

P. xantha (Fr.) Cooke, 1, 3, 4 and 5, *Pinus*.
Polyporus brumalis (Pers. ex Fr.) Fr., 3 and 4, *Betula*.

P. ciliatus Fr., 2, *Alnus*.

P. varius Fr., 1 and 3, *Salix*.

Pycnoporus cinnabarinus (Jacq. ex Fr.) Karst., 5, *Sorbus*.

Trametes confragosa (Bolt. ex Fr.) Jørst., 4 and 5, *Betula*. Both the poroid and the lamellate type are represented among the collections.

T. flavescens Bres. 1, *Pinus*. Rare in Fennoscandia. In Norway previously known from Selbu (S. Trøndelag) and Grane (Nordland).

T. protracta Fr., 1, *Pinus*. New to Northern Norway.

Trametes squalens Karst., Sørvaranger: Skogfoss, *Pinus* (cfr. Ryvarden 1970).

Tyromyces albobrunneus (Rom.) Bond., 1 and 5, *Pinus*. KALLIO & KANKAINEN (1964) have reported the species from Tana.

T. caesioides (Fr.) Murr., 5, *Alnus*. In Northern Norway it seems to prefer deciduous wood. In Southern Norway coniferous wood is preferred.

T. semisupinus (Berk. & Curt.) Murr., 2 and 4, *Alnus* and *Pinus*.

STECCHERINACEAE

Steccherinum fimbriatum (Pers. ex Fr.) Erikss., 4 and 5, *Alnus* and *Populus*. In Norway previously known north to Saltdal and obviously a southern species in Fennoscandia as remarked by ERIKSSON and STRID (1969: 133).

S. ochraceum (Pers. ex Fr.) Gray., 4, *Sorbus*. New to Norway. In Sweden known north to Älvkarlby sn. in Uppland and consequently this species belongs to same group of disjunct species like *Plicaturopsis crispa* and *Coriolellus campestris*.

THELEPHORACEAE

Caldesiella ferruginosa (Pers. ex Fr.) Sacc., 5, *Sorbus*, new to Northern Norway.

Thelephora terrestris Ehrh. ex Fr. 4, on the ground.

Tomentella palidofulva (Peck) Litsch. 4, *Populus*.

T. tristis (Karst.) Höhn & Litsch., 1, 3 and 4, *Salix* and *Pinus*.

Some collections of *Tomentella* had to be left for later determination.

Acknowledgements. Many of the above mentioned collections were determined during a course in the Corticiaceae held by Dr. J. ERIKSSON in Gothenburg in October 1970. I would like to express to him my sincere gratitude for his generosity and very stimulating interest.

