

## List of Figures

I — 1	Building the Index Master Chronology .....	6
I — 2	Index Master Chronology used in other parts of the world (as of 1987), after Schweingruber, 1988 .....	10
II — 1	Core specimen extractor and sample-support .....	19
II — 2	Increment borer and sample-support .....	19
II — 3	Incremental measuring machine .....	20
II — 4	Cross-dating by skeleton plots .....	21
II — 5	Tree-ring patterns: standardized (thick line) and measured .....	23
II — 6	Key-signature rings (thick lines) and the detection method .....	28
III — 1	Locality where samples of living <i>hinoki</i> cypress were collected .....	30
III — 2	Ring patterns taken radially in three directions from at the same level of a tree .....	32
III — 3	Comparison of ring patterns taken toward the exterior of a tree (rings formed in tree's late life) .....	35
III — 4	Comparison of ring patterns taken in the center of a tree (rings formed in tree's early life) .....	35
III — 5	Ring patterns of Samples No. 2 and No. 14 from Agematsu 上松, Nagano Prefecture .....	40
III — 6	Ring patterns of a sample from Agematsu and one from Tsukechi 付知, Gifu Prefecture .....	46
III — 7	Relationship between distance of two localities where samples were collected and <i>t</i> value [horizontal axis : distance ; vertical axis : <i>t</i> values] .....	47
III — 8	Ring patterns according to different localities .....	48
IV — 1	Standard chronology of a living tree: between 1009 and 1100 .....	62
IV — 2	Standard chronology of a living tree: between 1100 and 1400 .....	63
IV — 3	Standard chronology of a living tree: between 1400 and 1700 .....	64
IV — 4	Standard chronology of a living tree: between 1700 and 1984 .....	65
IV — 5	Key signature rings in Standard Chronology A of living trees .....	66
V — 1	Where three different samples were taken on the cross-section of the same tree .....	95
V — 2	Standard chronorology derived from six samples of <i>hinoki</i> cypress .....	97
V — 3	Basal plate of a funerary urn : site of Castle Town of Asakura Family of Ichijōdani, Fukui Prefecture .....	103
V — 4	Preserved lower portion of a pillar : Miyamachi site , Shiga Prefecture .....	105

V—5	Votive table of a horse: Higashi-Ni Bō on the Nijō Ōji, Heijo Capital, Nara Prefecture .....	111
V—6	Main building: Wakamiya Hachiman Shrine, Nagano Prefecture .....	115
V—7	Cross - section of the central pillar : Five story pagoda , Hōryū-ji temple, Nara Prefecture .....	117
V—8	Overhaul of the Main Hall: Ōtataneko Shrine, Nara Prefecture .....	119
V—9	Lacquered wooden-bent box of a temple in Kyoto Prefecture .....	121
V—10	One million miniature Pagodas of Hōryū-ji temple, Nara Prefecture .....	121
V—11	Guardian figure in the South Gate, Todai-ji temple; Nara Prefecture and its inner structure .....	123
V—12	Seated Amitabha at Hōkō-ji temple , and Standing Virupaksa at Gatsurin-ji temple, yamaguchi Prefecture .....	125
VI—1	Comparison of ring width spectrum over years in Lapland (1463–1960)[vertical axis: ring width spectrum: horizontal axis: years] (upper) and mean temperature (from April to September) spectrum over years (1659–1973)[vertical axis: mean temperature spectrum ; horizontal axis: year](lower) .....	129
VI—2	Moving averaged ring pattern (ten year mean) of <i>hinoki</i> cypress in the Kiso region [vertical axis: ring width; horizontal axis: year] .....	131
VI—3	Drastic changes in tree ring width which took place around 1840 [vertical axis: gap in millimeters; horizontal axis: year] .....	131
VI—4	Spectrum of tree ring width to which the Lopus filtering has been applied [horizontal axis: year] .....	132
VI—5	Fluctuation in tree ring width: measured (upper) and standardized after correcting base line fluctuation (lower)[vertical axis : ring width in millimeters; horizontal axis: year] .....	132
VI—6	Fluctuations in ring width of <i>hinoki</i> cypress year by year: measured [vertical axis: ring width in millimeters; horizontal axis: year] .....	134
VI—7	Fluctuation in ring width of <i>hinoki</i> cypress : standardized by smoothing of the spline algorithm [vertical axis: ring width in millimeters; horizontal axis: year] .....	135
VI—8	Localities in Nagano Prefecture where per annum rainy day <sup>3</sup> data were obtained .....	137
VI—9	Descriptions of weather in the <i>Bokuō Nikki</i> 墨翁日記(parentheses indicate the applicable descriptions.) .....	137
VI—10	Comparison between moving averaged per annum rainy days (ten year mean)[vertical axis: per annum rainy days; horizontal axis: year](upper) and moving averaged fluctuation in precipitation (ten	

