

Nr 161 · 1981

# Photosynthesis and Respiration in Conifers

*A Classified Reference List, Supplement 1*

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# Abstract

ODC 161.32—174.7 : 161.2—174.7 (048.1)

*The report contains 158 references on photosynthesis and respiration in coniferous species and is a supplement to a previous bibliography on the same subject. To facilitate the finding of relevant information each paper has been classified according to its content and this information has been compiled into tables. The tables show which processes other than photosynthesis and/or respiration were studied, and which factors were studied in relation to the exchange of carbon dioxide.*

*Everything should be made as simple  
as possible, but not simpler.*

*Albert Einstein*

LF/ALLF 293 81 006  
ISBN 91-38-06732-3  
ISSN 0039-3150

Berlings, Arlöv 1982, 9362

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# 1 Introduction

A bibliography on photosynthesis and respiration in conifers was compiled a few years ago (Linder 1979) containing 410 references divided between 85 species. With the present publication rate it is now time to publish the first supplement, including another 158 references covering 44 species, of which five were not represented in the original bibliography. Two-thirds of the papers have been published since 1977 and one-third should have been included in the previous report, but were missed for various reasons. The main reason for "missed" papers is that their titles did not reveal that they contained information on gas exchange.

During the latest five years, the publication rate seems to have stabilized at 2—3 papers per month, which suggests that the "exponential period of growth" is over. The distribution of papers between species is

approximately the same as before, Scots pine and Norway spruce being the most popular species. There is a tendency in the material for a higher proportion of field studies than before, and an increasing number of papers include the study of water relations as well. It is satisfying to note that reports on *in situ* measurements of respiration in the "non-green" part of the biomass are more frequent, but the field of root respiration is unfortunately still almost entirely neglected.

The supplement is arranged in accordance with the previous report, in which the classified references are arranged in alphabetical order according to their scientific names. A scientific and English index is found in the Appendices, in which species in the previous bibliography are also included.

## 2 Material and Methods

### 2.1 Classification of papers

Only papers including direct measurements of photosynthesis, respiration or both are included in the bibliography. Therefore a number of papers which include the words "photosynthesis" or "respiration" in the title have been excluded, since the measurements actually consisted of gravimetric determination of changes in dry weight.

This supplement, like the previous bibliography (Linder 1979), covers literature published in English, French, German or the Scandinavian languages only. An exception has been made to this when a paper contained an abstract and figure legends in one of the above languages.

The availability of papers from Swedish libraries has been a general criterion for the selection of papers. This means that most unpublished theses are not included in the bibliography, even if their subject was relevant.

Since one of the objectives of the bibliography is to facilitate the finding of papers concerned with different aspects of the carbon dioxide exchange of coniferous species, a classification key was worked out. The classification is tabulated, each paper being classified according to its content. The object of the classification is not to indicate whether a paper is good or bad—that is for the reader to judge—but to indicate concisely the content of each paper.

### 2.2 How to read the tables

The tables are divided into nine different main entries; Species, Stage, Organ, Processes, Abiotic (factors), Biotic (factors), Time (span), Season and Place. Each of the titles is then divided into a number of sub-titles, making a total of 33 different entries.

In spite of the many key-words, it is not possible to cover all the different features found in the reports. Some simplification has been necessary in the form of combining different subjects under the same key-word. To facilitate the use of the tables, some guidance is given below.

*Species:* The tables are arranged in alphabetical order, according to the scientific name of the species. The English name is found within brackets. The scientific and English names are in most cases according to "A Handbook of Coniferae and Ginkgoaceae" (Dallimore & Jackson 1966) and "A Field Guide to the Trees of Britain and Northern Europe" (Mitchell 1974).

If the common English name of the species only is known to the reader, he can find his way in the tables by using an English index in the Appendix. In the appendices, English and scientific, are included also species that were included in the previous bibliography (Linder 1979).

*Stage:* Here is shown whether the measurements were performed on trees, seedlings or both. "Seedling" is not clearly defined, but in most cases the definition from the paper in question has been used.

