Empirico-Statistical Analysis of Narrative Material and its Applications to Historical Dating
Volume I

Empirico-Statistical Analysis of Narrative Material and its Applications to Historical Dating

Volume I:
The Development of the Statistical Tools

by

A.T. FOMENKO
Department of Geometry and Topology,
Faculty of Mathematics,
Moscow University,
Moscow, Russia

KLUWER ACADEMIC PUBLISHERS
DORDRECHT / BOSTON / LONDON

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 0-7923-2604-0 (Volume I)
ISBN 0-7923-2606-7 (Set of 2 Volumes)

Published by Kluwer Academic Publishers,
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

Kluwer Academic Publishers incorporates
the publishing programmes of
D. Reidel, Martinus Nijhoff, Dr W. Junk and MTP Press.

Sold and distributed in the U.S.A. and Canada
by Kluwer Academic Publishers,
101 Philip Drive, Norwell, MA 02061, U.S.A.

In all other countries, sold and distributed
by Kluwer Academic Publishers Group,
P.O. Box 322, 3300 AH Dordrecht, The Netherlands.

Translated by O. Efimov

Artwork on the cover by the author

Printed on acid-free paper

Printed in the Netherlands

Contents

FOREWORD

Today the methods of applied statistics have penetrated very different fields of knowledge, including the investigation of texts of various origins. These "texts" may be considered as signal sequences of different kinds, long genetic codes, graphic representations (which may be coded and represented by a "text"), as well as actual narrative texts (for example, historical chronicles, originals, documents, etc.). One of the most important problems arising here is to recognize dependent text, i.e., texts which have a measure of "resemblance", arising from some kind of "common origin". For instance, in pattern-recognition problems, it is essential to identify from a large set of "patterns" a pattern that is "closest" to a given one; in studying long signal sequences, it is important to recognize "homogeneous subsequences" and the places of their junction. This includes, in particular, the well-known change-point problem, which is given considerable attention in mathematical statistics and the theory of stochastic processes.

As applied to the study of narrative texts, the problem of recognizing dependent and independent texts (e.g., chronicles) leads to the problem of finding texts having a common source, i.e., the same original (such texts are naturally called *dependent*), or, on the contrary, having different sources (such texts are naturally called *independent*). Clearly, such problems are exceedingly complicated, and therefore the appearance of new empirico-statistical recognition methods which, along with the classical approaches, may prove useful in concrete studies (e.g., source determination) is welcome.

The present book by A.T. Fomenko, professor of pure mathematics, is mainly aimed at developing such new methods to be applied to recognizing dependent and independent narrative texts and dating them (with respect to texts with known reliable dates).

The author proposes a new approach to the problem of recognizing dependent and independent narrative (historical) texts based on the several new empirico-statistical models (regularities) which he has discovered during his extensive statistical emperiments involving various quantitative characteristics of concrete texts, chronicles, originals, and so forth. Verification of these models (statistical hypotheses) on concrete chronicles confirmed the efficacy of the models and made it possible to put forward new methos for dating texts (more precisely, for dating events described in the texts).

The approach proposed in this book is nonstandard and requires attention and diligence on the part of the reader to new and probably unfamiliar logical constructions. At the same time, the basic ideas of the author seem quite natural from the viewpoint of modern mathematical statistics and can easily be included in the conceptual system of applied statisticians.

The author's scientific results and ideas are very interesting, and perhaps already today we may speak of the appearance of a new (and rather unexpected) scientific trend in applied statistics whose development is of undisputed importance. This book is a result of a tremendous amount of work done by the author and his colleagues, most of whom specialize in mathematical statistics and its applications.

Since the book is devoted to problems at the interface of several branches of science, the necessity of establishing contact between people of different professional backgrounds becomes obvious. Many concepts and terms customary to specialists in one branch require translation into the language of specialists in another field of research. This should be borne in mind by representatives of both the natural sciences and the humanities. Such "difficulties of communication" are typical and must be successfully overcome with any mixed group of scientists working on joint problems. One may hope that many of the readers of this book will join to form such an interdisciplinary group in order to successfully continue the studies started here by this well-known mathematician.

Along with developing new empirico-statistical methods for dating events, the book also includes applications to the problem of modern scientific argumentation of the chronology of past events. One should clearly distinguish between the main statistical result obtained by the author (namely, the layered structure of the global "chronological map" and its representation as a "sum" of four layers) and its various interpretations and substantiations. Stating hypotheses and providing substantiations of results are beyond the scope of exact mathematical knowledge, and therefore special care should be taken in formulating conclusions concerning the possible structure of a new "statistical chronology of antiquity". The author has repeatedly insisted upon the necessity of critical analysis and upon distinguishing between strictly established facts and hypotheses or interpretations concerning these facts.

The concepts proposed by the author are new, sometimes unexpected, and deserve extensive and thorough investigation.

The book is written at a high scientific level, it is a unique phenomenon in the scientific literature in the field of applications of mathematical statistics, and the reader will not remain indifferent to it. The book also enables us to get to know the engaging personality of its author—mathematician and investigator of history ....

I hope that, after perusing the first few pages of the book, the reader will be intrigued to read to the end with unabating interest. He will, at the very least, get to know an interesting set of scientific problems and, perhaps, will even engage in further investigations in this new and promising field of science.

Albert N. Shiryaev
President of the International Bernoulli Society for
Mathematical Statistics and Probability Theory

PREFACE

This book presents new empirico-statistical methods for the discovery of dependences between texts, on which we base our dating methods. As one of various possible applications, the datings (or dates) of certain events described in ancient and medieval texts are analyzed.

The problem of recognizing dependences (and dependent texts) arises in many branches of applied statistics, linguistics, physics, genetics, and so forth. For example, as applied to source research, the discovery of dependent texts with a common primary source or original (which may not have survived) is of considerable interest. On the other hand, it is useful to have an idea which texts may be called independent or are based on substantially different primary sources and archival data. Meanwhile, the concept of text itself can be treated extremely differently. We can consider a sequence of symbols, signals, codes (of various kinds; for example, genetic codes in DNA chains) as a text, where the general problem in the search for "dependent texts" consists of finding "similar" portions in a given long signal sequence, i.e., textual fragments "duplicating" each other.

Today, there are many methods for finding dependences of this sort. We suggest certain new empirico-statistical procedures which can prove useful both in analyzing narrative texts (such as annals and chronicles) and in studying biological codes to find so-called homologous fragments, and so on.

For the reader's convenience, we divide the contents into several "topics", which may be helpful in getting oriented in the material and in separating reliable statistical evidence from hypotheses. This devision is arbitrary in the sense that the highlights listed in the following are intimately related to each other. Therefore, it would be more correct to speak of the book's "fibres", rather than of its parts. The book's chapters receive different emphasis, and I will briefly describe this accentuation here. I hope that the reader will be able to relate each fragment of the book to some particular "fibre", and, in particular, to make out the author's attitude toward each fibre.

The first fibre. The problem of discovering statistically covert dependences and dependent texts is solved, to which purpose a number of new statistical models (or hypotheses) are formulated. They are then checked against sufficiently extensive experimental data consisting of concrete narrative texts like annals or chronicles. It turns out that the suggested models can be confirmed.

In other words, we managed to discover interesting statistical regularities controlling the chroniclers' process of creating long narrative texts. The discovery of these laws is one of the principal results of our work. And on their basis, the methods for dating the events described are offered, for which the texts under investigation are statistically compared with those whose dating is undisputed. The methods are then verified against sufficiently extensive concrete material. We see that their application to texts describing the events from the 13th to the 20th century supports the efficiency of the method. Namely, the statistical datings obtained are consistent with those that had been known previously and were established by traditional methods. In particular, textual pairs originating from common primary sources, and known *a priori* as dependent between the 13th and the 20th century, also turn out to be dependent from the point of view of our methods; and pairs of texts known as positively independent prove to be independent from the standpoint of our methods as well.

The discovery of the laws that govern the distribution of information in large historical texts, with the establishment and experimental verification (based on these laws) of new dating methods (there being eight of them at present), is the first basic result of our work. Certainly, the dates we obtained cannot be regarded as absolute and final. Therefore, we will speak in the following only of "statistical datings", although, for brevity, we will sometimes omit the term "statistical", which is always implied. We thereby regard the obtained empirico-statistical dates only as a formal result of the statistical experiments carried out with narrative texts and do not believe that they are undisputed. Meanwhile, the consistency of these dates with those known earlier and obtained by the classical methods points to the objective character of our results.

The second fibre. This fibre can be called "critical". Here, we analyze the traditional datings of events of the ancient and medieval history of Europe, Egypt, and the Mediterranean. To make it convenient for the reader, we gather here the vast data scattered throughout the scientific literature, known to the specialists of various disciplines (however, often not of general common knowledge), and shall reveal the serious difficulties on the way to justifying the dates of certain ancient events.

We shall inform the reader of the fundamental research of the remarkable Russian scientist and universal scholar N.A. Morozov (1854–1946), Honorary Member of the USSR Academy of Science, who was the first to pose and fully formulate the problem of justifying ancient chronology by means of the methods of natural science, and who collected enormous critical material, putting forward daring hypotheses. We also speak of Isaac Newton's chronological research (questioning the dates of many ancient events), of well-known representatives of the critical school in chronology, and of various others working in the field. We then let major specialists in archaeology, source research, or numismatics speak and often resort to quoting and supplying the opinions of well-known scientists, juxtaposing different points of view so that the reader can form his own attitude toward the problems touched upon. The analysis of the dates of ancient events is the basic application of the empirico-statistical methods we worked out. I was therefore forced to analyze possibly all preserved versions of the datings of particular events. As a matter of fact, ancient and medieval texts often differ with respect to the dates of many important events. Attempting to stay as close as possible to the "original" versions (and perhaps to reconstruct them), we usually preferred the versions established in the chronological documents from the 11th to the 16th century. The chronologists of that time were nearer to the ancient events described, which is very important. The versions recorded between the 17th and the 20th century are often the consequence of later, secondary treatment, sometimes blurring the original chronological scheme. The reader should always remember this when looking at the dates given in this book.

Let me clarify this thought. Consider the evolution in time of historical documents and that of attitudes toward the datings of the described events. In the absence of a unique system for denoting dates in antiquity and the Middle Ages, the same events and documents could be dated differently by different chronologists belonging to different epochs. Let an event occur in the year t_0 and be fixed in a document X written in t_0 (or around this time) by a contemporary. X starts "living" when generations succeed each other. Another chronicler living in a later year t could no longer have access to all the necessary information and might "calculate" the date of an event. Denote by $D(t_0, t)$ the date ascribed to an event in X, and actually occurring in t_0, by a chronicler who lived in the year t. It is clear that $D(t_0, t)$ can be different from t_0 by some positive or negative value. The chronicler's version of the date can turn out to be older (then $D(t_0, t)$ is less than t_0) or, on the contrary, younger (then $D(t_0, t)$ is greater than t). Thus, $D(t_0, t)$ establishes the point of view elaborated by the chronicler in t with respect to the datings pertaining to X. It is obvious that $D(t_0, t)$ is dependent either of t_0 or t. We can assume that $D(t_0, t_0) = t_0$, i.e., the contemporaries mostly date the contemporary events correctly.

Let us construct the graph of the dependence of $D(t_0, t)$ on t for a fixed t_0. We then obtain the visual representation of the evolution of the later chroniclers' view of dating an event actually occurring in t_0. It is convenient to represent it in the form shown in Fig. A. Dating the event t_0, given by the contemporary chronologists, is denoted by $D(t_0, 1986)$. In other words, $D(t_0, 1986)$ indicates the modern version of the dating if the event actually occurred in t_0. Of course, $D(t_0, 1986)$ can be different from the true dating, for example, be more ancient or younger.

Since the same event in t_0 could be described by the contemporaries in several different documents (this being the typical situation), these individual versions start existing individually as separate texts not related to each other from the viewpoint of subsequent generations. We have represented this fact schematically in Fig. B by doubling or repeating some events and their datings several times. The further evolution of each version is represented by its own

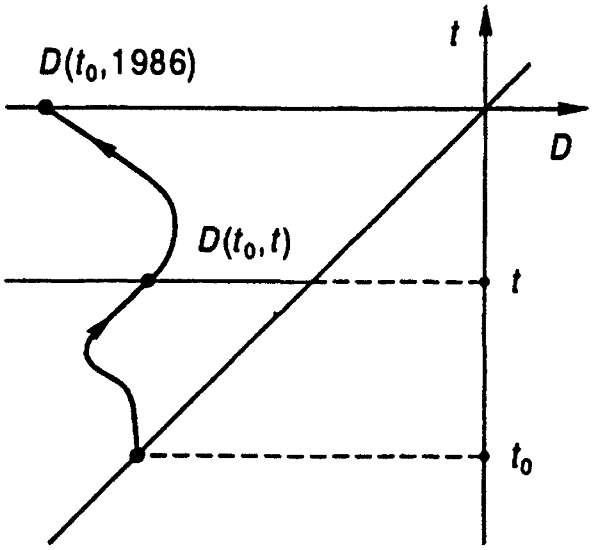


Figure A. Visual representation of the later chroniclers' view of the evolution of dating an ancient event.

curve, each emanating from the same diagonal but subsequently behaving absolutely independently. Meanwhile, different versions of the description of an event, outwardly totally different, can diverge far from each other from the standpoint of later chronologists. The complete evolution of datings of ancient events is given in Fig. C. Each subsequent epoch finds its own attitude toward the datings of the past events. These versions can vary substantially with time (we give examples of this in the book). Starting with the period from the 16th to the 17th century (see Fig. C), the chronological version of ancient times suggested by I. Scaliger and D. Petavius, is being "stabilized",

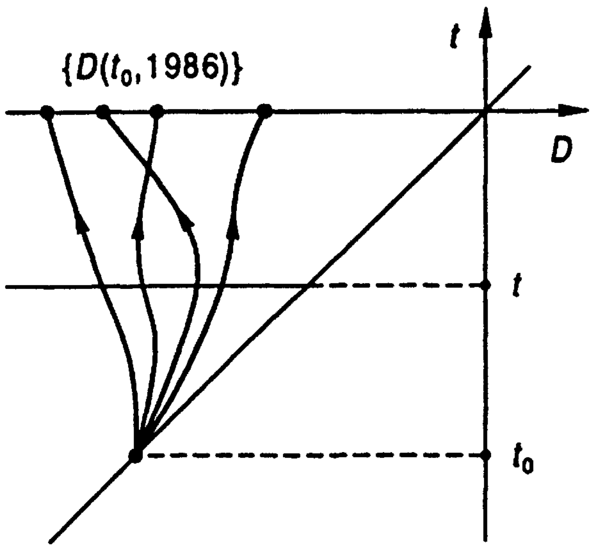


Figure B. Different versions of the description of an event can diverge far from each other from the standpoint of later chronologists.

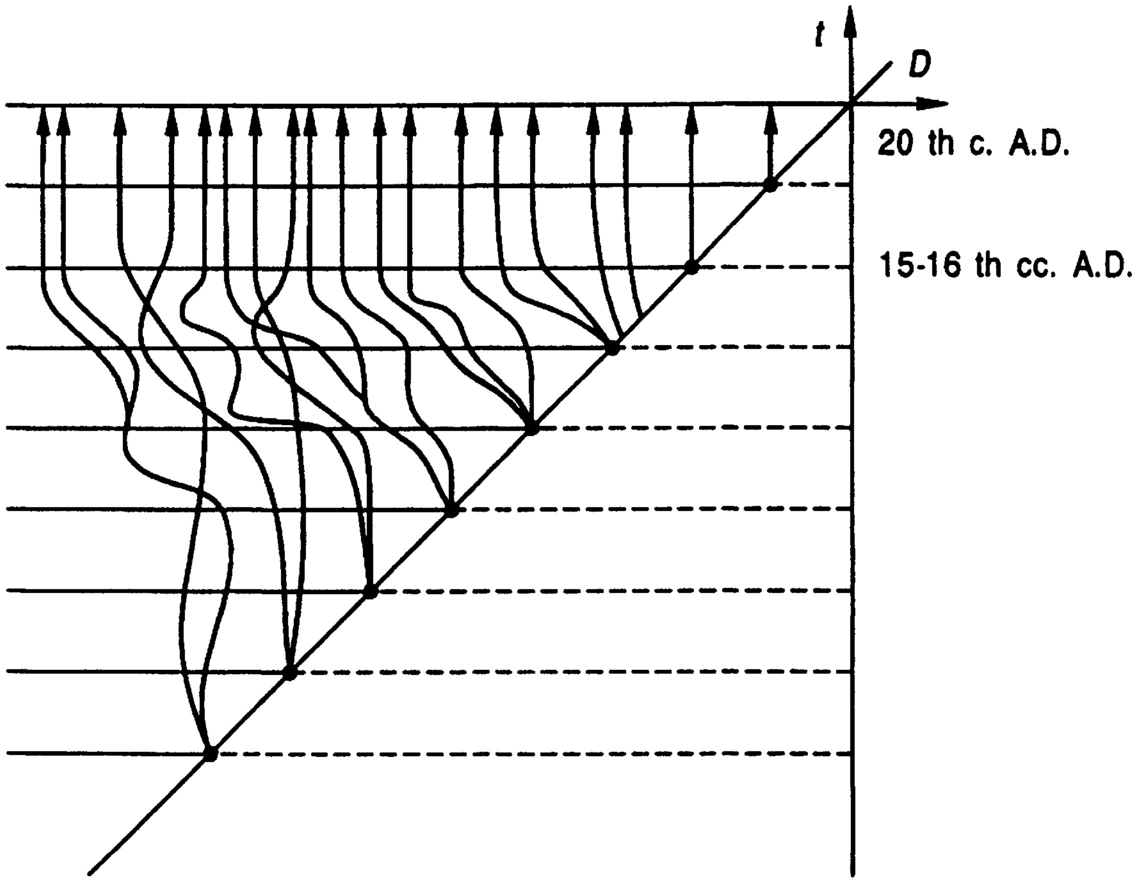


Figure C. The complete evolution of dating ancient events.

and the modern point of view coincides, in its basic features, with their chronology. This circumstance shows in the increasing straightening of the "alignment" of the dating trajectories. Today, we have assimilated only this version. However, very little is known about all the previous versions, which often differ sharply from today's. In other words, we are only well aware of the topmost line for the dates $D(t_0, 1986)$ and know very little of other lines, which obviously make up the bulk of the diagram. Thus, the enormous base of the chronological iceberg is hidden, within which the modern version of ancient chronology has been formed. The basic question formulated in the critical fibre of the book (the second "fibre") is related only to the underwater part. It is in this sense that we paid so much attention to the ancient chronological versions of the 10th- to 15th-century scientists.

We now elucidate what is meant by "correct", or "authentic", chronology in terms of the graphs in Figs. A, B, and C. It is the chronology in which the evolution of the date of an ancient event would be represented by approximately vertical lines (see Fig. D). Only in this case can the dates accepted today be regarded as realistic. To verify whether today's ancient chronology satisfies this condition, we should exhibit chronological tables associated with each horizontal line in Fig. C, made up by subsequent chronologists of ancient times. In other words, we should find the originals of those ancient

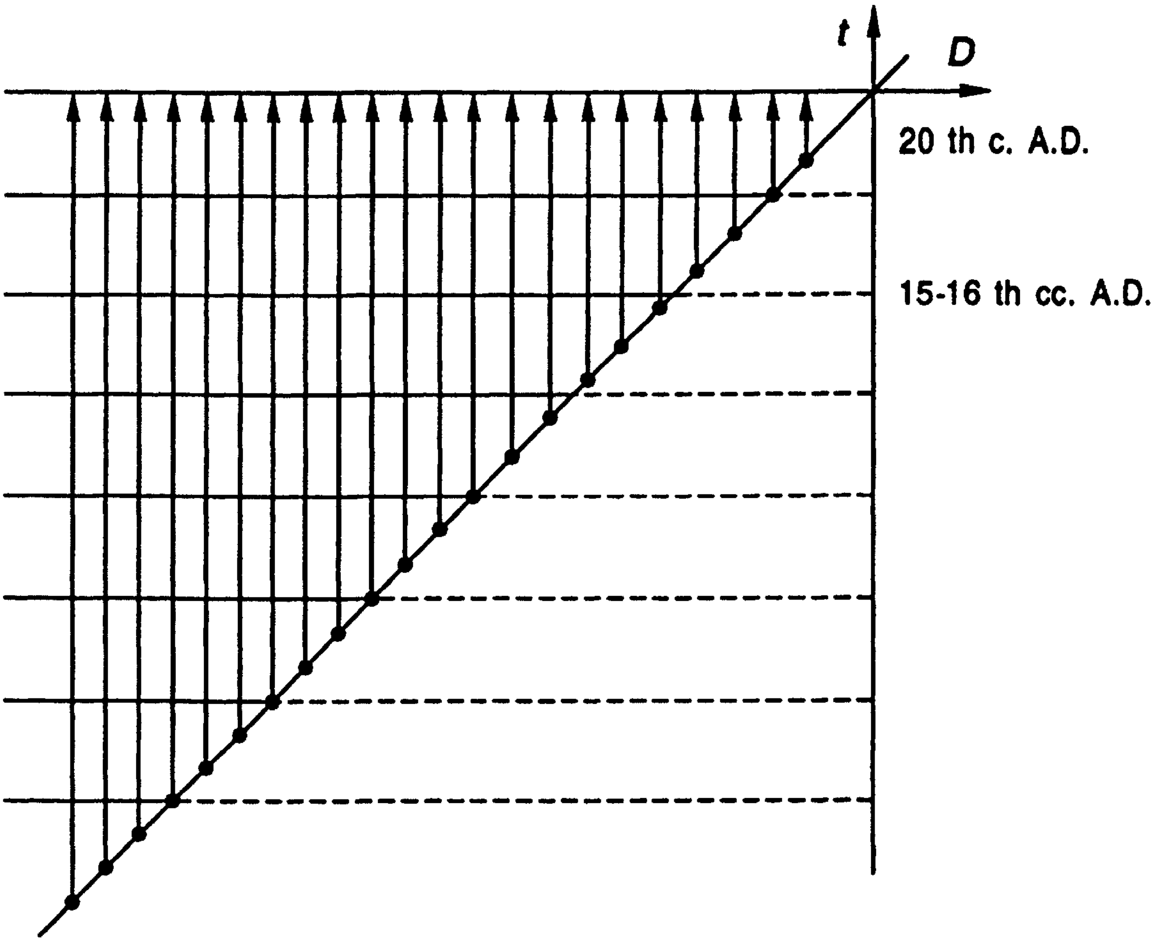


Figure D. Correct or authentic ancient chronology. The evolution of the dates of events is represented by vertical lines.

chronological versions forming the steps of a staircase which the dates were "ascending". Meanwhile, we have to see that the transition from each version to the previous or subsequent one is represented by vertical lines in Fig. C.

However, an attempt to descend into the past on these "steps", say by jumping over the 20 to 30 years that make up a generation, permits us to move only to the 12th and 13th centuries (with the "staircase" breaking earlier than that). Here we only discover "dating" of pieces that are not united into chronological tables preserved until today, and which fix the viewpoints of the ancient chronologists. Earlier than approximately the 13th century, no sequence of "shorter" predecessors of the chronological table can be found. It is desirable that the "shortening" of the table (respectively, its "extension") occurred approximately by 20 to 30 years, in the hope that the events of this time were described by a contemporary. The important characteristic of the second "fibre" is that the critical material is gathered only here. It thus acquires a new quality and permits us to embrace a larger volume of critical data on the basis of one point of view, accumulated in special works on ancient chronology. We assume that the reader is at least roughly familiar with tradtional ancient chronology (having studied it at school, university, etc.) In general, we do not repeat the traditional version, since we believe it to be known by everyone, but rather focus our attention on the account and criticisms of the competing versions, which are sometimes much different from the traditional one and were developed by many scientists between the 16th and the 20th century.

Within the framework of the second "fibre", we also supply a brief analysis of the traditional dating methods based on archaeological or radiocarbon data, which is of use if the reader would like to estimate the degree of reliability and accuracy. We shall also pay much attention to the dating of events that are about one, two, or three thousand years old and will demontrate, again by citing a number of authors, the difficulties that arise. Dating of material more than three thousand years old is beyond the scope of this book.

The third fibre. The author has constructed the so-called global chronological diagram (GCD), which can be regarded as a sufficiently complete and traditional "textbook" for ancient and medieval chronology. All the basic events of ancient history with their traditional dates, lists of the names of principal characters, and so forth, have been plotted on the time axis, and the basic preserved primary sources marked for each epoch. The diagram contains tens of thousands of dates, names, references. Occupying an area of several tens of square metres, it is a convenient collection of statistical data and a guidebook to the building of the traditional version. The graphic representation along the time axis of the principal dates proved useful for the statistical experiments. Since the GCD contains too much material, it was included in this book only in abbreviated form as short tables or graphs and is often replaced by this shorter version. We stress once again that the GCD is based on the traditional dating of ancient events, arising from the Scaliger and Petavius chronology.

The fourth fibre. The whole set of empirico-statistical methods we developed was applied to the GCD statistical material (see the first "fibre"). All possible pairs of time intervals (epochs) along with the basic texts describing them were considered, and the texts were statistically examined and compared. The "proximity coefficients" or textual "dependence coefficients" were subsequently calculated. If the dependence coefficient for two texts X and Y was the same (in order) as for two *a priori*, positively dependent texts from the 13th to the 20th century, then X and Y along with the associated time intervals were called "statistically dependent". This was represented in the GCD by denoting the corresponding time segments by the same symbols, for example, by the same letter T. The symbols were chosen arbitrarily. However, if the proximity coefficient was the same (in order) as for two *a priori* independent texts from the 13th to the 20th century, then X and Y were termed "statistically independent" and hence represented by noncoincident symbols like the letters H and C. We would like to make it clear that by investigating experimentally reliably dated texts describing the 13th to the 20th century, it was discovered that the proximity coefficients distinguish between *a priori* dependent and independent texts. For example, one of these coefficients, $p(X, Y)$, did not exceed 10^{-8} for two texts known previously as dependent and was not less than 10^{-3} for two surely independent texts, which shows the difference of about 4–5 orders. Now, comparing two arbitrary texts X and Y, we can say whether the value of the coefficient is in the zone for dependent or independent texts. It can also be in the zone of "neutral" texts. It goes without saying that the indicated bounds for the values of the coefficient have been found experimentally. Further discovery of dependent and independent texts is then carried out within the framework of the experimental material (which is, though, sufficiently large).

For vast computational experiments, the GCD revealed pairs of statistically dependent texts and the corresponding epochs. The results of applying different methods turned out (and this is very important) to be remarkably consistent; namely, if a pair of texts (and periods) were statistically dependent from the standpoint of one method, then they were also dependent from the point of view of other methods applicable, in principle, to the tests in question. This consistency seems to be important. Our methods discovered no unexpected, formerly unknown duplicates of documents belonging to the period from the 13th to the 20th century. However, for documents preceding the 13th, and especially the 10th century, the same methods led to the quite unexpected discovery of many new statistical duplicates regarded as independent in all respects, and referring to different epochs.

