ISSN 0096-7807

Vol. 10, No. 1, January-February, 1979

September, 1979

SJECAH 10(1) 1-92 (1979)

THE SOVIET JOURNAL OF ECOLOGY

ЭКОЛОГИЯ/ÉKOLOGIYA

TRANSLATED FROM RUSSIAN

CONSULTANTS BUREAU, NEW YORK

SOME IRREGULAR APPROACHES TO DENDROCHRONOLOGICAL INVESTIGATIONS

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UDC 581.143.3

The author discusses at length the dendrochronological series on Dahurian larch obtained by N. V. Lovelius for the forest outlier Ary-Mas (Eastern Taimyr). He shows that this series cannot be used for the age determination of wood, nor for the reconstruction of climatic conditions, nor for the indication of different natural processes, since the most elementary procedures acceptable in dendrochronology are not observed in its construction. The causes of the appearance of weak and superficial dendrochronological work are examined.

In our country the interest in dendrochronological investigations on the part of specialists in different fields of science — geographers, climatologists, geophysicists, ecologists, geobotanists — has notably increased in the last 10-20 years. The reason for this lies in the fact that annual rings of radial increment of woody plants contain valuable information on the fluctuations of some important factors of external environment, in particular climatic, for many hundreds and even thousands of years. The utilization of such information contributes to the solution of a number of scientific problems that are very urgent at the present time (study of the dynamics of different natural processes, elaboration of methods of forecasting them).

This growing interest in dendrochronological works led not only to expanding and deepening the sphere of investigations but also revealed undesirable phenomena holding back the development of a prospective scientific direction. In particular, some investigators endeavored to make wide use of dendrochronological information to solve the tasks confronting them without examining, as is proper, the essence of the basic principles and methods of dendrochronology. Poorly familiar with dendrochronological methods, they obtained unreliable and even false information and on this basis made far-reaching deductions and conclusions. Typical for such investigators is a lack of critical regard for the results obtained, a facility and irresponsibility to deduction and depositions.

Institute of Plant and Animal Ecology, Training Science Center, Academy of Sciences of the USSR. Translated from Ékologiya, No. 1, pp. 25-36, January-February, 1979. Original article submitted February 20, 1978.

 0096-7807/79/1001-0016$07.50

A typical example of a superficial approach to dendrochronological investigations are the works of N. V. Lovelius which often appear in periodicals and at scientific conferences. There is no need to analyze all of them in order to demonstrate this. A few will suffice, since his method of treating initial material and constructing dendrochronological series is the same in all.

We chose for analysis the dendrochronological series on Dahurian larch obtained by N. V. Lovelius (Knorre, Lovelius, and Norin, 1971a)* for the forest outlier Ary-Mas (Eastern Taimyr, Novaya river valley, 72°30'N). In his construction five models of trees growing in three different associations of larch open forest were used. The measurement of annual rings took place according to one (maximal) radius with an accuracy of 25 μ. The absolute thicknesses of the annual rings were converted into normed values (indices) according to the V. E. Rudakov method (1951). In the final sum, a series from 1756 to 1969 was obtained and also the age of the models used (58, 118, 130, 176, and 213 years). Apparently N. V. Lovelius considered this series the best, since many works were published on its basis (Knorre, Lovelius, and Norin, 1971a, b; Lovelius, Norin, and Knorre, 1972; Lovelius, 1972). In addition, somewhat later, a second series based on the use of eight models of larch (Lovelius, 1973) was obtained for the same forest outlier Ary-Mas. It is not possible to analyze this series in detail, because in the work published there is merely a graph of smoothings according to 15 years of reconstructed temperatures of July from 1711 to 1964.

Our interest in Lovelius' series on Ary-Mas arose from the task of determining the absolute age of recently felled wood collected at the lower reaches of the Khatanga River by archaeologist L. P. Khlobystin and hydrologist V. A. Troitskii. However, all efforts to date the ancient wood with the help of Lovelius' series were unsuccessful, although the age of some of the buildings from which the sawn parts had been taken were no older than 150 years.