*Organ:* Here it is shown which organ(s) of the plant was used for the measurements, and whether the organ was attached or detached. If the shoot of a tree or a seedling was used, it is indicated only whether or not the shoot was attached. It should be noted that in some investigations, different organs may have been used, which may cause some confusion. For example, an attached shoot and a detached root may have been used, and it is then not possible

to decide from the table which organ was attached.

Studies on cones and buds have been included under the subtitle *Stem, branches*.

*Processes*: Either photosynthesis or respiration must have been studied if a paper is found in the tables. Therefore, one or both of these processes will always be marked. If other processes were studied as well, this may be discovered under the relevant subtitle.

**ABIOTIC (factors)**: When the effect of an abiotic factor upon photosynthesis or respiration has been studied, this may be found under this main title. However, if a diurnal pattern of CO<sub>2</sub>-exchange is reported, together with simultaneous records of temperature and irradiance, nothing will be marked under the key-words irradiance and temperature. If the same data set was used to plot a dose-response curve for CO<sub>2</sub>-exchange against irradiance, temperature or both, marks will be found under the relevant subtitles.

Under the different subtitles Abiotic (factors) the following can be found:

*Irradiance*: Includes both quantity and quality of light.

*Temperature*: Includes both air- and soil temperature.

*Water*: Covers different aspects of water supply, induced water stress or both.

*Chemicals*: Includes biocides, antitranspirants, hormones, etc.

*Pollution*: Includes all air-borne pollutants.

**BIOTIC (factors)**: Marks under this title do not necessarily mean that dose-response curves have been established between CO<sub>2</sub>-exchange and the marked factor.

*Chlorophylls*: A mark under this subtitle shows that figures for the chlorophyll content of the organ studied can be found in the paper.

*Age*: May be the age of the plant material or the organs used in the investigation. A mark means that more than one age has been studied.

*Provenances*: Includes different genetic aspects such as provenance, crossings, clones, etc.

*Time*: Gives the time span of the study.

*Season*: Gives the season when the study was performed.

*Place*: Studies where the plant material was brought from the field into the laboratory are classified as laboratory studies. The same is true for measurements in greenhouses, even if no artificial light was used.

Often some basic information is lacking in the tables, such as stage of plant material or whether the measurements were made on attached shoots or not. When information such as this is missing, it is due to incomplete description of the experiments in the original paper.

### 3 Acknowledgements

I wish to express my sincere thanks to Miss E. Arwidsson for her patient assistance when gathering the references. I am also

indebted to the helpful librarians at the Swedish University of Agricultural Sciences in Uppsala.

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## 5 Tables





CALOCEDRUS DECURRENS (INCENSE CEDAR)	X		X	X X	X					X	X	55
CHAMAECYPARIS OBTUSA (HINOKI CYPRESS)	X		X	X X		X X			X	X X X X X	X	44
	X	X		X X X		X X			X	X X X X X	X	45
	X	X X		X X					X	X X X X X	X	46
	X		X	X		X					X	47
	X		X	X		X			X	X X X X X	X	114
	X		X	X	X	X			X X	X X	X	115
JUNIPERUS DEPPEANA (CEDRO)	X		X	X X		X					X	21
	X		X	X X X		X					X	22
JUNIPERUS VIRGINIANA (PENCIL CEDAR)	X X		X	X X	X	X X					X	125
LARIX DECIDUA (EUROPEAN LARCH)	X		X	X X	X	X			X X	X X	X	15
	X	X		X X	X						X	34
	X		X	X		X X					X	39
	X		X	X X	X	X		X			X	42
	X		X	X	X	X				X	X	52
	X		X	X			X X X		X	X X X	X	66
	X		X X	X X	X	X					X	128
	X		X	X X		X					X	143
LARIX KAEMPFERI (JAPANESE LARCH)	X		X	X		X					X	47
	X		X	X			X X X		X	X X X	X	66