The *global chronological diagram showing all statistical duplicates is the second principal empirico-statistical result obtained by the author.*

The third basic result is the decomposition of the GCD into the sum of four chronicles practically identical to each other, but shifted by considerable time intervals. To give a rough idea, the third statistical result can be formulated in the following way: The modern "textbook" of traditional ancient and medieval chronology and history is the sum, from the statistical point of view, of the four replicas of one shorter "chronicle".

The principal part of the book concentrates on these three empirico-statistical results. The subsequent "fibres" are mostly of hypothetical and interpretational character. Roughly speaking, they are required so that we may answer the question: What do the obtained empirico-statistical results mean?

The fifth fibre. It can be called *interpretational.* Here, we offer different hypotheses which can explain the regularities discovered and the reasons for the duplicate appearance. We do not regard this material as final. The "shorter" textbook I suggested certainly does not claim completeness and can only be regarded as a possible version. Interpretations of the obtained statistical results can be of different nature and will require much work by many specialists in various fields.

My attitude toward many of the questions discussed is a result of cooperation and numerous discussions. In particular, the statistical results were reported at the Third, Fourth, and Fifth International Vilnius Conferences on Probability Theory and Mathematical Statistics in 1981, 1985, and 1989, respectively; the First World Congress of the International Bernoulli Society for Mathematical Statistics and Probability Theory in 1986 in Tashkent; the seminar "Multidimensional Statistical Analysis and Probabilistic Modelling of Real-Time Processes" by Prof. S.A. Aivazyan (Central Economical-Mathematical Institute, Moscow); the All-Union Seminar on the Stochastic Continuity Model and Stability Problems by Prof. V.V. Kalashnikov (All-Union Systems Research Institute) and Prof. V.M. Zolotaryov (USSR Academy of Science. V.A. Steklov Mathematics Institute); Controllable Processes and Martingales by Prof. A.N. Shiryayev (USSR Academy of Science. V.A. Steklov Mathematics Institute).

I would like to express my indebtedness to the participants in the discussions.

I am also indebted to Acad. Ye.P. Velikhov and Acad. Yu.V. Prohorov for their assistance.

My work received great stimulus from numerous private talks, consultations, and discussions with colleagues, and also from specialists in mechanics and from physicists; in particular, I am much indebted to the Moscow University staff members Prof. V.V. Kozlov, Prof. N.V. Krylov, Prof. M.M. Postnikov, Prof. A.S. Mishchenko, Prof. Ye.M. Nikishin, Prof. V.A. Uspensky, Prof. P.L. Ulyanov (Assoc. Member of the Academy of Science), Prof. Ye.V. Chepurin, Prof. Ye.G. Sklyarenko, Prof. V.I. Piterbarg, Prof. V.V. Moshchalkov, Prof. M.K. Potapov, Prof. N.V. Brandt, Prof. R.N. Kuzmin, Prof. V.V. Surikov, Prof. Yu.P. Gaidukov, Prof. Yu.P. Solovyov, Prof. Ya.V. Tatarinov, Prof. V.V. Alexandrov, Cand. Sci. N.N. Kolesnikov, Cand. Sci. G.V. Nosovsky, Prof. V.M. Zolotaryov and Prof. A.N. Shiryaryev (USSR Academy of Science. V.A. Steklov Mathematics Institute), Prof. V.V. Kalashnikov and Prof. V.V. Fyodorov (USSR Academy of Science. Systems Research Institute), Prof. S.T. Rachev (Santa Barbara, USA), and D.I. Krystev (Mathematics Institute; Sofia, Bulgaria), Prof. Yu.M. Kabanov (USSR Academy of Science. Central Economical-Mathematical Institute), Prof. A.V. Chernavsky (All-Union Research Information Transmission Problems Institute), Cand. Sci. I.A. Volodin (Moscow Oil and Gas Institute), Prof. S.V. Matveyev (Chelyabinsk University), and Cand. Sci. M.V. Mikhalevich (Kiev University), Prof. Yu.M. Lotman (Tartu University), Prof. V.K. Abalakin (Leningrad), Prof. M.I. Grossman (Moscow), Prof. L.D. Meshalkin (Moscow), Prof. R.L. Dobrishin (Moscow), Prof. I.Z. Schwartz (Moscow), and Cand. Sci. S.Yu. Zholkov (Moscow), and Cand. Sci. L.E. Morozova (USSR Academy of Science. History Institute).

My special thanks go to my colleagues Prof. V.V. Kalashnikov and Cand. Sci. G.V. Nosovsky for their support and collaboration on many problems of mathematical statistics, astronomy, and computer experiments.

I would like to express my gratitude to all of them.

In addition, I would like to thank Cand. Sci. G.V. Nosovsky, Cand. Sci. N.S. Kellin, P.A. Puchkov, M. Zamaletdinov, A.A. Makarov, N.G. Chebotaryov, Ye.T. Kuzmenko, V.V. Byasha, T. Turova, L.S. Polyakova, my parents

V.P. Fomenko and Cand. Sci. T.G. Fomenko, and my wife Cand. Sci. T.N. Fomenko for their help with the primary statistical processing of the historical sources, statistical tables, and frequency graphs.

Much help in computer programming and processing of the statistical material was given by Cand. Sci. G.V. Nosovsky, Cand. Sci. N.S. Kellin, Cand. Sci. N.Ya. Rives, Cand. Sci. I.S. Shiganov, P.A. Puchkov, M. Zamaletdinov, and A.V. Kolbasov.

I would like to express my debt to T.G. Zaharova, the Director of the N.A. Morozov Museum, and V.B. Biryukov for their assistance in studying the material related to Morozov's scientific work.

Further, I would like to thank Kluwer Academic Publishers and, in particular, Prof. M. Hazewinkel and Dr. David J. Larner for their effort in publishing the book, with special thanks to Dr. Larner, the head of the Science and Technology Division, for his support of this project.

I am also grateful to Mr. V.V. Novoseltsev of the Copyright Agency of the USSR for his help.

And, finally, this book could never have been published without the interested attention and initiative of the distinguished mathematician and editor Prof. M. Hazewinkel, who made it possible to combine and publish an English translation of all my basic works on this problem, which had already been published in the USSR as individual articles.

The book is dedicated to the memory of the outstanding scientist and universal scholar Nikolai Alexandrovich Morozov (1854–1946), Honorary Member of the USSR Academy of Science, author of many profound works in chemistry, physics, mathematics, astronomy, and history. It was he who first posed the problem of scientifically substantiating ancient chronology by using the methods of natural science, and who obtained fundamental results.

In conclusion, I would like to emphasise that, fully aware of the unusualness and unorthodox nature of certain of the obtained results, I nevertheless believe it my scientific duty to present the work to the reader's judgement in hope that it may serve as the next step in working out new statistical methods for the study of narrative sources and in solving the problem of justifying ancient chronological dates.

The book contains only part of the obtained results. I hope to publish others separately. In particular, the following books have recently been published:

A.T. Fomenko, *Methods for Statistical Analysis of Narrative Texts and Applications to Chronology*, Moscow University Press, 1990 (in Russian).

A.T. Fomenko, V.V. Kalashnikov, and G.V. Nosovsky, *Geometrical and Statistical Methods for Dating Ancient Star Catalogues (When Was Ptolemy's "Almagest" Compiled in Reality?)*, (in Russian; English translation in preparation).

CHAPTER 1

Problems of Ancient and Medieval Chronology

§1. The Global Chronological Diagram of Ancient and Medieval History[1]

1.1. The moon's elongation and R. Newton's conjecture

Chronology informs us of how much time has passed since a certain historical fact. Meanwhile, the chronological data of a narrative source describing the fact should be reduced to the modern dating units, i.e., be referred to by B.C. or A.D. This problem proves to be quite complicated, since many a historical inference depends on which date we ascribe to the events discussed in the source.

Modern global chronology embracing the majority of events of the past is the result of the lengthy work of chronologists who lived from the 15th to the 19th century A.D. Thus, all the major events of ancient and medieval history are associated with certain dates in the Julian calendar, which permits us to study historical processes, evolution of scientific and cultural ideas, technological progress, and so forth, within the scope of large time intervals [1], [2], [4].

However, such research has led to the discovery of certain phenomena which cannot easily be explained for the present. We give an example from natural science, namely, from astronomy. The lunar theory deals, *inter alia*, with a parameter called the second derivative of the moon's elongation (D''). Depending on time, the values of this parameter should be available for past eras. It can be computed if the ancient eclipse data are known. The problem has been solved by the prominent American astronomer R. Newton [10]. The

[1] First published as an article in *Khimiya i zhyzn'*, 9(1983), pp. 85–92.

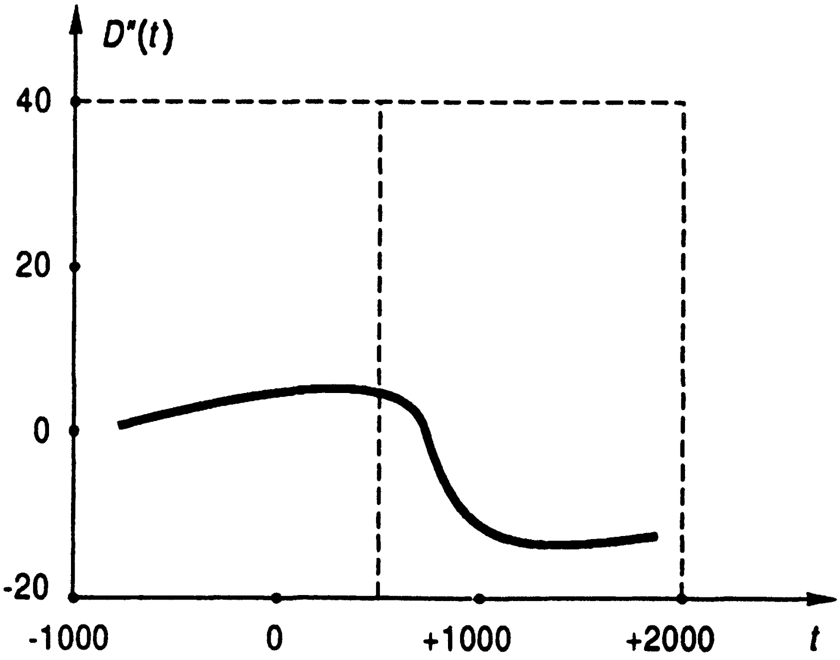


Figure 1. R. Newton's graph demonstrating that $D''(t)$ decreases with time. See the astonishing, inexplicable jump at around the first millenium A.D.

graph (Fig. 1) he obtained turned out to be extremely surprising. Newton wrote:

> "The most striking feature of Fig. 1 is the rapid decline in D'' from about A.D. 700 to about A.D. 1300. ... This decline means that there was a 'square wave' in the osculating value of D''. ... Such changes in D'', and such values, are unexplainable by present geophysical theories. ... " ([10], p. 114)

To explain this square wave (one-order jump), Newton was forced to suggest that there should exist some nongravitational interactions in the earth–moon system [11]. These enigmatic forces do not manifest themselves in any other way, which is in itself quite unusual.

Below, we shall see that there is at least one more explanation of the jump in D''.

1.2. The Dark Ages and the Renaissance epochs

Let us return to chronology. In the history of Europe and the Mediterranean, there are several Renaissance epochs during which many achievements of ancient scientific thought, lost in the period of the Dark Ages, were discovered. The epoch in the history of Europe when many scientific facts and cultural habits of the past were rediscovered (from the 13th to the 16th century) has been studied most extensively. Such duplication is explicitly traced in astronomy, military engineering, architecture, literature, and many other branches of science and art. For example, the famous Greek fire, which had played such an important role in the sea battles of antiquity, and which had then been forgotten for centuries, was rediscovered only in the Middle Ages.

Apart from the classical Renaissance, the Carolingian Renaissance (the time of Charlemagne) is also generally known, when many authors imitated the antique paragons, duplicating the literary themes which had been forgotten earlier. Similar phenomena (termed Restoration) are also known in the history of ancient Egypt. The prominent Orientalist B.A. Turaev noted that the culture of the Saite period had reproduced that of the Old Kingdom: 2,000-year-old texts again went into use, tombs were decorated following the ancient ways, titles that had sunk into oblivion were reintroduced, and so forth.

As we see, duplicates present themselves as a rather frequent phenomenon in history. Naturally, the question arises as to how they are distributed in time: in a random manner or subject to some covert governing law?

1.3. How to substantiate ancient chronology

To calculate the dates of ancient events is not as simple as it may seem at first glance. The final proof of the correctness of certain dates still remains a problem today. It continues to attract the attention of historians and the specialists of physical and chemical dating methods. It is but natural: The further we move from an ancient event in time, the harder it is to date it. The contradictions that often arise in doing so have caused some historians to express doubts regarding the dating of certain events, as suggested by the first chronologists of the 16th to the 18th century, which, by the way, are still accepted with few exceptions at present [12], [13]. A new scientific discipline was born, namely, hypercriticism, which denied not only the correctness of dating a particular event, but also the trustworthiness of certain ancient events. The famous representative of this school, who specialized in the history of ancient Rome, T. Mommsen, noted, in particular, that different versions of dating the foundation of Rome diverged to the extent of 500 years, and that this oscillation influenced the dating of all the documentation counting years since the "foundation of Rome" ([14]; [14*], pp. 513–514).

Chronological problems interested the Egyptologists, too. Thus, H. Brugsch stressed the enormous difference in the determination of the date when Menes had been placed on the throne, writing that the difference between the extreme conclusions was striking, it being equal to 2,079 years. In spite of all the discoveries in this branch of Egyptology, the numerical data were (at the end of the 19th century) still in a very unsatisfactory state ([16]; [16*], pp. 95–97).

Another example: The chronology of certain events in Egyptian history, which was given by Herodotus in his famous *Histories*, differs by more than a millennium from that accepted today. Herodotus' chronology is much shorter than the modern version; sometimes, he even places near each other (see [17]) rulers who according to the modern version are separated by 18 centuries ([17*], pp. 512, 513, 516).

But especially many discrepancies show up if one compares the dates given in medieval texts with the dating ascribed to them today. The distinguished modern chronologist E. Bickerman even speaks of "the chaos of medieval datings" ([4], p. 78).

Chronology in its present form was created in a series of fundamental works by the founders of modern chronology as a science, J. Scaliger (1540–1609) and D. Petavius (1583–1652). It became a precise science later; however, the work is not yet completed, and, as Bickerman notes, there is no sufficiently complete investigation of ancient chronology that would satisfy modern requirements ([4]; [4*], p. 90).

It is not surprising that certain sceptical minds have drawn dramatic conclusions from the above-mentioned difficulties. Thus, as early as the 16th century, a professor of Salamanca University, de Arcilla, published two papers in which he stated that the whole of history preceding the 4th century had been falsified (see de Arcilla, *Programma Historicae Universalis, Divinae Florae Historicae*). The same conclusion was reached by the historian and archaeologist J. Hardouin (1646–1724), who regarded the entire classical literature as the work of 16th-century monks. Isaac Newton devoted many years to historical and chronological studies. Having thoroughly investigated practically the entire historical and theological literature, he wrote *Abrégés de la Chronologie* [19], asserting that the time scale of the chronology of antiquity was unnaturally extended. Newton made up his own tables in accordance with a new version of chronology which related the biblical texts to the history of the Mediterranean. In his book *Newton*, V.G. Kuznetsov wrote that Newton had collected

> "fantastically large volumes of historical material. This was the total of forty years of work, toilsome research and enormous erudition. Newton, in fact, studied all the basic literature in ancient history and all primary sources ... " ([18], pp. 104–105).

> "Certainly, being unable to read cuneiform and hieroglyphic texts and having no archaeological data, which were then unavailable, ... Newton was in error to the extent not only of tens or hundreds of years, but even millennia ... " ([18], pp. 106–107).

As a matter of fact, many of the most important events of Greek history were chronologically moved forwards by Newton by 300 years, and those of Egyptian history by 1,000 and even 1,800 years.

And now in this century, in his *Historie und Kritik*, the German researcher R. Baldauf was proving on the basis of philological arguments that not only ancient but even early medieval history was a later falsification.

An attempt to systematize the considerable critical material and to analyze historical paradoxes and duplicates from the standpoint of natural science was carried out in the work of a scientist with encyclopaedic knowledge, the revolutionary, public figure and honorary academician, N.A. Morozov (1854–1946) [3]. He actually held the opinion of de Arcilla and believed that traditional chronology had been artificially stretched [2]. It should be noted that he apparently came to this idea independently of de Arcilla. Remarkable scientific intuition and strict logical argumentation permitted Morozov to list numerous data in support of such a conjecture. However, his striving to dot all the i's led to poor substantiation of many of his statements; some contained factual errors, and the new chronological version as a whole (including the hypothesis regarding the falsification of ancient history) was rejected, which does not at all lessen his achievements, for the problem is so complicated and many-sided that one mind alone, even if outstanding, is unable to solve it completely.

1.4. Statistical dating methods: new possibilities

To overcome the above difficulties, we should try to consider the subject from a different angle and create a certain independent dating method which is not based on subjective estimation. This done, we can start analyzing the whole of chronology. In my opinion, an approach involving the statistical analysis of various numerical characteristics associated with ancient texts is most suitable for this purpose. The interested reader can learn about concrete methods and some of their applications to the analysis of global chronology from the short bibliography at the end of the section. Here, we shall confine ourselves to a short account of the essentials and give several examples.

We make the immediate reservation that the methods suggested by the author do not pretend to be universal. Moreover, the results obtained by each individual method cannot be regarded as impeccably trustworthy. A sound criterion of their validity is the consistency of the dating obtained by different methods (today, there are seven of them). The general scheme is as follows. First, a statistical hypothesis is formulated for modelling some process (e.g., loss of information with time). Then numerical coefficients are introduced which permit us to quantitatively measure the deviations of experimental curves from those predicted theoretically. Further, the model is checked against *a priori* true historical material, and if it is confirmed, then the method can be used for the dating of events.

For simplicity, we give an example. Let a period in the history of a region P from a year M to a year N be described in a text X (chronicle or annals) broken into separate chapters $X(T)$, each of which is devoted to the events of a year T. We calculate the volume of all the chapters (number of pages or lines) and represent the obtained data as a volume graph, plotting the years, T, on the horizontal, and the volumes of the chapters on the vertical axis. A similar graph for another text, Y, describing the same events, in general will have different form; most probably, the interests or tendencies of the chronologist will have bearing on it. But how essential are these differences? Is there anything common between the volume graphs? Indeed, there is. But, before stating the details, some words about the information-loss pattern.

The essential characteristic of any graph is its peaks, or extremal points. In our volume graph, they correspond to the years in which the curve attains local maxima. Such peaks indicate the years described by the chronicle in the time interval under investigation with the finest points of detail. Denote by $C(T)$ the volume of all texts created by contemporary writers and describing a year T. We call it the "primary stock" (Fig. 2a). The precise form of its graph is not known to us, since texts get partly lost in the course of time.

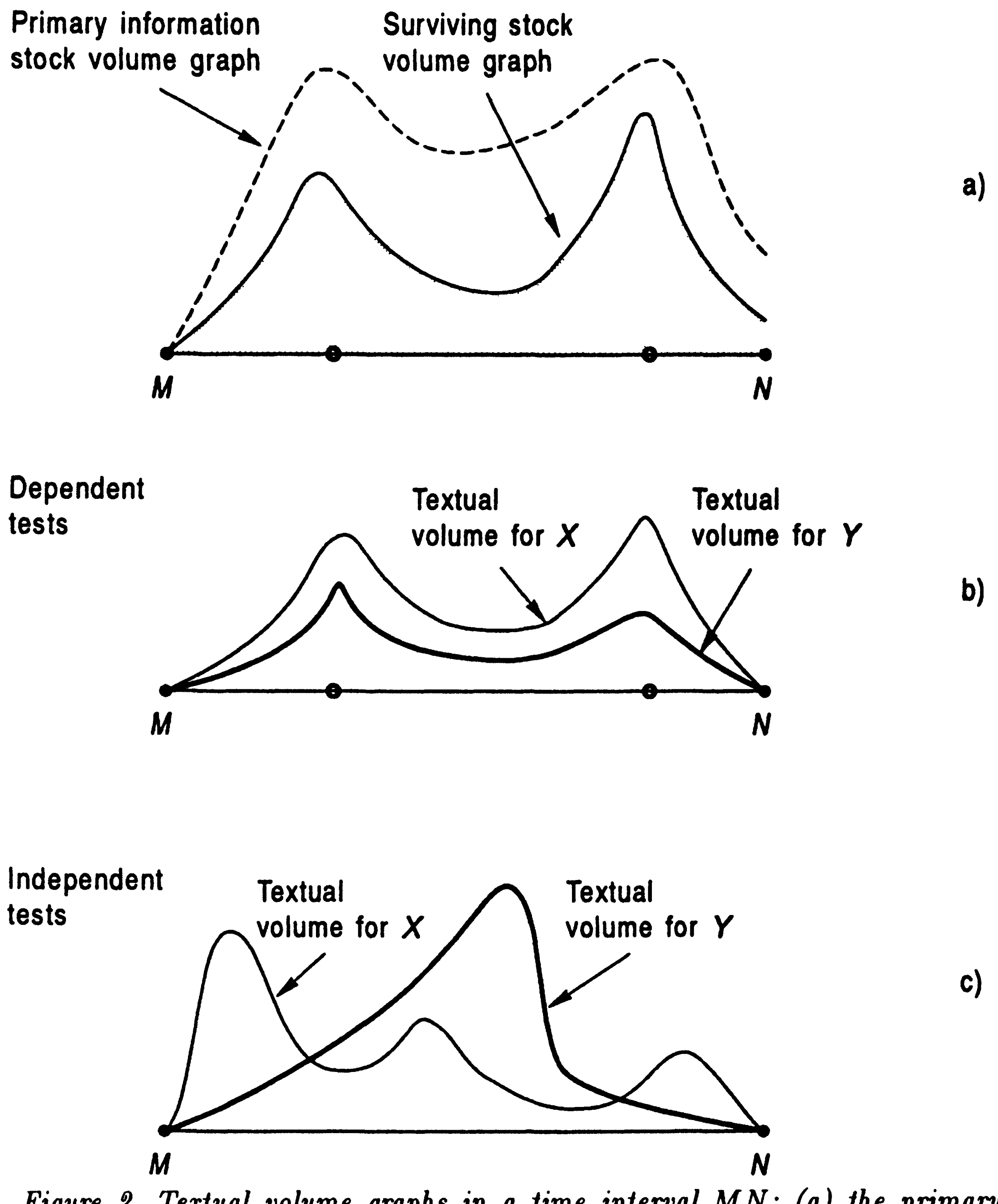


Figure 2. Textual volume graphs in a time interval MN: (a) the primary and surviving stocks (curves should exhibit peaks approximately in the same years); (b) the curves for dependent texts are correlated; (c) the curves for independent texts are not correlated.

We now formulate the information-loss model, namely, there will be more texts for those years to which more texts were originally devoted. It goes without saying that to verify the model in this form is difficult, because the graph of the primary stock remains unknown. But one of the corollaries can be verified. Later authors, X and Y, while describing the same period (and not being its contemporaries), will be forced to employ approximately the same set of ancient texts available. Therefore, they will be able to describe best those years from which more texts remain.

Eventually, the model conjecture is formulated as follows: *The graphs of the volumes of chapters for two dependent texts X and Y* (i.e., describing the same period of history and the same region) ***must have simultaneous peaks***; in other words, the years described in detail in X and Y should coincide or be close (Fig. 2b). On the other hand, *if two texts X and Y are independent* (either describing essentially different periods of history of the same length, or for different regions), *then the graphs of the volume for X and Y attain local maxima at different points* (Fig. 2c).

After the mathematical formalization, an experiment was carried out in which the model (*maximum correlation principle*) was verified for several hundreds of pairs of dependent and independent historical sources. The principle was confirmed, which made it possible to offer a method for dating texts and also for discovering interdependency among them. For example, to date events described in a chronicle, we have to try to choose an *a priori* dated text such that the volume graphs attain maxima practically simultaneously. If, however, the dating of two comparable texts is unknown, but the peaks in the graphs coincide, then we can assume with a high degree of probability that the texts are dependent, i.e., the events described are close or coincide.

Now, just a few words about some other methods of dating. They are based on the statistical analysis of such parameters as the frequency of mentioning the names of historical characters and that of various astronomical phenomena, the period of the rule of kings in various dynasties, formalized biographical data of historical figures, and so on. All these methods have been verified for undoubtedly true material of the 13th to the 20th century, and their validity has been confirmed [5], [6], [7].

1.5. The duplication effect in ancient history and chronology

The methods briefly described above are applicable not only to the dating of texts. They also permit us to find various literary borrowings, repetitions, literary clichés, citations, and parallels in the texts being compared. For example, if in comparing two dynasties of kings a certain dependence is discovered (i.e., if the corresponding graphs of the rule duration are extremely close), then this can be interpreted in different ways. One interpretation consists of our probably having discovered an intentional imitation by the annalist of a certain authoritative source. However, another version is also probable, namely, that we are dealing with duplicates which were never recognized to be identical and are narrating the same events, and which were related to different historical epochs.

Sometimes these methods help discover the proximity of chronicles, i.e., their having originated from the same source. In particular, they make it possible to indicate the duplication effects discussed at the beginning of the section in connection with the Renaissance epochs. As it turns out, there are essentially more such historical epochs than is usually thought. To avoid a terminological muddle, we will speak in the following simply of ***duplicates***.

It is now time to formulate our problem: to find possibly all duplicates in ancient and medieval history, and if we succeed, to construct on their basis a hypothetical chronology without repetitions and Renaissance periods which are sometimes hard to explain.

1.6. The global chronological diagram and the "modern textbook" of ancient and medieval history

Before coming to the thorough analysis of historical texts for the purpose of discovering and systematizing duplicates, we have to construct as complete a table of events of the ancient and medieval history of Europe as possible and also that of the Mediterranean region, Egypt, and certainly the Near East, showing their traditional dating. To this end, the author has investigated 15 basic chronological tables and 228 fundamental primary sources (chronicles, annals, records, etc.). Together, these texts contain the description of practically all the basic events of the period from 4000 B.C. to A.D. 1800. All this information was then represented graphically on the plane. Each historical epoch with all of its basic events was shown on the time axis. Meanwhile, each event was represented by a point or horizontal line-segment in accordance with its duration, with the beginning and end of the line-segment being those of the event (e.g., a king's rule). Simultaneous events were represented one above the other, so that any ambiguity or overlapping would be avoided.

Thus, a maximally complete chart was constructed. We will call it the global chronological diagram (GCD); see Fig. 3, upper line. To see which events took place in a particular year according to modern chronology, we have to draw a vertical line through that year on the GCD and collect all the events being intersected.