In this context, in September 1977, we collected in this region drilled specimens of wood from the now living old trees of Dahurian larch for the construction of a new dendrochronological series. The specimens were taken at the estuary of the Kazach'ya River (15 km north of Khatanga, 50 km southeast of the forest outlier Ary-Mas). In all we used 18 models of trees growing on the first terrace above the flood plain of the Khatanga River in scrub-*Hylocomium* larch open forest. Information on the age of the models is given in Table 1. Although the width of the annual rings was measured with the accuracy of 15 μ along one radius, to determine the site of the missing rings a second radius (opposite) was used. The indices of increment were calculated according to an earlier proposed method (Shiyatov, 1972). The time span of this series proved to be 464 years (from 1514 to 1972). For the purposes of brevity, we have assigned No. 1 to N. V. Lovelius' series based on five models; to his series based on eight models, No. 2; and to our series, No. 3

In Fig. 1 there is a graphic depiction of series 1 and 3 from 1756 to 1969. It can be seen that between 1886-1969 the basic minima of increment coincide, while between 1756-1885 this does not hold true. Evidence of synchronism in the right part and its absence in the left part of the graphs are the calculation of the coefficient of synchronism: Between 1886-1969 it was 75% and between 1756-1885 it was a total of 54%. The dissimilar structure of series 1 is in the left and right of its parts. After 1886 the fluctuations in indices of increment from year to year mainly follow different directions, up to 1886 they are smoother and unidirectional. In our series 3 the character of fluctuations of indices of increment from year to year is the same in the left and right of its parts.

Analysis of the compared series and cross age determination between them reveal that the absence of synchronism between 1756 and 1885 is due to the incorrect determination by N. V. Lovelius of the calendar dates of the formation of rings of increment which came about because the missing and very thin rings were not identified. Since information is available on the age of the models used, the determination of the number of missing and omitted rings on the whole for series 1 is simple. We utilized the earliest segment of the series represented in all by one model where distortions connected with averaging the increment are absent (from 1756 to 1794, 39 years). Dating this segment of series 1 by crossing with series 3 we find that the earliest ring in series 1 was formed not in 1756, as N. V. Lovelius determined, but in 1744, i.e., 12 years earlier. Thus, in the oldest model 12 annual rings were not calculated. The calendar dates of the formation of the rings were determined by

*A. V. Knorre and B. N. Norin took part only in the selection of material. Measurement, age determination of rings, and assembling the dendrochronological series were drawn up by N. V. Lovelius.

TABLE 1. Number of Missing and Very Thin (up to 30 μ) Annual Rings of Increment in Young Trees Used for the Construction of Series 3

Model number	Number of annual rings of increment						
	total, specimens	missing		very thin		missing and very thin	
		specimens	%	specimens	%	specimens	%
101	464	27	6	26	6	56	12
103	436	12	3	31	7	43	10
99	416	—	—	—	—	—	—
104	415	2	—	11	3	13	3
96	396	20	5	16	4	36	9
100	371	9	3	19	5	28	8
105	364	13	4	16	4	29	8
106	361	10	3	8	2	18	5
94	351	8	2	20	6	28	8
90	322	11	4	20	6	31	10
102	347	8	2	11	3	19	5
91	345	7	2	31	9	38	11
88	310	14	5	20	6	34	11
95	298	26	9	15	5	41	14
98	225	1	—	4	2	5	2
87	215	3	1	4	2	7	3
92	142	1	0,5	1	0,5	2	1
89	122	—	—	—	—	—	—
Total	5900	172	3	256	4	428	7

Note. Very thin rings were not used in Model 90 from 1950 to 1977.

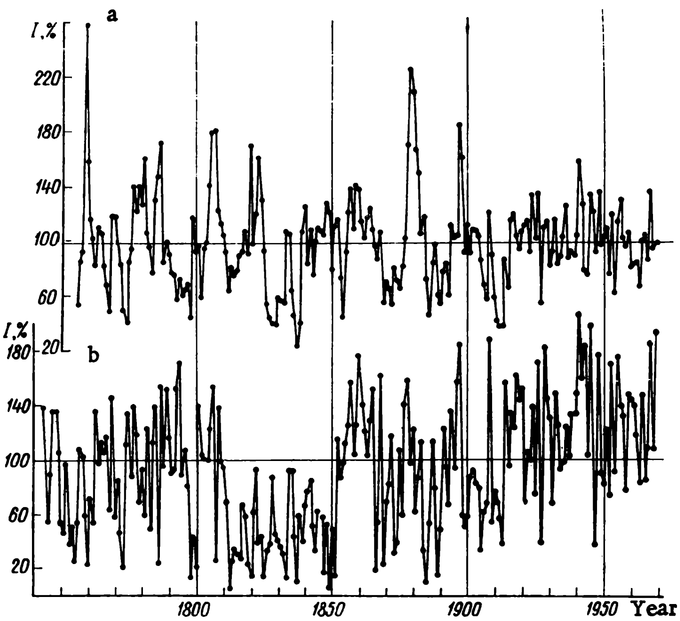

Fig. 1. Annual fluctuations of indices of increment in series 1 (a) and 3 (b).

