyze light competition among plants, in: Hikosaka, K., Niinemets, U., Anten, N.P.R. (Eds.), Canopy Photosynthesis: From Basics to Application. Springer, pp. 379–398.

2   Arrhenius S (1915) 'Quantitative laws in biological chemistry'. (Bell, London, UK)

3   Ball JT, Woodrow IE, Berry JA (1987) A model predicting stomatal conductance and its contribution to the control of photosynthesis under different environmental conditions. In 'Progress in Photosynthesis Research: Volume 4 Proceedings of the VIIth International Congress on Photosynthesis Providence, Rhode Island, USA, August 10–15, 1986.' (Ed. J Biggins.) pp.221-224. (Martinus-Nijhoff Publishers: Dordrecht, the Netherlands)

4   Beck PSA, Atzberger C, Hogda KA, Johansen B, Skidmore AK (2006) Improved monitoring of vegetation dynamics at very high latitudes: A new method using MODIS NDVI. Remote Sensing of Environment 100,321-334.

5   Bernacchi CJ, Pimentel C, Long SP (2003) In vivo temperature response functions of parameters required to model RuBP-limited photosynthesis. Plant, Cell and Environment 26,1419-1430.

6   Bernacchi CJ, Portis AR, Nakano H, von Caemmerer S, Long SP (2002) Temperature response of mesophyll conductance. Implications for the determination of rubisco enzyme kinetics and for limitations to photosynthesis in vivo. Plant Physiology 130,1992-1998.

7   Bernacchi CJ, Singsaas EL, Pimentel C, Portis Jr ARP, Long SP (2001) Improved temperature response functions for models of Rubisco-limited photosynthesis. Plant, Cell and Environment 24,253-259.

8   Blanken PD, Black TA, Yang PC, Neumann HH, Nesic Z, Staebler R, Hartog GD, Novak MD, Lee X (1997) Energy balance and canopy conductance of a boreal aspen forest: Partitioning overstory and understory components. Journal of Geophysical Research 102,28915-28927.

9   Bras RF (1990) 'Hydrology, an introduction to hydrologic science'. (Addison Wesley Publishing Company)

10   Brodribb TJ, Bowman DJMS, Nichols S, Delzon S, Burlett R (2010) Xylem function and growth rate interact to determine recovery rates after exposure to extreme water deficit. New Phytologist 188,533–542.

11   Buckley T, Martorell S, Diaz-Espejo A, Tomàs M, Medrano H (2014) Is stomatal conductance optimized over both time and space in plant crowns? A field test in grapevine (Vitis vinifera). Plant, Cell and Environment 37,2707-2721.

12   Buckley TN, Diaz-Espejo A (2015) Partitioning changes in photosynthetic rate into contributions from different variables. Plant, Cell and Environment 38,1200-11.

13   Cabon A, Martínez-Vilalta J, Poyatos ., Martínez de Aragón J, de Cáceres M (2018) Applying the eco-hydrological equilibrium hypothesis to estimate root ditribution in water-limited forests. Ecohydrology 11, e2015.

14   Cherkauer KA and Lettenmaier DP (1999) Hydrologic effects of frozen soils in the upper Mississippi River basin. Journal of Geophysical Research 104,19599-19610.

15   Collatz GJ, Ball J, Grivet C, Berry J (1991) Physiological and environmental regulation of stomatal conductance, photosynthesis and transpiration: a model that includes a laminar boundary layer. Agricultural and Forest Meteorology 54,107-136.

16   Cowan I, Farquhar G (1977) Stomatal function in relation to leaf metabolism and environment: stomatal function in the regulation of gas exchange. Symposia of the Society for Experimental Biology 31,471-505.

17   de Cáceres M, Martínez-Vilalta J, Coll L, Llorens P, Casals P, Poyatos R, Pausas JG, Brotons L (2015) Coupling a water balance model with forest inventory data to predict drought stress: the role of forest structural changes vs. climate changes. Agricultural and Forest Meteorology 213,77-90.

18   de Cáceres M, Mencuccini M, Martin-StPaul N, Limousin JM, Coll L, Poyatos R, Cabon A, Granda V, Forner A, Valladares F, Martínez-Vilalta J (2021) Unravelling the effect of species mixing on water use and drought stress in holm oak forests: a modelling approach. Agricultural and Forest Meteorology 296,108-233.