We have applied the above dating and duplicate-recognition methods to the enormous historical data recorded on the GCD. The entire period of history on the diagram was broken into epochs, for which, roughly speaking, a set of characteristic graphs was calculated. For example, for each epoch (a line-segment on the time axis) in the history of each region, the volume graphs for all the basic primary sources describing this epoch were plotted, and those for different epochs were compared pairwise. As a result of the extensive experiment in which hundreds of texts were investigated, containing altogether tens of thousands of names and hundreds of thousands of lines, the author unexpectedly discovered pairs of epochs which are regarded as independent in traditional history (in every sense), but with extraordinarily close and sometimes even practically indistinguishable graphs.

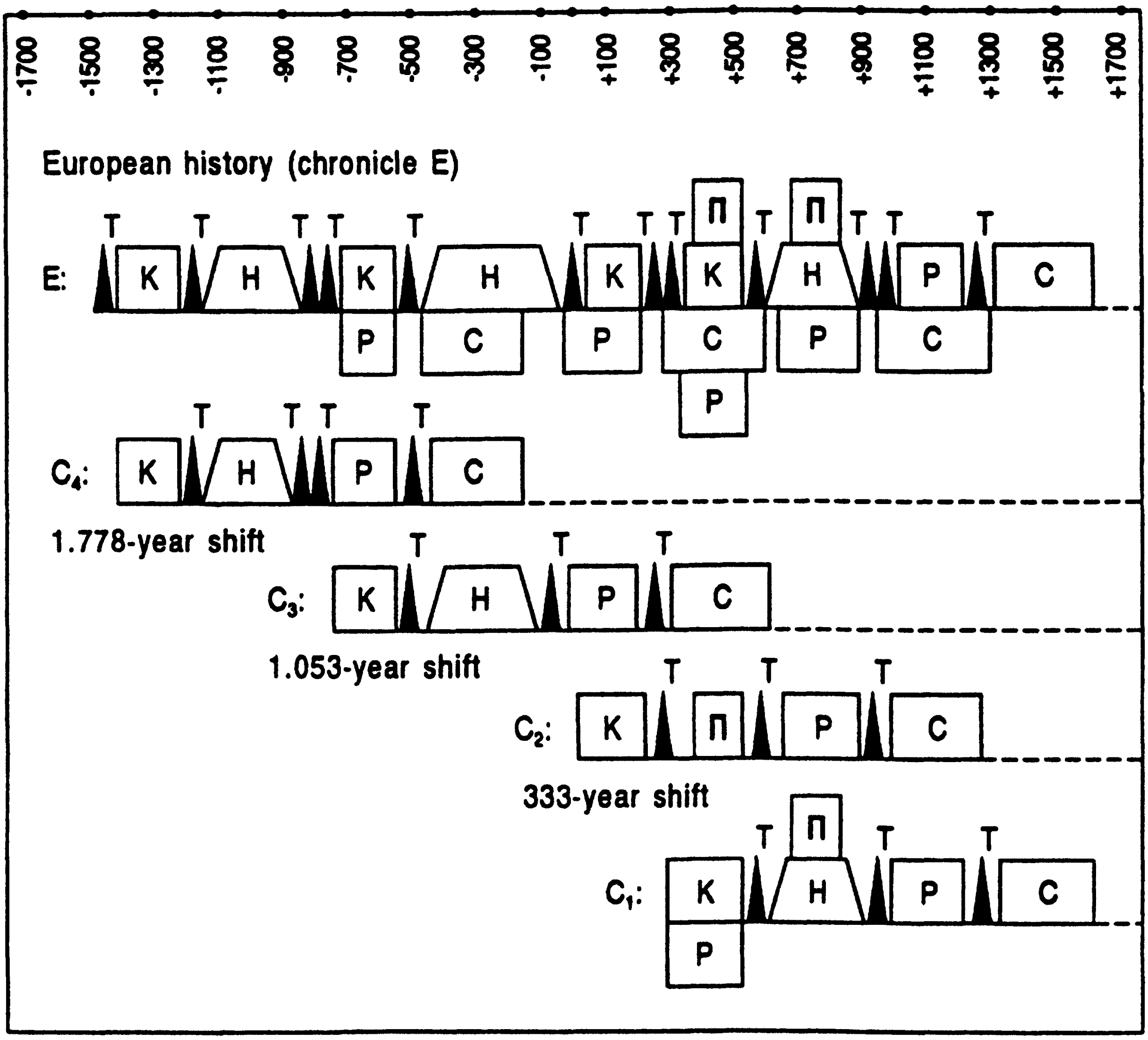


Figure 3. The "modern textbook" of European history and its decomposition into the sum of four short isomorphic chronicles.

We illustrate this with an example. The volume graph of the primary sources describing the history of ancient Rome from 753 to 236 B.C. exhibits peaks practically in the same years as a similar graph constructed for medieval Rome from A.D. 300 to 816. To verify this fact, these two time intervals of 500 years in length should be superimposed first (Fig. 4). The same coincidence of the two seemingly independent series of events (antique and medieval) was also discovered by other methods. The GCD happened to include quite a number of duplicates, i.e., pairs of historical epochs which are as close as are undoubtedly dependent texts describing the same historical period. We once again emphasize that the results obtained by different methods are invariably consistent.

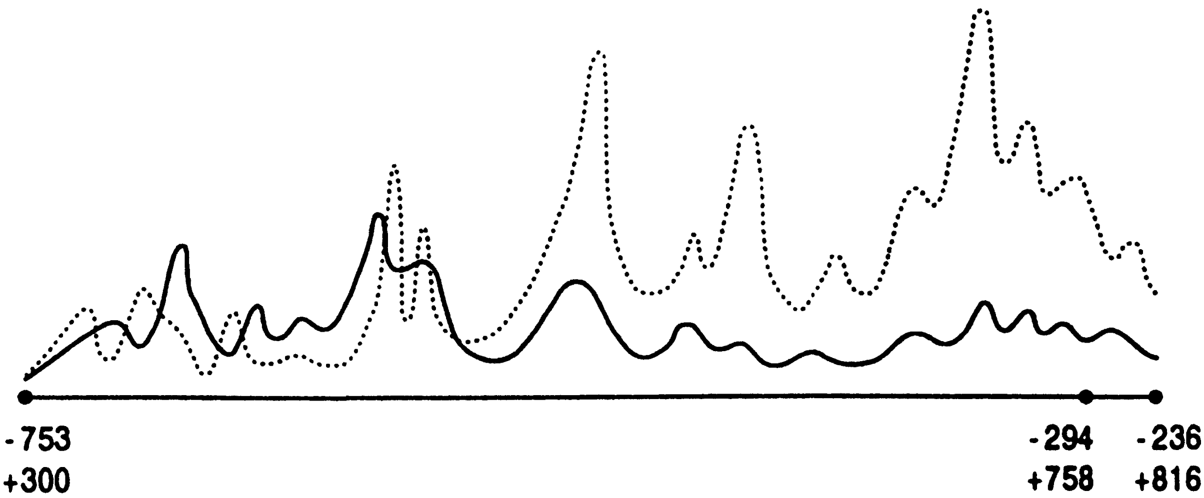


Figure 4. Primary source volume graph, describing ancient (dotted line) and latest (solid line) Roman history: this maximum correlation can hardly be accidental.

1.7. The "modern textbook", a composition of four identical pieces

Let us once more carefully consider the upper line in Fig. 3. To represent the set of all the discovered epochs of duplicates clearly, they are marked on the GCD by the same geometric symbols and letters (chosen arbitrarily). More precisely, duplicates are designated by the same letters, and the epochs that are considerably different from one another by different ones.

Some of the letters repeat continually (e.g., T repeats eleven times, and C four times). The length of the geometric figures indicates the duration of the corresponding epoch. Say, the black triangles T are associated with periods that are about 20–30 years long, and the rectangles C with periods approximately 300 years long. Certain intervals of time on the GCD are covered by several figures. Thus, the period from *ca.* A.D. 300 to 550 is represented by four superimposed rectangles Π, K, C, P, which means that part of the chart devoted to this period is composed of four pieces designated by different letters. In other words, in the set of events which occurred in the interval from A.D. 300 to 550, those making up the piece Π are first distinguished, then those composing K, and so forth. The events falling into a particular piece are most often associated by what happened in the region. By the way, all the Renaissance epochs noted by the historians are contained in the duplicates on the GCD.

But the main thing is that a rather complicated structure of the GCD is naturally obtained as the result of one quite surprising process. If the four lines (chronicles) C_1, C_2, C_3, C_4 (also shown in Fig. 3) are distinguished in the chart and are glued together along the vertical line by superimposing, then we shall obtain, as can be expected, the same line on the GCD, consisting of the lettered epochs. But the most surprising fact is that these four chronicles are represented by practically the same series of letters and symbols. The four duplicate pieces differ from one another only by their position on the time axis. Thus, the second chronicle differs from the first one only by a backward shift in time of about 333 years, the third by a shift of already 1,053 years, and the fourth by an approximately 1,778-year-long shift. Admitting a certain liberty, we can say that the "modern textbook" of the ancient and medieval history of Europe, the Mediterranean region, Egypt, and the Near East is a composite chronicle obtained by gluing together four practically identical replicas of the abridged chronicle C_1. Three other chronicles are derived from it by redating and renaming the events described, while the whole of C_1 is lowered (i.e., shifted back in time) by about 333, 1,053, and 1,778 years, respectively. Thus, the entire GCD can be restored from its part C_1.

Another fact to be emphasized is that nearly all the information in the chronicle C_1 is concentrated to the right of A.D. 960. The periods P, T, C (to the right of the 10th century A.D.) are very rich in information, whereas K, H, Π (from A.D. 300 to 960) contain very few events.

1.8. Certain corollaries and interpretations

This formal decomposition of the "history textbook" into the sum of four chronicles can be interpreted differently. First, that the periodic behaviour I discovered is possibly accidental. It can be calculated, however, that the probability of such a random event is extremely small. Another possible interpretation is that insufficient written evidence casting light on certain periods of ancient history encumbers the application of statistical methods. Finally, a third possible explanation, which seems to me worth notice, is that the existing global chronology of the period preceding the 13th century A.D. requires quite substantial corrections in certain cases. These will require the redating of certain blocks of events now related to earliest antiquity, for which the chronicles C_4, C_3, C_2 of the modern chronological chart should be distinguished and lifted upwards in accordance with the mentioned shifts. After this formal procedure, the known written history of Europe, the Mediterranean, and so forth, will be abridged, and most of the events now dated as having occurred earlier than the 10th century A.D. will be placed in the interval from the 10th to the 17th century A.D.

This hypothesis can help explain certain long-known paradoxes of traditional chronology, including those mentioned at the beginning of the section. However, I do not at all agree with the assumption of N.A. Morozov and some of his predecessors that the information today available regarding ancient history is, allegedly, a later falsification. The results obtained by new methods of dating show that most of the primary sources which have been prescribed are originals describing real events. Almost all the events mentioned in ancient documents did occur; the question remains only where and when.

Generally speaking, the principal result of the work done is of formal statistical character, and no more. Nonspecialists in history have already attempted to interpret this result in a pseudoscientific manner, with the data of social science being ignored. I am decisively against such conclusions.

1.9. What is to be done with the moon's elongation?

Let us return to the beginning of the chapter, to the moon's elongation and its second derivative. The computation of D'' was based on the data of ancient eclipses adopted by traditional chronology. The attempts to explain the surprising square wave in the graph of D'' do not touch at all upon the question whether the data of the eclipses were determined correctly. We will assume that an eclipse has been dated correctly if its characteristics exactly described in a historical source coincide with the parameters of the real eclipse offered by chronology.

Morozov suggested a method of "impartial" dating, namely, the comparison of the characteristics of an eclipse given in a primary source with those from astronomical tables. Analysis demonstrates that, while not questioning the chronology of ancient events and *a priori* regarding it as true, the astronomers often could not find a suitable eclipse in the "desired" century and thus resorted to strained interpretations. For example, in the *History of the Peloponnesian War* by Thucydides, three eclipses were described, traditionally dated as belonging to the 5th century B.C. However, even in the last century, a discussion around this triad started, being caused by the fact that there were no eclipses with suitable characteristics in the assumed epoch. Still, an exact solution can be found if we extend the interval of the search. One solution is the 12th century A.D., and the second one the 11th century A.D. There are no other solutions.

A similar effect of "shifting the dates forwards" can be extended to those eclipses which are traditionally dated in the interval from A.D. 400 to 900. It is only after A.D. 900 that the traditional dates are satisfactorily consistent with the precise datings given by astronomy, and undoubtedly after A.D. 1300.

But why, in fact, speak of it here? Because such a shift of dates is completely consistent with the GCD being glued together from four identical chronicles. If an earlier and traditional date for an eclipse was assigned to an epoch, say, labelled by C on the GCD, then its precise astronomical date lies much farther to the right on the time axis. It occurs in the period of history denoted on the diagram by the same letter. In particular, the date shift just described is reduced to advancing certain groups of eclipses up by about 333 years, others by 1,053 years, and so on. In such a time advance, the mutual occurrence of dates inside each of these groups is practically unaltered, and the group is advanced as a block.

But what's to be done with D''? Its recalculation on the basis of the reconsidered dates of ancient eclipses showed that the graph (Fig. 5) is qualitatively altered. It cannot now be moved reliably to the left earlier than the 10th

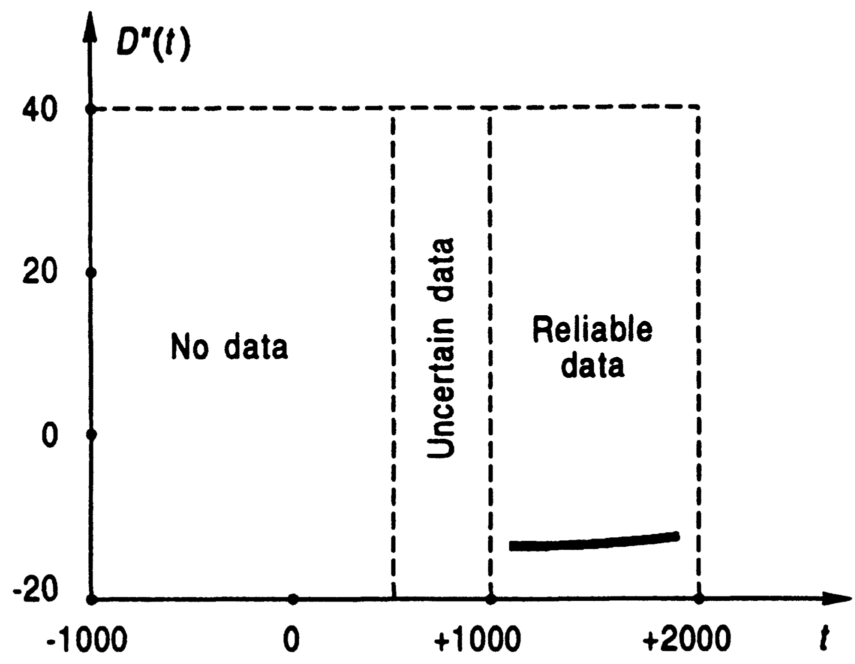


Figure 5. The new graph of $D''(t)$, constructed on the basis of the recalculated dates of ancient eclipses, has no anomalies: there are simply no reliable data to extend it to the left.

century A.D., while in the later period, it almost coincides with the curve already found and is represented by an almost horizontal line. No square wave is found in the second derivative, and no mysterious nongravitational theories should be invented. ...

It goes without saying that the work discussed here cannot claim to be the basis for any final conclusion, the more so as the most complicated, multifarious and often subjectively interpreted historical data are analyzed here by strictly mathematical methods. To process the material will certainly require a large variety of methods, purely historical, archaeological, philological, physical and chemical, and, *inter alia*, mathematical, which as the reader can see, will permit us to look at the problems of chronology from a new angle.

References

[1] Blair, J., *Blair's Chronological and Historical Tables, from the Creation to the Present Time, etc.* G. Bell & Sons, London, 1882.

[2] Morozov, N.A., *Christ.* Giz, Moscow–Leningrad, 1926–1932 (in Russian).

[3] *Nikolai Aleksandrovich Morozov: A Universal Scholar.* Nauka, Moscow, 1982 (in Russian).

[4] Bickerman, E., *Chronology of the Ancient World.* Thames & Hudson, London, 1968.

[4*] Russian translation of [4]. Nauka, Moscow, 1975.

[5] Fomenko, A.T., "Informative functions and related statistical regularities", Abstracts of the Reports of the Third International Vilnius Conference on Probability Theory and Mathematical Statistics. Institute of Mathematics and Cybernetics of *AN LSSR* **2**(1981), pp. 211–212.

[6] Fomenko, A.T., "A method of duplicate recognition and some applications". *DAN SSSR* **258**, 6(1981), pp. 1326–1333 (in Russian).

[7] Fomenko, A.T., "New empirico-statistical methods in ordering texts and applications to dating problems", *DAN SSSR* **268**, 6(1983), pp. 1322–1327 (in Russian).

[8] Fomenko, A.T., "The jump of the second derivative of the moon's elongation", *Celestial Mechanics* **25**, 1(1981), pp. 33–40.

[9] Newton, I., *The Chronology of Ancient Kingdoms amended. To which is prefix'd, a short chronicle from the first memory of things in Europe, to the conquest of Persia by Alexander the Great.* J. Tonson, etc., London, 1728.

[10] Newton, R., "Two uses of ancient astronomy", *Phil. Trans. Royal Soc.*, Ser. A., **276**(1974), pp. 99–116.

[11] Newton, R., "Astronomical evidence concerning non-gravitational forces in the Earth–Moon system", *Astrophys. Space Sci.* **16**, 2(1972), pp. 179–200.

[12] Scaliger, J., *Opus novun. de emendatione temporum.* Lutetiae, 1583.

[13] Scaliger, J., *Thesaurus temporum: Eusebii ... Chronicorum canonum omnimodae historiae libri duo ... Opera ac studio J.J. Scaligeri, etc.* Lutetiae, 1606.

[14] Mommsen, T., *The History of Rome.* Macmillan & Co., London, 1913.

[14*] Russian translation of [14]. Giz, Moscow, 1936.

[15] Petavius, D., *Opus de doctrina temporum divisum in partes duas, etc.* Lutetiae Parisiorum, 1627.

[16] Brugsch, H., *Egypt Under the Pharaohs.* John Murray, London, 1891.

[16*] Russian translation of [16]. Petersburg, 1880.

[17] Herodotus, *The Histories of Herodotus, etc.* Everyman's Library, London–New York, 1964.

[17*] Russian translation of [17]. Nauka, Leningrad, 1972.

[18] Kuznetsov, V.G., *Newton.* Mysl', Moscow, 1982 (in Russian).

[19] Newton, I., *Abrégés de la Chronologie des Anciens Royaumes.* Chez Henri-Albert Gosse, Genève, 1743.

§2. Computation of the Second Derivative of the Moon's Elongation and Statistical Regularities in the Distribution of the Records of Ancient Eclipses[1]

2.1. Parameter D'' and R. Newton's paper "Astronomical evidence concerning non-gravitational forces in the Earth–Moon system"

The present section discusses in more detail my results described in [4] (see the list of references at the end of §3). It is known that, for certain problems of computational astronomy, the behaviour of the so-called second derivative of the moon's elongation $D''(t)$ as a function of time t should have been known for large time intervals in the past [13]. Let $\dot{n}_M$ be the acceleration of the moon with respect to ephemeris time, and $\dot{w}_E$ that of the earth. The quantity $D'' = \dot{n}_M - 0.033862\dot{w}_E$, which is the second derivative of the moon's elongation, is called an acceleration parameter [10], [13]. D'' is normally measured in arc seconds per century squared. The dependence of the parameter $D''(t)$ on time has been established in a series of remarkable works by the American astronomer R. Newton [9], [10], [13], who calculated 12 values of the parameter D'' on the basis of the investigation of 370 observations of ancient and medieval eclipses, extracted from historical sources ([11], p. 113). In computing the date $t_{\text{ecl.}}$ of the observation of a particular concrete eclipse, the parameter D'' can be neglected. Therefore, it can, in turn, be found from the distribution of ancient eclipse dates $t_{\text{ecl.}}$, which is *a priori* regarded as known. In R. Newton's papers [9], [10], [11], [13], the computation of D'' was based on the dates of ancient eclipses contained in the chronological canons of F. Ginzel and T. Oppolzer [8], [12]. They are generally accepted in the contemporary literature. The results of Newton, related to those of Martin, who studied about 2,000 telescopic observations of the moon from 1627 to 1860, allowed him to construct an experimental curve for $D''(t)$ in the interval from 900 B.C. to A.D. 1900. In the following, we will sometimes designate A.D. by "+", and B.C. by "−". In Fig. 6, the symbol • indicates the values of the parameter D'' calculated by means of solar eclipse data, while ◊ denotes those of D'' which were computed from the lunar eclipse durations fixed in the documents. The sign Δ implies the values of D'' calculated on the basis of information regarding the duration of solar eclipses. Finally, ∇ indicates the values of D'' computed from the phases of solar eclipses (see [11]).

Commenting upon the graph of D'' obtained, Newton wrote:

> "D'' has had surprisingly large values and ... it has undergone large and sudden changes within the past 2000 years ... " ([11], pp. 114–115).

---

[1] First published as an article in *Operations Research and ACS*, Vol. 20, Kiev University Press, Kiev, 1982, pp. 98–113 (in Russian).

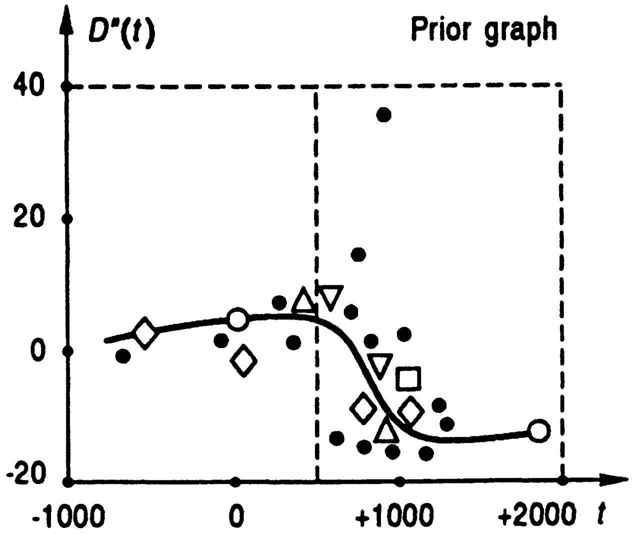


Figure 6. Experimental curve for $D''(t)$ in the interval from 900 B.C. to A.D. 1900 (R. Newton).

Newton's paper "Astronomical evidence concerning non-gravitational forces in the Earth–Moon system" [9] was also devoted to the attempts to explain this strange gap (one-order jump) in the parameter D''.

Thus, on the basis of Newton's works [9]–[11], we can make the following conclusions.

(1) In the interval A.D. 400–600, the parameter D'' starts falling sharply (one-order jump).

(2) Before this interval, until A.D. 300-400, the values of D'' do not deviate much from zero.

(3) Starting with about A.D. 1000, the values of D'' are close to those of today; in particular, they are practically constant.

(4) In the interval 6000 B.C. to A.D. 1000, the parameter D'' undergoes considerable variance, with the oscillation amplitude reaching up to $60''/\text{century}^2$.

Hereafter, the bounds of the time intervals indicated are approximate. Newton writes that D'' "has even changed its sign near about A.D. 800" ([11], p. 115).

In the following, we shall point out two bounds in the behaviour of the graph D'', the first of them being about A.D. 500 (the beginning of the square wave on the graph), and the other one about A.D. 1000 (the end of the square wave).

In the present section, we give the results of a new interpretation and calculations of the graph of D'', based on the dates of astronomical observational data made precise, which form the basis for computing the parameter D''. The curve of $\bar{D}''$ which we obtained has qualitatively different character. In particular, the incomprehensible one-order gap of the graph completely vanishes. As it turns out, the new graph of $\bar{D}''$ is, in reality, oscillating around a constant numerical value which coincides with the modern one. As a corollary, the necessity to invent "nongravitational forces" for the explanation of the "gap" in the graph becomes unnecessary.

2.2. Available observations of ancient solar and lunar eclipses

Let X be the set of all available observations of ancient solar and lunar eclipses. Their complete list has been given by F. Ginzel ([8], pp. 167–271). Let A be the set of all eclipses described in the ancient texts X. We have to bear in mind that the same eclipse may be described in several ancient texts. We denote them by $X_{\text{ecl.}}$. Let $t_{\text{ecl.}}$ be the date ascribed to a particular eclipse in accordance with the traditional chronology. These traditional dates have been fixed in the papers of F. Ginzel and T. Oppolzer [8], [12]. They all form a basis for the computation of $D''(t)$. In computing $D''(t_{\text{ecl.}})$ (i.e., at a point $t_{\text{ecl.}}$ on the time axis t), the theoretical, calculated characteristics of an eclipse, obtained for the date $t_{\text{ecl.}}$ on the basis of modern lunar theory, are compared with the description of the eclipse, portrayed by the ancient sources $X_{\text{ecl.}}$. The deviation between these two groups of data is exactly what permits us to find the value of the parameter D'' at the moment $t_{\text{ecl.}}$. This value of D'' certainly depends on the choice of the eclipse date, and only those ancient texts are important which contain sufficiently much information about it, e.g., the description of the trajectory, phase, and so on. The analysis of all the ancient texts available (see F. Ginzel [8]) permitted us to distinguish a list of sufficiently complete descriptions of eclipses. We do not have the space to give it here. All our computations in the following are related just to these eclipses.

Newton's attempts to explain the mysterious square wave of the function $D''(t)$ do not touch upon the problem of the precision and correctness of the dates ascribed to the ancient and medieval eclipses by traditional chronology [8], [12]. In other words, the question as to how well the descriptive parameters of an eclipse, fixed in an ancient text, correspond to the calculated eclipse parameters found for the moment $t_{\text{ecl.}}$ on the basis of lunar theory, was addressed, with $t_{\text{ecl.}}$ meaning here the date ascribed by traditional chronology [8], [12]. The dating and the description of a given eclipse can be regarded as correct only in the case where the two groups of characteristics, i.e., calculated and fixed in a historical source, coincide. Note that changing the dates of the eclipses will alter the graph of D''.

The relation between the problem of calculating the parameter D'' and the known investigations of N.A. Morozov [2] was indicated for the first time in the author's paper [4], which, in particular, touched upon the problem of correctly dating ancient eclipses and their descriptions. On the basis of the analysis of considerable factual data, Morozov suggested and partly substantiated his fundamental conjecture that the traditional chronology of the ancient world might be artificially extended in comparison with the real situation. An important role in forming this conjecture was played by the method of astronomical dating.

The descriptions of eclipses from certain ancient texts started to be employed for dating these sources and related events as early as the 16th century. However, the method was applied only for the purpose of obtaining the dates in a somewhat more precise and, usually, quite narrow, prescribed time interval where traditional chronology placed them and the simultaneous eclipse under investigation.