References

- ANDERSSON, O. 1945: Utbredningen av Schizophyllum commune Fr. og Trogia crispa (Pers.) Fr. i Fennoscandia s. str. — Friesia 3: 129—142.
- BOURDOT, H. & GALZIN, A. 1928: Hymenomycetes de France. — 753 pp. Paris.
- BRESADOLA, J. 1903: Fungi polonici. — Ann. Mycol. 1: 65—131.
- ERIKSSON, J. 1958: Studies in the Heterobasidiomycetes and Homobasidiomycetes — Aphyllophorales of Muddus National Park in North Sweden. — Symb. Bot. Ups. 16 (1): 1—172.
- , & STRID, Å. 1969: Studies in the Aphyllophorales (Basidiomycetes) of Northern Finland. — Rep. Kevo Subarctic Res. Stat. 4: 112—158.
- JØRSTAD, I. 1928: Nord-Norges skogsykdommer. — Tidskr. Skogbr. 36: 365—456.
- KALLIO, P. & KANKAINEN, E. 1964: Notes on the macromycetes of Finnish Lapland and adjacent Finnmark. — Rep. Kevo Subarctic Res. Stat. 1: 178—235.
- , & —, 1966: Additions to the mycoflora of the northernmost Finnish Lapland. — Rep. Kevo Subarctic Res. Stat. 3: 177—210.
- KARSTEN, P. A. 1881: Symbolae ad Mycologiam fennicam, VIII. — Medd. Soc. F. Fl. Fenn. 6: 7—13.
- , 1882: Rysslands, Finlands och den skandinaviske halföns Hattsvampar. — Bidr. Känned. Finl. Natur Folk 37: 1—257.
- , 1883: Symbolae ad Mycologiam fennicam IX. — Medd. Soc. F. Fl. Fenn. 9: 39:56.
- , 1889: Kritisk öfversigt af Finlands basidsvampar. — Bidr. Känned. Finl. Natur Folk 48: 1—470.
- LANGÉ, M. & SKIFTE, O. 1967: Notes on the macromycetes of Northern Norway. — Acta Borealia A 23: 1—51.
- LAURILA, M. 1939: Basidiomycetes novi rarioresque in Fennia collecti. — Ann. Bot. Soc. 'Vanamo' 10 (4): 1—24.
- LITSCHAUER, V. 1941: Neue schwedische Corticiaceen aus dem Herbar L. Romells. — Ann. Mycol. 39: 117—135.
- LOWE, J. L. 1966: Polyporaceae of North America. The genus Poria. — Techn. Publ. St. Univ. Coll. Forestry Syrac. Univ. 90: 1—183.
- LUNDELL, S. 1932: Bidrag till Uppsalatraktens Hymenomycetflora. I Vårdsätra naturpark. — Kungl. Sv. Vetensk. Akad. Skr. Naturskydd. 22: 1—32.
- MAAS GEESTERANUS, R. & ECKBLAD, F.-E. 1962: Stilkete piggsopper. En oversikt over arter slekter som forekommer i Norge. — Blyttia 20: 122—135.
- NATHORST-WINDAHL, T. 1946: Anmärkningsvärda fynd av hymenomyceter i Bohuslän och Västergötland. — Acta Hort. Goth. 16: 135—164.
- NORDIN, I. 1969: Mykologiska notiser. — Friesia 9: 180—192.
- PARMASTO, E. 1967: Corticiaceae U.R.S.S. IV. Descriptiones taxorum novorum, Combinationes novae. — Eesti NSV Akadeemia Toimetised XVI Kõide, Biologia 4: 377—394.
- POUZAR, Z. 1967: Studies in the taxonomy of the polypores III. — Ceska Mykol. 21: 205—212.
- RYVARDEN, L. 1968 a: Flora over kjuker. — 97 pp. Oslo.
- , 1968 b: New or interesting records of Norwegian polypores. — Nytt Mag. Bot. 15: 267—270.
- , 1969: The genus Polyporus s. str. in Norway. — Nytt Mag. Bot. 16: 151—157.
- , 1970: New or interesting records of Norwegian polypores II. — Nytt Mag. Bot. 17: 163—168.
- , 1971: Flora of Poria and Stereum. — Oslo (in press).

Coinciding periodicity in recent tree rings and glacial clay sediments

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Received March 30, 1971 Printed July 31, 1971

Abstract

SIRÉN, GUSTAF & HARI, PERTTI. (Dept. of Silviculture, Unionink. 40 B, Helsinki 17, Finland) Coinciding periodicity in recent tree rings and glacial clay sediments. REP KEVO SUBARCTIC RES STAT 8. 155—157. Illus. 1971. — The periodicity of three time series was studied, viz. tree rings from Lapland (1181—1960), clay sediments from South Finland (about 11 000 B.P.), and from Estonia (about 12 000 B.P.). Distinct cycles were detected, many of them coinciding in all three series. The most striking cycles were 2.24, 3.60, 4.3, 6.0, and 32 years.

1. The problem

Research in the field of dendrochronology has revealed the occurrence of more or less regular fluctuations of tree ring width. The original causes of the periodicities observed seems to be unknown, even if the climate supposedly governs the main pattern of tree growth (cf. HUSTICH 1941; FRITTS et al. 1970). The structure of a series of tree rings may additionally be distorted or at least influenced by endogenic, physiological phenomena of the trees. Reliable information about the stationarity of the fluctuations also seems difficult to obtain, because of the short span of the tree ring series collected in Scandinavia. Meteorological data series are short all over the world (LANDSBERG 1970).

