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Teak tree-ring chronologies in Myanmar — A first attempt

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ABSTRACT

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A preliminary dendrochronological study with teak in Myanmar was performed in order to test its potential as a palaeoclimatic archive. There was a strong signal for rainfall in April, i.e., for the transition period between the dry and the rainy season.

Key-words—Teak, Dendrochronology, Myanmar.

म्याँमार में टीक वृक्ष वलय कालानुक्रम सम्बन्धी प्रथम अनुसन्धान कार्य

नासुदा पूमिजुमनांग, डीटर आक्सटाइन एवं वोन-क्यू पार्क

सारांश

एक पुराजलवायुविक संग्रह के रूप में म्याँमार के टीक की प्रभाविता को प्रेक्षित करने के उद्देश्य से वहाँ की टीक का प्रारंभिक वृक्ष वलय कालानुक्रमिकीय अध्ययन किया गया। यहाँ शुष्क एवं वर्षा के मौसम के बीच के संक्रमण काल हेतु अर्थात् अप्रैल माह में वृष्टि के महत्त्वपूर्ण संकेत मिले हैं।

संकेत शब्द—टीक, वृक्षवलयकालानुक्रमिकी, म्याँमार.

INTRODUCTION

TEAK (*Tectona grandis* L.) has been proven for some time to be of great dendroclimatic potential in several areas of its natural distribution: Berlage (1931) and D'Arrigo *et al.* (1994) studied teak in Java, Bhattacharyya *et al.* (1992) and Wood (1996) in India, Pumijumnong *et al.* (1995) in Thailand and Eckstein and Xayvongsa (unpubl.) in Laos. However, in Myanmar teak has not yet dendrochronologically been explored. Since the old-grown teak forests in the whole area from India to Laos are endangered by logging activities, it is high time to rescue the unique source of climatic information archived in those trees. The present paper is the first attempt from Myanmar.

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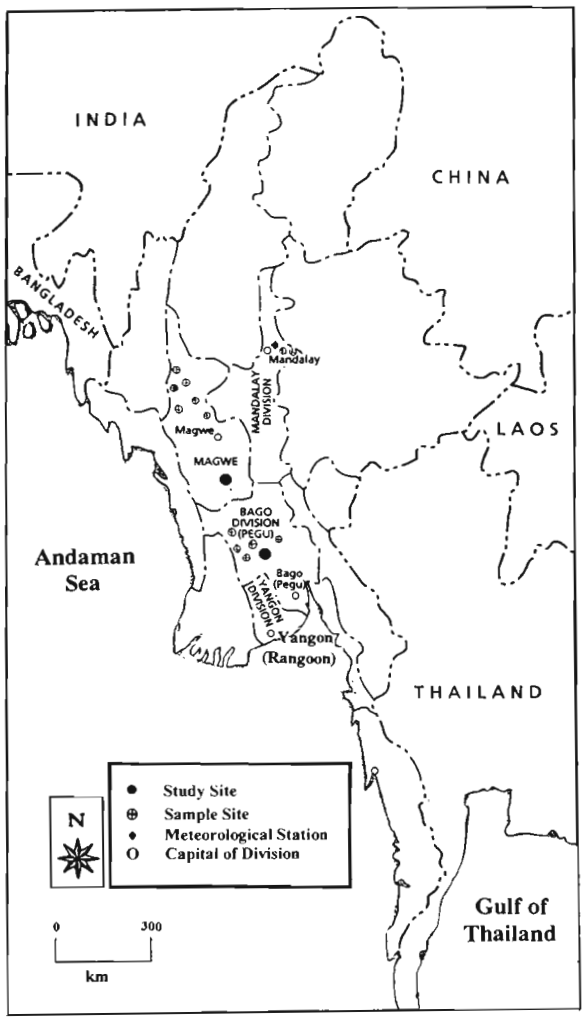

Fig. 1—Map of Myanmar: the two sample sites for the present study are located in the Mandalay Division near the Meteorological Station and the location of the study sites.