19   de Kauwe MG, Lin YS, Wright IJ, Medlyn BE, Crous KY, Ellsworth DS, Maire V, Prentice IC, Atkin OK, Rogers A, Niinemets Ü (2016) A test of the 'one-point method' for estimating maximum carboxylation capacity from field-measured, light-saturated photosynthesis. New Phytologist 210,1130-1144.

20   Duursma RA (2015) Plantecophys - an R package for analysing and modelling leaf gas exchange data. PLoS ONE 10, e0143346.

21   Duursma RA, Barton CVM, Lin YS, Medlyn BE, Eamus D, Tissue DT, Ellsworth DS, McMurtrie RE (2014) The peaked response of transpiration rate to vapour pressure deficit in field conditions can be explained by the temperature optimum of photosynthesis. Agricultural and Forest Meteorology 189-190, 2-10.

22   Duursma RA, Payton P, Bange MP, Broughton KJ, Smith RA, Medlyn BE, Tissue DT (2013) Near-optimal response of instantaneous transpiration efficiency to vapour pressure deficit, temperature and [CO2] in cotton (Gossypium hirsutum L.). Agricultural and Forest Meteorology 168,168-176.

23   Eagleson PS (1982) Ecological optimality in water-limited natural soil-vegetation systems: 1. Theory and hypothesis. Water Resources Research 18,325-340.

24   Eilers PHC, Peeters JCH (1988) A model for the relationship between light intensity and the rate of photosynthesis in phytoplankton. Ecological Modeling 42,199-215.

25   Ellsworth DS, Crous KY, Lambers H, Cooke J (2015) Phosphorus recycling in photorespiration maintains high photosynthetic capacity in woody species. Plant, Cell and Environment 38,1142-1156.

26   Elmore AJ, Guinn SM, Minsley BJ, Richardson AD (2012) Landscape controls on the timing of spring, autumn, and growing season length in mid-Atlantic forests. Global Change Biology 18,656-674.

27   Ethier G, Livingston N (2004) On the need to incorporate sensitivity to CO2 transfer conductance into the Farquhar von Caemmerer Berry leaf photosynthesis model. Plant, Cell and Environment 27,137-153.

28   Farquhar G, Sharkey T (1982) Stomatal conductance and photosynthesis. Annual Review of Plant Physiology

29   Farquhar GD, von Caemmerer S, Berry JA (1980) A biochemical model of photosynthetic CO2 assimilation in leaves of C3 species. Planta 149,78-90.

30   Gale J (1972) Availability of Carbon Dioxide for Photosynthesis at High Altitudes: Theoretical Considerations. Ecology 53,494-497.

31   Gu L, Pallardy SG, Tu, K Law BE, Wullschleger SD (2010) Reliable estimation of biochemical parameters from C3 leaf photosynthesis-intercellular carbon dioxide response curves. Plant, Cell and Environment 33,1852-1874.

32   Gu L, Post WM, Baldocchi D, Black TA, Suyker AE, Verma SB, Vesala T, Wofsy SC (2009) Characterizing the Seasonal Dynamics of Plant Community Photosynthesis Across a Range of Vegetation Types. In: Phenology of Ecosystem Processes (Ed: Noormets A, Springer New York), pp 35-58.

33   Gu L, Post WM, Baldocchi DD, Black TA, Suyker AE, Verma SB, Vesala T, Wofsy SC (2009) Characterizing the Seasonal Dynamics of Plant Community Photosynthesis Across a Range of Vegetation Types, in: Noormets, A. (Ed.), Phenology of Ecosystem Processes: Applications in Global Change Research. Springer New York, New York,

34   Harley P, Loreto F, Marco G, Sharkey T (1992) Theoretical considerations when estimating the mesophyll conductance to CO2 flux by analysis of the response of photosynthesis to CO2. Plant Physiology 98,1429-1436.

35   Heskel MA, O'Sullivan OS, Reich PB, Tjoelker MG, Weerasinghe LK, Penillard A, Egerton JJG, Creek D, Bloomfield KJ, Xiang J, Sinca F, Stangl ZR, la Torre AM, Griffin KL, Huntingford C, Hurry V, Meir P, Turnbull MH, Atkin OK (2016) Convergence in the temperature response of leaf respiration across biomes and plant functional types.