2.3. A method of formal astronomical dating

In paper [2], a method of formal astronomical dating was suggested, consisting of the extraction of the eclipse's descriptive characteristics from a historical text, and then purely mechanically recording all dates of the eclipses with these characteristics from the modern astronomical tables. The recalculation of the ancient eclipse data was performed just by this method in the indicated work, with the dates traditionally being ascribed to the time interval from 700 B.C. to A.D. 400. For the purpose of computing the parameter D'', I carried out a new series of calculations of the ancient and medieval eclipse dates, thus confirming, in particular, the effect of shifting the dates of ancient eclipses forwards from 700 B.C. to A.D. 400 ([2]; [4]; see below).

We now describe the method of formal astronomical dating in more detail. The papers of Ginzel and Oppolzer [8], [12] supply a list of 89 ancient eclipses and indicate the ancient texts which reported them. The latter are usually (traditionally) dated to have occurred in the interval from 700 B.C. to A.D. 592. A list of the eclipses' descriptive characteristics extracted from an ancient text can be complete to varying degrees. For example, the moment of an eclipse during an entire day can be indicated, but not its phase, and so forth. Besides, the canons of Ginzel and Oppolzer contain the complete and theoretically calculated list of eclipses occurring from 900 B.C. to A.D. 1582, with the basic characteristics including the date and phase of an eclipse, the umbra coordinates, and so on. The problem of dating an eclipse described by an ancient text (and, therefore, that of the accompanying events) is solved as follows. We take the eclipses from the canons [8], [12], all of whose calculated characteristics exactly coincide with those in a historical source. At the same time, it is required that (1) there should be no deviation from the description in the document, and (2) the time interval in which the astronomical solution is sought should not be bounded. This means that we do neglect the *a priori* outside information of "nonastronomical origin".

Analysis shows that requirements (1) and (2) are not fulfilled in the classical works [8] and [12] in the overwhelming majority of cases: The date of an eclipse is usually sought there not in the possible whole historical time interval, *but only within narrow prescribed limits* (normally, one century) in which, according to earlier chronological tradition, an approximate date of the event studied (and, therefore, of the eclipse) was pre-established.

The application of the method of formal astronomical dating to eclipses traditionally dating from 700 B.C. to A.D. 400 [2], [4] shows that the written evidence concerning them can be separated into two classes.

(1) *Short and vague evidence* (*without any details*). Here, it is often unclear whether the text describes an eclipse at all. In this class, the astronomical dating of written evidence is either senseless or allows for so many possible astronomical solutions that they all fall into practically any of the prescribed historical epochs.

(2) *Detailed evidence.* In this class, an astronomical solution often turns out to be unambiguous (or there are two or three solutions).

2.4. The effect of shifting the dates of eclipses forwards

One important fact discovered in [2] is that all the eclipses of the second class are not dated by the formal astronomical approach traditionally as, for example, in [8] and [12], by 700 B.C. to A.D. 400, but *substantially later*. These dates sometimes differ from the traditional ones by several centuries. Meanwhile, these new astronomical solutions (dates) fall into the time interval from A.D. 400 to 1600. The forceful distortion of the dates, made by the earlier chronologists, and fixed in the classical papers [8] and [12], is due to the pressure of chronological tradition. The astronomers had to look for the required astronomical solutions only within a narrow, prescribed time interval. More than that, in most cases, an exact astronomical solution could not be found, and the astronomers had to exhibit an eclipse only partly satisfying the description contained in the ancient document (see the examples below). In making use of the method of formal astronomical dating, this deviation (strained solution) vanishes, which leads to the appearance of new astronomical solutions (dates), although different from the traditional ones.

Continuing the investigations started in [2], the author has also analyzed the medieval eclipses from A.D. 400 to 1600 on the basis of formal astronomical dating methods. It turned out that the effect of shifting the eclipse dates forwards, which had been discovered in the above-mentioned paper only for ancient eclipses, could be extended also to the eclipses traditionally dated as belonging to the interval A.D. 400–900. In particular, many pieces of written evidence (due to the extreme vagueness of their formulations) proved to admit a large spectrum of astronomical solutions distributed over the entire possible period of history. It is only beginning with about A.D. 900, and not A.D. 400, as was suggested originally [2], that the traditional eclipse dates become satisfactorily consistent with the results of the application of the formal astronomical dating method. Finally, this consistency becomes reliable only after about A.D. 1300.

This result agrees with the theory of empirical corrections employed in ([8], pp. 4–6), to revise the formulas for the calculation of eclipse dates. Thus, as 21 "basic eclipses" receiving detailed descriptions in at least 10 ancient texts, we can take those dated to the right of (later than) A.D. 840 (42 reports) and distributed in the interval up to A.D. 1386 [8]. On the other hand, we recall that it is since A.D. 1300 ([12], p. 114) that the graph of parameter D'' has finally been stabilized and aligned. Thus, this moment of the graph's stabilization coincides with the origin of the interval of reliable consistency of the dates of ancient eclipses and with the results of the application of the formal astronomical dating method. An extremely small number of the dates of eclipses in the time interval from A.D. 400 to 900 we discovered and which do not contradict the formal astronomical dating method, is of little importance statistically. At any rate, this is true from the standpoint of the new computation of the graph of D''.

Before stating the results of the new computations of the graph of D'', we shall dwell at length on the effect of shifting the dates of ancient eclipses in the Middle Ages. Above, we have indicated the difficulties facing the astronomers in dating many of the eclipses traditionally. They were caused by the requirement of traditional chronology to place the dates of eclipses in a narrow, prescribed time interval. The formal astronomical dating method removes these obstacles. Because of considerable factual material, we give here only a short summary, the final results, and typical examples.

2.5. An example: three eclipses of Thucydides

Example 1. Consider the three famous eclipses of Thucydides (the so-called triad; see [8], pp. 176–179, eclipses 6, 8, 9). They are linked into one triad by their having been described in one historical text, namely the *History of the Peloponnesian War* (Bks. II, 27–28; IV, 51–52; VII, 18–19, 50). The descriptive characteristics of the triad, which are extracted from Thucydides' text unambiguously, are of the following form.

(1) All three eclipses were observed in the Mediterranean region, namely, in a square approximately bounded by the longitudes 15° E. and 30° E. and the latitudes 30° N. and 42° N.

(2) The first eclipse was solar.

(3) The second eclipse was solar.

(4) The third eclipse was lunar.

(5) The time interval between the first and second eclipses was 7 years.

(6) The time interval between the second and third eclipses was 11 years.

(7) The first eclipse occurred in summer.

(8) The first (solar) eclipse was total (since "the stars were visible"), i.e., its phase Φ is 12″.

(9) The first eclipse occurred in the afternoon (local time).

(10) The second (solar) eclipse occurred at the beginning of summer.

(11) The third (lunar) eclipse occurred at the end of summer.

(12) The second eclipse occurred approximately in March.

Condition 12 is not clearly determined from Thucydides' text and, therefore, is not included in the final list of conditions.

The problem arises to find a triad of eclipses completely satisfying all conditions 1–11. Work [8] gives the traditional astronomical solution, namely, 431, 424, and 413 B.C. However, as has been known long ago, it does not satisfy all the data of the problem. As a matter of fact, the eclipse of 431 B.C. was not total as required by condition 8. It was only annular with phase 10″ for the observation zone and could not be observed as total anywhere on the earth's surface ([8], pp. 176–177). This important circumstance was noted by many authors, e.g., J. Zech, E. Heis, N. Struyck, G. Riccioli, F. Ginzel, and I. Hoffman [8]. A considerable number of astronomical papers were devoted to the recalculation of the phase Φ of the eclipse of 431 B.C., for which various admissible corrections were introduced into the equations of the lunar theory in order to make the phase close to 12″. Thus, Dionysius Petavius obtained $\Phi = 10''25$ for the observation zone, Struyck 11″ ([8], p. 176), Zech 10″38 [14], Hoffman 10″72 ([8], p. 176), and Heis even 7″9(!) ([8], p. 176). In the modern literature, the phase value is assumed to be 10″ [8]. We stress once again that, due to its annular form, the first eclipse in 431 B.C. was total nowhere on earth for any latitude and longitude. Accordingly, Ginzel wrote[2]:

> "The insignificance of the eclipse phase was somewhat shocking. ... According to the new calculations, the phase was equal to 10″. ... " [8].

Besides, certain other conditions were not fulfilled either. For example, the umbra passed through the observation zone only after 17 hours local time, and even after 18 hours according to Heis [8], which means that condition 9 (the eclipse occurring in the afternoon) is satisfied only approximately.

Certain authors ([8]; see the survey) carried out the calculation of the coordinates of bright planets, thinking that they could have been seen during the annular eclipse, in order to satisfy the important condition 8. However, the obtained results showed clearly that the planets' positions on the celestial sphere during the eclipse of 431 B.C. did not provide for their reliable visibility. If Venus could have been visible, then, for example, Mars was only 3° over the horizon (Heis's computation), while Jupiter and Saturn were below the horizon, and so forth ([8], p. 177). Johnson suggested another astronomical solution for Thucydides' first eclipse, namely, 433 B.C. Although it soon became clear that this solution still did not satisfy the data of the problem posed, it was now for other reasons [8]. Besides, this eclipse had a short phase, namely, 7″8 [8].

The largest variation possible of certain constants in the lunar equations, with the purpose to increase the phase of the eclipse in 431 B.C., was made by Stockwell. However, it yielded only 11″06 for the observation zone, which did not account for the completeness of the eclipse either. The computations were questioned in the literature, too [8].

In this connection, an attempt to revise Thucydides' text itself, and, in particular, condition 8, should be noted also. However, its detailed analysis carried out at the author's request by E.V. Alexeeva (Faculty of Philology, Moscow University) showed that the eclipse characteristics were unambiguously determined from Thucydides. This circumstance had not been questioned earlier, though.

---

[2]Translated from the German (*tr.*)

No other astronomical solutions in 600–200 B.C., which would be more suitable than the traditional solution of 431, 424, 413 B.C., seem to have been found. It is because of this fact that this incorrect "solution" has been retained in spite of the above contradiction repeatedly discussed in the literature.

Meanwhile, the application of the formal astronomical dating method and the extension of the search interval (for astronomical solutions) to 900 B.C.–A.D. 1600 yield two and only two exact solutions, the first having been given in paper [2] (Vol. 4, pp. 509, 493–512), while the second one was given by the author of the present work during the repeated analysis of all the eclipses from the indicated interval and the construction of their trajectories on the diagram.

Thus the first solution yields August 2, 1133, March 20, 1140, and August 28, 1151, whereas the second is August 22, 1039, April 9, 1046, and September 15, 1057. Note that the fact of the availability of *exact* solutions itself is nontrivial. In both exact solutions found, even condition 12 is fulfilled, the one not originally included in the list of basic data. Besides, the first eclipse is total in both solutions (for the observation zone), which is just what was required by condition 8.

2.6. An example: the eclipse described by Livy

Example 2. Consider eclipse 25 (see [8], pp. 189–190) described in the *History of Rome* by Livy (Bk. XXXVII, 4.4). The characteristics extracted from Livy's text are as follows.

(1) The eclipse was solar.

(2) It occurred 5 days earlier than the ides of July, i.e., on July 10.

(3) The approximate coordinates of its observation zone were $30° \leq$ lat. N. $\leq 45°$ and $10° \leq$ long. E. $\leq 25°$.

(4) In the observation zone, the moon's trajectory passed below the centre of the sun during the eclipse if the moon and sun were projected on the celestial sphere.

The traditional solution suggested in Ginzel's canon [8] was March 14, 190 B.C. However, since condition 2 was not fulfilled, the astronomers also offered other astronomical solutions, e.g., July 17, 188 B.C. But the conditions of the problem posed were not satisfied in this case either ([8], p. 190). Owing to the absence of other astronomical solutions for the time interval 300–100 B.C., determined beforehand due to the *a priori* requirements of tradition, and which would satisfy conditions 1–4 better, the traditional one of 190 B.C. was retained in the canon.

Meanwhile, the application of the formal astronomical dating method and extension of the interval in which an exact solution was being sought to the periods from 600 B.C. to A.D. 1600 permits us to reach the following conclusion [2].

(1) As it turns out, there is an eclipse fully satisfying all the conditions of the problem.

(2) This exact solution is unique for the interval from 600 B.C. to A.D. 1600.

(3) It is July 10, A.D. 967.

(4) It is stable with respect to a small perturbation of the initial data, namely a perturbation of the principal condition 2, which means that it remains unique in extending the search interval from July 10 to July 9 and 11, i.e., by one day. This exact solution was found in [2], assuming, naturally, that the Julian names of the months correspond to the Julian calendar.

2.7. An example: the eclipse described by Livy and Plutarch

Example 3. Consider the list of descriptive characteristics of eclipse 27 (see [8], p. 190) also described in Livy's *History of Rome*, Bk. LIV, 36.1. See also Plutarch's *Vitae Aemilius Paulus*, 17.

(1) The eclipse was lunar.

(2) It occurred on the night of September 4 to September 5.

(3) The observation zone was bounded by lat. 40° and 50° N, and long. 10° and 25° E.

(4) It occurred from 2 to 4 A.M. local time.

(5) Its phase was close to 12″, and possibly exceeded 12″.

Remark. The phase of a solar eclipse is found by the formula $\Phi = 12\lambda$, where λ is the ratio of the part of the sun's diameter, covered by the moon at the eclipse's maximum, to the whole diameter. However, in the case of a supertotal lunar eclipse, a quantity proportional to its duration is added to the phase of 12″ (the moon stays in the shadow of the earth for a long time). Hence, the phase of a lunar eclipse can reach 22″7.

(6) This lunar eclipse occurred after the summer solstice.

The traditional solution given in the canon ([8], p. 190) is June 21, 168 B.C. This does not satisfy conditions 2 and 6 of our problem. Attempts of many authors to find a better astronomical solution for the interval from 300 to 100 B.C., determined *a priori* from the requirements of tradition, did not lead to positive results. Omitting the details, we should note that the situation is perfectly similar to the one described in Examples 1 and 2.

Application of the formal astronomical dating method and extension of the search time interval from 600 B.C. to A.D. 1600 permit us to draw the following conclusions [2].

(1) There exist exact astronomical solutions fully satisfying all conditions 1–6.

(2) There are only three exact solutions for the time interval from 600 B.C. to A.D. 1600.

(3) These solutions are (a) the night of September 4 to September 5, A.D. 415, (b) the night of September 4 to September 5, A.D. 955, and (c) the night of September 4 to September 5, A.D 1020 ([2], Vol. 5, pp. 266–272).

(4) For a small perturbation of the initial data, i.e., while considering lunar eclipses occurring not only at night but also at sunset, there arises only one more possible solution, (d) the night of September 4 to Septemer 5, A.D. 434.

Yet another solution is theoretically possible, namely, the lunar eclipse of September 4 to September 5, 106 B.C.; however, it possesses the phase 5″9, which is far too small. If we select those with greatest phases from the above astronomical solutions (see condition 5 of the problem), then two of them are ideally suitable, namely the eclipse of A.D. 955 with the phase of 16″1 and that of A.D. 1020 with the phase of 18″7, the latter being still more adequate than the former.

Upon further perturbation of the initial data of the problem, namely, also considering the night of September 3 to September 4, four other new astronomical solutions present themselves; however, they all relate to the medieval period, occurring in A.D. 453, 936, 1457, and 1476. A perturbation of the initial data in the other direction, namely, considering the night of September 5 to September 6, is impossible, which follows from Livy's text.

2.8. An example: the evangelical eclipse described in the New Testament in connection with the Crucifixion

Example 4. Let us consider the characteristics of lunar eclipse 36 (see [8], pp. 200–201) described in the New Testament, i.e., the so-called evangelical eclipse (Mt 27:45, Mk 15:33, Lk 23:44–45).

(1) The eclipse was lunar.

(2) It was related to the spring equinox or occurred on the eve of Passover (Jn 19:14, 19:30–34). For the present, we do not distinguish between Easter and Passover.

(3) It occurred on Friday during Passover (Jn 19:14, Mt 27:62).

(4) It lasted for about three hours (Mk 15:33–34).

(5) It lasted from 0 A.M. to 3 A.M. according to the modern count of hours. This condition is sometimes questioned in the chronological literature; however, there are valid reasons to believe that the eclipse started approximately at midnight (see [2]).

The traditional solution given in [8] is April 3, A.D. 33 (the date of the crucifixion). However, just like in the above examples, this solution does not satisfy the data of our problem. Namely, although conditions 1, 2, and 3 are fulfilled (the eclipse occurs on the eve of Passover), conditions 4 and 5 are not. In particular, the phase of this eclipse (for the observation zone, i.e., Jerusalem) is so small that it could have been observed only for several minutes as the umbra was already sliding off the rim of the lunar disc.

In spite of the quite controversial descriptive characteristics of this lunar eclipse and the conjecture of some medieval authors and annalists, such as Synkellos, Phlegon, Africanus, and Eusebius, that it had in reality been solar (Lk 23:45), we can, nevertheless, endeavor to apply the formal astronomical dating method. We obtain (see [2]) that the above problem does have at least one solution.

(1) In the time interval from 200 B.C. to A.D. 800, there really exists a lunar eclipse satisfying conditions 1–5.

(2) In the time interval from 200 B.C. to A.D. 800, this astronomical solution is unique.

(3) The solution is March 21, A.D. 368. The (supertotal) eclipse phase is large and equals 13″3.

It should be noted that the calculations with the purpose of discovering a suitable lunar eclipse were made in the interval only up to A.D. 800 [2]. As a matter of fact, Morozov believed that the related historical events (the crucifixion) could not have occurred later than A.D. 800 ([2], Vol. 1, p. 97). Without imposing this restriction *a priori*, we extended the calculations along the time axis to embrace the whole interval up to A.D. 1600.

The author has therefore found only one more possible astronomical solution of the problem: *the eclipse of April 3, A.D. 1075.* There are no other solutions. The eclipse of A.D. 1075 did occur on Friday on the eve of Passover, which was on April 5, 1075. However, its phase was small, $\Phi = 4''8$. The moment when half of the period of the eclipse elapsed was at 23 hours and 18 minutes GMT, which means, in particular, that, in the latitude of Rome, for example, it occurred at about midnight. The coordinates of the zenith were lat. 10° N and long. 8° W. Its date (April 3) coincides with the canonical one of the evangelical eclipse (see, e.g., [8], p. 200). The date April 3 is regarded as canonical and traditional. Besides, the lunar eclipse of A.D. 1075 occurred precisely on the eve of Passover, which is consistent with the requirements of the tradition that assumes that the crucifixion occurred on the eve of Passover. Recall that the traditional astronomical solution of April 3, A.D. 33, is also two days prior to Passover, which occurred on April 5, A.D. 33.

2.9. The oscillation of a new graph of D'' about one and the same value. No nongravitational theories are necessary

We now list certain results. If $t^{\text{new}}_{\text{ecl.}}$ denotes the date of an eclipse obtained by the formal astronomical dating method, and $t^{\text{old}}_{\text{ecl.}}$ is the traditional date given, e.g., in the canons of Ginzel and Oppolzer [8], [12], then we obtain the following result. As it turns out, for all the eclipses of the second class (i.e., those thoroughly described in ancient texts), the following important inequality is valid, namely,

$$t^{\text{old}}_{\text{ecl.}} > t^{\text{new}}_{\text{ecl.}}.$$

Moreover, this shifting of the dates of ancient eclipses of the second class forwards in time (see above) is carried out in the following uniform manner. All eclipses of the second class traditionally dated in the interval from 900 B.C. to A.D. 400, turn out to be mechanically shifted further ahead than A.D. 400 into the Middle Ages. It happens that the percentage of eclipses of the first class (inaccurately and vaguely described in the sources) is extremely high from A.D. 400 to 900. The dates of such eclipses are either almost incalculable by astronomical means due to the imprecision of written evidence about them or are shifted forwards again. Starting with A.D. 900, the new dates $t^{\text{new}}_{\text{ecl.}}$ are satisfactorily consistent with $t^{\text{old}}_{\text{ecl.}}$. Only beginning with A.D. 1300 does this correlation get quite reliable. The complete picture of shifting the dates of ancient eclipses forwards on the time axis turns out to be rather confusing and complicated because of the nonuniqueness of astronomical solutions. Nevertheless, it obeys a certain law which we shall describe below.

Recall that the behaviour of the graph of $D''(t)$, computed by R. Newton on the basis of the prior eclipse dates $t^{\text{old}}_{\text{ecl.}}$, also makes it possible to naturally distinguish certain time intervals characterized by an essentially different behaviour of the parameter D'' on the time axis. Remember that the values of D'' oscillate about zero (though very few of them have been computed) earlier than A.D. 400. Then, in the time interval A.D. 400–1000, a considerable chaotic variance of the parameter values is noticeable. Finally, since A.D. 1000 (and still more since A.D. 1300), the values of D'' are already close to those known today. Thus, we obtain one important conclusion. It turns out that the time limits discovered for the behaviour of $D''(t)$ almost coincide with the characterization of different shifts of the dates of ancient eclipses forwards on the time axis. This indicates a possible relation between the two important effects, namely, (1) the square wave in the behaviour of D'' and (2) the shift of the dates of ancient eclipses forwards due to the application of the formal astronomical dating method.

Let us ascribe to each ancient eclipse from historical sources its new date $t^{\text{new}}_{\text{ecl.}}$ calculated by the formal astronomical dating method. The recalculation of the values of parameter D'' on the basis of these new dates, which I carried out in [4], is shown in Fig. 7.

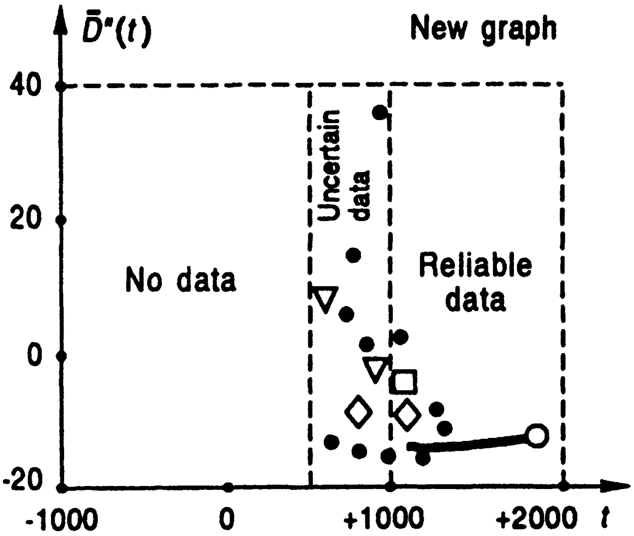


Figure 7. New curve for $D''(t)$ in the interval from 900 B.C. to A.D. 1900 (A.T. Fomenko).

We see that the replacement of the date $t^{\text{old}}_{\text{ecl.}}$ by $t^{\text{new}}_{\text{ecl.}}$ not only shifts the historical events and texts describing the eclipses forwards in time, but also, in most cases, leads to the identification of "former eclipses" (previously regarded as ancient) with medieval ones known from other sources. Moreover, the "ancient eclipses" overlap with the medieval ones, many of which were used by R. Newton for the computation of the former graph of D'' for the period from A.D. 400 to 1900, thus adding new texts previously treated as antique and traditionally dated as older to the formerly medieval one, with information about medieval eclipses being used to determine the "medieval part" of the graph of D''. Therefore, we now have to take into account these new additional data (characteristics of eclipses) which earlier were ascribed to other, presumably ancient eclipses in recalculating the medieval part of the graph of D''. *A priori*, such an extension of the list of descriptive characteristics of certain medieval eclipses could have led to a contradiction with their characteristics known earlier from medieval texts, and, in particular, to a change of the formerly medieval values of $D''(t)$ from A.D. 400 to 1900. However, the detailed investigation of all descriptive characteristics, both old and new, has shown that the formerly medieval values of D'' from A.D. 400 to 1900 are almost unaltered.

Based on this result, we can make the following conclusions: The new curve of $\bar{D}''$ from A.D. 400 to 1900 practically coincides with the former. From 900 B.C. to A.D. 400, the new curve of $\bar{D}''$ is simply undetermined, since no reliable eclipse dates $t_{\text{ecl.}}^{\text{new}}$ exist for this time period.

The new graph of $\bar{D}''$ is qualitatively different from the former. We see that $\bar{D}''$ varies along a smooth and nearly constant curve (horizontal in Fig. 7) which oscillates about one and the same value $-18''/\text{century}^2$ from A.D. 900 to 1900. The parameter $\bar{D}''$ undergoes no sharp change. It invariably retains approximately the modern value. No nongravitational theories of the type suggested in [9] are therefore necessary. It is interesting that the variance of the values of $\bar{D}''$, quite insignificant from A.D. 900 to 1900, gradually increases in shifting to the left from A.D. 900 to A.D. 400. In our opinion, this fact indicates the vagueness and insufficiency of the observational data contained in ancient historical texts describing this period. Then (see Fig. 7), to the left of A.D. 400, the zone starts where reliable observational data (which may have survived to the present day) are absent, which reflects the natural distribution in time of astronomical observational data supplied by the ancient chroniclers. Apparently, the exactness of observational data and textual descriptions from A.D. 400 to 1000 was extremely low. The precision of observations and descriptions started to improve afterwards as the technology and the instruments improved and became more sophisticated, which is reflected by the gradual decrease in the variance of the values of $\bar{D}''$. Finally, in the era of developed astronomy, we see that the curve of $\bar{D}''$ is all but aligned, and stable from A.D. 900 to 1900.

All the previous results show that the dates of ancient eclipses are shifted forwards in their redating, with the magnitude of the shifts being expressed by the positive quantities $t_{\text{ecl.}}^{\text{new}} - t_{\text{ecl.}}^{\text{old}}$.

2.10. Three rigid "astronomical shifts" of ancient eclipses

We see that, for different eclipse groups previously regarded as ancient, the values of the shifts forwards are much different, which leads to a great confusion in the general picture of redating ancient eclipses. Nevertheless, it so happens that the system of redating and shifting the dates forwards in time, which appears rather chaotic at first glance, allows the derivation of an important regularity, discovered by the author. This law completely agrees with the system of the three rigid chronological shifts in ancient history, discovered by the author in [5] on the basis of quite different statistical investigations (of nonastronomical character), which we shall not define here due to lack of space. However, we formulate only the final result, while referring the reader to the aforementioned work.