3 In this chapter, by "per annum rainy days" we mean the total number of rainy days from April to September in each year.

year mean) in Kiso-Fukushima [vertical axis: precipitation in millimeters; horizontal axis: year](lower) .....	137
VI—11 Power spectra of ring width (in millimeters) of <i>hinoki</i> cypress in the Kiso region (upper) of mean temperature (in degrees in centigrade) in Nagano City (middle), and of per annum rainy days (in days) in Nagano City (lower)[vertical axis: power spectrum; horizontal axis: year] .....	140—141
VI—12 Cross correlation coefficient of per annum rainy days and tree ring width (upper) and cross correlation coefficient of mean temperature and tree ring width (lower) [vertical axis: cross correlation coefficient; horizontal axis: year] .....	142
VI—13 Fluctuation in mean temperature in England [vertical axis: temperature in degrees in centigrade; horizontal axis: year](upper) and fluctuation in frequency of floods of Kamo 鴨, River in Kyoto Basin for fifty years [vertical axis: number of floods; horizontal axis: year] .....	143
VI—14 Comparison of per annum rainy days estimated by cross correlation coefficient and actual data of rainy days [solid line: estimated; broken line: actual; vertical axis: rainy days; horizontal axis: year] .....	147
VI—15 Power spectra of estimated per annum rainy days and of actual data of rainy days [solid line: estimated ; broken line: actual ; vertical axis: power spectra; horizontal axis: year] .....	147
VI—16 Patterns of per annum rainy days estimated from tree-ring width by cross correlation coefficient and of actual data of rainy days [solid line: estimated; broken line: actual; vertical axis: rainy days; horizontal axis: year] .....	147
VI—17 Process of the identification of system parameters by autoregressive moving average coefficients of Kalman filtering algorithm [vertical axis: system parameter; horizontal axis: iteration] .....	151—153
VI—18 Fluctuation in per annum rainy days estimated from tree ring data [vertical axis: rainy days; horizontal axis: year] .....	154
VI—19 Power spectra of estimated per annum rainy days over years and of actual per annum rainy days [vertical axis: power spectrum; horizontal axis: year] .....	155
VI—20 Fluctuation of estimated per annum rainy days for one thousand years [vertical axis: rainy days; horizontal axis: year] .....	156
VII—1 Ring patterns taken from preserved lower portions of four pillars discovered at the Mawaki 真脇 site of the Jomon Period, Ishikawa Prefecture .....	160
VII—2 Ring patterns taken from three pieces of timber discovered at the Paleolithic Tomizawa 富沢 site, Miyagi Prefecture .....	161