In order to surmount at least some of these obstacles, it seemed desirable to replace the tree rings by a similar type of serial material. The postglacial clay sediments offer such a possibility. In principle, these sediment series should reflect climatic changes in the same way as the tree rings of the subarctic region.

The problem was suggested by coauthor Sirén. The idea to use material from different epochs came from coauthor Hari who also planned and carried out the statistical analysis required. The writing was done by the coauthors together.

2. Material and methods

The basic series analysed in this study are from three distinctly different regions, and are also of different origin.

The tree ring series from the forest tree limit in Lapland has previously been described by SIRÉN 1961. It covers the time span from 1181 to 1960. Collection, crossdating and standardization have been carried out conventionally. A tentative serial analysis gave indication of some cycles coinciding with earlier suggested cycles. In the light of later research, the method of analysis seems however unsatisfactory (SIRÉN 1963).

The clay sediment series from Estonia (provided by Dr. Endel Rähni, The Marine Research Institute of Estonia, USSR) consisting of 748 single annual layers, was extracted from sediments accumulated in the Baltic Ice Lake about 12 000 B.P. The structure of the layers was distinct enough to enable a separate measurement of sub-layers originating from summer and winter sedimentation. In the present study the summer layer only will be subjected to statistical analysis.

Data from the second clay sediment have been provided by the Finnish Research Institute of Geology. The original sedimentation rate and morphology of the cores will be described by NIEMELÄ (1971). The core was taken from a clay deposit in southern Finland (south of the Salpausselkä formation). Its oldest part is estimated to be from 11 000 B.P. The number of annual sediment layers totals 780.

Thus the time-series studied originates not only from different geological epochs (1181—1960, about 12 000 B.P. and 11 000 B.P.) but also from completely diffe-

rent regions representing even more different ways of formation.

These facts entitle the series to be considered completely independent. They may, however, reflect the climatic fluctuations of the period they represent.

A comparison of the independent periodicity of the series was assumed to reveal periods of either coinciding or non-coinciding length. In the case of coinciding, a preliminary hypothesis of a common generating agent appeared acceptable.