Consider the historical time interval from 1600 B.C. to A.D. 1700. Cover it with a system of line-segments denoted arbitrarily by the letters K, H, П, C, T. Placed on the time axis, they are of different length, and the same letter, or interval, can be repeated several times. Moreover, different intervals designated differently can overlap one another, in which case we will denote the letters of the overlapping intervals by "fractions". In Fig. 8, they are represented for better visualization by different geometrical symbols such as rectangles, triangles, and trapezia. The covering of the obtained time axis will be referred to as the global chronological diagram (GCD). It has the following form:

$$\mathrm{GCD} = T\ \ K\ \ T\ \ H\ \ T\ \ T\ \ \frac{K}{P}\ \ T\ \ \frac{H}{C}\ \ T\ \ \frac{K}{P}\ \ T\ \ T\ \ \frac{\frac{K}{\Pi}}{\frac{C}{P}}\ \ T\ \ \frac{H}{\frac{\Pi}{P}}\ \ T\ \ T\ \ \frac{PT}{C}\ \ C$$

We will also indicate the end-(boundary-)points of all these intervals, for which we rewrite the chronicle line in the GCD, marking the dates of the beginning and end of each epoch interval. For example, the symbol 1570 T 1550 means that the given copy of the epoch interval T starts in 1570 B.C. and ends in 1550 B.C. If the left-hand number is greater than the right-hand one, then we mean the years B.C.; otherwise, the years A.D. are meant. Thus, we have:

$$\begin{aligned}\mathrm{GCD} = {} & 1570\ T\ 1550,\ 1460\ K\ 1240\ T\ 1226\ H\ 850\ T\ 830,\ 760\ T\ 753\ \frac{K}{P}\ 523, \\ & 523\ T\ 509\ \frac{H}{500\ C\ 250}\ 82\ T\ 27\ \frac{27\ \text{B.C.}\ K\ 217\ \text{A.D.}}{82\ \text{B.C.}\ P\ 217\ \text{A.D.}}\ 217\ T\ 251, \\ & 270\ T\ 306\ \frac{\frac{306\ K\ 526}{333\ \Pi\ 526}\ 526\ T\ 552}{240\ \frac{C}{P}\ 580}\ \frac{\frac{552\ H\ 915}{681\ \Pi\ 887}}{650\ P\ 900}\ 915\ T\ 925,\ 932\ T\ 954, \\ & 962\ \frac{962\ P\ 1254\ T\ 1273}{950\ C\ 1300}\ 1273\ C\ 1619.\end{aligned}$$

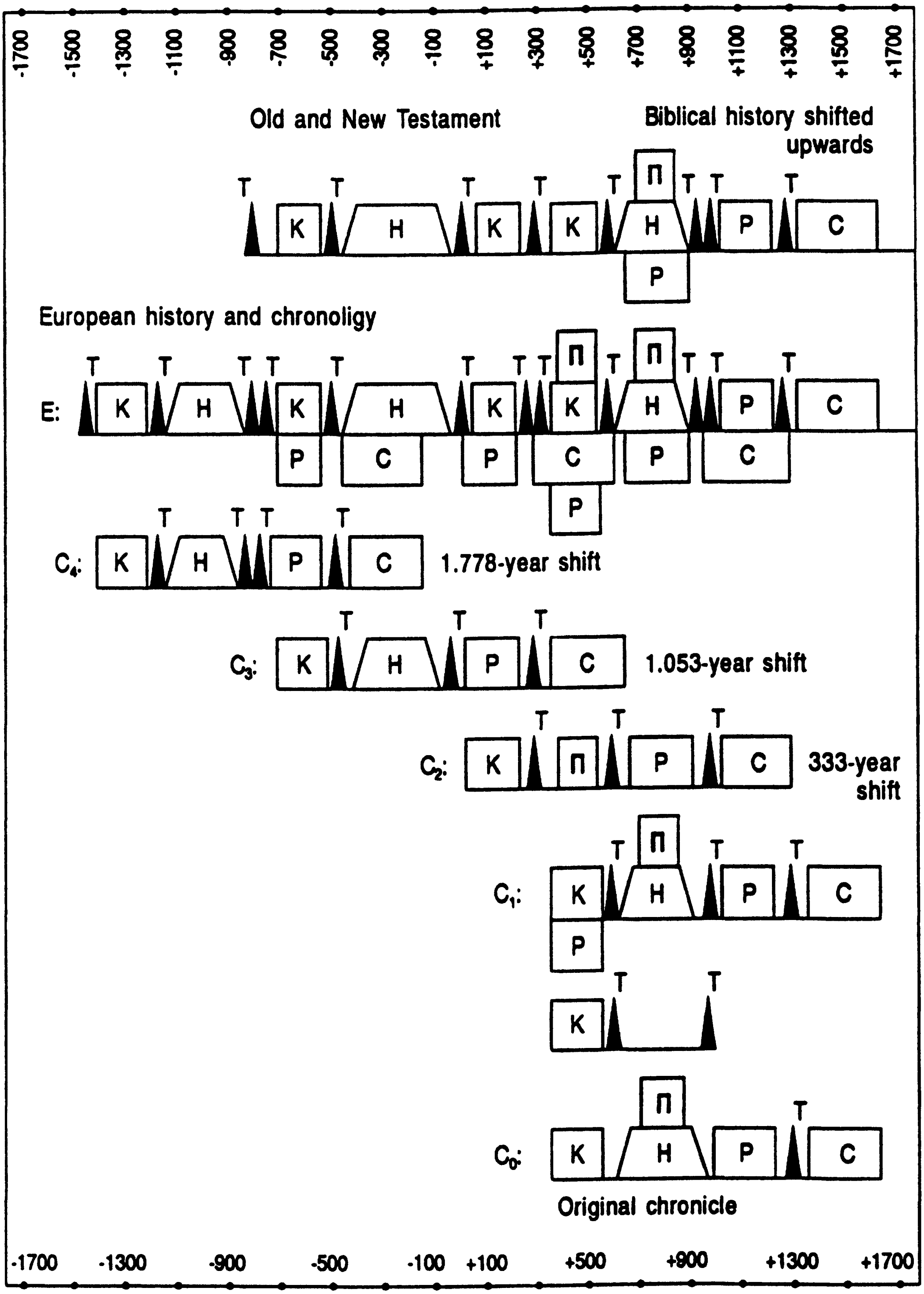


Figure 8. Statistical duplicates in European history and biblical history (shifted forwards). Three chronological shifts.

-1570	-1550	-1240	-1236	-850	-830	-753	-523	-509	-82	-27	+217	+251	+306	+526	+552	+900	+925	+954	+1254	+1273	+1619	
	T	K	T	H	T	T	K – P	T	H – C	T	K – P	T	T	K – П – C – P	T	H – П – P	T	T	P – C	T	C	
		K	T	H	T	T	P	T	C													C_4
1.778-year shift							K	T	H	T	P		T	C								C_3
1.053-year shift											K	T		П	T	P		T	C			C_2
333-year shift														K – P	T	H – П	T		P	T	C	C_1
														P	T		T					C'
Different letters represents different periods														K		H – П			P	T	C	C_0

Figure 9(1). Formal decomposition of the "modern textbook" of ancient history into the sum of four "isomorphic fibres".

The identical letters indicate the epoch duplicates. For example, the epoch 500 C 250 duplicates 950 C 1300. The GCD resolves into the composition of the three rigid shifts shown in Fig. 9(1). By adding the horizontal lines vertically (i.e., by superimposing them) and by identifying the same letters placed over each other in the same column, we obviously obtain the complete GCD. Thus, we can write symbolically that the GCD $= C_1 + C_2 + C_3 + C_4$, where the chronicle line C_1 equals $C_0 + C'$. All four chronicle lines C_1, C_2, C_3, and C_4 are almost indistinguishable, i.e., they consist of the same sequences of letters. The chronicle C_2 is meanwhile glued to C_1 with a backward shift of about 333 years, C_3 to $C_1 + C_2$ with a backward shift of approximately 1,053 years, and C_4 to $C_1 + C_2 + C_3$ with a backward shift about 1,778 years in length. All three basic rigid shifts are counted from one and the same point (Fig. 7).

We obtain that the three chronological shifts discovered on the basis of statistical methods of nonastronomical character (see the author's paper [5]) manifest themselves also in a rather complicated picture of a forward shift of the revised ancient eclipse dates. It should be noted, as can be seen in the above examples, that for many ancient eclipses, there usually exist several different astronomical solutions, all "enjoying equal rights". Hence, it is apparent that the inverse problem, namely restoration of the three chronological shifts on the GCD based only on astronomical data, cannot be solved reliably today.

2.11. The complete picture of astronomical shifts

We can now outline the complete picture of shifting the redated ancient eclipse dates forwards.

If the traditional date of an eclipse $t^{\text{old}}_{\text{ecl.}}$ is represented by a point in the time interval from 1600 B.C. to A.D. 1700, then it will necessarily fall on one of the chronicle lines C_1, C_2, C_3, and C_4, which make up the GCD. C_4, C_3, and C_2 are moved forwards in the inverse shift by 1,778, 1,053, and 333 years, respectively. Meanwhile, they are again identified with the chronicle C_1 embracing the events from A.D. 300 to 1619. The following important statement turns out to be valid.

The forward shift of an astronomically redated eclipse by the quantity $t^{\text{new}}_{\text{ecl.}} - t^{\text{old}}_{\text{ecl.}}$ usually coincides with that of one of the chronicles C_2, C_3, and C_4 into which the date $t^{\text{old}}_{\text{ecl.}}$ fell originally. However, the value of $t^{\text{new}}_{\text{ecl.}} - t^{\text{old}}_{\text{ecl.}}$ sometimes coincides with the difference or sum of certain of the three basic chronological shifts. In other words, the astronomical and chronological shifts are consistent.

Thus, all the dates $t^{\text{old}}_{\text{ecl.}}$ of astronomically redated ancient eclipses are broken into certain groups, each of which is shifted forwards by about 1,778, 1,053, and 333 years, or their difference or sum. It is important that the relative position of the dates $t^{\text{old}}_{\text{ecl.}}$ inside each of these groups is then retained qualitatively and that the eclipses fall into the time interval A.D. 400–1800.

This shift of the dates of ancient eclipses can also be described thus: If an eclipse has fallen into some copy of the interval P on the GCD, then, redated astronomically, its new date $t^{\text{new}}_{\text{ecl.}}$ is shifted forwards and gets into one of the other replicas of P to the right of the traditional date $t^{\text{old}}_{\text{ecl.}}$. Further, it turns out that the majority of the dates of eclipses previously regarded as ancient are shifted into the time interval A.D. 800–1700 [5].

2.12. The coincidence of the astronomical shifts with the three basic chronological shifts in the global chronological diagram

We illustrate our statement regarding the coincidence of the astronomical shifts, arising in redating the eclipses, with the three basic chronological shifts on the GCD by several typical examples.

(1) The triad of eclipses described in Thucydides' *History of the Peloponnesian War* (see Example 1 above) is closely related to the historical events in ancient Greece, traditionally dated for about the 5th century B.C. [8], [12]. As we have noted, the first eclipse mentioned by Thucydides is placed by

traditional chronology according to the ancient sources at around 431 B.C. [8]. Redated astronomically, its date was shifted forwards, and the eclipse was identified (see the second astronomical solution in Example 1) with the medieval one of A.D. 1039. Therefore, the value of the astronomical forward shifts of the eclipse date is approximately equal to $1039 + 430 = 1469$ years, which is close to the difference of two basic chronological shifts on the GCD, namely, $1778 - 333 = 1445$ years.

(2) The lunar eclipse of Livy from Example 3 is closely related to the events in ancient Rome, which occurred, according to traditional chronology, in the middle of the 2nd century B.C. [8], [12]. Astronomically redated, it was also shifted forwards, and the eclipse was identified with the medieval one of A.D. 955, the first astronomical solution in Example 3. Thus, the astronomical shift forwards is approximately 1,100 years, which is close to the basic chronological shift on the GCD of 1,053 years. The shift makes the chronicle line C_3 coincident with C_1.

(3) The lunar eclipse of Example 4 (see above) is inseparably linked with the events (the crucifixion) occurring, according to the traditional chronology, in about A.D. 33 [8].

Astronomically redated, it was shifted forwards, too, and identified either with that of A.D. 368 or 1075. In the former case, the astronomical shift is 335 years, which all but exactly coincides with the basic chronological 333-year shift of the chronicle line C_2 on the GCD; in the latter, the shift forwards is about $1075 - 33 = 1042$ years long, which is close to the astronomical shift by 1,053 years.

We should not think that the three astronomical shifts discovered reflect any periodicity in the distribution of authentic eclipse dates belonging to the past. As a matter of fact, in case (1) in Example 1, the astronomically exactly calculated date is only $t_{\text{ecl.}}^{\text{new}}$, A.D. 1039. The first and traditional date of 431 B.C. is astronomically inexact and appears only under the pressure of chronological tradition, which *a priori* relates the historical events linked with Thucydides' eclipses to the 5th century B.C. However, the above date of 431 B.C. was obtained by the astronomers as the result of a forcibly strained calculation in order to satisfy the requirements of tradition [8].

§3. Traditional Chronology of the Flares of Stars and the Dating of Ancient Horoscopes

3.1. Ancient and medieval flares of stars. The star of Bethlehem

The important fact is that the three discovered chronological shifts on the GCD are very consistent with many other astronomical data not yet linked to the eclipses directly. For example, I have analyzed the traditional chronology of the flares of the so-called novae and supernovae. Let us list the flares of all such stars regarded as reliable in accordance with [3], [6]: 2296 and 2241 B.C., A.D. 185, 393, 668, 902, 1006, 1054, 1184, and 1230, and those of the 16th century (see Kepler's list). The so-called star of Bethlehem described in the New Testament (Mt 2:3), i.e., a flare occurring in about A.D. 1, is also usually added. The study of the astronomical situation in about A.D. 1 with the purpose of discovering the remains of this famous "star" was taken up, for example, by J. Kepler and L. Ideler (see [1], pp. 128–129). In the chronological shift backwards by 1,053 years (which corresponds to the superposition of the chronicle C_3 on $C_1 + C_2$), the time interval A.D. 962–1250 is placed on the time interval 91 B.C.–A.D. 197 (see the chart).

Ancient History from 91 B.C. to A.D. 197	Medieval History in A.D. 962–1250
The complete list of the flares of stars in this epoch, fixed in antique sources, is: the famous flare in A.D. 1; — the flare in A.D. 185.	The complete list of the flares of stars in this epoch, fixed in medieval sources, is: the flare in A.D. 1006; the famous flare in A.D. 1054; the flare in A.D. 1230.
(1) The famous "star" of A.D. 1 when Christ was born (Mt 2:2, 8, 9–11).	(1) The famous flare in A.D. 1054 of the supernova in Taurus. Hildebrand was "born" as reformer of the Church.

The dates of these flares are ideally coincident in shifting by 1,053 years (see the GCD).

(2) The flare in A.D. 1 was visible "in the east" (Mt 2:2,9) ("The star which they saw in the east").	(2) The flare of the star in A.D. 1054 was visible "in the eastern sky"[6].
(3) The flare of the star in A.D. 185.	(3) The flare of the star in A.D. 1230

The dates of the flares in A.D. 185 and 1230 can also be made coincident under the same 1,053-year chronological shift with a difference of only 8 years.

(4) The star flare in A.D. 185 lasted 7 months [3], [6].	(4) The star flare in A.D. 1230 lasted 6 months [3], [6].

Thus, the dates (regarded as trustworthy) of all star flares from 900 B.C. to A.D. 390 are obtained from those of the medieval flares of stars from the 10th to the 13th century under the backward 1,053-year chronological shift. This new independent corroboration of the existence of the global 1,053-year chronological shift is interesting, since we have analyzed here the dates given by the written sources of quite irregular astronomical phenomena. Note that the previous traditional dating of these flares was carried out on the basis of a written chronological tradition of "nonastronomical origin".

3.2. Astronomical dating of ancient Egyptian horoscopes

We now turn to an analysis of the astronomical results of [2] of dating the zodiacal positions of the planets, which are described in certain historical sources, namely, the so-called horoscopes. Recall that all planets are placed near the ecliptic, relative to the stars (i.e., on the fixed astral sphere), and their position can be calculated similarly to the method of determining the dates of ancient eclipses. That is, we have to fix the positions of observable planets relative to the zodiacal constellations at some modern moment of time. Then, plotting integral multiples of the (known) sidereal periods of the planets backwards, we can, in principle, calculate horoscopes of the past, i.e., the position of the planets relative to the zodiac at a prescribed moment of time.

Thus, if a horoscope is described in some historical source, then, proceeding analogously with the procedure of calculating ancient eclipse dates, we may attempt to date it. To this end, we have to compare its description in a historical text with the calculated tabular horoscopes and attempt to find a horoscope with the same characteristics.

The seeming simplicity of this idea is made very complicated by the difficulties of the calculations and, which is most important, by various secondary reasons of "nonastronomical" character similar to those with which we are already familiar.

In [2], Morozov analyzed the traditional dates of all the basic horoscopes fixed in the surviving ancient sources. Omitting the details, we inform the reader that the result was the same forward shifts of their dates obtained astronomically as occurred previously in the case of ancient eclipses. We give a typical example.

The well-known Egyptologist W. Flinders Petrie in 1901 discovered in Upper Egypt (Athribis) an ancient Egyptian interment dated by the traditional chronology from the 1st century B.C. to the 1st century A.D. The interment was found to contain two graphic images of the planets on the zodiac. The two horoscopes probably indicated the dates of the two tombs. The specialist Knobel [7] attempted to date the horoscopes within the *a priori* time interval from the 1st century B.C. to the 1st century A.D. However, no exact astronomical solution was found. We make the precise statement that the *a priori* interval was determined, proceeding from the style and character of the inscriptions in the grave, due to which Knobel was forced to offer only quite approximate values, namely, A.D. 52 and 59. Knobel noted the imprecision, because the position of Venus at that time was different from its representation in the tombs.

Then the Russian astronomer M.A. Vilyev analyzed all the horoscopes from 500 B.C. to A.D. 600; however, he discovered no exact astronomical solution for the Athribis horoscopes. Nevertheless, the extension of the search time interval and the application of the formal astronomical dating method led Morozov to the discovery of an exact astronomical solution, namely, A.D. 1049 and

A.D. 1065 ([2], Vol. 6, p. 745). It is important that it is unique in the whole historical interval.

3.3. Astronomical dating of the horoscope described in the Book of Revelation

Consider another example. An exact astronomical solution for the horoscope described in the Book of Revelation was suggested by Morozov [2]. Though its descriptive characteristics can be extracted from the Book of Revelation only with some controversial interpretation, this circumstance does not encumber the application of the formal astronomical dating method. As it turns out, there are only two exact astronomical solutions in the whole historical time interval, namely, A.D. 395 and A.D. 1249, although the latter was rejected as "too late" ([2], Vol. 1, p. 53). Besides, it is less satisfactory astronomically.

My analysis of the whole collection of horoscope datings given in [2] has shown that their forward chronological shift obtained by the formal astronomical method is also due to the same three basic ones on the GCD (Fig. 8). For example, the forward shift of the dates of the two Athribis horoscopes is approximately 1,000–1,050 years. Recall that traditional chronology dates them to about the beginning of the present millennium. Thus, the astronomical shift is close to the chronological one of 1,053 years (see Fig. 67 in Vol. 2 of this book).

The same situation occurs in our last example, that of the Book of Revelation. The second of the two astronomical solutions for its horoscope, A.D. 1249, yields the forward shift of its creation by about 1,050–1,100 years. Note that the approximate traditional date of writing the Book of Revelation is, according to A. Harnack, Eberhard, J. Martineau, and van Eising, the second half of the 2nd century A.D. In this case, the value of the astronomical shift is thus also close to that of the chronological one by 1,053 years (Fig. 8).

In conclusion, we indicate another interesting astronomical fact [2], which also turned out to agree with the discovered decomposition of the GCD into the sum of three shifted chronicles.

The first Latin edition of Ptolemy's famous *Almagest* (published in A.D. 1537 in Cologne) contains a catalogue of stars with the indication of their longitudes and latitudes, i.e., coordinates on the celestial sphere. As is clear from the text, the catalogue was made by Claudius Ptolemy himself in the second year of the rule of the Roman emperor Antoninus Pius, traditionally related to A.D. 138–161. It turns out that there exists a reliable method to determine from its star catalogue the date when the *Almagest* was written [2]. Since it contains ecliptic star coordinates, we can make use of the generally known property of stars to annually increase their longitudes by $50''2$ (due to precession). Dividing the difference between the longitudes indicated in the Latin edition and those of the present day by $50''2$, we shall obtain the required date. This simple calculation unexpectedly shows that the longitudes of the stars listed in the first Latin edition of the *Almagest* were observed or

Figure 9(2). Portrait of the "Imperator Caesar Diuus Maximilianus Pius Felix Augustus" (A. Dürer).

recalculated by its author in the 16th century A.D. Hence, these astronomical data belong to the time when the book was published.

Morozov's work ([2], Vol. 4), supplies many other arguments in favour of the conjecture that this text was created by the astronomers of the 10th to the 16th century A.D. In our case, the forward shift of the date of writing the *Almagest* is about 700 or 1,390 years if obtained astronomically. Meanwhile, we compare the date A.D. 1530 (epoch of the first editions of the *Almagest*) with A.D. 140 (second year of Antoninus Pius' rule). We obtain 1530 – 140 = 1390 years. The value of this shift is also completely consistent with the GCD

(Fig. 7), since it practically coincides with the sum of the two basic chronological shifts: $1053 + 333 = 1386$ years.

In such a forward shift of dates, the period of Antoninus Pius' rule falls into the epoch when the first editions of the *Almagest* appeared, namely, A.D. 1528, 1537, 1515(?), 1538, 1542, and 1551. Note, in conclusion, that immediately before this medieval epoch, the emperor Maximilian I Pius (!) Augustus (A.D. 1493–1519) had ruled in the medieval Empire of the Hapsburgs. It is interesting that he was a contemporary of A. Dürer, the creator of the astrographic charts that accompanied Ptolemy's *Almagest*. The prints were made by Dürer in about A.D. 1515. Therefore it cannot be excluded that it was under Maximilian Pius that the astronomical observations fixed in the *Almagest* were carried out (Fig. 9(2)). The statistical analysis of the latitudes in the star catalogue of the *Almagest* was made in the recent paper [15]. The result is as follows: the latitudes in the star catalogue of the *Almagest* were observed somewhere in the time-interval A.D. 600–1300. See also [16].

References

[1] *Context*. Nauka, Moscow, 1978 (in Russian).

[2] Morozov, N.A., *Christ*. Gosizdat, Moscow-Leningrad, 1926–1932 (in Russian).

[3] Pskovsky, Y.P., *Novae and Supernovae*. Nauka, Moscow, 1974 (in Russian).

[4] Fomenko, A.T., "On the computation of the second derivative of the moon's elongation", in *Controllable Motion Problems: Hierarchal Systems*. Perm University Press, Perm, 1980, pp. 161–166 (in Russian).

[5] Fomenko, A.T., "Certain statistical regularities of information density distribution in texts with scale", in *Semiotika i Informatika*, Vol. 15, VINITI, Moscow, 1980, pp. 99–124 (in Russian).

[6] Shklovsky, I.S., *Supernovae*. Wiley, New York–London, 1968.

[7] British School of Archaeology in Egypt and Egyptian Research Account. London, 1908.

[8] Ginzel, F., *Spezieller Kanon der Sonnen- und Mondfinsternisse für Ländergebiete der klassischen Altertumswissenschaften und der Zeitraum von 900 vor Chr. bis 600 nach Chr.* Berlin, 1899.

[9] Newton, R., "Astronomical evidence concerning non-gravitational forces in the Earth–Moon system". *Astrophys. Space Sci.* **16**, 2(1972), pp. 179–200.

[10] Newton, R., *Ancient Astronomical Observations and the Accelerations of the Earth and Moon*. Johns Hopkins Press, Baltimore, 1970, pp. 32–47.

[11] Newton, R., "Two uses of ancient astronomy". *Phil. Trans. Royal Soc.*, Ser. A, **276**(1974), pp. 99–116.

[12] Oppolzer, T., *Kanon der Finsternisse ... Mit 160 Tafeln*. K.K. Hof- und Staatsdruckerei, Wien, 1887.

[13] *The Place of Astronomy in the Ancient World: Joint Symposium of the Royal Society and the British Academy*, organized by D.G. Kendall et al. Oxford University Press for the British Academy, Oxford, 1974.

[14] Zech, J., *Astronomische Untersuchungen über die wichtigeren Finsternisse, welche von den Schriftstellern des classischen Altertums erwähnt werden, etc.* S. Hirzel, Leipzig, 1853.

[15] Fomenko, A.T., Kalashnikov, V.V., Nosovsky, G.V. "When was Ptolemy's star catalogue in the Almagest compiled in reality?" Statistical Analysis. *Acta Applicandae Mathematicae* **17**(1989), pp. 203–229.

[16] Kalashnikov, V.V., Nosovsky, G.V., Fomenko, A.T. "The dating of the Almagest based on the variable star configurations". *Doklady Akad.* Nauk SSSR **307**, 4(1989), pp. 829–832 (in Russian).

CHAPTER 2

NEW STATISTICAL METHODS FOR DATING

§4. Certain Statistical Regularities of Information Density Distribution in Texts with A Scale[1]

4.1. Text with a scale. The general notion

4.1.1. In the present paper, we list the results of a series of statistical investigations carried out by the author, and which led to the discovery (for narrative texts) of new statistical invariants such as the *laws of information density conservation.*

By a text X with a scale P, we understand a text (e.g., a narrative one) endowed with a fixed program plan whose items are numbered by a parameter t. Meanwhile, we shall require that X should admit a unique partition associated with this parametrization (program), and such that (1) to each value of the parameter $t \in P$, a certain part $X(t)$ of the text may necessarily correspond; and, vice versa, (2) each phrase (or word) of the text T may necessarily belong to one and only one fragment $X(t)$ for a certain t.

We call such a program plan a *scale*, or parametrization of the text X. We will say that the text X is parametrized by t, with $X = \bigcup_{t \in P} X(t)$, and $X(t_1) \cap X(t_2) = \emptyset$ if $t_1 \neq t_2$.

Such parametrized texts X are well illustrated by those with historical character, e.g., historical monographs, chronicles, annals, college textbooks, diaries, and so forth. In these cases, the part of the parameter t is played by time, i.e., the dates of the events described (according to a system of chronology or any other method of their dating).

Still, the above concept of a text with a scale is considerably more general than in the given example. In particular, the parameter t may range over more complicated domains than the set of natural numbers (dates of events). For

[1] First published as an article in *Semiotika i Informatika*, Vol. 15, VINITI, Moscow, 1980, pp. 99–124 (in Russian).

example, t can possess a continuous domain in the case where we take as a text with a scale the description of some physical continuous process parametrized by continuous time. Then we can consider the description of the instantaneous state as a "textual fragment" $X(t)$ when the process of interest is going on. The description may be "composed" of some system characterizing the process continuously.

Further, for the applications considered below, the following example is very important. We can assume that a scale P consists of a sequence of disjoint intervals (A_k, B_k) with integral endpoints. In other words, two intervals (A_k, B_k) and (A_c, B_c) are disjoint if $k \neq c$ and the union of all of them makes up the initial segment (A, B), with the parameter t ranging over their entire sequence (see the details in Section 4.2.2).