N. V. Lovelius not by the method of cross dating, as is the custom in dendrochronology, but by using a reverse calculation with the result that the missing and very narrow rings were not found and the series between 1756-1886 was inaccurately constructed.

To establish the number of missing and omitted rings in other models on the basis of averaging series 1 was impossible, because the number of rings missing in different models was not the same and as a result annual increments formed in different calendar years were averaged. For this reason the exact place of the missing and omitted rings could not be determined. For this purpose we have to have the results of measurements of the width of the rings individually for each model. We can only conclude that the rings were missing between

1794-1886, i.e., within the segment of series 1 ensured by 2-4 models. The largest number of rings were missing between 1811-1851 when the most unfavorable period for the growth of trees in the last 200 years was observed (see Fig. 1b).

The reason for incorrect determination of calendar dates of the formation of rings of increment in trees is very clear from Fig. 2 which depicts smoothed indices of increment in series 1 and 3 and also the smoothed temperatures of July reconstructed on the basis of series 1 and 2. In the right part of the graphs where the date in series 1 and, obviously, in series 2 is shown correctly, there is observed a more or less good concurrence of minima and maxima in the course of showing the 22-year cycle (the borders of this cycle by minima in series 1 and 3 are indicated in Fig. 2 by arrows). The difference in advance of minima does not exceed 3-4 years. Quite a different picture is observed in the left part of the graphs. In series 1, in contrast to series 3, the minima of the 22-year cycle are shifted to the right to 12-17 years, i.e., as the result of the incorrect dating of the rings, one 11-year or half of a 22-year cycle has disappeared! In view of the fact that the missing rings were not revealed there was a reduction in the time length of two 22-year cycles: cycle 1799-1821 was shortened from 22 years (by series 3) to 17 years (by series 1) and cycle 1821-1846 from 25 to 16 years, respectively (Table 2). A reduction in length of cycles is also observed in series 2, showing that in this series as well the missing rings of increment were not revealed (Fig. 2). Hence the incorrect assertion by N. V. Lovelius, that the accuracy of determining the length of the 22-year cycle was ±3.7 years in maxima and ±2.0 years in minima. In actual fact, only because of the omission of the missing rings the error in determining the length of the different cycles reached 7-9 years.

The incorrectly dated series cannot be used to determine the characteristics of intrasecular cycles, the more so to compare cycles in different physicogeographical regions. In such series the number of undetermined rings may be the most varied, depending on the object and region of investigations, the number of models used, etc. The shifts in phases of cycles originating in this context may so distort the picture that the study of natural regularities becomes impossible. An example of this could be series 1 and 2 in which the intrasecular cycles become asynchronous in the left part of the graphs (Fig. 2).

That a large number of annual rings are missing under conditions that are extreme for the growth of trees, in particular at the northern border of the forest, may be illustrated by the data in Table 1, where for each model used in constructing series 3 is shown the number of missing and very thin (often omitted in measurement) annual rings. In the examination of one radius in Dahurian larch of this region an average of about 3% rings (in some models up to 9%) were missing. Besides this there are about 4% of very narrow (up to 30 μ) rings. Finally, if there is no special preoccupation with these rings, then the overall number of missing rings comes to about 7%. Approximately such a number of rings (12 out of 213 or 6%) was omitted by N. V. Lovelius in the oldest model used to construct series 1.

Dendrochronologists who know the method of cross dating will have no problem in finding the missing and spurious rings of increment and in determining their precise position in the chronological scale. This method was already elaborated in 1911 by A. E. Douglass, the founder of dendrochronology, and lies at the basis of any competently carried out work. There is no possibility here of outlining the gist of this method, the more so since it has more than once been described in detail in the literature: Douglass, 1919; Glock, 1937; Schulman, 1956; Stokes and Smiley, 1968). We shall only note that the absolute or relative dating of rings of increment with the accuracy of a year is an obligatory condition in constructing temporal series, and in this dendrochronological analysis of the course of tree growth differs from the evaluation analysis.