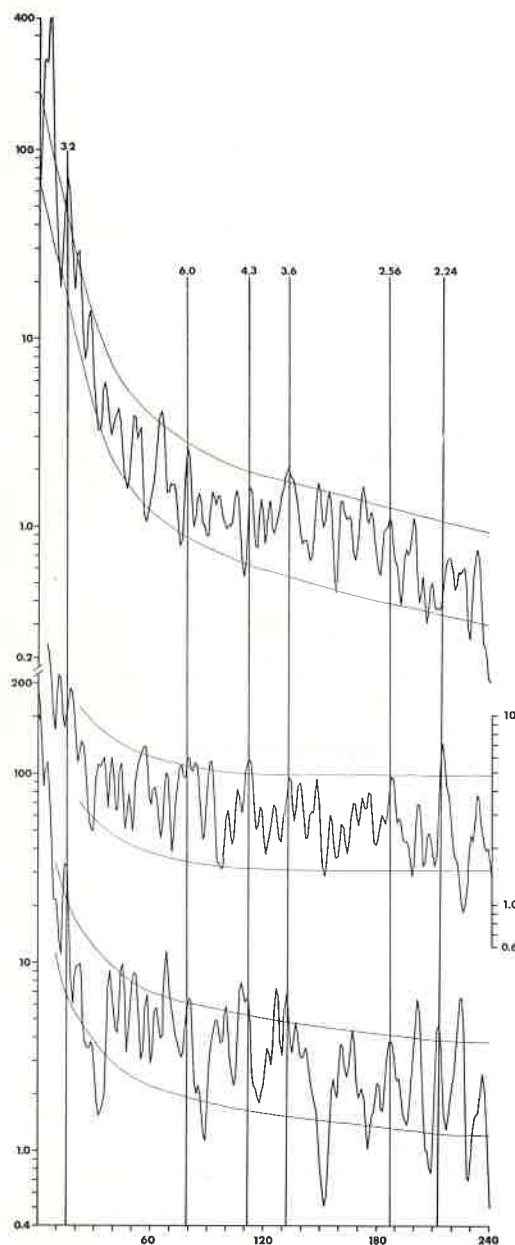


Fig. 1. Estimated power spectra for tree rings (above), and for clay sediments from Uusimaa (in the middle) and from Estonia (below). The most distinct cycles are indicated with vertical lines. For information concerning the scales, see GRANGER & HATANAKA 1964: 64—68.

The time series were analysed according to the power spectrum method. The estimates of Parzen were used (cf. GRANGER & HATANAKA 1964: 60, 61). The significance of the cycles was tested according to a method described by the same authors (62, 63). This test is originally constructed for the Tukey-Hanning estimates. According to PARZEN (1961: 150), the latter test method is, however, not the most powerful, which indicates that the limits of confidence used in this study are wider than necessary. This means that some of the peaks of the estimated power spectrum not reaching the confidence level would potentially pass the level if a more powerful test method could be exploited.

3. Results

The main result is given in Fig. 1, which displays the spectra of the clay sediments and the subarctic tree rings. The dominant coinciding cycles are indicated by vertical lines. The cycles in question are also presented in tabular form (Table 1). In order better to demonstrate the coinciding of cycles the product of all the three spectra is given in Fig. 2. Here the most coinciding cycles 2.24; 2.56; 3.6; 4.3; 6.0; 9.1 and 32 can be seen as prominent peaks expect the last mentioned which reaches outside the figure.

Table 1. List of nearly coinciding cycles of different origin

Origin and age of series		
Tree ring (Lapland) 1181—1960 A.D.	Annual clay sediment (South Finland) 11 000 B.P.	Summer clay sedi- ment (Estonia) 12 000 B.P.
Length of period, years		
2.20	2.24**	2.24**
2.56	2.56	2.56
3.28*	3.28	—
3.63*	3.60	3.60**
4.30	4.30**	4.30*
6.06	6.06*	5.93*
7.40*	7.05	6.95**
8.9	8.6*	9.1*
11.4	10.9	10.7*
13.7	13.7	—
22.8*	—	22.8
32 **	28. *	32. **
80—96**	—	80—96

— corresponding cycle missing

* cycle occurs distinctly at 10 % risk level

** cycle occurs distinctly at 5 % risk level

4. Discussion

The power spectrum analysis indicates that in all three series studied, periods of different length do occur. Many of these periods coincide in two or all three of the basic series — even if not in all cases with indisputable significance. This finding may of course be open to

various interpretations. One possibility is that some features in the climatic fluctuation pattern governing the observed periodicity have remained more or less unchanged during the last 12,000 years. To seek for an explanation is however beyond the authors' competence. Many well-known rhythmical astro- or geophysical phenomena in Nature may play some part in the complicated cause-and-effect relations of natural climatic changes. The sun-spot cycle, the moon-orbit fluctuations and the changes in seacurrents may be mentioned in this context as probable causes of some of the climatic changes. Some of the periods presented above are well known from the literature. A brief enumeration gives the following information about the cycles encountered.

- the 2.24-year cycle occurring in both of the clay sediments coincides with the quasi-biennial oscillation caused by the changes of the movements of the moon (cf. e.g. BRIER 1968; LAULAJA 1970)
- the ca 11-year, slightly irregular sunspot cycle is well known from many reviews on cycle research and astrophysics
- the weak 13.7-year period may be caused by the influence of the moon (BRIER 1968)
- the 22-year cycle seems, according to WILLETT (1961), to be generated by sun-spot activity
- the 32-year cycle probably corresponds to the 33—35-year cycles mentioned by many authors since BRÜCKNER. No physical explanation is yet available, except the possibility of a multiple of the sun-spot cycle
- the undistinct 80—96-year period resembles a cycle, which WILLETT (1961) suggested to be a multiple of the normal sun-spot cycle; it may correspond to the 92—93-year cycle proposed by SIRÉN (1961; 1963) here tentatively indicated as an 80—90-year period.