36   Hobbs JK, Jiao W, Easter AD, Parker EJ, Schipper LA, Arcus VL (2013) Change in heat capacity for enzyme catalysis determines temperature dependence of enzyme catalyzed rates. ACS Chemical Biology 8,2388-2393.

37   Jassby AD, Platt T (1976) Mathematical formulation of the relationship between photosynthesis and light for phytoplankton. Limnology and Oceanography 21, 540-547.

38   Johnson FH, Eyring H, Williams RW (1942) The nature of enzyme inhibitions in bacterial luminescence: sulfanilamide, urethane, temperature and pressure. Journal of Cellular and Comparative Physiology 20,247-268.

39   Kattge J and Knorr W (2007) Temperature acclimation in a biochemical model of photosynthesis: a reanalysis of data from 36 species, Plant, Cell and Environment 30,1176–1190.

40   Kirk AP (2011) High efficacy thinned four-junction solar cell. Semiconductor Science and Technology 26,125013.

41   Klosterman ST, Hufkens K, Gray JM, Melaas E, Sonnentag O, Lavine I, Mitchell L, Norman R, Friedl MA, Richardson AD (2014) Evaluating remote sensing of deciduous forest phenology at multiple spatial scales using PhenoCam imagery. Biogeosciences 11,4305-4320.

42   Koide RT, Robichaux RH, Morse SR, Smith CM (2000) Plant water status, hydraulic resistance and capacitance. In: Plant Physiological Ecology: Field Methods and Instrumentation (eds RW Pearcy, JR Ehleringer, HA Mooney, PW Rundel), pp. 161-183. (Kluwer, Dordrecht, the Netherlands)

43   Kok B (1956) On the inhibition of photosynthesis by intense light. Biochimica et Biophysica Acta 21,234-244.

44   Kosugi Y, Takanashi S, Ueyama M, Ohkubo S, Tanaka H, Matsumoto K, Yoshifuji N, Ataka M, Sakabe A (2013) Determination of the gas exchange phenology in an evergreen coniferous forest from 7 years of eddy covariance flux data using an extended big-leaf analysis. Ecological Research 28:373-385.

45   Kruse J, Adams MA (2008) Three parameters comprehensively describe the temperature response of respiratory oxygen reduction. Plant, Cell and Environment 31,954-967.

46   Kruse J, Hopmans P, Adams MA (2008) Temperature responses are a window to the physiology of dark respiration: differences between CO2 release and O2 reduction shed light on energy conservation. Plant, Cell and Environment 31,901-914.

47   Leuning R (1995) A critical appraisal of a combined stomatal-photosynthesis model for C3 plants. Plant, Cell and Environment 18,339-355.

48   Leuning R (2002) Temperature dependence of two parameters in a photosynthesis model. Plant, Cell and Environment 25,1205-1210.

49   Liang LL, Arcus VL, Heskel MA, O'Sullivan OS, Weerasinghe LK, Creek D, Egerton JJG, Tjoelker MG, Atkin OK, Schipper LA (2018) Macromolecular rate theory (MMRT) provides a thermodynamics rationale to underpin the convergent temperature response in plant leaf respiration. Global Change Biology 24,1538-1547.

50   Liang X, Wood EF, Lettenmaier DP (1999) Modeling ground heat flux in land surface parameterization schemes. Journal of Geophysical Research 104(D8), 9581-9600. Nijssen BN, Schnur R and Lettenmaier DP (2001) Global retrospective estimation of soil moisture using the Variable Infiltration Capacity land surface model, 1980-1993. Journal of Climate 14,1790-1808.

51   Lloyd J, Grace J, Miranda A, Meir P, Wong S, Miranda H, Wright I, Gash J, Mclmtyre J (1995) A simple calibrated model of Amazon rainforest productivity based on leaf biochemical properties. Plant, Cell and Environment 18,1129-1145.

52   Marshall B, Biscoe PV (1980) A model for C3 leaves describing the dependence of net photosynthesis on irradiance. Journal of Experimental Botany 31,29-39.

53   McCree KJ (1972) Significance of Enhancement for Calculations Based on the Action Spectrum for Photosynthesis. Plant Physiology 49,704-706.