Through the use of the method of cross dating, the missing rings in the individually taken model cannot be found, even if the rings are examined over the entire surface of the sawn part. Complete confidence in the accuracy of dating is manifest when the series of rings in different models is compared. The experience of dendrochronologists shows that 5-10 model trees are usually sufficient to find all the missing and spurious rings. In series 1 obtained by N. V. Lovelius the missing rings occurred within the time interval ensured by 2-4 models. This number of models is fully sufficient to determine all or nearly all the missing rings. Eight models are more than sufficient to find the missing rings in series 2. It goes without saying that the determination of such rings necessitates not only the use of the proper methods but also additional time in realizing this operation, since the specimens of wood must be examined by microscope many times and graphs of the change in width of the

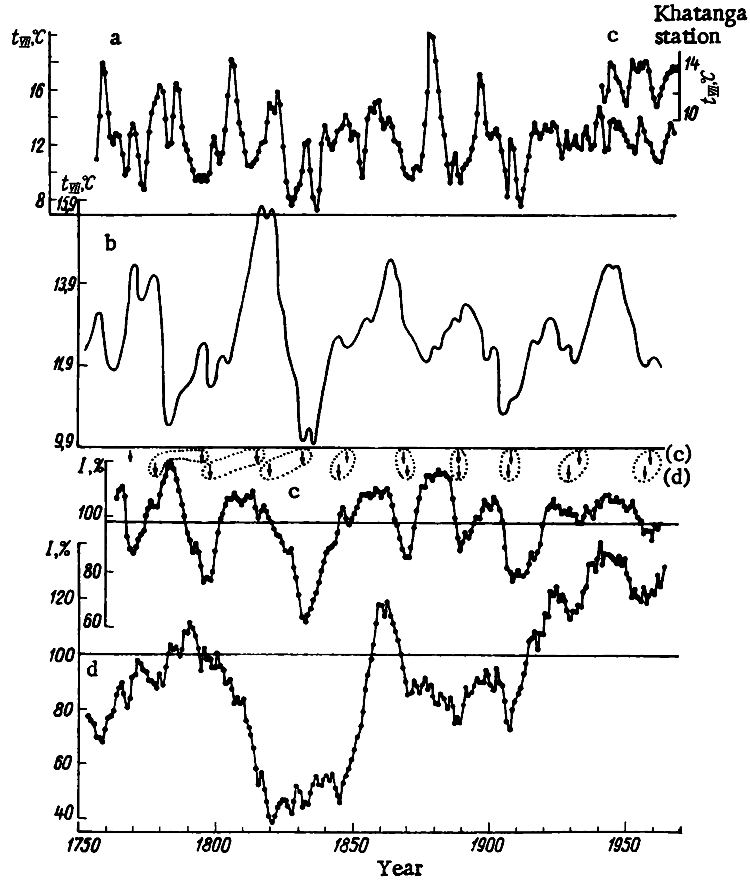

Fig. 2. Indices of increment in series 1 (c) and 3 (d) and reconstructed in series 2 temperature of July (b), smoothed with the help of a 15-year average sliding; reconstructed in series 1 temperature of July (a) and temperature of July according to observations at Khatanga meteorological station (e), smoothed with the help of a 5-year average sliding. Arrows indicate minima of the 22-year cycle in series 1 and 3.

annual rings must be compared. It is the obligation of every dendrochronologist to publish only accurately dated series. This requirement is obligatory, in particular, on receiving intial material from the depositors in the International Tree-Ring Data Bank. An unreliably dated series is not suitable for further investigation, because only false conclusions can be made on its basis.

Ignoring the method of crossed dating would be tantamount to the same gross error, let us say, were a climatologist, endeavoring to characterize the climatic fluctuations in a certain territory, to heap together the annual data of some meteorological stations and then make a random selection in order to construct a new, generalized, chronological series. It would not be difficult to visualize his colleagues' reaction to this "innovation." But while the results of a climatologist's work are easily verified in view of the regular publication of meteorological observations which are accessible to all, the matter is otherwise in the case of dendrochronological material. The results of the measurements of the width of annual rings for each model are usually not published and the only way to verify the accuracy of the construction of a generalized series is to collect new material. Clearly, such a method of control is inadmissible and impossible, especially for foreign investigators and investigators who are not engaged in constructing dendrochronological series. Hence the requirements concerning the quality of published series are rigid for the dendrochronologist.