STUDY AREA AND SAMPLE SITES

Increment cores were taken from 187 living teak trees in different areas and various forest types in Myanmar (Fig. 1). These are: humid mixed-deciduous forest at Seinye Research Station in the Pago Division, dry mixed-deciduous forest at Moswe Research Station in the Magwe Division and humid mixed-deciduous forest at Pyinoolwin Forest Reserve in the Mandalay Division. The elevation of all sites is in between 300 and 700 m asl., the slopes are moderate and facing to the east, south-east or south, respectively. All sites provide good growing conditions for teak because there is one dry and one wet season per year (Fig. 2). From November to April, monthly rainfall amounts to only 42 mm on average, whereas from May to October the monsoon brings rain with a monthly average of 159 mm. The climate data for the present study are

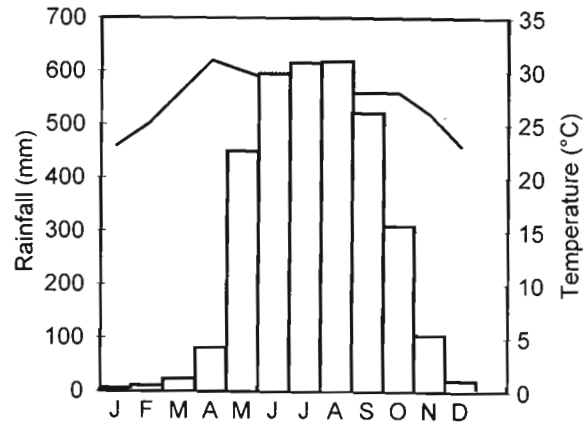

Fig. 2—Climate diagram of the Mandalay Meteorological Station: climate diagram.

from the Mandalay Meteorological Station. The monthly sums of rainfall extend from 1990 back to 1889 AD, the monthly mean temperatures from 1990 to 1931 AD.

The objective of the present study is to evaluate the dendroclimatic potential of teak in Myanmar using a subsample from two sites, named Mandalay A (MA) and Mandalay B (MB), in the Pyinoolwin Forest Reserve (Fig. 3). On site MA, 12 trees with 36 cores and on site MB, 21 trees with 73 cores were sampled. On average, three cores per tree were taken from the ridges of the often fluted trunks.

METHODS

The tree-ring widths of these cores were measured to the nearest 0·01 mm using a binocular microscope with a linear stage interfaced with a computer. Various routines out of the DPL program package (Holmes, 1994) were applied for the data management and analyses, among them COFECHA (Holmes, 1983) to statistically check the visual cross-dating, and ARSTAN (Cook, 1985) to detrend and autoregressively model the tree-ring series. Finally, the series were averaged for each site to a master chronology using the robust mean function.

RESULTS AND DISCUSSION

A 136-year long chronology covering the time span from 1998 to 1863 (Fig. 4) has been made from the site MA (12 teak trees with 36 cores). The mean tree-ring width is 1·77 mm. The mean sensitivity of the raw tree-ring series is fairly high (0·48) and conversely, the autocorrelation rather low (0·54). The mean correlation of all tree-ring series with the master chronology made from all tree-ring series except the one which is not correlated, is 0·45.

From the site MB, 21 teak trees with 73 cores were included into a 165-year long chronology from 1998 to 1834

Fig. 3—Teak forest in the Pyinoolwin Forest Reserve.