54   Medlyn BE, Dreyer E, Ellsworth D, Forstreuter M, Harley PC, Kirschbaum MUF, le Roux X, Montpied P, Strassemeyer J, Walcroft A, Wang K (2002) Temperature response of parameters of a biochemically based model of photosynthesis. II. A review of experimental data. Plant, Cell and Environment 25,1167-1179.

55   Medlyn BE, Duursma RA, Eamus D, Ellsworth DS, Prentice IC, Barton CVM, Crous KY, de Angelis P, Freeman M, Wingate L (2011) Reconciling the optimal and empirical approaches to modelling stomatal conductance. Global Change Biology 17,2134-2144.

56   Meyers TP, Hollinger SE (2004) An assessment of storage terms in the surface energy balance of maize and soybean. Agricultural and Forest Meteorology 125,105-115.

57   Nobel PS (1974) 'Introduction to Biophysical Plant Physiology'. (Freeman, New York.)

58   Ogle K, Barber JJ, Willson C, Thompson B (2009) Hierarchical statistical modeling of xylem vulnerability to cavitation. New Phytologist 182,541-554.

59   Okajima Y, Taneda H, Noguchi K, Terashima I (2012) Optimum leaf size predicted by a novel leaf energy balance model incorporating dependencies of photosynthesis on light and temperature. Ecological Research 27,333-46.

60   Pammenter N, van der Willigen C (1998) A mathematical and statistical analysis of the curves illustrating vulnerability of xylem to cavitation. Tree Physiology 18,589-593.

61   Platt T, Gallegos CL and Harrison WG (1980) Photoinhibition and photosynthesis in natural assemblages of marine phytoplankton. Journal of Marine Research 38,687–701.

62   Rayment MB, Loustau D, Jarvis PG (2002) Photosynthesis and respiration of black spruce at three organizational scales: shoot, branch and canopy. Tree Physiology 22,219-229.

63   Sack L, Cowan PD, Jaikumar N, Holbrook NM (2003) The 'hydrology' of leaves: co-ordination of structure and function in temperate woody species. Plant, Cell and Environment 26,1343-1356

64   Schenk HJ, Jackson RB (2002) The Global Biogeography of Roots. Ecological Monographs 72, 311.

65   Silsbe GM, Kromkamp JC (2012) Modeling the irradiance dependency of the quantum efficiency of photosynthesis. Limnology and Oceanography: Methods 10,642-652.

66   Sperry J, Venturas M, Anderegg W, Mencuccini M, Mackay D, Wang Y, Love D (2016) Predicting stomatal responses to the environment from the optimization of photosynthetic gain and hydraulic cost: a stomatal optimization model. Plant, Cell and Environment 40,816-830.

67   Stocker BD, Wang H, Smith NG, Harrison SP, Keenan TF, Sandoval D, Davis T, Prentice IC (2020) P-model v1. 0: an optimality-based light use efficiency model for simulating ecosystem gross primary production. Geoscientific Model Development 13,1545-1581.

68   Streibig JC (1998) Joint action of natural and synthetic photosystem II inhibitors. Pesticide Science 55,137–146.

69   Terashima I, Masuzawa T, Ohba H, Yokoi Y (1995) Is photosynthesis suppressed at higher elevations due to low CO_2 pressure? Ecology 76,2663-2668.

70   Tyree M, Hammel H (1972) The measurement of the turgor pressure and the water relations of plants by the pressure-bomb technique. Journal of Experimental Botany 23, 267-282.

71   Ueyama M, Tahara N, Iwata H, Euskirchen ES, Hiroki I, Kobayashi H, Nagano H, Nakai T (2016) Optimization of a biochemical model with eddy covariance measurements in black spruce forests of Alaska for estimating CO_2 fertilization effects. Agricultural and Forest Meteorology 222,98-111.

72   Urli M, Porte AJ, Cochard H, Guengant Y, Burlett R, Delzon S (2013) Xylem embolism threshold for catastrophic hydraulic failure in angiosperm trees. Tree Physiology 33,672-683.

73   uzet A, Perrier A, Leuning R (2003) A coupled model of stomatal conductance, photosynthesis and transpiration. Plant, Cell and Environment 26,1097-1116.

74   von Caemmerer S (2000) 'Biochemical models of leaf photosynthesis'. (CSIRO Publishing: Collingwood, Australia).