In the example of the same series 1 and 2 it can be shown that not only did N. V. Lovelius err in the age determination of the annual rings of increment but also in selection of

TABLE 2. Characteristics of the 22-year Cycle in Fluctuations of Indices of Increment of Dahurian Larch (lower reaches of Khatanga River)

Series 1		Series 3	
year of minima	length of cycle, years	year of minima	length of cycle, years
1770	26	1759	20
1796	20	1779	20
1816	17	1799	22
1833	16	1821	25
1849	21	1846	25
1870	20	1871	19
1890	19	1890	18
1909	25	1908	22
1934	26	1930	28
1960		1958	

models and sawn parts for analysis, construction of generalized dendrochronological series, and interpretation of the data obtained.

The model trees for the construction of series 1 were taken from three associations of open forest larch that essentially differ from each other in soil-ground conditions, ground cover, and tree layer. For example, the evaluation characteristics of stands (canopy, density (number of trunks/ha), average and maximum height, average and maximum diameter) in different associations differ from each other by more than two times. This means that within those limits the absolute value of the annual increment in height and diameter changes. Therefore, before combining models that grow in habitats where the conditions are different, there first must be established the degree of similarity and synchronism in the fluctuations of the indices of increment. It should also be noted that five models are far from adequate to construct a reliable dendrochronological series. It is difficult to pass judgement on the conditions of the site from which the trees were taken for the construction of series 2, since the description speaks only of models taken "from the best site conditions of larch" (Lovelius, 1973: 296).

At variance with reality is the assertion by N. V. Lovelius that for the purpose of constructing series 1 "the values of increment for the calendar year *for each model* [our emphasis — S.S.] were obtained by averaging the given measurements of the width of the annual ring in a few sawn parts" (Knorre, Lovelius, and Norin, 1971a: 628). As evidenced by the data in Table 1, the sawn parts described in this work were processed only in three of the youngest models, while in two of the oldest, only one (zero) sawn part. In this context in the groups of models examined the initial data were not compared. In addition the use of sawn parts taken from different heights of the trunk to obtain averaged absolute values of increment inevitably leads to additional heterogeneity in the series. This heterogeneity is due to the nonuniform width of the annual ring at a different height of the trunk in trees and to the different number of repetitions in enumerating the average values. It is clearly traced in series 1 between 1920-1964 (Fig. 2). The amplitude of the last two cycles is markedly reduced, because sawn parts taken at a different heights of trunk were used.

For the construction of series 2 only zero sawn parts were taken and therefore the amplitude of the last cycles did not change in comparison with the preceding. We should note that the supplementary sawn parts are used for analysis of the dynamics of radial increment in prostrate woody plants in which the cambial activity at the base of the branches and trunks is reduced with age (Kolishchuk, 1968). However, the use of this method in relation to straight-stemmed trees is unfeasible until special methodological investigations are conducted.

In order to obtain generalized dendrochronological series, N. V. Lovelius at first averaged absolute values of increment by calendar years. At the same time he maintained that the use of uneven-aged models enabled the leveling of the age curve of tree growth.

This is absolutely not true. On the contrary, effecting such an operation results in summation of age effects within the limits of different time intervals of the series. Moreover, summed up are also effects connected with the differences in soil-ground conditions with the individual features of the growth of trees, and with all other factors exerting an influence on the value of the annual increment. The role of these effects are particularly great in taking a small number of models, using uneven-aged trees growing in sites with different conditions. If the number of model trees changes, the curve of averaged absolute increment changes substantially at once, which means that the indices of increment calculated on its basis will also change. For example, this is clearly seen in comparing the smoothed values in series 1 and 2 which are ensured by the dissimilar (5 and 8) number of models. In these series the same intrasecular cycles greatly differ in amplitude, some cycles are manifest only in one series, and some are found in antiphase to each other (Fig. 2). Even in the case of a weakly expressed age curve in trees, the averaged absolute values of increment may be applied only for a rough qualitative evaluation of the fluctuations of natural conditions, but under no circumstances for a quantitative evaluation.