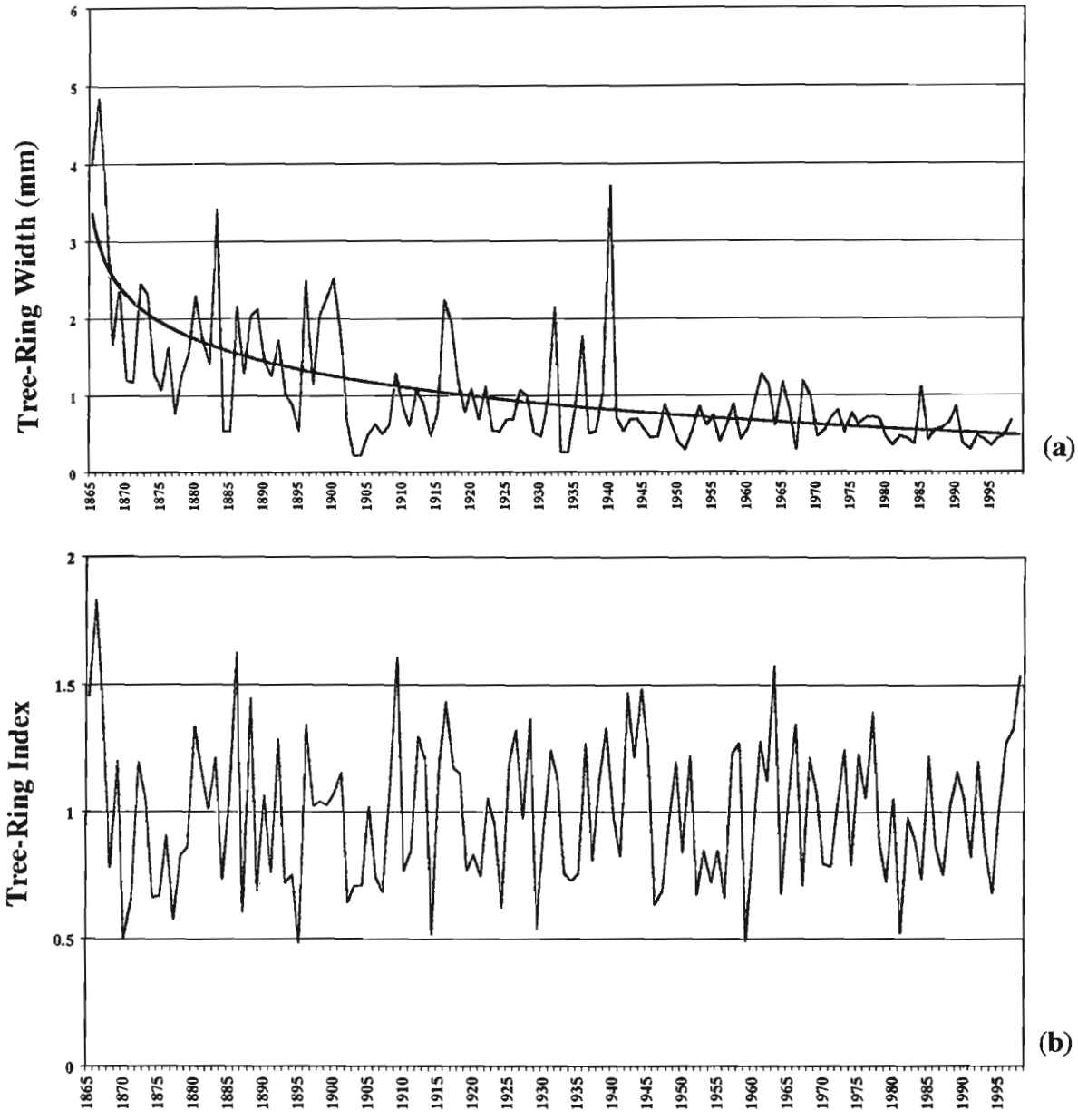

Fig. 4—MA tree-ring width (a) and index chronologies (b).

(Fig. 5). The mean tree-ring width is 2·08 mm, and the mean sensitivity and autocorrelation are 0·50 and 0·49, respectively. The mean correlation is 0·46 (Fig. 6).

To study the climate/growth relationships, the monthly values for rainfall and temperature from October prior to the growing season until current September were correlated with the so-called residual tree-ring chronology, that is the chronology where the autocorrelation has been eliminated by autoregressive modelling (Fig. 7). The highest positive correlation is with rainfall in April, i.e., the transition period from the dry to the wet season. However, there is also an unexpectedly high negative correlation with rainfall in the preceding October, but only for one of the two sites. There is also some correlation with temperature in the previous December, a result which is physiologically not explainable since we know from our studies in N.-Thailand (Pumijumnong *et al.*, 1996) that the cambium is dormant after the beginning of November.

In N. Thailand, the growth of teak is also mainly stimulated by the amount of rainfall during the beginning of the rainy season, although not as strictly concentrated on one single month as in Myanmar. In addition, our results get supported by Pant and Borgaonkar (1983) who found a similar response of teak in India. The climate-growth relationship for