75   Walker BJ, Ort DR (2015) Improved method for measuring the apparent CO_2 photocompensation point resolves the impact of multiple internal conductances to CO_2 to net gas exchange. Plant, Cell and Environment 38,2462-2474.

76   Wang Y, Jarvis PG (1990) Description and validation of an array model - MAESTRO. Agricultural and Forest Meteorology 51,257-280.

77   Webb WL, Newton M, Starr D (1974) Carbon dioxide exchange of Alnus rubra. Oecologia 17,281-291.

78   Wheelwright NT, Logan BA (2004) Previous-year reproduction reduces photosynthetic capacity and slows lifetime growth in females of a neotropical tree. Proceedings of the National Academy of Sciences (USA) 101, 8051-8055.

79   Yin X, Struik P, Romero P, Harbinson J, Evers J, van der Putten P, Vos J (2009) Using combined measurements of gas exchange and chlorophyll fluorescence to estimate parameters of a biochemical C3 photosynthesis model: a critical appraisal and a new integrated approach applied to leaves in a wheat (Triticum aestivum) canopy. Plant, Cell and Environment 32,448-464.

80   Yin X, Sun Z, Struik P, Gu J (2011) Evaluating a new method to estimate the rate of leaf respiration in the light by analysis of combined gas exchange and chlorophyll fluorescence measurements. Journal of Experimental Botany 62,3489-3499.

81   Zhang X, Friedl MA, Schaaf CB, Strahler AH, Hodges JCF, Gao F, Reed BC, Huete A (2003) Monitoring vegetation phenology using MODIS. Remote Sensing of Environment 84,471-475.

Appendix S6

Name	Software	Year
lovelilyinfall/Photosynthesis-model	R	2013
mdekauwe/Maestra	Fortran	2013
stowns/photosynthesis	JavaScript	2013
Sum 2013		3
caomw/Photosynthesis	C#	2014
jniznan/rbm-photosynthesis	Python	2014
mcordischi/photosynthesis	Java	2014
Sum 2014		3
dwestontn/poplar_GWAS_photosyn	HTML	2015
keremgokhan/ggj15	C#	2015
martin-rossgoodwin/photosynthesis	JavaScript	2015
soldair/plants	JavaScript	2015
vishesharma/Photosynthesis-Project-Website	CSS	2015
Sum 2015		6
agvozdevaite/Ghana-photosynthesis-data	R	2016
AleMorales/InteractivePhotosynthesis	R	2016
arnaldorusso/PyPAM	Python	2016
collijk/photosynthesis	Jupyter Notebook	2016
kakearney/photosynthesis-pkg	MATLAB	2016
kmcollins/photosynthesis_app	Swift	2016
nagdab/Photosynthesis-Algorithm	Java	2016
sisch/dissertation-C4-photosynthesis	TeX	2016
Sum 2016		8
AleMorales/DynamicPhotosynthesis	C	2017
dmsnell/photosynthesis	JavaScript	2017
glitteringkatie/photosynthesis	Elm	2017
gmboyer/HydrothermalPhotosynthesis	Jupyter Notebook	2017
jonathantsang/Photosynthesis	Python	2017
kwentz10/Photosynthesis_Optimization_Modeling	Python	2017
lookang/photosynthesis	HTML	2017
mdekauwe/optimise_nitrogen_allocation	Python	2017
pmo3/photosynthesis	Ruby	2017
qthen/Photosynthesis	Python	2017
rjoomen/PHOLIAGE	Pascal	2017
rjoomen/StratiPHOLIAGE	Pascal	2017
rohilbahl/Photosynthesis	HTML	2017
seanth/maestra---1997	Fortran	2017
ugultopu/Photosynthesis_Analysis	Python	2017
zhangyaonju/Global_sensitivity_analysis_for_Farquhar	MATLAB	2017
Sum 2017		16
adjablonski/Plant-Physiology	Python	2018
Akahadaka/photosynthesis	TypeScrip	2018
AndreaSanchezTapia/PFTC-3-Photosynthesis	R	2018
ARS-CSGCL-DT/PhotoSynthesisModule	C++	2018
drewthayer/photosynthesis-climate	Python	2018
ElyseCoberly/lessons	HTML	2018
fordja3/project-photosynthesis	Java	2018
JoeyBernhardt/photosynthesis	R	2018
johnboronkas/photosynthesis	C#	2018