In converting averaged absolute values of increment to indices of increment (i.e., relative values), N. V. Lovelius accepts a 31-year average sliding norm. He calculates that in this way there would be a reiterative smoothing of the age curve. As was noted above absolute increments averaged by calendar years represent the sum effect of all factors influencing growth. Using a 31-year average sliding in the capacity of the norm only excludes from the averaged series fluctuations of growth increment exceeding in length the period of averaging, regardless of their nature. In the final account, in indices of generalized series 1 the fluctuations of growth increment have been preserved for a period less than 30 years due to intrasecular fluctuations of climate and growth, chance, and other types of effect. For example, one of the highest maxima of increment in series 1 (the eighties of the 19th century) was undoubtedly due to the increase in increment of trees of young age and not to improved climatic conditions.

The experience accumulated by dendrochronologists in different countries attests to the fact that in averaged and different kinds of compared series, the relative, and not the absolute, values must be used. N. V. Lovelius, by averaging absolute values of increment by calendar years, thus increased the heterogeneity of the series which essentially distorted the climatically conditioned fluctuations of increment.

N. V. Lovelius claims that smoothing averaged absolute values of increment with the help of a 31-year average sliding removes "the differences in number of specimens in different sections of the 213-year series obtained" (Knorre, Lovelius, and Norin, 1971a: 629). Apparently, he has in mind here the heterogeneity of the series occurring as the result of the different number of models within its individual time intervals (Schulman, 1956). However, smoothing cannot remove this heterogeneity, because smoothing of values always follows actual increment. Evidence of this lies in the curves of change of indices of increment in series 1 shown in Figs. 1 and 2. Fluctuations of indices of increment and smoothing have the appearance of a drawn-out accordion in connection with the increase in number of models used, from one in the left part of the graph, to five in the right. A similar heterogeneity is traced also in series 2. In order to remove the effect of this heterogeneity, the relevant corrections in the values of annual increment achieved must be made, which N. V. Lovelius did not do.

On the basis of his dendrochronological series, N. V. Lovelius also drew up an annual reconstruction of an average July air temperature. The reconstructed temperature in series 1 for 1756-1969 was published in the proceedings of the Fourth International Symposium on Biological Productivity of Tundra Biome (Lovelius, 1972, Fig. 5) and in series 2 in the proceedings of the Fifth All-Union Symposium on Biological Problems of the North (Lovelius, 1973, Fig. 2). These graphs are shown in Fig. 2. It is obvious that on the basis of an inaccurately dated series with substantial heterogeneities, the only reconstruction emerging will be one that does not correspond to reality. For example, the strongest and most enduring cooling of the climate in the last 200 years started in 1811, and not in 1825, as follows from the data of N. V. Lovelius. Moreover, the cold period continued for 41 years, from 1811 to 1852, and not for 14 years (from 1825 to 1839) (see Figs. 1 and 2).

Even a cursory glance at the reconstructed air temperature of the series (Fig. 2a) reveals its substantial heterogeneity. For example, the course of smoothed temperature of July (the period of smoothing is not shown in the work but the 5-year average smoothing was most probably used) for 1756-1914 fluctuated from 7.2 to 20.1,C, while from 1915-1969, it fluctuated from 10.3 to 14.4°C. In other words the range of July temperature fluctuations after 1915 was reduced by three times (!) in comparison with the preceding period. Data of meteorological instrument observations in the northern hemisphere for the past 150-200 years (Rubinshtein and Polozova, 1966) and also data of series 3 (Fig. 1) show that at the end of 1915 there was no jump in the character of fluctuations of July air temperature. It was noted above that such a break is connected in the main with the use of additional sawn parts of a different height of the trunk and not with climatic effects.

Particularly improbable are the reconstructed air temperatures in extreme years and periods. Thus, smoothing of the value of the July temperature for 1879-1880 reaches 20.1°C, while the maximal smoothed July temperature, according to the Khatanga meteorological station, does not exceed 14.5° (Fig. 2e). The reconstructed smoothed July temperature for 1837-1838 is 7.2-8.1°, for 1911-1912, 7.7-8.1°, and the smoothed minimal temperature for July, according to instrument observations, is 11.0°. If we take into account that the unsmoothed values are approximately 3.0° higher and lower than the smoothed values, then in the last 200 years the July temperature reconstructed by N. V. Lovelius fluctuated more than once from 4-5 to 22-23°! These are the fluctuations in the July temperature reconstructed on the basis of series 2 (Fig. 2b). Even the temperature curve smoothed for 15 years fluctuates from 10 to 16°C.