4.1.2. Let X be a certain historical (or, more generally, narrative) text with a scale P, represented as the union of the fragments $X(t)$. For simplicity, let the parameter t range over the positive or negative integers from A to B. For example, we can assume that X describes the events from the year A to the year B, though the quantities t, A, and B can then be measured not only in years, but, say, in months, days, or hours.

4.2. Information characteristics (i.e., informative functions) of a historical text. Volume function, name function, and reference function

4.2.1. Now, we associate each value of the parameter t with a set $f_1(t), f_2(t), \ldots, f_N(t)$ of the formal information characteristics of part $X(t)$ of a historical text X, which may describe the events of one year t. As we shall now see, the quantitative information characteristics $f_i(t)$ can be quite multifarious. We illustrate this with some basic examples.

Example 1. Let $f_1(t) = \frac{\operatorname{vol} X(t)}{V}$, where $\operatorname{vol} X(t)$ is the number of lines, pages, signs, or words making up a textual fragment $X(t)$. We then, obviously, get $f_1(t) \geq 0$, and $\sum_{A \leq t \leq B} f_1(t) = 1$, with $V = \operatorname{vol} X$ denoting the total volume of the text X without illustrations, diagrams, or bibliography. The normalizing condition $\sum_t f_1(t) = 1$ often happens to be convenient in various instances of such averaging and comparing and is a discrete analogue of the normalizing condition in the case of a continuous parameter, namely $\int_A^B f_1(x)dx = 1$.

Example 2. Let $f_2(t) = \frac{s(t)}{S}$, where $s(t)$ is the number of references to a year t in the entire text X, and S that of all the dates (years).

Example 3. Let $f_3(t) = \frac{m(t)}{M}$, where $m(t)$ is the number of the names of historical characters mentioned in a textual fragment $X(t)$, and M that of all the names of all the historical characters from the text X. We shall sometimes also count the number of *references* to the names of historical figures in the fragment $X(t)$, i.e., we shall take into account their multiplicity, or frequency, of use in the text.

Example 4. Let $f_4(t) = \frac{m_j(t)}{M_j}$, where $m_j(t)$ is the number of references to some concrete name m_j in a textual fragment $X(t)$, and M_j is the total number of references to m_j in the entire text X. In general, this name can be ascribed to different historical characters.

We shall give other important examples of the functions $f_i(t)$ below. We call them informative, or frequency functions, defined by X.

4.2.2. To determine $f_i(t)$ means to formally compute an indicated numerical characteristic such as volume, the number of names, and so on, of all textual fragments $X(t)$ of some concrete historical texts X, which may be arranged so that only the partitions of X into the sum of the fragments $X(A_k, B_k)$ are specified uniquely, with $X(A_k, B_k)$ denoting that part of X in which the events of the interval (A_k, B_k) with integral endpoints are described. Meanwhile, their description inside $X(A_k, B_k)$ may not be specifically related to the years composing (A_k, B_k), due to the convenience of considering an enlarged scale for a parameter which does not range over separate years but over separate time intervals, in which case we will denote it by T. It should be noted that, generally, there can exist several different scales for the same text X. Thus, the choice of a particular scale in X may vary in accordance with the problem posed. If a parameter T ranges over a sequence of time intervals (A_k, B_k), then the normalized volume function $f_1(T)$ is determined as $f_1(T) = \frac{\text{vol}(A_k,B_k)}{\text{vol}(A,B)\cdot(B_k - A_k)}$. In other words, we compute the average value of the textual volume function in (A_k, B_k), where $\text{vol}(A_k, B_k)$ and $\text{vol}(A, B)$ are the values of the volume function in (A_k, B_k) and (A, B), respectively. The "averaged" functions for the other examples listed above are defined similarly.

For example, $\text{vol}(A_k, B_k)$ is the number of lines, pages, or words making up the fragment $X(A_k, B_k)$ that describes the events in the time interval (A_k, B_k). Further, $\text{vol}(A, B)$ is the total volume of the entire text X represented as the union of its disjoint fragments $X(A_k, B_k)$.

Thus, each informative function $f_i(t)$ is given by a certain graph defined on an interval (A, B). All the informative functions under investigation are nonnegative.

4.2.3. Denote by $f(t)$, or $f(t, X)$, some informative function $f_i(t)$ for a text X, omitting the subscript i for brevity. Let two (or several) historical texts X and Y be given, which describe the events in an interval (A, B) of the history of one region (e.g., state, town, etc.). It is clear that the informative functions $f(t, X)$ and $f(t, Y)$ constructed for X and Y, respectively, will, in general, be different. This must be so, since their form is influenced by both the individual propensities of the authors and the general attitude toward the events characteristic of the time when the text was written. It is clear that a monograph on art history and one on military history devoted to the same period will accentuate various things differently, which can lead, for instance, to a different distribution of the textual volumes.

A natural question thus arises: How essential are these differences in texts with a statistical approach to the analysis of their informative functions? In other words, can we discover certain general, invariant characteristics of the informative functions $f(t, X)$ and $f(t, Y)$, which do not depend (or depend little) on the authors' tendencies, and which are determined mostly by the time interval (A, B) and the region Γ?

4.2.4. Let us investigate the behaviour of such important characteristics of the graphs of $f(t, X)$ as the distribution of local maxima ("peaks"). Denote by $r_i(X)$ those years t of a time interval (A, B) in which the graph of $f(t, X)$ attains local maxima, i.e., exhibits peaks. Let i vary from 1 to $q(X)$, where $q(X)$ is the total number of local maxima.

In the case where the scale of the text X is enlarged (see the above example), the informative function f is represented by a "steplike" graph. This step function is constant on each separate interval (A_k, B_k). It is then convenient to take its midpoint as a local maximum attained in (A_k, B_k).

Consider the volume function $\operatorname{vol} X(t)$ as a basic example. Its value at a point t equals the volume of a textual fragment $X(t)$, measured in pages, lines, or words. What is the meaning of "the volume function $\operatorname{vol} X(t)$ reaches a local maximum at a certain point $r_i(X)$ in an interval (A, B)"? It means that the year $r_i(X)$ represented as a point in (A, B) is described in the text X in more detail, on a greater number of pages, and with more particulars than the nearby years. What can explain such a difference in the description of different years? One of the possible (and, probably, basic) reasons for this phenomenon can be formulated as follows. The author of X possessed more information for the year $r_i(X)$ (e.g., historical texts or more extensive documentation) than for the neighbouring years. It could be for this reason that the events of the year $r_i(X)$ of the epoch (A, B) have been described in more detail.

4.3. A theoretical model describing the distribution of local maxima for the volume function of a historical text. Primary stock. The information density conservation law

In Section 4.2.4, we formulated a theoretical model (statistical hypothesis) describing the distribution of local maxima for the textual volume function. We now designate by $C(t)$ the total volume of all the texts written by contemporaries about the events of a year t. We shall measure the volume in lines (pages, words, etc.). It is clear that, in general, we cannot reconstruct the original form of the graph of $C(t)$ today, which is due to a loss of the old texts with time. It is only the part $K(t)$ of the primary information stock $C(t)$ that has survived. $K(t)$ will be called the surviving information (textual) stock regarding the year t. Denote by c_i the years in which the volume graph for the primary stock $C(t)$ has reached local maxima. It follows that especially many texts were written in these years (for particular reasons which we do not discuss here), i.e., the contemporaries have recorded a particularly large amount of written evidence about them. Let us ask ourselves the following question: What might be the statistical mechanism of loss and falling into oblivion of textual information which leads to a gradual decrease of the amplitude of the volume graph for the primary stock $C(t)$?

We formulate the following hypothesis. *Though, with time, the amplitude of the volume graph for the surviving textual stock decreases gradually (since ancient texts get lost and destroyed), more remains from those years c_i whose events were described by contemporaries in a considerable number of texts.*

In other words, the years c_i in which the volume graph for the primary stock $C(t)$ reached local maxima must be close to those points k_i in which that of the surviving stock $K(t)$ attains local maxima. *In particular, c_i and k_i must be close to those years $r_i(x)$ in which the volume graph* $\operatorname{vol} X(t)$ *of the text X describing the events in a time interval (A, B) has reached local maxima.*

Since the volume graph for the primary stock $C(t)$ is unknown, it is hard to verify the hypothesis stated in its present form. However, we can verify one of its important corollaries.

4.4. The correlation of local maxima for the volume graphs of dependent historical chronicles. The surviving-stock graph

4.4.1. *Namely, the years of local maxima $r_i(X)$ should be close to those denoted by $r_i(Y)$ for any two historical texts X and Y describing one historical epoch (A, B) in the history of the same region Γ.*

In other words, the volume graphs $\operatorname{vol} X(t)$ *and* $\operatorname{vol} Y(t)$ *must attain local maxima, i.e., form peaks, approximately at the same points (years) in the time interval (A, B).*

We call this corollary the *F-model.* To substantiate it intuitively and informally, we assume that two texts X and Y describe the events in a time interval (A, B) in the history of one region. Let this period be considerably removed in time from the authors of X and Y. This means that they are no longer contemporaries of the described ancient events and, therefore, have to employ a collection of historical sources surviving from the historical epoch (A, B), i.e., the surviving information stock. However, we can assume (without making a gross mistake) that this surviving textual set (information stock) is approximately the same for both X and Y. Hence, the volume graphs $\operatorname{vol} X(t)$ and $\operatorname{vol} Y(t)$ must more or less simultaneously reflect the maxima of the graph of the surviving stock while simultaneously reaching local maxima in (A, B). Thus, a chronicler describes in more detail those years from which more texts have been preserved.

Recall that the years of the local maximum of the volume graph are characterized by especially much surviving information in comparison with the neighbouring ones. Another natural corollary to the basic hypothesis will be given in Section 4.7.2 (the K-model).

4.4.2. We should not think that the amplitudes themselves of the local maxima of the volume function (the absolute values of the textual volumes) of two historical texts describing the same events are close (even with normalizing).

Simple examples of concrete chronicles show that the values of $\operatorname{vol} X(r_i)$ and $\operatorname{vol} Y(r_i)$ may be considerably different. Thus, the absolute values of $\operatorname{vol} X(r_i)$ at the local maximum points r_i vary upon altering the text X (i.e., depend on it), which shows that the discovery of the rough "invariants of historical epochs" should not be based on the absolute amplitudes of informative functions. The analysis of "fine amplitude invariants" was carried out by S.T. Rachev and the author.

4.4.3. Let us verify the theoretical F-model against the material of concrete texts (chronicles, etc.), for which we should first formulate the concept of proximity of two sequences of numbers $r_i(X)$ and $r_i(Y)$ of local maximum points for two texts X and Y, namely, their volume graphs can, in general, have different numbers of local maxima, and $q(X) \neq q(Y)$ (see above). However, as will now be shown, without loss of generality, we can put $q(X) = q(Y)$, for which it suffices to assume that certain $r_i(Y)$ coincide with some new, additional local maxima to be added in the case where $q(Y) < q(X)$. In other words, some maxima of the graph of $\operatorname{vol} Y(t)$ are declared to be multiple, i.e., we assume that several maxima coincide.

Equalizing the number of local maxima for two volume graphs can be carried out differently and in accordance with the supposedly multiple maximum points and their multiplicity. We now choose a particular method for equalizing the number of maxima. In the following, we shall perform the minimization of the functions in question with the help of all such equalizing methods.

4.5. Mathematical formalization. The numerical coefficient $d(X,Y)$, which measures the "distance" between two historical texts X and Y

4.5.1. We now describe the mathematical formalization. The points $r_i(X)$ break the time interval (A, B) into smaller intervals whose lengths are given by the integers $a_1, a_2, \dots, a_p$, where $a_1 = r_1 - A$, $a_i = r_i - r_{i-1}$ for $2 \leq i \leq q(X)$, and $a_p = B - r_{p-1}$, their number being $p = q(X) + 1$. Therefore, we can define a certain integral vector $a(X) = (a_1(X), \dots, a_p(X))$ belonging to the Euclidean space R^p of dimension p. Since the sum of all a_i is, obviously, equal to $B - A$, the length of (A, B), we can assume that the endpoint of $a(X)$ lies on a $(p-1)$-dimensional simplex σ, which can be given by the equation $\sum_{i=1}^{p} x_i = B - A$, where x_i are nonnegative Euclidean coordinates for the space R^p. The simplex σ is a closed subset, i.e., with the boundary belonging to it, which follows from the fact that some a_i can be zero (the case of multiple maxima).

Now, let us consider two historical texts X and Y. We can construct two integral vectors $a(X)$ and $a(Y)$ with their endpoints on one and the same simplex σ (Fig. 10). Meanwhile, we assume that both texts describe events on the same time interval (A, B). Note that we have made use here of the above remark according to which we can assume that the volume graphs for both texts have the same number of local maxima.

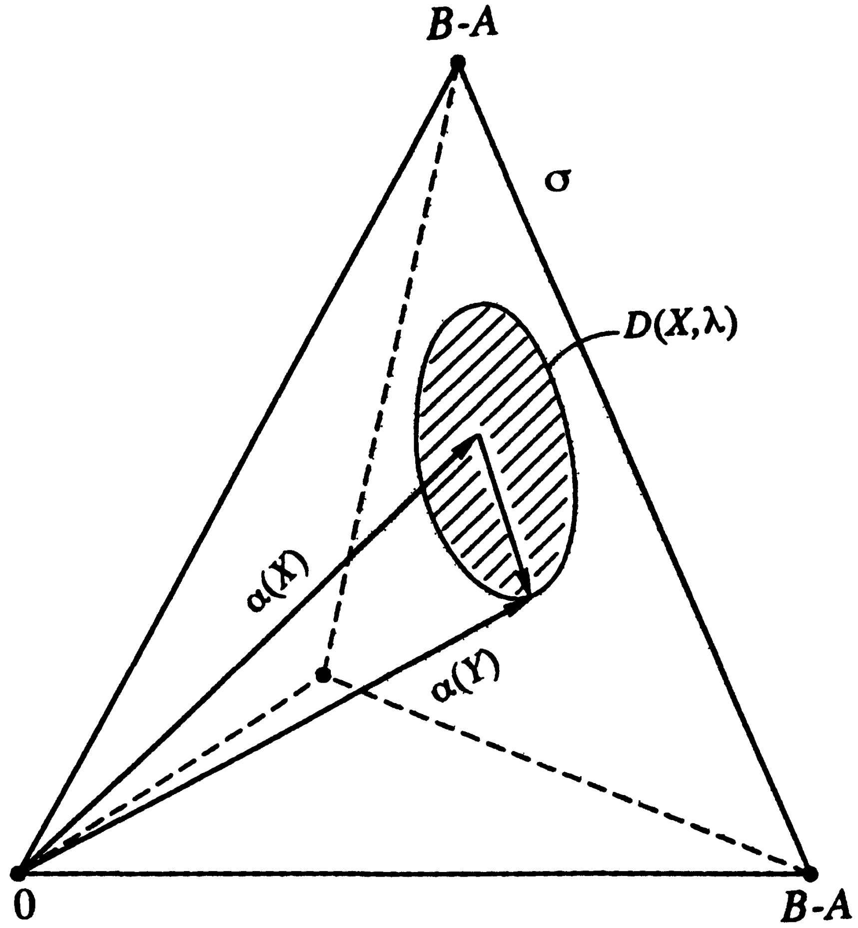


Figure 10. Method for comparison of two historical texts X and Y. We can construct and compare two integral vectors.

Consider the difference Δ of the two vectors $a(Y)$ and $a(X)$. The vector Δ belongs to our simplex (Fig. 10). Let λ be the usual Euclidean length of the vector Δ. Recall that $\lambda = \sqrt{\sum_{i=1}^{p}(a_i(Y) - a_i(X))^2}$.

We now introduce the numerical coefficient $d(X,Y) = \frac{\text{vol}(D\cap\sigma)}{\text{vol}(\sigma)}$, where $D = D(X,\lambda)$ denotes a $(p-1)$-dimensional ball placed in the hyperplane specified by the equation $\sum_{i=1}^{p} x_i = B - A$. This ball is centered at $a(X)$ and has the radius λ, while $D \cap \sigma$ denotes its intersection with the simplex. If λ is large, then the ball D may contain points located outside the simplex. If, however, the number λ is small, and the point $a(X)$ (the center of the ball) does not lie on the boundary of the simplex, then the ball $D(X,\lambda)$ is small and wholly contained in the simplex, in which case we have the equality $D\cap\sigma = D$. Finally, $\text{vol}\, S$, where S is an arbitrary $(p-1)$-dimensional subset in the hyperplane $\sum_{i=1}^{p} x_i = B - A$, denotes either the usual Euclidean $(p-1)$-dimensional volume of the subset S (in which case we will say that we are dealing with a continuous model) or the number of integral points in the set S. Recall that a point is said to be integral if its Euclidean coordinates are integers. In the latter case, we will say that we are dealing with a discrete model.

4.5.2. Assume that a text X is fixed. While varying the text Y, it becomes obvious that the number $d(X, Y)$ which we introduced in Section 4.5.1 can be interpreted (under certain natural assumptions) as the probability of the point $a(Y)$ getting randomly into the ball D with fixed radius λ and with its center at $a(X)$. This probabilistic interpretation is not at all essential for the following and is given here only as a formalism which is useful for the calculations.

We now introduce on our simplex a $(p-1)$-dimensional measure μ in the following two ways:

Version 1. $\mu(S) = \frac{\text{number of integral points in the domain S}}{\text{number of integral points in the simplex}}$ consistent with the discrete model (see above).

Version 2. $\mu(S) = \frac{\text{Euclidean volume of the domain S}}{\text{Euclidean volume of the simplex}}$ consistent with the continuous model, where S is a $(p-1)$-dimensional domain (subset) in the simplex σ.

Further, to interpret the coefficient $d(X, Y)$ probabilistically, we need a hypothesis regarding the distribution of the random vector $a(Y)$ on the simplex. In the simplest case, we assume that $a(Y)$ is uniformly distributed on the simplex, which means that the probability that it gets into some domain S equals the measure $\mu(S)$. Since $\mu(\sigma) = 1,\ 0 \leq \mu(S) \leq 1$.

Applied to our problem, this conjecture can be confirmed somewhat by the distribution of the random vector $a(Y)$ being consistent with that of the local maxima of the volume graphs $\operatorname{vol} Y(t)$ for a variable text Y and a variable historical epoch (A, B) with invariable $A - B$. Since we intend to model the mechanism of information loss and the fall into oblivion, we should take into account the circumstance that if an archive of historical documents is lost during some sort of disaster, or similar circumstances, then it is appropriate to accept the hypothesis that the destruction of any text from this archive is "equally likely". The assumption can be restated as a conjecture regarding the uniform distribution of the random vector $a(Y)$, where the text Y ranges over all the texts surviving from all possible historical epochs.

To describe this distribution of the local maximum random vector formally is unreal for the moment, because we should calculate all the vectors $a(Y)$ for all surviving historical texts Y, which is, obviously, impossible. We could certainly investigate a sufficiently large sample from the set of all existing texts; however, certain complicated problems regarding the representability of such samples and their homogeneity arise here. Besides, such an experimental approach could considerably distort the general form of the distribution, since it is difficult to estimate *a priori* whether a particular sample from the texts reflects the real mechanism of information loss. At the same time, the assumed uniformity of the distribution of the random vector $a(Y)$ well reflects the circumstance that by altering the historical epoch (A, B), we "uniformly mix" all possible reasons for the loss of historical texts.

In certain examples related to other methods of dating (see below), where the total information requiring quantitative processing is sufficiently clear, we have experimentally calculated the desired distribution of the random vector. For example, we have found the empirical frequency histogram for the distribution of the duration of kings' reigns.

We would like to emphasize once again that the probabilistic interpretation of the coefficient $d(X,Y)$ will not be employed below. First, we carry out an experimental calculation of the concrete limits within which $d(X,Y)$ varies for "dependent historical texts" describing the same events. It is the values of $d(X,Y)$ found experimentally that in the following will serve as a standard for comparing other pairs of texts under investigation.

The coefficient $d(X,Y)$ ranges from zero to unity. With the assumed uniform distribution, we can say that the smaller its magnitude, the lower the probability of the random event that the random vector $a(Z)$ distributed on the simplex uniformly happened to be from the vector $a(X)$ at a distance not exceeding the observable one between the points (vectors) $a(X)$ and $a(Y)$.

If λ, the distance between $a(X)$ and $a(Y)$, is sufficiently large, then $d(X,Y)$ may be unity, in which case the above ball D wholly absorbs the simplex σ. Therefore, no statement regarding a possible proximity of the texts X and Y can be formulated; these texts are far from each other from the standpoint of their volume functions.

Note that, for any X and Y describing one historical epoch (A, B), we can always find the same scale P, which permits us (in principle, at least) to compare even texts of various nature, namely, textbooks, annals, and so forth.

Section 4.6 is of formal mathematical character and may be omitted on first reading.

4.6. Mathematical formulas for computing $d(X,Y)$. Mathematical corrections of the maxima correlation principle

4.6.1. In this section, we give certain mathematical formulas for computing and estimating $d(X,Y)$. If a simplex σ is specified by the equation $\sum_{i=1}^{p} x_i = s$, where all x_i are nonnegative, then its volume in the continuous model, i.e., in the usual Euclidean volume, equals $\frac{s^{p-1}\sqrt{p}}{(p-1)!}$ Hence,

$$d(X,Y) \leq \frac{\pi^{\frac{p-1}{2}} \lambda^{p-1} (p-1)!}{\Gamma(\frac{p-1}{2}+1) s^{p-1} \sqrt{p}},$$

where $s = B - A$, λ is the length of the vector $a(Y) - a(X)$, and Γ is the classical gamma function. For small λ, the inequality turns into an equality.

If $B - A$, and p and λ are all sufficiently small, then we have to make use of the discrete model to calculate $d(X,Y)$ (see above). In order to do this, we have to find the number of integral points in the ball D and the simplex σ for the given values of $B - A$, p, and λ. Unfortunately, an exact universal formula cannot be offered in this case; however, we can derive an asymptotic relation, which is omitted due to lack of space.

We can estimate this mathematically, beginning with which numerical values of $B - A$, p, and λ it is possible to resort to the continuous model without committing a gross mistake. As a matter of fact, concrete calculations are more simple within the framework of the continuous than the discrete model. Any concrete numerical estimation is also omitted. Note, in this connection, that an interesting mathematical problem arises here: How can an exact boundary be found, separating the area of application of the discrete model from that of the continuous one (for a prescribed value of admissible error)?

4.6.2. We now indicate the first mathematical correction to the F-model. Since, when equalizing the numbers of the local maxima of the volume graphs of two texts being compared, we are forced to assume certain of the coordinates a_i of the vector $a(Y)$ to be equal to zero in the case where $q(Y) < q(X)$, this process is explicitly equivocal. It is clear that we can take any of a_1 to a_p as the zero coordinate. We should therefore consider all possible methods of equalizing the numbers of the maxima and then take the least of all the values obtained as the coefficient $d(X,Y)$. To eliminate the asymmetry between the texts X and Y due to the definition of $d(X,Y)$, we have to "symmetrize" the value, i.e., consider $\frac{d(X,Y)+d(Y,X)}{2}$.

4.6.3. Now we present the second correction of the F-model. We have carried out previous constructions for informative functions of the form $f(t,X)$. However, we should also consider all their possible smoothings in order to establish the invariant, characteristic properties of the graphs better. For example, as the simplest method of smoothing a graph, we can consider the "neighbourwise averaging". For a function $f(t)$, its first smoothing is then constructed as $S^1 f(t) = \frac{f(t-1)+f(t)+f(t+1)}{3}$, the second, $S^2 f(t)$, as the expression $S^1(S^1 f(t))$, and so on. It is evident that this procedure smoothes the graph and eliminates random, small local maxima. Their corresponding coefficient $d_j(X,Y)$ is computed after each stage of the smoothing procedure applied to $S^j f(t,X)$ and $S^j f(t,Y)$. As the final value of $d(X,Y)$, we should again take the least of all numbers obtained in such a manner. Having calculated $d(X,Y)$ for the original and nonsmoothed graphs $f(t,X)$ and $f(t,Y)$, we obtain an upper estimate of the final value of the coefficient. Note that if we are comparing two texts X and Y which describe different historical epochs of the same length, then we should make these intervals coincident on the time axis by superimposing.

4.6.4. The third mathematical correction of the F-model is as follows. For greater statistical invariance of the obtained results, we should compare not simply a pair of separate texts X and Y, but two sufficiently large groups of texts $X_1, \dots, X_n$ and $Y_1, \dots, Y_m$, where n and m are supposed to be sufficiently large. Denote the first text group by $\{X\}$, and second by $\{Y\}$. Then we have to compare the graphs of the functions $f(t,\{X\}) = f(t, X_1, \dots, X_n)$ and $f(t,\{Y\}) = f(t, Y_1, \dots, Y_m)$, where $f(t,\{X\})$ is the averaged function defined by the equality $f(t,\{X\}) = \frac{1}{n}\sum_{i=1}^{n} f(t, X_i)$. The averaged graphs $f(t,\{X\})$ and $f(t,\{Y\})$ so formed have been freed of the random local maxima which might have appeared in one or the other text for some particular reason of nonuniversal character. The comparison of the averaged graphs yields a more reliable statistical picture of the evolution in time of written evidence.