jrpleban/Beta_photosynthesis_model	C++	2018
koruko/PIcurves	R	2018
Kukustar/photosynthesisFront	JavaScript	2018
magnus-haw/Photosynthesis-camera	Python	2018
mdekauwe/warming_photosynthesis_VWC	Python	2018
Omotola28/Photosynthesis-Game	Java	2018
optifat/photosynthesis	Python	2018
OyamaPlati/Photosynthesis	Java	2018
pontuslaestadius/rs-photosynthesis	R	2018
QAAFI/DCaPS	C#	2018
QTB-HHU/photosynthesismodel	Jupyter Notebook	2018
RishikeshRamjith/Photosynthes	Java	2018
sgebhard6/Photosynthesis	C#	2018
SWotherspoon/Platt	R	2018
sycrus/Photosynthesis	C#	2018
Timothy-W-Hilton/VPRMLandSfcModel	R	2018
traczpasruchu/photosynthesis	HTML	2018
yaolhhmi/Photosynthesis	CSS	2018
yaolhhmi/photosynthesis_interactive	CSS	2018
yin8686/Botany-Photosynthesis-Prallel-	Java	2018
Sum 2018		29
agecho/Photosynthesis-	Jupyter Notebook	2019
Andre-Nonaka/Rubisco-genetic-circuits	Jupyter Notebook	2019
bvsonawane/photosynthesis	R	2019
cropsinsilico/C3Photosynthesis MetabolicModel Archived	MATLAB	2019
davidjpmoore/WUE_ci	R	2019
godlovexiaolin/A-genetic-network-for-host-control-of-phyllosphere-microbiota-for-plant-health	HTML	2019
harishpalani/photosynth	Processin	2019
ingelectronicadj/ArticuloVision Electronica	TeX	2019
isgilman/photo_db	Jupyter Notebook	2019
jgomezdans/photosynthesis_practical	Jupyter Notebook	2019
kai860/photosynthesis	HTML	2019
KgomotsoWelcome/Parallel_Programming_with_the_Java_Fork-	Java	2019
Leonruocco/Machine-Learning-algorithms-in-	MATLAB	2019
liuzhongbao/photosynthesis	JavaScript	2019
MarkusLoew/Li6400helper	R	2019
Mayne941/modelsOfPhotosynthesis	Python	2019
mdekauwe/GDAY	C	2019
mdekauwe/heat_extremes_decoupling	Python	2019
mdekauwe/lpj_photosynthesis	Python	2019
NortonAlex/BETHY-SCOPE-Interactive-Phenology	Fortran	2019
othomantegazza/ps_booklet	R	2019
ruchikadubey2000/SELF-FEEDING-PLANT	C++	2019
sanozmen/matlabGEM	MATLAB	2019
Shabadoo89/Photosynthesis-board-game	C++	2019