The unreality of such jumps in July temperature for this region is obvious: The extreme values of the thermic regime of the warmest month in the year correspond at times to the subtropical zone (22-26°), at times to the arctic (3-5°). If the average July temperature in definite years and periods dropped to 4-6°, the existence of woody plants in this region would be impossible. The presence here of a vast number of very old trees (from 400-500 years) is evidence that such a drop in summer air temperature in the past centuries could never have taken place. We should also note that as a result of smoothing of reconstructed temperatures in series 1 there occurred a mixture of minima and maxima for 1-3 years in comparison with the initial series of indices of increment. This also distorts the picture of heat assurance of the different vegetation periods.

A comparison of the reconstructed July temperatures on the basis of series 1 and 2 reveal substantial divergences (Fig. 2a, b). The highest maximum of temperatures in series 1 (about 1880) corresponds to the rather deep minimum of series 2, and the highest maximum in series 2 (about 1815) corresponds to the minimum in series 1. In this connection the attempt to synchronize the stages of mountain glaciation of the Alps and northern hemisphere with unreliably reconstructed July temperatures (Lovelius, 1973) can only be considered as a misunderstanding.

From the data and conclusions of N. V. Lovelius it does not follow that "alongside the fluctuations of the intrasecular rhythm there is *clearly* [our emphasis — S. S.] traced the tendency toward improving forest-growing conditions in the north from the second half of the 19th century" (Knorre, Lovelius, and Norin, 1971a: 629). On the contrary, if his graphs are analyzed objectively there are only conclusions, namely that in the last 200 years there was a continuous reduction in the increment of trees, meaning a deterioration of thermic conditions of the vegetation period, and that in time the amplitude of the 22-year cycle decreased. In series 1 and 2 there cannot be detected secular or longer cycles for the simple reason that in calculating the indices the 31-year average smoothing was used in the capacity of norm. In series 3, for example, the prolonged fluctuations of increment are highly visible, since the indices are calculated by another method (Fig. 2). Wholly unsubstantiated is N. V. Lovelius' conclusion that the fluctuations of increment of Dahurian larch in the forest outlier of Ary-Mas "sharply reflects the global changes in the natural setting of Arctic latitudes of the northern hemisphere" (Knorre, Lovelius, and Norin, 1971a: 630), since there are no factual data at all on other regions of the Subarctic in the work.

The claim by N. V. Lovelius that the best connections were obtained between the increment of trees and the July temperature of the preceding year is puzzling. This may be so. But then why does he present a graph just below this statement that shows the connection of the increment of larch with the average temperature of the current year that serves as the basis for reconstruction of the temperatures of the series up to 1704 (Lovelius, 1973)?

In examining the material on the construction and interpretation of series 1, one is struck by the large number of inaccuracies that are inadmissible in dendrochronological investigations. Thus, in the figure showing intrasecular fluctations of the indices of increment, the vertical scale is depicted incorrectly. The range of fluctuations of values of increment, smoothed by 15-year periods, comprises not 62-155% (Knorre, Lovelius, and Norin, 1971a) but 62-119% (Fig. 2). In the graph illustrating the connection between indices of increment and July temperature (Lovelius, 1972, Fig. 4), three years (1945-1947) are ommitted, two points are indicated by one and the same year (1956), the point for 1968 in the network of coordinates is incorrect (instead of 94%, we see 64%). Even the time length of series 1 is incorrectly determined — it is equal to 214 years and not 213.

Thus, analysis of the two dendrochronological series obtained by N. V. Lovelius on Dahurian larch in the forest outlier of Ary-Mas reveals that they cannot be applied for age determination of the wood, nor for reconstruction of climatic conditions, nor for indication of the different type of natural processes. On the basis of such series the final goal of the investigation, which, according to N. V. Lovelius' declaration, is to make "reliable forecasts of the directions of changes in the increment of woody plants in the Far North," is unattainable (Knorre, Lovelius, and Norin, 1971a: 631).

What are the reasons for the appearance in print of weak and superficial dendrochronological works?