## List of Tables

II-1	<i>t</i> values for two pairs of the cross-correlations of tree-ring patterns	26
III-1	Localities, where samples of living <i>hinoki</i> cypress trees were collected	30
III-2	Correlation <i>t</i> values of ring patterns taken radially in three directions from the same sample [A1 - A3: sample numbers; outside of the parenthesis : <i>t</i> value; number in the parenthesis : correlation coefficient] .....	32
III-3	Comparison of ring patterns taken in the center of a tree (rings formed in tree's early life) and taken toward the exterior of a tree (rings formed in tree's late life)[ED1: ring pattern showing tree's late life (last 100 years); ED2: ring pattern of tree's early life (from the center to ED1); bold characters: <i>t</i> values above 3.5] .....	33
III-4	Correlation <i>t</i> values among samples taken radially in four directions at two levels of the same tree [A1-B2: sample number; number in parenthesis: level at which each sample was taken] .....	36
III-5	Correlation <i>t</i> values among ring patterns taken at different levels of the same tree .....	37
III-6	Correlation <i>t</i> values among ring patterns taken at different levels and the average ring pattern of samples taken at Agematsu, Nagano Prefecture .....	38
III-7	Correlation <i>t</i> values among the ring patterns of twenty samples taken at Agematsu, Nagano prefecture .....	40
III-8	Correlation <i>t</i> values among eighteen ring patterns taken at Miura 三浦, Nagano Prefecture .....	41
III-9	Correlation <i>t</i> values among six ring patterns taken at Kōrigase 氷ヶ瀬, Nagano Prefecture .....	44
III-10	Correlation <i>t</i> values among five ring patterns taken at Komata 小俣, Nagano Prefecture .....	44
III-11	Correlation <i>t</i> values among seventeen ring patterns taken at Tsukechi, Gifu Prefecture .....	42
III-12	Correlation <i>t</i> values among eighteen ring patterns from 150 samples taken at Kosaka-Ōbora 小坂大洞, Gifu Prefecture .....	43
III-13	Correlation <i>t</i> values among eleven ring patterns from 211 samples taken at Kosaka-Ōbora, Gifu Prefecture .....	44
III-14	Correlation <i>t</i> values among six ring patterns taken at Owase 尾鷲, Mie Prefecture .....	44

III-15	Correlation <i>t</i> values among two ring patterns taken at Kōyasan 高野山, Wakayama Prefecture .....	44
III-16	Correlation <i>t</i> values among six ring patterns taken at Yanase 魚梁瀬, Kochi Prefecture .....	44
III-17	Correlation <i>t</i> values among the average ring patterns of the ten localities above .....	46
III-18	Correlation <i>t</i> values between the average ring patterns of the Tsukechi samples and of the Yanase samples .....	48
III-19	Non-cypress species and the localities where samples were collected	49
III-20	Correlation <i>t</i> values among ten ring patterns of <i>hiba</i> arborvitae taken at Ōhata 大畠, Aomori Prefecture .....	50
III-21	Correlation <i>t</i> values among ten ring patterns of <i>hiba</i> arborvitae taken at Kawauchi 川内, Aomori Prefecture .....	51
III-22	Correlation <i>t</i> values among ten ring patterns of <i>hiba</i> arborvitae taken at Yokohama 横浜, Aomori Prefecture .....	51
III-23	Correlation <i>t</i> values among eight ring patterns of <i>hiba</i> arborvitae taken at Masukawa 増川, Aomori Prefecture .....	51
III-24	Correlation <i>t</i> values among ten ring patterns of <i>hiba</i> arborvitae taken at Imabetsu 今別, Aomori Prefecture .....	52
III-25	Correlation <i>t</i> values among eight ring patterns of <i>hiba</i> arborvitae taken at Kanagi 金木, Aomori Prefecture .....	52
III-26	Correlation <i>t</i> values among seven ring patterns of <i>hiba</i> arborvitae taken at Kawai 川井, Iwate Prefecture .....	52
III-27	Correlation <i>t</i> values among the average ring patterns of <i>hiba</i> arborvitae taken at different localities .....	53
III-28	Correlation <i>t</i> values among ten ring patterns of <i>sugi</i> cedar taken at Fujisato 藤里, Akita Prefecture .....	55
III-29	Correlation <i>t</i> values among ten ring patterns of <i>sugi</i> cedar taken at Akita 秋田, Akita Prefecture .....	56
III-30	Correlation <i>t</i> values among nine ring patterns of <i>sugi</i> cedar taken at Yanase, Kochi Prefecture .....	56
III-31	Correlation <i>t</i> values among four ring patterns of <i>sugi</i> cedar taken in the Yaku 屋久 Island, Kagoshima Prefecture .....	56
III-32	Correlation <i>t</i> values among the mean ring patterns of <i>sugi</i> cedar taken at the four localities above .....	56
III-33	Correlation <i>t</i> values among eight ring patterns of <i>sawara</i> cypress at Ōtaki 王滝, Nagano Prefecture .....	57
III-34	Correlation <i>t</i> values among four ring patterns of <i>kōyamaki</i> pine at Ōtaki, Nagano Prefecture .....	58
III-35	Correlation <i>t</i> values among three ring patterns of <i>mizunara</i> oak at Kawauchi, Aomori Prefecture .....	58
III-36	Correlation <i>t</i> values among three ring patterns of <i>mizunara</i> oak at	