SmartProjectUser/Photosynthesis-Idle-Miner	C#	2019
sophiaylnd/e-learning-photosynthesis-	HTML	2019
stcolema/photosynthesis	TeX	2019
taoroalin/Photosynthesis	JavaScript	2019
Tech-J/aframe-photosynthesis	HTML	2019
wusunlab/leaf-pst	OCaml	2019
Sum 2019		30
AGValdes/photosynthesis	HTML	2020
AleMorales/photofit	R	2020
allanw/photosynthesis	CSS	2020
ARCHIMED-platform/archimed-	TeX	2020
ardhadj/GreenBox_Photosynth	C++	2020
arthurslins/photosynthesis-aquatic-model	Python	2020
bnytprod/PHOTOSYNTHESIS1	JavaScript	2020
bnytprod/PHOTOSYNTHESIS2	JavaScript	2020
cdmuir/photosynthesis	R	2020
cdmuir/stomata-tradeoff	TeX	2020
cran/photosynthesis	R	2020
ewuweblab/movie-trailer	HTML	2020
GCEL/DALEC-CropN	Fortran	2020
gnishihara/ptzimodel	R	2020
HarveyBates/PhotosynthesisMicroMacro	Jupyter Notebook	2020
Iqbalwasim01/Sunlit-shaded-canopy-photosynthesis-model	R	2020
jakumin/Photosynthesis_quantum-simulation_code	Jupyter Notebook	2020
jakumin/Photosynthesis-quantum-simulation	Jupyter Notebook	2020
jmtsuji/chlorobia-cyc2-genomics	Jupyter Notebook	2020
knowledgeworld-	HTML	2020
liujialin8931/PVPRM	R	2020
long-lab/Dynamic-photosynthesis-model-of-soybean-canopy	MATLAB	2020
MaciejReimann/photosynthesis	TypeScrip	2020
manishverma09/VPRM	MATLAB	2020
ManuelLamothe/RapidACi	R	2020
McHailey/Carbon.Tree	Jupyter Notebook	2020
mdekauwe/BEES3041_lab_photosynthesis	Jupyter Notebook	2020
mdekauwe/CLIM3001_lab_photosynthesis	Jupyter Notebook	2020
Nesbox314/Photosynthesis	JavaScript	2020
NicholeMatters/Photosynthesis-starter-and-tests	Python	2020
nutint/photosynthesis-boardgame	Scala	2020
nutint/photosynthesis-	TypeScrip	2020
Prikaziuk/FvCB_photosynthesis	MATLAB	2020
Prikaziuk/Spe	HTML	2020
Sanjana711/PIT-boltproject	JavaScript	2020
sohymg/photosynthesis-	HTML	2020
solsword/chlorophyll	JavaScript	2020
SonyCSLParis/photosynthesis_models	Python	2020
tadzi/spectral_niches_photosynthesis	Jupyter Notebook	2020
TESTgroup-BNL/Matlab-Canopy_Photosynthesis Archiv	MATLAB	2020
TESTgroup-BNL/R-Canopy_Photosynthesis	R	2020
TobGerken/PhotosynthesisLab	Jupyter Notebook	2020

USGS-R/streamMetabolizer R 2020
zhangyaonju/EndofSeasonPhotosynthesis R 2020
ZuluScience/photosynthesis.github.io JavaScript 2020

Sum 2020 45

Sum All Years 140

	2013	2014	2015	2016	2017	2018	2019	2020	**Languages**	**Sum**
R	1			2		6	4	10	R	23
Fortran	1				1		1	1	Fortran	4
JavaScript	1		3		1	1	1	6	JavaScript	13
C#		1	1			4			C#	6
Python		1		1	5	5	3	3	Python	18
Java		1		1		5	1		Java	8
HTML			1		2	2	4	5	HTML	14
CSS			1			2		1	CSS	4
C					1		1		C	2
Jupyter Notebook				1	1	1	4	9	Jupyter Notebook	16
MATLAB				1	1		3	4	MATLAB	9
Swift				1					Swift	1
TEX				1			2	2	TEX	5
elm					1				elm	1
Ruby					1				Ruby	1
Pascal					2				Pascal	2
TypeScript						1	2	2	TypeScript	5
C++						2	2	1	C++	5
Processing							1		Processing	1
OCaml							1		OCaml	1
Scala								1	Scala	1
Sum	3	3	6	8	16	29	30	45		