Above all, we should point to the inadequate professional preparation of some investigators who have a completely superficial conception of the fundamental principles and possibilities of dendrochronology and its methods, but nevertheless undertake dendrochronological investigations. The weak organization of dendrochronological investigations also contributes to such works. As was the case 10-15 years ago, the amateur continues to occupy himself with dendrochronology, which contradicts the very essence of this complex scientific discipline associated with nearly all the natural and many humanitarian sciences. In the modern system of divisions of science dendrochronology has not yet found its "proprietor." The Commission on Dendroclimatological Investigations established at the Scientific Council in 1973 on the problem of the "Biological bases of rational exploitation, transformation, and conservation of the plant world" has virtually done little for the development of complex investigations corresponding to modern requirements. Up to now little use is made of the rich foreign experience gained in the utilization of dendrochronological information; the necessary methodological aids and guidance are lacking. Finally, the poor works are due to the lack of exacting requirements on the quality of dendrochronological publications accepted in print.

LITERATURE CITED

Douglass, A. E., Climatic Cycles and Tree Growth, Vol. 1, Carnegie Institution of Washington, Publ. 289, Washington (1919).

Glock, W. S., Principles and Methods of Tree-Rings Analysis, Carnegie Institution of Washington, Publ. 486, Washington, D. C. (1937).

Knorre, A. V., Lovelius, N. V., and Norin, B. N., "Fluctuations of the increment of *Larix dahurica* Turcz. in the forest outlier of Ary-Mas (Taimyr)," Bot. Zh., 56, No. 5, 627-632 (1971a).

Knorre, A. V., Lovelius, N. V., and Norin, B. N., "Rhythmical fluctuations of increment of trunk wood of Dahurian larch in the arctic boundary (Ary-Mas, Taimyr)" in: Rhythmicity of Natural Phenomena [in Russian], Gidrometeoizdat, Leningrad (1971b), pp. 87-89.

Kolchin, B. A., "Dendrochronology of Novgorod," Tr. Novgorodskoi Arkheologicheskoi Ékspeditsii, Izd. Akad. Nauk, Moscow (1963), Vol. 3, pp. 5-103.

Kolishchuk, V. G., "Method of investigating increment of woody plants" in: Materials of the All-Union Scientific Conference on Questions of Dendrochronology and Dendroclimatology (June 7-8, 1968) [in Russian], Vilnius (1968), pp. 36-40.

Lovelius, N. V., "Reconstruction of the course of meteorological processes on the basis of the annual tree rings along the northern and altitudinal forest boundaries." Tundra Biome (Proc. IV. Intern. Meeting Biol. Productivity of Tundra, Leningrad, USSR, October, 1971), Stockholm, pp. 248-260 (1972).

Lovelius, N. V., "Rhythm of increment of trees and intrasecular stages of mountain glaciation" in: Soil and Vegetation of Frozen Ground Regions of the USSR [in Russian], Magadan (1973), pp. 296-300.

Lovelius, N. V., Norin, B. N., and Knorre, A. V., "Rhythmical fluctuations of increment of trunk wood of Dahurian larch in the northern limit of distribution (Ary-Mas, Taimyr, 72°30'N)," Izv. VGO, 104, No. 5, 391-393 (1972).

Rubinshtein, E. S. and Polozova, L. G., Contemporary Climate Change [in Russian], Gidrometeoizdat, Leningrad (1966).
Rudakov, V. E., "Method of investigating the effect of climatic fluctuations on thickness of annual tree rings," Dokl. Akad. Nauk Arm. SSR, 13, No. 3, 75-79 (1951).
Schulman, E., Dendroclimatic Changes in Semiarid America, University of Arizona Press, Tucson, Arizona (1956).
Shiyatov, S. G., "Dendrochronological investigation of Siberian spruce at the lower reaches of Taza River" in: Dendroclimatochronology and Radiocarbon [in Russian], Kaunas (1972), pp. 76-81.
Shiyatov, S. G., "Dendrochronology, its causes and methods," Zap. Sverdl. Otd. Vses. Bot. Ova., Sverdlovsk, No. 6, 53-81 (1973).
Stokes, M. A. and Smiley, T. L., An Introduction to Tree-Ring Dating, University of Chicago Press, Chicago (1968).

0096-7807/79/1001-0025$07.50