The periods mentioned in Table 1 seem to be of stationary character. This might indicate the existence of invariable generators of regular climatic oscillations. The above suggested explanations of generating causes of cyclicity do not cover the cycles of medium duration, i.e. the cycles 2.56, 3.60, 4.3, 6.0 and about 7 years' length.

When supplementary evidence from other regions, time periods and materials is available,

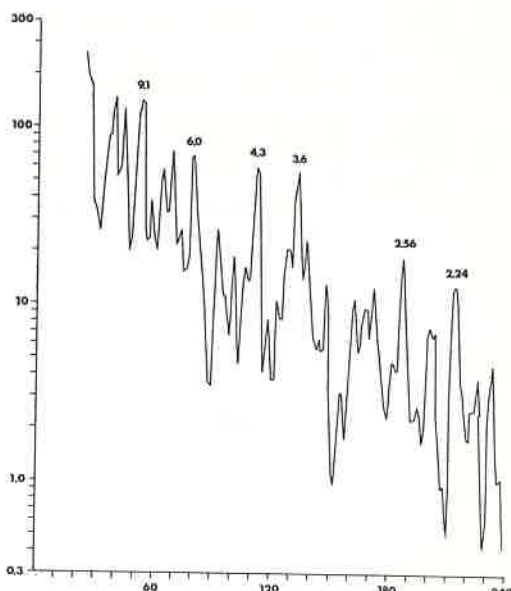


Fig. 2. The three spectra in Fig. 1 as multiplied together.

a full elucidation of the causes of the cyclic phenomena may easily be given by geophysicists, meteorologists, and astrophysicists.

Acknowledgements. The authors express their deepest gratitude to Dr. RÄHNÄ and Lic. NIEMELÄ for providing the two sediment data series used in the study.

References

- BRIER, G. W. 1968: Long-range prediction of the zonal westerlies and some problems in data analysis. — *Reviews of geophysics* 6: 525—557.
- FRITTS, H. C., BLACING, T. J., HAYDEN, B. P. & KUTZBACH, J. E. 1970: Multivariate techniques for specifying tree-growth and climatic relationships and for reconstructing anomalies in paleoclimate. — Tucson.
- GRANGER, C. & HATANAKA, M. 1964: Spectral analysis of economic time series. 299 pp. Princeton.
- HUSTICH, I. 1941: Tallens tjocklekstillväxt som klimatisk indikator. — *Terra* 13.
- HUSTICH, I. & ELFING, G. 1944: Die Radialzuwachsvariationen der Waldgrenzkiefer. — *Comm. Biol. Soc. Scient. Fenn.* 9.8.
- LAMB, H. H. 1966: The changing climate. London.
- LANDSBERG, H. 1970: Man-made climatic changes. — *Science* 170.
- LAULAJA, V. 1970: Om användning av parametrar vid bestämning av väderlekstypen. — VII Nord. meteorologmötet, Helsinki 1966: 130—140. Helsinki.
- MITCHELL, J. 1961: Recent secular changes of global temperatures. — *Ann. New York Acad. Sci.* 95.
- NIEMELÄ, J. 1971: Stratigraphie der Tonablagerungen zwischen Helsinki und Hämeenlinna in Südfinnland. — *Bull. Comm. Géol. Finl.* (in press).
- PARZEN, E. 1961: Mathematical considerations in the estimation of spectra. — *Technometrics* 3: 167—190.
- SIRÉN, G. 1961: Skoggränstallen som indikator för klimatfluktuationerna i norra Fennoskandien under historisk tid. — *Comm. Inst. Forest. Fenn.* 54 (2).
- SIRÉN, G. 1963: Tree ring and climate forecasts. — *New Scientist* 19: 18—20.
- WILLETT, H. C. 1961: The pattern of solar-climatic relationships. — *Ann. New York Acad. Sci.* 95.