Appendix S7

Year	Assistat	Graph-Pad Prism 5	Mathematica	MATLAB	Minitab	MS EXCEL	OpenStat	Origin	PAST	PRIMER	Python
2010 citation ratio	Assistat	Graph-Pad Prism 5	Mathematica	MATLAB 1 0.067	Minitab 1 0.067	MS EXCEL 1 0.067	OpenStat	Origin 2 0.133	PAST	PRIMER	Python
2011 citation ratio	Assistat	Graph-Pad Prism 5 1 0.083	Mathematica	MATLAB	Minitab 1 0.083	MS EXCEL 2 0.167	OpenStat	Origin 2 0.167	PAST	PRIMER	Python
2012 citation ratio	Assistat	Graph-Pad Prism 5 2 0.133	Mathematica	MATLAB	Minitab	MS EXCEL 2 0.133	OpenStat	Origin 3 0.200	PAST	PRIMER	Python
2013 citation ratio	Assistat	Graph-Pad Prism 5 2 0.143	Mathematica	MATLAB 1 0.071	Minitab	MS EXCEL 1 0.071	OpenStat 1 0.071	Origin 1 0.071	PAST	PRIMER	Python
2014 citation ratio	Assistat	Graph-Pad Prism 5 1 0.050	Mathematica	MATLAB 5 0.250	Minitab	MS EXCEL 1 0.050	OpenStat	Origin 3 0.150	PAST	PRIMER	Python
2015 citation ratio	Assistat	Graph-Pad Prism 5	Mathematica	MATLAB 2 0.061	Minitab	MS EXCEL 5 0.152	OpenStat	Origin 5 0.152	PAST	PRIMER 2 0.061	Python
2016 citation ratio	Assistat	Graph-Pad Prism 5 2 0.056	Mathematica 1 0.028	MATLAB 5 0.139	Minitab	MS EXCEL 5 0.139	OpenStat	Origin 7 0.194	PAST 1 0.028	PRIMER	Python 1 0.028
2017 citation ratio	Assistat	Graph-Pad Prism 5 3 0.094	Mathematica 1 0.031	MATLAB 4 0.125	Minitab	MS EXCEL 4 0.125	OpenStat	Origin 5 0.156	PAST	PRIMER	Python
2018 citation ratio	Assistat	Graph-Pad Prism 5 1 0.037	Mathematica	MATLAB	Minitab	MS EXCEL 6 0.222	OpenStat	Origin 1 0.037	PAST	PRIMER 1 0.037	Python 1 0.037
2019 citation ratio	Assistat 1 0.036	Graph-Pad Prism 5 4 0.143	Mathematica	MATLAB 1 0.036	Minitab	MS EXCEL 4 0.143	OpenStat	Origin 5 0.185	PAST	PRIMER 1 0.036	Python
2020 citation ratio	Assistat	Graph-Pad Prism 5 1 0.071	Mathematica	MATLAB 4 0.286	Minitab	MS EXCEL	OpenStat	Origin 1 0.071	PAST	PRIMER	Python
sum	Assistat 1	Graph-Pad Prism 5 17	Mathematica 2	Matlab 23	Minitab 2	MS EXCEL 31	OpenStat 1	Origin 35	PAST 1	PRIMER 4	Python 2
rank				5		4		3			

Year	R	SAS	sigmaplot	Simca	SPSS	Statistica	Systat	XLSTAT	sum	others
2010 citation ratio	R 1 0.067	SAS 2 0.133	sigmaplot 1 0.067	Simca	SPSS 4 0.267	Statistica 1 0.067	Systat 1 0.067	XLSTAT	15	6 0.400
2011 citation ratio	R 1 0.083	SAS 1 0.083	sigmaplot	Simca	SPSS 1 0.083	Statistica 2 0.167	Systat 1 0.083	XLSTAT	12	6 0.500
2012 citation ratio	R 2 0.133	SAS	sigmaplot 5 0.333	Simca	SPSS 1 0.067	Statistica	Systat	XLSTAT	15	7 0.467
2013 citation ratio	R 2 0.143	SAS 1 0.071	sigmaplot	Simca	SPSS 5 0.357	Statistica	Systat	XLSTAT	14	4 0.286
2014 citation ratio	R 3 0.150	SAS 4 0.200	SigmaPlot 2 0.100	Simca 1 0.050	SPSS	Statistica	Systat	XLSTAT	20	8 0.400
2015 citation ratio	R 4 0.121	SAS 1 0.030	SigmaPlot 6 0.182	Simca	SPSS 6 0.182	Statistica 2 0.061	Systat	XLSTAT	33	11 0.333
2016 citation	R 3	SAS	SigmaPlot 1	Simca	SPSS 6	Statistica 3	Systat 1	XLSTAT	36	10

	R	SAS	SigmaPlot	Simca	SPSS	Statistica	Systat	XLSTAT		others
ratio	0.083		0.028		0.167	0.083	0.028			0.278
2017 citation ratio	3 0.094	5 0.156	4 0.125	Simca	2 0.063	1 0.031	Systat	XLSTAT	32	14 0.438
2018 citation ratio	6 0.222	3 0.111	SigmaPlot	Simca	5 0.185	2 0.074	Systat	1 0.037	27	9 0.333
2019 citation ratio	7 0.250	SAS	2 0.071	Simca	3 0.107	Statistica	Systat	XLSTAT	28	8 0.286
2020 citation ratio	3 0.214	SAS	SigmaPlot	Simca	5 0.357	Statistica	Systat	XLSTAT	14	1 0.071
sum	35	17	21	1	38	11	3	1	228	
rank	2				1					

others languages/applications not including Matlab,MS EXCEL, Orign, R, SPSS.