4.7. Verification of the maxima correlation principle against concrete historical material

4.7.1. Let us now verify the F-model against some concrete historical material. This model will be confirmed if the coefficient $d(X,Y)$ is "small" for the majority of pairs of real historical texts X and Y describing the "same" events in the same time interval (A,B) (we call such texts dependent). On the contrary, for independent texts, i.e., those describing essentially different events (or essentially different time intervals), this coefficient must be "large". For now, the concept of smallness for the coefficient will not formally be made precise, since we need more experimental data. Meanwhile, the broad statistical experience of natural science permits us to estimate (with the assumption of the uniform distribution of the random vector $a(Y)$) really small probabilities in problems of this kind. Since the explicit construction (from texts) and description of informative graphs for concrete historical texts of large size are sufficiently bulky, we are forced to omit the diagrams here and will give only some typical examples. We first consider the textual volume function $\operatorname{vol} X(t)$ (the volume is measured in pages; see also Section 4.2). For example, we have taken the monograph of V.S. Sergeev, *Essays on the History of Ancient Rome* [1], as the text X, and the famous *History of Rome* by Livy [2] as the text Y. The time interval (A,B) described in both books was taken from 758 to 288 B.C., which means that $A = -757$, $B = -287$, and the length of the interval $B - A = 470$ years. The "–" sign denotes the years B.C. The volume graphs of these texts (with respect to years) are shown in Fig. 11. The continuous line has been constructed for Sergeev's text, and the dotted one for Livy's. As it turns out, $\lambda = 21$, $p = 14$, and the coefficient $d(X,Y)$ measuring the

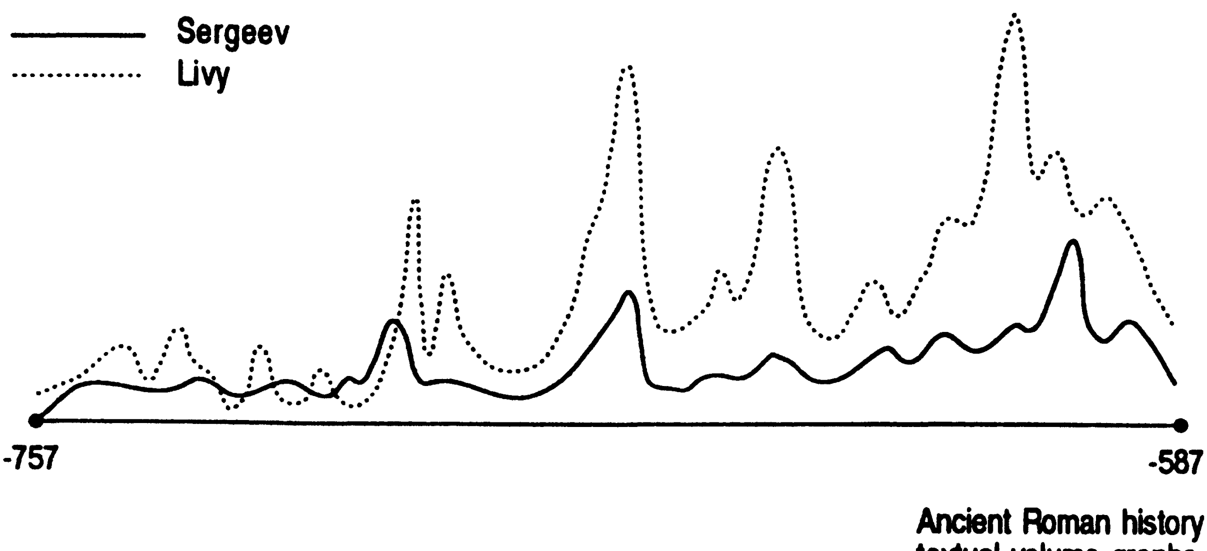


Figure 11. Volume functions of two dependent texts: V.S. Sergeev's monograph "Essays on the History of Ancient Rome" and Livy's "History of Rome".

proximity of the vectors $a(X)$ and $a(Y)$ in the statistical sense equals $2 \cdot 10^{-12}$. The distance between them in the Euclidean sense is 21.

In other words, the probability of random proximity of the texts X and Y (at the distance $\lambda = 21$) is majorized by $2 \cdot 10^{-12}$. We had obtained it even before minimizing d with respect to smoothing all the graphs (see Section 4.6.3). Therefore, $2 \cdot 10^{-12}$ is the upper estimate of the final value of the coefficient. Being very small, it indicates a considerable correlation between the historical texts by Sergeev and Livy from the point of view of the volume graphs. It is but natural, because, describing the "same events", they are *a priori* dependent. The most important is not the small absolute value of $d(X,Y)$, but the large difference between the values of $d(X,Y)$ for dependent pairs X, Y and independent pairs X, Y.

Similar results are also obtained for the comparison of the different informative functions $f_i(t, X)$ and $f_j(t, Y)$ for dependent X and Y, which describe the same events in the same time interval (A, B). For example, consider for the above historical texts X by Sergeev and Y by Livy the informative function $f_2(t, X) = \frac{s(t)}{S}$, where $s(t)$ = number of mentions of a year t in X. Compare its graph with the volume graph $\operatorname{vol} Y(t)$ for Y. We have thus considered the time interval from 521 to 294 B.C., i.e., $A = -520$, $B = -293$, and the length $B - A = 227$. It turns out that $\lambda = 8$, $p = 8$. The result of the calculations is $d(\operatorname{vol} Y(t), f_2(t, X)) = 5 \cdot 10^{-6}$.

In the latter example, we have smoothed the graphs once, i.e., compared the graphs of $S^1 f_2(t, X)$ and $S^1 \operatorname{vol} Y(t)$. Such a small value of the coefficient measuring the probability with which the vectors $a(\operatorname{vol} Y(t))$ and $a(f_2(t, X))$ may randomly be at the distance $\lambda = 8$ explicitly expresses the correlation between different informative functions of dependent texts describing the same period in the history of the same region or state.

These results indicate the existence of another special law of information density conservation to be formulated as a K-model below.

Similar results are obtained when investigating other pairs of historical texts. I performed the computational experiment with the help of M. Zamaletdinov (Faculty of Mechanics and Mathematics of Moscow University).

4.7.2. We now formulate another natural model of the evolution of written information. If a historical text X describes events in a time interval (A, B), then there is a correlation between the different informative functions constructed for X. For example, the graphs $f_i(t, X)$ and $f_j(t, Y)$ for different i and j attain local maxima at approximately the same points (years) in (A, B).

The K-model (statistical hypothesis) is subject to all the mathematical corrections indicated above for the F-model; accordingly, we do not give them here.

Its intuitive substantiation can be extracted from the following observation. Say, if a year t from a time interval (A, B) is described in a historical text X in more detail than the neighbouring years, then this circumstance must lead not only to a local increase of the number of pages in X, which will have bearing on the function f_1, but also to an increase of references to the year t (this has bearing on the function f_2), while the number of names of historical characters mentioned at the same time in X increases locally, too (which has bearing on the function f_3), and so on. Roughly speaking, the longer a textual fragment $X(t)$, the more names are mentioned there. Certainly, all these statements (models) are valid only "on the average" and for large time intervals.

It is easy to see that the K-model is, actually, a corollary to the same basic statistical hypothesis (information density conservation law) formulated in Section 4.3 and is modelling the mechanism of loss and the fall into oblivion of written evidence. To derive the K-model from it, it suffices to apply the hypothesis to an arbitrary pair of informative functions f_i and f_j (and not only to the volume function $f_1 = \text{vol}$). In this sense, both the F- and the K-model can be regarded as corollaries to the basic hypothesis of 4.3.1.

4.7.3. We now turn to the verification of the K-model against concrete historical data. It will be confirmed if the vectors $a(f_i(X))$ and $a(f_j(X))$ are proximal for most sufficiently large concrete texts X, i.e., if the number $d(f_i(X), f_j(X))$ is sufficiently small. Omitting the diagrams, I shall give just one typical example.

Sergeev's monograph *Essays on the History of Ancient Rome* was again taken as a text X for which the volume function $\text{vol}\, X(t)$ and the frequency of mentioning particular dates (years) $f_2(t, X)$ have been calculated. It turns out that these two graphs are strongly correlated, i.e., their peaks practically coincide. The calculations have shown that $\lambda = 25$, $p = 11$, and $B - A = 280$ years ($A = 241$ B.C., and $B = 521$ B.C.). Finally, $d(\text{vol}\, X(t), f_2(t, X)) = 7 \cdot 10^{-5}$. Similar results have been obtained for other chronicles, textbooks, monographs, and so forth, which we investigated. This confirms the K-model. The values of the coefficients obtained in the experiment are close to those obtained by us earlier in verifying the F-model against necessarily dependent pairs of historical texts.

4.7.4. We should not think that the coefficient $d(f_i(X), f_j(Y))$ is generally small for the arbitrary texts X, Y, and the functions f_i, f_j. If it were so, then the extreme smallness of the numbers d obtained above (for texts known *a priori* to be dependent) would not reveal anything.

Recall that, with the assumed uniform distribution of the random vector on a simplex, all points of this simplex are treated equally during the random walk of the vector $a(Y)$ (and for a fixed vector $a(X)$). Hence, when the vector $a(Y)$ is moving farther from $a(X)$, the ball $D(X, \lambda)$ enlarges, and the coefficient $d(X, Y)$ approaches unity (the ball occupies a greater and greater part of the simplex).

Concrete computations were then carried out for the independent historical texts X and Y, i.e., texts describing events or periods of history (A, B) and (C, D) known *a priori* to be different. It turned out that the coefficient d was of the order of unity for a small number of local maxima. For a large number of maxima, this lower bound of the coefficient values for independent texts decreases but continues to be several orders greater than its upper bound for *a priori* dependent texts.

We illustrate this with a typical example. Consider the first and second halves of Sergeev's text as X and Y. They describe different historical epochs, namely, the periods (A, B) from 521 to 381 B.C., and (C, D) from 381 to 241 B.C. in the history of ancient Rome. The functions $f_2(t, X)$ and $f_2(t, Y)$ represent the frequencies of mentioning particular dates (years) in the texts. It then turns out that $\lambda = 59, B - A = D - C = 140$ years, and $p = 5$. Finally, $d = 1/3$, which is close to unity in contrast to the above examples of dependent texts.

4.7.5. Our computational experiments confirm both of the theoretical hypotheses, i.e., the F- and K-models. We thereby discover specific laws of information density conservation in historical texts describing sufficiently large time intervals. They are partly manifest in certain quantitative characteristics of textual informative functions such as the distribution of local maxima. Though their intuitive substantiation seems to be rather clear (see above), the number of parameters of the informative functions, which can play the role of "historical epoch invariants", does not at all include all of them. For example, the absolute amplitudes of the volume graphs, the frequencies of names, and so forth, can be substantially different even for *a priori* dependent texts. The amplitude is, therefore, not an invariant of the period. The discovery of other "dependent text invariants" is a nontrivial problem and requires more statistical research.

4.8. A new method for dating historical events. The method of restoring the graph of the primary and surviving information stock

4.8.1. We now offer a new method for dating historical events described in ancient texts. The laws of information density conservation permit us to introduce a formal procedure to date the events described in texts with lost or unknown dating.

In fact, let Y be a historical text with undated events. Let it be supplied with dates according to some unknown chronology. For example, let the years t be counted from the unknown absolute date of the foundation of some city. We can assume, nevertheless, that the text Y is parametrized by a time t in the period between the years C and D according to the unknown chronology. How can we restore the absolute dates of the events?

Construct the informative functions $f_i(t, Y)$ and consider the set of all absolutely dated texts X. We also construct their informative functions $f_i(t, X)$ and assume that we can choose X with some $f_i(t, X)$, or at once their whole set, close in the sense of smallness of the coefficient d to an informative function $f_i(t, Y)$. In other words, $d(f_i(X), f_i(Y))$ is "small" (i.e., it is close to the values of the coefficient $d(f_i(Z), f_i(V))$ for surely dependent pairs Z and V). It then means that within the framework of the F- or K-model substantiated by us, the texts X and Y may be dependent. In particular, the time interval

(C, D) is close to (A, B) described in X or simply coincides with (A, B).

Moreover, the smallness of d will indicate not only a possible proximity of the time intervals (A, B) and (C, D), but also that of the events and the historical epochs described (and even the coincidence). Meanwhile, it is important to bear in mind that the descriptions of the same events in X and Y can be outwardly different, with different names or nicknames of the historical characters, different geographical names, and so on. For example, the texts X and Y can be two versions of the description (chronicle) of the history of a region or state, but written in different languages, by different chroniclers, in different countries, or according to different chronologies.

4.8.2. Let $X_1, \dots, X_k$ be the collection of certain historical texts describing events in the same time interval (A, B). Consider the averaged function of their volumes, i.e., $\tilde{K}(t) = \mathrm{vol}(t; X_1, \dots, X_k) = \frac{1}{k}\sum_{j=1}^{k} \mathrm{vol}\, X_j(t)$.

If the quantity of texts (i.e., the number k) is sufficiently large, then the graph of $\tilde{K}(t)$ can be assumed, due to the computational experiments described above, to be coincident with (or close to) the graph of the original or surviving information stock $C(t)$ or $K(t)$, respectively. Meanwhile, the local maxima of the graph of $\tilde{K}(t)$ indicate those years in the time interval (A, B) for which an especially large amount of written information (texts) has survived.

This circumstance can help in dating available ancient historical texts. Namely, especially extensive texts (describing individual years) must concentrate close to the local maximum points of the graph of $\tilde{K}(t)$. To avoid a misunderstanding, we stress once again that dating a text here implies dating the events described in it. Besides, the text itself can have been written quite recently, e.g., a textbook on ancient history.

4.9. The discovery of dependent (parallel) historical epochs traditionally regarded as different

4.9.1. From 1978 to 1979, I made a series of experiments for calculating the coefficients $d(f_i(X), f_i(Y))$ for different pairs of historical surveys X and Y which embrace considerable historical periods (A, B) and (C, D) of the same length, i.e., $B - A = D - C$. This condition is necessary for a formal comparison of the informative functions of different texts.

Unexpectedly, pairs of historical epochs (A, B) and (C, D) traditionally regarded as different (and pairs of corresponding texts X and Y which describe them) were discovered for which the coefficient d turned out to be extremely small, i.e., characteristic of *a priori* dependent texts (epochs). Let me give one example.

Let Z be the part of F. Gregorovius' work *History of the City of Rome in the Middle Ages* [3] embracing the events in medieval Rome from A.D. 300 to 754. In other words, $A = 300$, and $B = 754$. As a text Y, we take the part of Livy's *History of Rome* ([2]) describing the antique history of Rome from the year 1 since the foundation of the City (Rome) to the year 459 since the foundation of the City. It is traditionally assumed that the year 1 since the foundation of the City coincides with 753 B.C. Therefore, we can take the 460-year-long interval from 753 to 294 B.C. as (C, D). Traditional history certainly regards these two texts, and the events described by them, as independent in all respects. However, the computation shows that $d(Z, Y) = 6 \cdot 10^{-10}$ for the volume function, which means that, due to the smallness of the coefficient, the two texts and epochs are "like" dependent texts or epochs.

Recall that Sergeev's text X [1] is necessarily dependent on Livy's text Y [2]. This circumstance was confirmed above by a calculation according to which $d(X, Y) = 2 \cdot 10^{-12}$. We should, therefore, expect that from the standpoint of the coefficient d, Gregorovius' and Sergeev's texts, i.e., Z and X, respectively, will turn out to be dependent. Computations fully confirm this assumption, too.

4.9.2. It is interesting to investigate the behaviour of d by enlarging the textual time scale. For example, let the parameter t now range not over years, but over separate half-centuries. As a text Z, we take the part of Gregorovius' book [3] which describes medieval Rome from A.D. 300 to 950, i.e., during a 650-year-long time interval. As a second text, X, we take the part of Sergeev's book [1] describing the events in ancient Rome from the year 1 to 650 since the foundation of the City, i.e., from 753 to 103 B.C. (assuming that the year 1 since the foundation of the City coincides with 753 B.C.). Ranging over half-centuries, the parameter t, therefore, assumes 13 values in the indicated time interval. Calculations show that $d(Z, X) = 1/50$. Here, we have made use of the textual volume graphs.

Similar results are valid for the information function f_2 both for the initial (where t ranges over separate years) and the enlarged time scale.

The order of the coefficient d remains practically unaltered also in smoothing the graphs of the functions f_1 and f_2, which indicates the stability of the results relative to the smoothing, or averaging operation. We can also see here the advantages of "long time scales", when the length of the time interval described in the texts is of the order of 100–1,000 years. With the functions $f_i(X)$ and $f_i(Y)$ being correlated, the coefficient d then turns out to be especially small for dependent texts. Enlarging the scale certainly makes the picture rougher, which affects the increase of d. In the example given, it increased to 1/50.

4.10. The dynasty of rulers and the durations of their reigns as an important informative function

We now give an example of another important textual informative function. Consider a continuous (or gap-free) sequence R of some rulers (kings) $R_1, \ldots, R_n$. Let them be indexed by an integral parameter i whose increase is associated with ordering the kings chronologically. As the informative function, we take the duration of a rule, i.e., let $f_5(i) =$ the duration of the rule of king R_i who is ith in order. The sequence (dynasty) of the rulers $R_1, \dots, R_n$ will be called a *dynastic stream* for short.

Along with a sequence of numbers representing the durations of the rules, we can define (as above) the vector $a(R)$ of the local maximum points of this graph, which permits us to compare two sequences of rulers by comparing the graphs of the durations of their reigns.

The difference from the previous algorithm lies in the fact that the proximity coefficient d must be calculable in a more complicated way for two dynasties, which is related to the impossibility of regarding the random vector which schematically represents the graph of the rule durations in a dynasty to be distributed uniformly. Because of lack of space, we omit the details of this investigation. It turns out that the distribution of the durations of the reigns of kings (monarchs) is subject to a sufficiently nontrivial law which forms the basis for defining the proximity coefficient for two dynasties.

4.11. Frequency distribution of the rules of kings who lived from A.D. 1400 to 1800 and from 3000 B.C. to A.D. 1800

Figure 12 represents the result of processing the numerical information regarding the durations of reigns contained in J. Blair's chronological tables [4]. The rule durations of historical characters of Europe and of the Mediterranean region are marked off on the horizontal axis S in the time interval from 3000 B.C. to A.D. 1800, where the parameter S ranges not over separate years of a reign, but pairs of years, i.e., 1–2 years, 3–4 years, 5–6 years, ..., 89–90 years. Further, the values of the following function, $P(S)$ = number of historical characters whose rule duration lies in the interval S, are marked off on the vertical axis P. For example, there were 55 personages (included in Blair's tables) ruling from 19 to 20 years. The dotted line in Fig. 12 represents the frequency distribution of the rules of those kings who lived from A.D. 1400 to 1800. The continuous line describes those kings who lived from 3000 B.C. to A.D. 1800 according to traditional chronology. In the investigation of the complete lists of the European and Mediterranean rulers from 3000 B.C. to A.D. 1800, I was assisted by M. Zamaletdinov and P. Puchkov.

The proximity coefficient d for two dynasties should be calculated by taking into account the above histogram of the rule duration frequency. The following experiment also indicates the necessity of resorting to it. All 1200 rulers listed in Blair's chronological tables were aligned in sequence, ordered chronologically inside one dynasty (in one region). Simultaneous reigns were placed in line one after another. We now index the obtained sequence of rulers by $i = 1, 2, \dots, 1200$. Let ξ_i be the random variable representing the duration of the ith king's rule. Consider another random variable $\eta_i(k) = \xi_{i+k}$. The sequence η is thus obtained from ξ by shifting as a rigid block through k units (numbers). Let $r(k)$ be the correlation coefficient for ξ and $\eta(k)$. The graph of the variable $r(k)$ for $1 \leq k \leq 300$ is shown in Fig. 13. The calculations have been performed on a computer by P. Puchkov. We do not have the space here

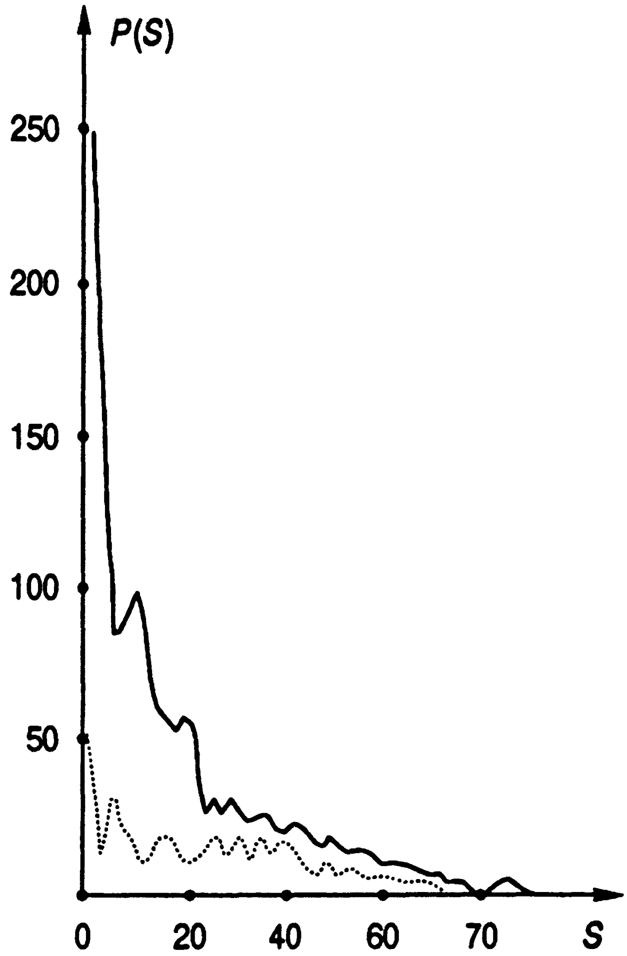


Figure 12. Frequency distribution of the rules of kings of Europe and the Mediterranean region from 3000 B.C. to A.D. 1800 and from A.D. 1400 to 1800

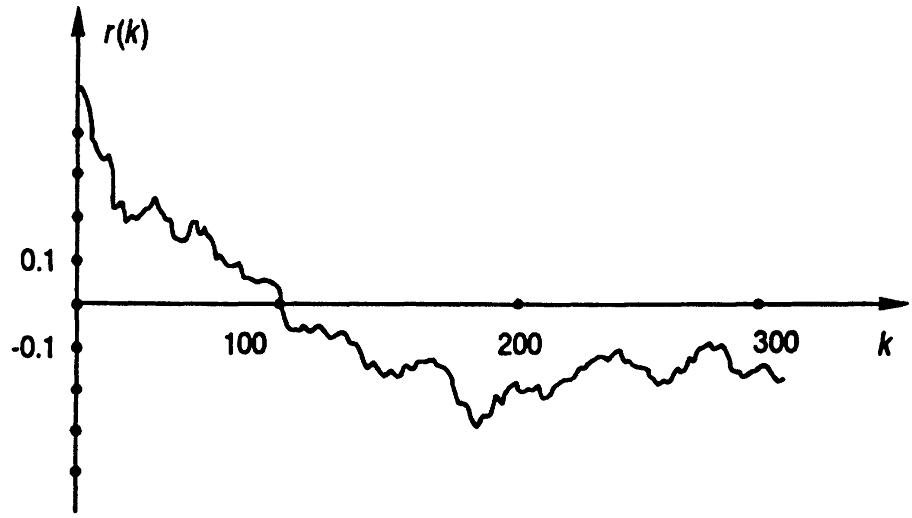


Figure 13. Graph of the variable $r(k)$.

to list the results of other experiments or the related conclusions. That will be carried out in Vol. 2 of this book.

4.12. The concept of statistically parallel historical texts and epochs

We now formulate the concept of formal, statistical isomorphism (parallel) of historical texts and epochs. Let a time interval (A, B) in the history of some region or state M be described in the historical texts $X = \{X_1, \dots, X_k\}$. Let another time interval (C, D) in the history of another and, in general, different region or state H be described in the texts $Y = \{Y_1, \dots, Y_p\}$. Consider the set of informative functions $f_i(X)$ and $f_i(Y)$ of these collections of texts. We will say that the above historical epochs (texts) are formally isomorphic (parallel) if the proximity coefficients $d(f_i(X), f_i(Y))$ are "small". More precisely, they must be as small as those of *a priori* dependent texts (epochs).

The concept of formal isomorphism of epochs described in some historical texts does not at all mean that the epochs or events themselves are identical. Their isomorphism (parallelism) can indicate the convention of ascribing, for some reason, certain historical documents from one epoch to another. Our goal is to solve the global problem, i.e., to describe the collection of all parallel epochs and texts in the whole historical period of written language (see below) for which we extend the stock of informative functions.

4.13. The "written biography" or enquête-code of a historical character

4.13.1. Very heterogeneous historical information has survived concerning the ancient dynasties of rulers. Meanwhile, different sources speaking of the same ruler can be very different in the details concerning the description of his or her activity. Sources can deal with the events during the monarch's rule differently, characterize differently the rulers themselves, and refer to them by different names or nicknames, and so on.

But there exist more or less "invariant" facts whose description is less dependent on a bias or political pressure on the chroniclers. One of these "invariant" parameters, for example, is the duration of a king's rule. Usually, there are no special reasons for which a chronicler would like to considerably distort this value (since it is emotionally neutral). By a "dynasty" of kings, we will understand a continuous (i.e., gap-free) sequence of rulers of one region. We do not assume that the throne should always be passed on hereditarily (from father to son, etc.). With each ruler or prominent statesman playing an important role in a particular period of history, we associate a certain table called an enquête-code, or "formal biography". By a "written biography" of a historical character, we will understand the collection of all preserved evidence about him or her. Normally, this "biography" is a set of individual facts which are rather uncoordinated and traditionally ascribed to the "ruler" by the later historians and chronologists based on the systematization and dating of the available written evidence. Besides, arising from the investigation of the primary sources, this "biography" can have almost nothing to do with the actual biography of the ruler. Strictly speaking, in many cases, we can only guess at the ruler's real biography. Therefore, we only deal with "written biographies" in the following. Now, we associate each "written biography" established in the primary sources with the enquête-code, or "formal biography", by possibly distinguishing all the basic facts from the "written biography". In doing so, we hierarchically order the facts of the "formal biography" in accordance with their decreasing invariance. The facts most often distorted by chroniclers will be nearer the end of the table.

(1) Sex of a personage: (a) male, (b) female.

(2) Length of life of the personage (or at least the year of death).

(3) Duration of the rule. It should be noted here that the end of the rule is nearly always fixed uniquely by the chronicles. It is usually the death of the ruler. The beginning of the rule sometimes (though, rather rarely) admits several versions, among which are the official coronation date, those of conferring the title of "Caesar" or "Augustus", and of the death of a more powerful co-ruler, and so on.

During the statistical investigation, all possible versions of the beginning of a rule are then indicated by all available means, considered to be equally likely, and included in the enquête-code. Note that, in analyzing real chronicles, we found that the number of versions of the date of the beginning of a rule only rarely reached three.

(4) Social status: (a) emperor, king, queen, etc., (b) army commander, (c) politician, public figure, or statesman, (d) scientist, (e) religious leader (pope, bishop, high priest, prophet, etc.).

(5) Cause of death of the personage: (a) natural, (b) on the battlefield, or as the result of a mortal wound, (c) result of conspiracy in peace time, (d) result of conspiracy in war time, (e) due to some special, exotic circumstance.

(6) Natural disasters during the personage's rule: (a) hunger, (b) floods, (c) epidemic diseases, (d) earthquakes, (e) volcanic eruptions. The duration of the event and the year (or years) when it occurred are noted by all available means.

(7) Astronomical phenomena during the rule: (a) did occur, (b) did not occur, (c) solar or lunar eclipses, (d) appearance of comets (often as "swords" in the sky, etc.), (e) "star" flares, (f) horoscopes, i.e., the planetary positions relative to the zodiacal constellations.

(8) Wars during the rule of the personage: (a) did take place, (b) did not take place.

(9) Number of wars (different wars are usually separated in chronicles).

(10) Basic time characteristics of the wars $B_1, B_2, \dots, B_p$. Namely, $a_k =$ year of the king's rule in which the war numbered k, i.e., B_k, took place; $h_k =$ duration of the war B_k; $c_{kx} =$ distance in years between the wars B_k and B_x.

(11) Intensity of the war B_k for each k. The intensity of a war can be estimated, for example, by the volume of texts in chronicles devoted to it. Roughly speaking, wars can be divided into two classes, namely, (a) large-scale wars, (b) local wars.