	Species	Stage	Organ	Processes	Abiotic	Biotic	Time	Season	Place	No.
		Trees Seedlings	Stem, branches Roots Needles Chloroplasts Attached Detached	Photosynthesis Respiration Photorespiration Transpiration Growth Electron transfer	Irradiance Temperature Carbon dioxide Water Mineral nutrients Chemicals Pollution	Chlorophylls Age Provenances	Diurnal variation Seasonal variation	Spring Summer Autumn Winter	Laboratory Field	Reference
	PICEA ABIES (NORWAY SPRUCE)	X	X	X X		X X	X	X X	X X	5
		X	X	X		X X		X X	X X	7
		X	X	X		X X		X X	X X	8
		X	X	X		X X		X X	X X	34
		X	X	X		X X		X X	X X	39
		X	X	X		X X		X X	X X	43
		X	X	X		X X		X X	X X	52
		X	X	X		X X		X X	X X	64
		X	X	X		X X		X X	X X	65
		X	X	X		X X		X X	X X	66
		X	X	X		X X		X X	X X	67
		X	X	X		X X		X X	X X	69
		X	X	X		X X		X X	X X	70
		X	X	X		X X		X X	X X	71
		X	X	X		X X		X X	X X	72
		X	X	X		X X		X X	X X	76
		X	X	X		X X		X X	X X	99
		X	X	X		X X		X X	X X	113
		X	X	X		X X		X X	X X	116
		X	X	X		X X		X X	X X	117
		X	X	X		X X		X X	X X	118





PINUS CONTORTA (LOGPOLE PINE)	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	15
	X		X	X														18
PINUS DENSIFLORA (JAPANESE RED PINE)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	110
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	111
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	112
PINUS DENSI-THUNBERGII	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	114
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	115
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	107
PINUS ECHINATA (SHORTLEAF PINE)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	153
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	36
PINUS KESYIA (BENGUET PINE)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	12
PINUS MUGO (MOUNTAIN PINE)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	15
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	106
	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	146

Species	Stage	Organ	Processes	Abiotic	Biotic	Time	Season	Place	No.
PINUS NIGRA (AUSTRIAN PINE)	Trees	Stem, branches	Photosynthesis	Irradiance	Chlorophylls	Diurnal variation	Spring	Laboratory	Reference
	Seedlings	Roots	Respiration	Temperature	Age	Seasonal variation	Summer	Field	
		Needles	Photorespiration	Carbon dioxide	Provenances		Autumn		
		Chloroplasts	Transpiration	Water			Winter		
		Attached	Growth	Mineral nutrients					
		Detached	Electron transfer	Chemicals					
				Pollution					
PINUS PINASTER (MARITIME PINE)	X	X	X	X	X X			X	63
	X	X	X X	X X	X			X	11
	X	X	X X	X X	X			X	21
	X	X	X	X	X			X X	22
	X	X	X	X	X			X	23
PINUS PONDEROSA (WESTERN YELLOW PINE)	X	X	X	X	X			X	27
	X	X	X	X	X			X X	28
	X	X	X	X	X			X X	29
	X	X	X	X	X			X X	31
	X	X	X	X	X			X X	37
X	X	X	X	X			X	55	
X	X	X	X	X			X X	56	

PINUS RADIATA (MONTEREY PINE)	X	X	X	X	X	X				X	129	
	X	X	X	X	X	X						
	X	X	X	X	X	X		X	X	X	13	
	X	X	X	X	X	X					17	
	X	X	X	X	X	X					62	
	X	X	X	X	X	X					106	
	X	X	X	X	X	X		X	X	X	130	
	X	X	X	X	X	X					142	
PINUS RESINOSA (RED PINE)	X	X	X	X	X	X		X	X	X	41	
	X	X	X	X	X	X		X	X	X	121	
	X	X	X	X	X	X		X	X	X	131	
	X	X	X	X	X	X		X	X	X	141	
	X	X	X	X	X	X		X	X	X	154	
PINUS RIGIDA (NORTHERN PITCH PINE)	X	X	X	X	X	X		X	X	X	20	
	X	X	X	X	X	X		X	X	X	22	
	X	X	X	X	X	X		X	X	X	85	
PINUS SYLVESTRIS (SCOTS PINE)	X	X	X	X	X	X		X	X	X	2	
	X	X	X	X	X	X		X	X	X	15	
	X	X	X	X	X	X		X	X	X	16	
	X	X	X	X	X	X		X	X	X	19	
	X	X	X	X	X	X		X	X	X	30	
	X	X	X	X	X	X		X	X	X	34	
	X	X	X	X	X	X		X	X	X	40	











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# 7 Appendices

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