	Ottomo 乙供, Aomori Prefecture .....	58
III-37	Correlation <i>t</i> values among ring patterns of <i>buna</i> beech taken at three localities .....	59
IV- 1	Correlation <i>t</i> values among ring patterns of Group I of lumber samples taken from the Prayers Hall of the Nigatsu-dō at Tōdai-ji, Nara Prefecture .....	70
IV- 2	Correlation <i>t</i> values among ring patterns of Group II of lumber samples taken from the Prayers Hall of the Nigatsu-dō at Tōdai-ji, Nara Prefecture .....	71
IV- 3	Correlation <i>t</i> values among ring patterns of Group III of lumber samples taken from the Prayers Hall of the Nigatsu-dō at Tōdai-ji, Nara Prefecture .....	71
IV- 4	Key singnature rings of Standard Chronology B derived from lumber of the Prayers Hall of the Nigatsu-dō at Tōdai-ji, Nara Prefecture	71
IV- 5	Correlation <i>t</i> values among ring patterns of artifacts discovered at the site of the Kiyosu Castle Town , Aichi Prefecture [* indicates non-correlation at that point.] .....	72
IV- 6	Key signature rings of Standard Chronology C derived from artifacts discovered at the site of the Kiyosu Castle Town, Aichi Prefecture	72
IV- 7	Correlation <i>t</i> values among ring patterns of five nose rings discovered at the Kusado Sengen site, Hiroshima Prefecture [* indicates non-correlation at that point.] .....	73
IV- 8	Correlation <i>t</i> values among ring patterns of twelve artifacts discovered at the Kusado Sengen site, Hiroshima Prefecture [* indicates non-correlation at that point.] .....	75
IV- 9	Key signature rings of the mean ring pattern of samples from the Kusado Sengen site, Hiroshima Prefecture .....	75
IV-10	Correlation <i>t</i> values among ring patterns of six artifacts discovered at the Toba Detached Palace site, Kyoto [* indicates non-correlation at that point.] .....	75
IV-11	Key signature rings in Standard Chronology D .....	76
IV-12	Key signature rings in Standard Chronology E derived from artifacts discovered in the Heijō Capital .....	76
IV-13	Correlation <i>t</i> values among ring patterns of six artifacts discovered in the Heijō Capital, Nara Prefecture [* indicates non-correlation at that point.] .....	77
IV-14	Correlation <i>t</i> values among ring patterns derived from artifacts discovered in the Yayoi and Kofun Periods sites [* indicates non-correlation at that point.] .....	78
IV-15	Correlation <i>t</i> values among ring patterns of six different species grown in Nagano Prefecture .....	81
IV-16	Correlation <i>t</i> values among ring patterns of four different species	