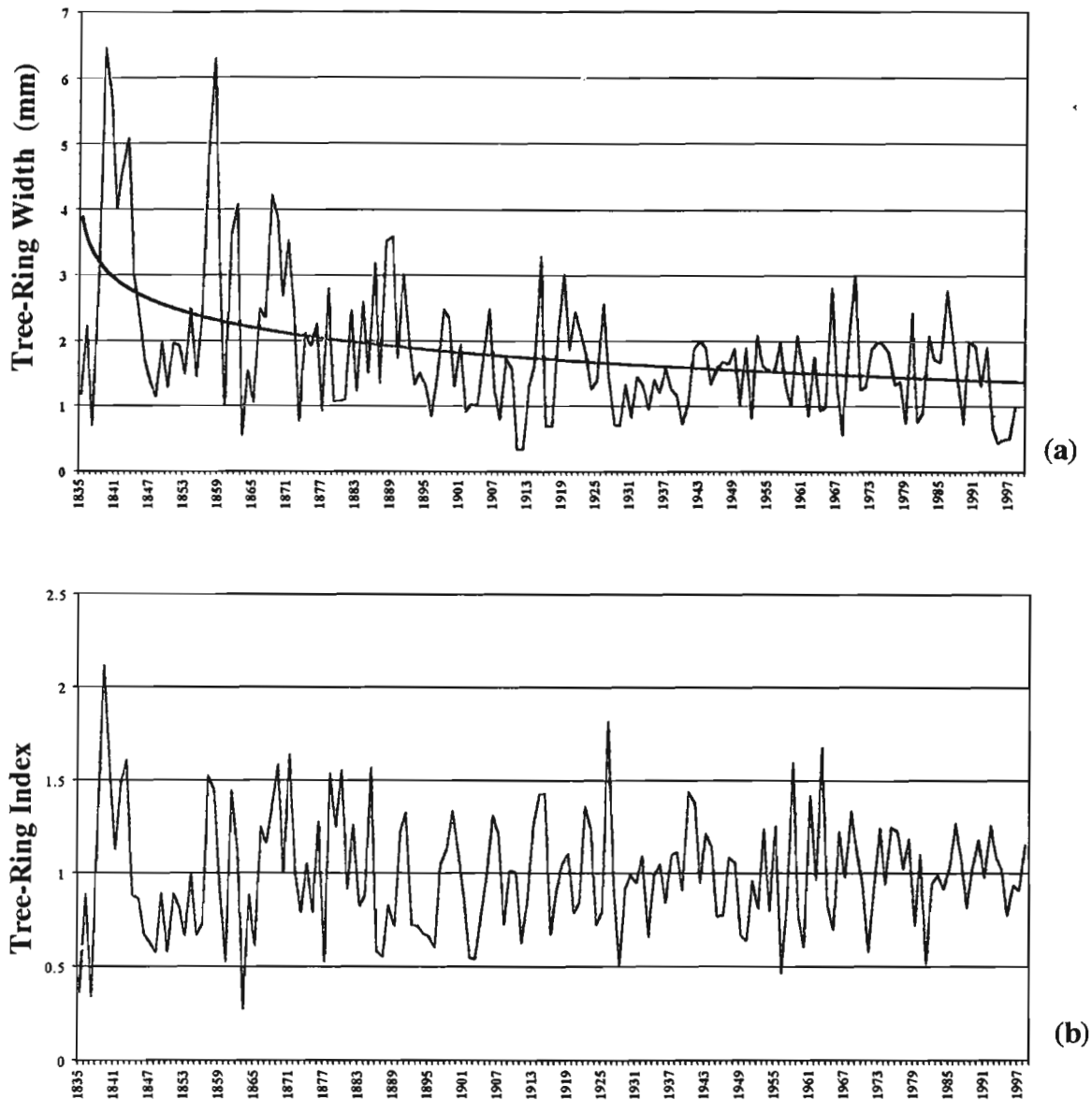

Fig. 5—MB tree-ring width (a) and index chronologies (b).

the teak in Laos has not been studied yet, but from the similarity of its growth pattern with teak in N-Thailand a similar climatic signal can be assumed.

CONCLUSION

Our first attempt to evaluate teak trees in Myanmar as an archive for palaeoclimatic information was successful. Teak

Study site	Trees(n)	Cores(n)	Start/endyear	Age (years)	Tree-ring width(mm)	S.D. (mm)	Auto-correlation	Mean sensitivity	Mean corr. with master chron.
MA	12	33	1863-1998	136	1·77	1·34	·54	·48	·45
MB	21	73	1834-1998	165	2·08	1·53	·49	·50	·46

Fig. 6—Pyinoolwin Forest Reserve: tree-ring statistics of the MA and MB site.

Site	-O	-N	-D	J	F	M	A	M	J	J	A	S
MA_p	-·13	·20	·16	-·09	-·12	-·05	·25**	·04	·16	·12	·08	·11
MA_t	-·19	-·12	·21	·17	-·04	·15	·09	-·13	-·07	-·03	-·04	-·01
MB_p	-·27**	-·15	·11	·07	-·04	·13	·35**	·05	·07	10	·09	-·00
MB_t	-·12	-·06	·26**	·17	·08	·02	·06	·16	·10	·07	-·09	-·06

Fig. 7—Correlation between tree-ring width and climate; T = temperature, P = precipitation; **= significance at 0·05 level.

is a reliable recorder of rainfall in April, which is an important month for the onset of the monsoon. In the nearest future it is urgently necessary to sample old-grown teak trees in Myanmar in order to get tree-ring series extending back into the past as far as possible. With such proxy data we want to contribute to the reconstruction of the variability of the monsoon climate and thus for its better understanding.

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