grown in Aomori Prefecture .....	81
IV-17 Correlation <i>t</i> values among ring patterns of different species grown in different regions .....	81
IV-18 Correlation <i>t</i> values among ring patterns taken from artifacts discovered in Yamagata Prefecture [* indicates non - correlation at that point.] .....	84
IV-19 Correlation <i>t</i> values among ring patterns taken from structural parts of architecture in Akita Prefecture [* indicates non - correlation at that point.] .....	85
IV-20 Correlation <i>t</i> values among ring patterns taken from frames of wells in Iwate Prefecture [* indicates non-correlation at that point.] .....	85
IV-21 Correlation <i>t</i> values among ring patterns taken from samples excavated at the Hotta no Saku fort site, Yamagata Prefecture [* indicates non-correlation at that point.] .....	88
IV-22 Correlation <i>t</i> values among ring patterns taken from artifacts discovered in Shizuoka Prefecture [* indicates non - correlation at that point.] .....	88
IV-23 Correlation <i>t</i> values among ring patterns taken from preserved lower portions of pillars excavated in the Heijo Palace site and Hokke-ji temple site , Nara Prefecture [* indicates non - correlation at that point.] .....	90
IV-24 Correlation <i>t</i> values among ring patterns taken from artifacts discovered at the Shijo Kofun burial site, Nara Prefecture [* indicates non-correlation at that point.] .....	93
IV-25 Correlation <i>t</i> values among ring patterns taken from a coffin discovered at the Kariya 雁屋 site, Osaka Prefecture [* indicates non-correlation at that point.] .....	93
V- 1 Dendrochronological date: Ochiai III site, Iwate Prefecture .....	100
V- 2 Dendrochronological date: Hotta no Saku fort site, Akita Prefecture .....	100
V- 3 Dendrochronological date: Kurumidate site, Akita Prefecture .....	100
V- 4 Dendrochronological date: Yamagi site, Shizuoka Prefecture .....	103
V- 5 Dendrochronological date: Shida Gunga county office site, Shizuoka Prefecture .....	103
V- 6 Dendrochronological date: Kiyosu Castle Town site, Aichi Prefecture .....	105
V- 7 Dendrochronological date : Bent of the ancient Seta no Karahashi bridge, Shiga Prefecture .....	105
V- 8 Dendrochronological date: Miyamachi site, Shiga Prefecture .....	105
V- 9 Dendrochronological date: Shijo Kofun burial site, Nara Prefecture .....	109
V-10 Dendrochronological date: Obaka Kofun burial site, Nara Prefecture .....	

	109
V—11 Dendrochronological date: Lower stratum of the Hokke - ji temple site, Nara Prefecture .....	110
V—12 Dendrochronological date: Kusado Sengen site, Hiroshima Prefecture .....	113
V—13 Dendrochronological date: Shimokawazu site, Kagawa Prefecture .....	113
V—14 Dendrochronological date: Hau'shiwake Shrine, Akita Prefecture .....	115
V—15 Dendrochronological date: Gaya-in temple, Hyogo Prefecture .....	116
V—16 Dendrochronological date: Ōtataneko Shrine, Nara Prefecture .....	119
V—17 Dendrochronological date: Hōtō-ji temple, Nara Prefecture .....	119
V—18 Dendrochronological date: Lacquered wooden bent-box at a temple in Kyoto Prefecture .....	121
V—19 Dendrochronological date : Hyakuman - tō [one million miniature pagodas] at Hōryū-ji, Nara Prefecture.....	121
V—20 Dendrochronological date : Guardian figure in the South Gate , Tōdai-ji temple, Nara Prefecture.....	123
V—21 Dendrochronological date : Seated Amitabha at Ganki - ji temple, Yamaguchi Prefecture.....	123
V—22 Dendrochronological date : Seated Amitabha at Hōkō-ji temple , Yamaguchi Prefecture.....	124
VI—1 Number of rainy days from April to September every year between 1813 and 1982 [left column: year; center column: rainy days between April and September; right column: sources].....	138—139
VI—2 Square errors between estimated number of rainy days and the observed number (determination of degrees of $p$ and $q$ )[left: number of $q$ ; center: number of $p$ ; right: number of n].....	146
VI—3 Square errors between estimated number of rainy days and the observed number (determination of degrees of $p$ and $q$ )[left: number of $q$ ; center: number of $p$ ; right: number of n] .....	150