(12) Allies, adversaries, and neutral forces in a war B_k (for each k); their

number and schematic diagram of their relations (who are allies or enemies, etc.).

(13) Geographical localization of a war B_k (for each k): (a) near or inside the capital, (b) inside the state, (c) outside the state and where exactly (external war), (d) both external and internal war simultaneously, (e) civil war or a war with external enemy.

(14) Final result of the war: (a) victory, (b) defeat, (c) uncertain result.

(15) Peace talks: (a) concluding a peace treaty after the victory of one of the adversaries (who exactly; see paragraph (12)), (c) concluding a peace treaty after the defeat of the ruler.

(16) Conquering the capital: (a) did occur, (b) did not occur, (c) specific circumstances of the capital's siege or its fall.

(17) Fate of the peace treaty: (a) it was violated (by whom and under what circumstances), (b) was not violated during the rule.

(18) Detailed description of conquering (or fall of) the capital during the war.

(19) Diagram of the armies' marches during the war.

(20) Ruler's participation in the war: (a) did occur, (b) did not occur.

(21) Conspiracies during the ruler's lifetime: (a) did occur, (b) did not occur.

(22) Geographical localization of wars, allies, adversaries.

(23) Name of the capital. A translation of the name is necessary.

(24) Name of the state. Translation is necessary.

(25) Geographical localization of the capital (with the terms translated).

(26) Geographical localization of the state (with the terms translated).

(27) Legislative activities of the ruler (a) reforms and their nature, (b) issuing of new code of laws, (c) reintroduction of former laws (which exactly).

(28) Complete list of all names of the ruler with their translations. As a matter of fact, practically all ancient names have meaningful translations and originally were simply nicknames (such as "mighty", etc.).

(29) Ethnic group of the ruler, members of his or her family, composition of the family.

(30) Ethnic group of people living in the region or city.

(31) Founding of new cities, capitals, fortresses, harbours, etc.

(32) Religious situation: (a) introduction of a new religion, (b) sectarian struggle (between what sects exactly, names of the leaders and their translations), (c) religious riots and wars, (d) religious meetings, councils, etc.

(33) Dynastic struggle inside the ruler's clan, murders of relatives (if any), usurpers of the throne, adversaries, etc.

(34) Other fragments of the "personage's biography" will not be differentiated in such a detailed manner and will be collected in this item. We will call the information gathered here the "biographical remainder". It is convenient to measure it as a percentage of the whole "biography".

Denote the listed items by EC-1, EC-2, ... , EC-34 (enquête-code, paragraph (1), (2), ... , etc.). The whole enquête-code (i.e., the above table) will be denoted by EC for short. Thus, each "written biography" can be represented as a certain formal table of EC, or "formal biography". Certain items in this table may be left blank, which occurs in the case where the corresponding information has been lost in the surviving documents.

4.13.2. If the parameter i ranges over the numbers of consecutive rulers in a dynasty (dynastic stream) $R_1, \dots, R_n$, then the enquête-codes EC_i of R_i can be regarded as the set of values of a certain new informative function. Since the set of enquête-codes of the rulers of a dynasty practically completely accumulates all the important information from that epoch, we can assume that the sequence, in fact, describes the epoch (A, B) in the history of the region. It is "covered" by the rulers of the given dynasty. Eventually, we can associate each historic epoch with a set of informative functions $v = \{f_1, f_2, \dots,$ EC-dynasties$\}$, where $f_1, f_2, \dots$ are the informative functions already familiar to us, and the EC-dynasties are the enquête-code collection for the rulers "covering" (A, B). Since the rulers in one region sometimes reign simultaneously (and are then called co-rulers), different "dynastic jets" should be distinguished from the total dynastic stream, i.e., continuous (gap-free) subsequences of personages among whom there are no co-rulers or very few of them.

Consider now the two epochs (A, B) and (C, D). Associate each with the above set of informative functions, i.e., $v = \{f_1, f_2, \dots,$ EC-dynasties$\}$ and $v' = \{f'_1, f'_2, \dots,$ EC$'$-dynasties$\}$.

4.14. A method of comparing the sets of informative functions for two historical epochs

4.14.1. Let us describe a method of comparing the sets of informative functions v and v' for two epochs. The comparison has been carried out in terms of coordinates, i.e., the functions f_i and f'_i of the same kind are compared to each other. For $f_1, f_2, \dots,$ the coefficients of the above d-type were calculated. The comparison of the dynastic enquête-codes, i.e., the EC-dynasties and EC$'$-dynasties, is more complicated owing to a finer structure of these informative functions. Without going into details, we only discuss the comparison principle.

We start with the comparison of rule durations. Let $T_1, \dots, T_n$ and $T'_1, \dots, T'_n$ be two sequences of dynastic rule durations in the epochs (A, B) and (C, D), respectively. We will measure the "distance" between them using the coefficient λ introduced in §5; see below. The coefficient λ can be called "stream deviation coefficient" (SDC).

4.14.2. Thus, we compared the items of the enquête-codes EC-3 and EC$'$-3 of two rulers R and R'. The comparison of the remaining items will be done as follows. Let EC-1, ..., EC-34 be the enquête-code EC for the ruler R, and EC$'$-1, ..., EC$'$-34 the enquête-code EC$'$ for R'. We introduce the numerical coefficients $E_1, \dots, E_{34}$ measuring the proximity (or remoteness) of the items EC-1 and EC$'$-1, ..., EC-34 and EC$'$-34. We have omitted here the times EC-3 and EC$'$-3, since they are compared already by means of the SDC. To compare the items EC-j and EC$'$-j, we introduce the coefficients E-j. Then the following three situations are possible.

(1) The biographical data compared are similar. For example, the items EC-5 and EC$'$-5 state that both rulers died a natural death, in which case we put $E\text{-}5 = +1$.

(2) The biographical data compared are not explicitly coincident. For example, EC-5 states that a ruler died a natural death, and EC$'$-5 that he died as the result of a conspiracy. We then put $E\text{-}5 = -1$.

(3) The biographical data compared are neutral in the sense that they are consistent, but not identically coincident. For example, EC-5 states that a ruler "died", whereas EC$'$-5 states that a ruler "was killed". We then put $E\text{-}5 = 0$.

We now introduce the resultant coefficient $E = E\text{-}1 + E\text{-}2 + E\text{-}4 + \cdots + E\text{-}33$. The coefficient E-3 is absent because the rule durations are compared by means of the SDC. Thus, the coefficient E measures the proximity of the enquête-codes of the two rulers R and R'. Now, given two sequences of rulers $\{R_i\}$ and $\{R'_i\}$, we obtain a sequence of coefficients E_i comparing them. Finally, we introduce the average coefficient $E_{\text{av.}} = \frac{1}{n}\sum_{i=1}^{n} E_i$ measuring the proximity of the complete enquête-codes of the dynasties of $\{R_i\}$ and $\{R'_i\}$. Collecting this information, we might be able to estimate the remoteness or proximity of the enquête-codes of two dynasties and their corresponding epochs by means of the coefficients $E_{\text{av.}}$ and the SDC.

4.15. A computational experiment

From 1978 to 1979, I performed a computational experiment, comparing several hundred pairs of epochs (A, B) and (C, D), i.e., sets of their informative functions $v = \{f_1, f_2, \ldots,$ EC of dynasties of rulers$\}$. The time limits for the experiment were 3000 B.C. and A.D. 1800, with the events localized in Europe, the Mediterranean region, Egypt, and the Near East.

In particular, the experiment showed that, in comparing the enquête-codes of some personages, we often had to put the coefficient E-j equal to zero, which occurred because the information compared there was consistent and, at the same time, unconfirmed. The role of $+1$ and -1 was therefore heightened. We discovered further that, in the overwhelming majority of concrete enquête-codes, the coefficient E-34 has to be made equal to zero, again because of the consistency of information compared. Recall that item EC-34 of an enquête-code is the personage's "bibliographical remainder". For a reliable comparison of the items EC-34 and EC$'$-34 in two biographies, we must be certain that we really possess sufficiently complete "written biographies" of the personages compared. However, to guarantee the completeness of the rulers' enquête-codes (all the more, of whole dynasties) is usually a complicated matter, due to which we have resorted to the following formal method.

For each historical epoch, we have chosen a (possibly) uniform and sufficiently large historical text describing the events. We took either a fundamental monograph of the type of Gregorovius' work or a fundamental primary source of Livy's type. Then item EC-34 of the enquête-code was identified with the "bibliographical remainder" for a historical character given in the historical work. For simplicity, the volume of item EC-34 was usually calculated as a percentage of the volume of the entire "biography" of the personage. Meanwhile, as a rule, we did not analyze the components of item EC-34.

We illustrate this with an example. The epoch of regal Rome from 753 to 510 B.C. described by Livy (see [2]) turns out to be sufficiently close to that of the Roman Empire in A.D. 300–552, with the SDC being less than the lower bound for most of the SDC values for independent dynasties. Further, it turns out for these epochs that $E_{\text{av.}} = +19$, and that the volume of item EC-34 equals 29%. In other words, about 29% of the "biographies" of historical characters in these epochs were "thrown overboard" from the discussed parallels, it being important that this entire "biographical remainder" is zero for the coefficient of EC-34, which means that the information not involved in the parallel is noncontradictory within the framework of the comparison.

It is useful to compare this result, which probably indicates the dependence of the epochs, with the numerical parameters found for an arbitrarily chosen pair of independent epochs. As an example of independent historical epochs, we take the following dynasties.

(1) The dynasty of the Russian grand dukes from Igor (912–944) to Demetrius I (1275–1293).

(2) The dynasty of the Byzantine emperors from Theodosius II (408–450) to Theophilus (829–842) [4]. Calculations show that the SDC is "very large"; further $E_{\text{av.}} = -8.7$. In this case, the volume of the "remainder" EC-34 is equal to 40%. This pair of dynasties is independent from the standpoint of the coefficients we introduced.

A great difference is obvious between this and the example of the two dependent Roman Empires (see above).

We shall now describe the results of the global computational experiment of comparing different epochs.

4.16. The remarkable decomposition of the global chronological diagram into the sum of four practically indistinguishable chronicles

4.16.1. The application of the above methods to the material of the GCD led to the discovery of isomorphic, parallel historical epochs in the history of Europe and the Mediterranean region (see Fig. 14). The sequence of figures forms a line in the diagram, schematically representing the history of ancient and medieval Europe. Identical geometric figures (denoted by the same letters) schematically represent historical epochs (or some parts of these epochs) which turn out to be formally isomorphic and parallel.

Figure 15(1) represents the decomposition of the GCD into the sum of four practically indistinguishable chronicles. We can say that the GCD is decomposable into the sum of several shifts of the same chronicle. As it turns out, we can distinguish a shorter part in the GCD, which we call the chronicle

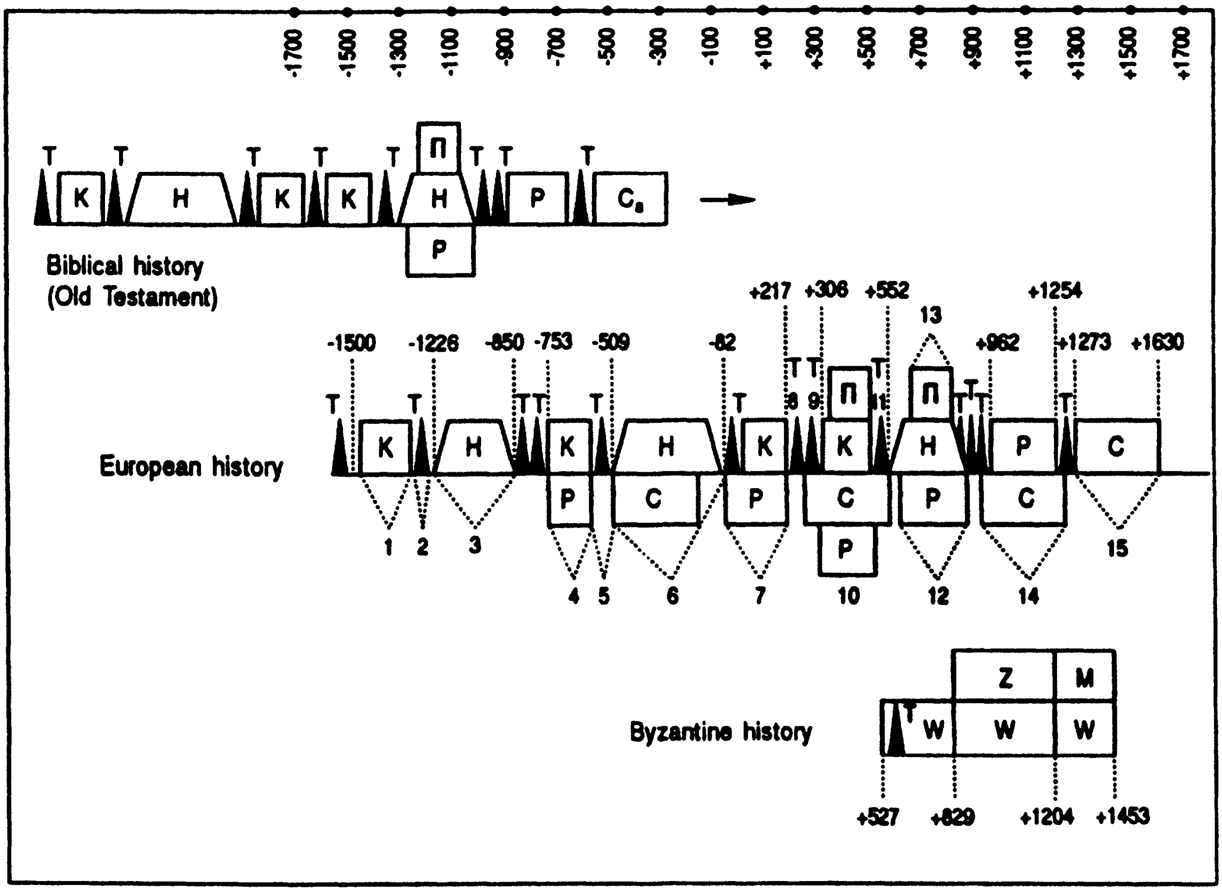


Figure 14. Parallel historical epochs in the history of Europe (and the Mediterranean region) and in biblical history.

C_1. We then take another three copies of the same chronicle, each of which is shifted back on the time axis (i.e., from right to left) by 333 years, 1,053 years, and 1,778 years, respectively, after which all the shifted copies of C_1 are glued to it and to each other, resulting in a longer GCD chronicle on which, therefore, parallel epochs duplicating each other appear.

4.16.2. We now give a short description of the GCD for Greece, Rome, and Germany. We shall move from left to right in Fig. 14 and list the historical epochs denoted by different geometric symbols. For a detailed description of all the dynastic jets for these cases, see Vol. 2 of this book.

The numbers of the following items correspond to those of the indicated historical epochs (from 1 to 15).

(1) The Trojan kingdom of 1460–1236 B.C. Seven legendary Trojan kings.

(2) The Trojan War, *ca.* 1236–1226 B.C. The fall of Troy, expulsion of the Trojans.

(3) Several dynastic jets of ancient Greek rulers from 1226 to 850 B.C., i.e., from the fall of Troy to the second version of dating the Trojan War according to the ancient authors Hellanic, Damast, and then Aristotle ([5]; [5*], p. 23) immediately before the foundation of Rome.

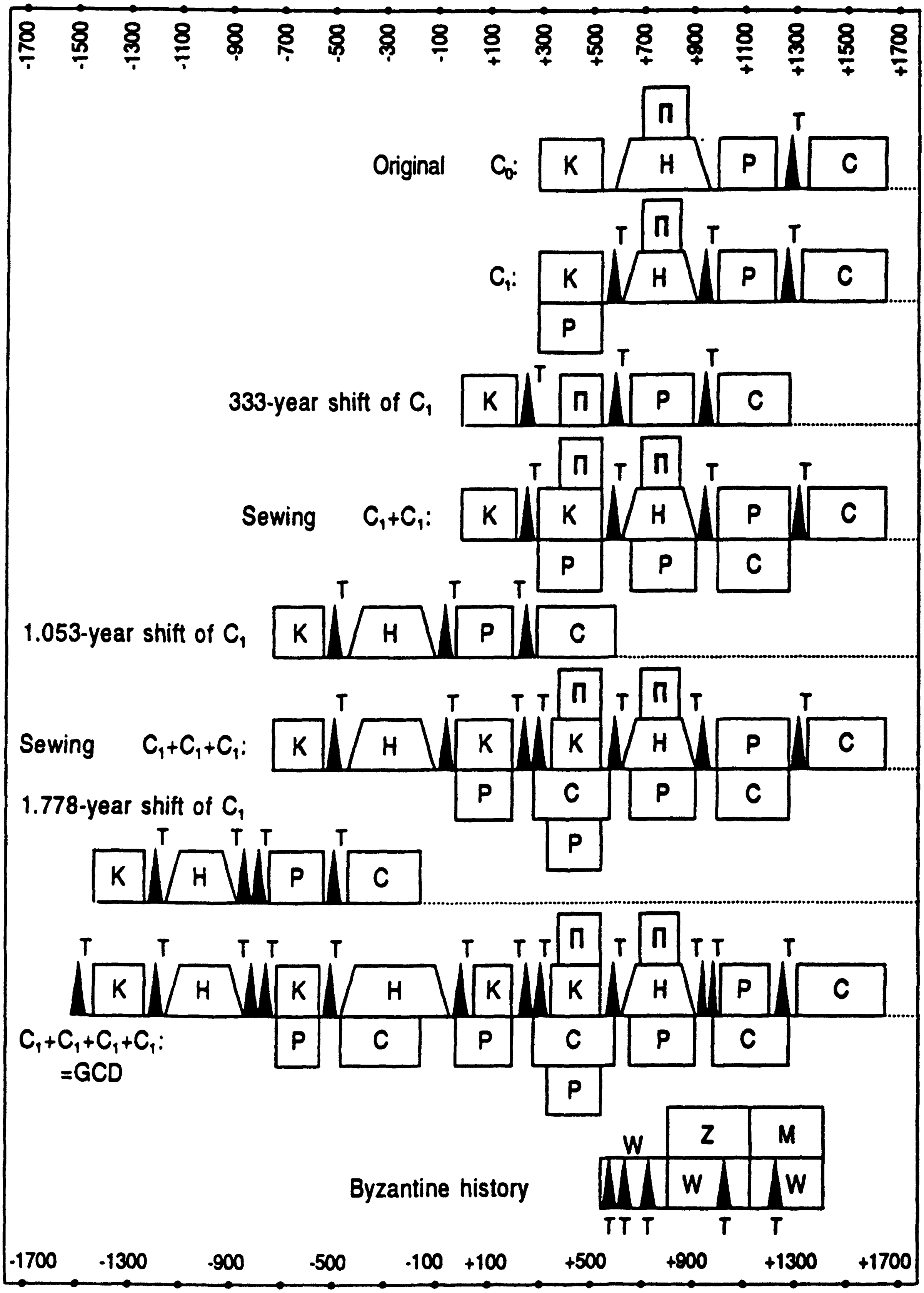


Figure 15(1). The remarkable decomposition of the GCD into the sum of four short and practically indistinguishable chronicles.

(4) The foundation of Rome and the regal period described by Livy, from 760 or 753 B.C. to 522 B.C.

(5) The war with the Tarquins, the kings' "exile" from Rome and the foundation of the ancient Roman republic (522–509 B.C.).

(6) Republican Rome and ancient Greece in 509–82 B.C. The end of classical Greece, start of Hellenism.

(7) Civil wars in Italy during the fall of republican Rome in the 1st century B.C. Beginning of imperial Rome. The Roman Empire (82 B.C.–A.D. 217).

(8) Wars in Italy and crisis of the Roman Empire in the middle of the 3rd century A.D. Wars with the Goths, "soldiers' Emperors" (A.D. 217–235–251).

(9) Restoration of the Roman Empire under Aurelian, and contemporary war in Italy (A.D. 270–300).

(10) Roman Empire A.D. 300–535. Western and Eastern Empires.

(11) Gothic War in the middle of the 6th century A.D. in Italy (535–552).

(12) Medieval papal Rome from A.D. 553 to the middle of the 10th century.

(13) Carolingian Empire, including the empire of Charlemagne 681–887. Wars of Charlemagne.

(14) Holy Roman Empire of the German Nation in the 10th to 13th century. The war in the middle of the 13th century; the fall of the dynasty of the Hohenstaufen (1250–1268).

(15) Empire of the Habsburgs (1273–1619 or 1637).

Besides, (10)–(13) also include the medieval dynastic branches of the Eastern Roman and Byzantine Empire.

The parallels marked in Fig. 14 sometimes link all duplicate historical epochs, and sometimes only certain layers within these epochs. Certain epochs in the GCD can branch into several layers parallel to other epochs.

4.16.3. Consider the epoch of ancient Rome from 753 B.C. to 230 B.C. and that of medieval Rome in from 300 to 820. Remember that these epochs are "parallel" in the sense that the coefficient d measuring the proximity of the local maxima of the volume function (for the primary sources describing these periods of history) is very small and equals $6 \cdot 10^{-11}$. This parallelism (overlapping) is confirmed by that of the enquête-codes which I found for the rulers' dynasties of these matching epochs. Moreover, I have discovered the parallelism of the events of the epoch of ancient Rome from 753 B.C. to A.D. 300 and that of medieval Rome from A.D. 300 to *ca.* 1353, which follows. The overlapping of parallel events occurs in shifting their dates by *ca.* 1,053 years. In other words, this rigid chronological shift can be written as the formula $T = X + 300$ years, where T are years A.D., and X the years from the foundation of the City (Rome). It is assumed traditionally that the year 1 since the foundation of Rome coincides with 753 B.C. In our forward shift, the "foundation of the city" falls in the year A.D. 300. I discovered this important "uniform forward shift" formula as a result of applying the enquête-code method and the method for the calculation of d. It turns out that $E_{\text{av.}} = +18$ in the time interval from the year 1 to 250 since the foundation of Rome (when compared with the duplicate period A.D. 300–550). In the next time interval, A.D. 550–820, the small value of the coefficient d calculated above for the duplicate epoch 250–520 since the foundation of Rome is consistent with the existence of a whole series of far-reaching parallelisms linking these two periods, i.e., the antique and medieval ones. An additional analysis of this overlapping (in the interval from A.D. 553 to 820) was then carried out by E.M. Nikishin. From 1978 to 1979, I also investigated the next time interval from the middle of the 9th to the 17th century (which overlaps with the period from 200 B.C. to A.D. 570) with the aid of the enquête-code method. The result is shown in the GCD in Fig. 14. For details, see Vol. 2.

4.16.4. As noted above, the concept of a text with a scale is more general than the examples of historical, narrative texts given above. For example, as a text X, we can take the collection of all the works of one author, as the parameter the numbers of pages (with consecutive pagination), and some quantitative characteristic of the text, for example, the average length of sentences, frequency of conjunctions, and so forth, as the informative function. The question arises whether there exist any conservation laws controlling the behaviour of such informative functions. It turns out that the answer is positive (see the author's paper "Authorial invariants in Russian literary texts of narrative sources" in *Methods of Quantitative Analysis of Texts of Narrative Sources*, History Institute of AN SSSR, Moscow, 1982, pp. 86–109; in Russian).

We stress that the present chapter is only a brief survey of the theses, the detailed treatment of each of which is rather voluminous and requires an extensive machinery designed for lengthy statistical material.

References

[1] Sergeev, V.S., *Essays on the History of Ancient Rome*. Sotsekgiz, Moscow, 1938 (in Russian).
[2] Livy, Titus, *Works*. Cambridge, Harvard University Press; Heinemann, London, 1914.
[3] Gregorovius, F., *History of the City of Rome in the Middle Ages*. G. Bell & Sons, London, 1900–1909.
[4] Blair, J., *Blair's Chronological and Historical Tables, from the Creation to the Present Time, etc.* G. Bell & Sons, London, 1882.
[5] Niese, B. *Grundriß der römischen Geschichte nebst Quellenkunde*, 2nd ed. München, 1923.
[5*] Russian transl. (from the 1st ed.), St. Petersburg, 1908.

§5. A Method of Duplicate Recognition and Some Applications to the Chronology of Ancient Dynasties[1]

5.1. The process of measuring random variables

Let a finite set of points D and a certain many-valued mapping $V : D \to R^n$ which transforms D into a larger, but still finite set of points $V(D)$ be given in the Euclidean space R^n. For example, V can model a multiple process of measuring a certain random discrete variable ξ taking values in the set D. The many-valuedness can be caused by the nonuniqueness of the results of measuring due to the existence of random errors. Meanwhile, $V(D)$ can be regarded as the set of values obtained by measuring the given random variable. Note that each true value x of ξ turns into the set of points (values) $V(x)$ upon its measuring. It represents the original value x of the variable ξ. In particular, each point of $V(x)$ can be regarded as an approximate value of the true value x.

In studying real processes of measuring random variables, the principal difficulty lies in correctly modelling, by means of the choice of a suitable mapping V, the mechanism of real measuring errors. Now, let the set D of the real values be unknown, and only the set $V(D)$ of the "results of measuring" the desired random variable be known. How can we recognize those points of $V(D)$ which correspond to the same point in the set D? The points (results of measuring) associated with the same real, true value will be called its duplicates, which, in turn, can naturally be called "original".

Let the mapping V be such that the sets $V(x)$ and $V(y)$ are disjoint if the points x and y are different.

5.2. The distance between two random vectors

We introduce a certain natural measure λ of the distance between the points in the set $V(D)$. We shall strive to make the points which belong to the same set $V(x)$ (i.e., duplicates) sufficiently close in the sense of the measure λ. On the contrary, points from different $V(x)$ and $V(y)$ should be distant in the sense of λ.

Let a and b be two points in $V(D)$. Fix a and construct its special neighbourhood H_r. We shall attempt to make the point a the centre of H_r, and let b lie on the boundary of the neighbourhood or close to it.

The simplest of such neighbourhoods is $H_r' = \{c \in R^n : |a_i - c_i| \le |a_i - b_i|,\ 1 \le i \le n\}$. In other words, H_r' is simply a parallelepiped with its centre at a and having b as one of its vertices, where $a = (a_1, \ldots, a_n)$, $b = (b_1, \ldots, b_n)$.

For this simplest construction to become suitable in important applications, we have to extend it to model the mechanism of the random errors of interest, which influence the measurements of the true values of the variable ξ. We

[1] First published as an article in *DAN SSSR* **258**, 6(1981), pp. 1326–1333 (in Russian).

construct such a neighbourhood $H_r(a, b)$ below and thereby introduce the natural measure λ, permitting us to estimate the distance between two points a and b. As the basis for defining the measure, we shall take the procedure developed in §4. Namely,

$$\lambda(a, b) = \frac{\mathrm{vol}\, H_r(a, b)}{\mathrm{vol}\, V(D)},$$

where vol $V(D)$ is the number of points in the whole set $V(D)$, and vol $H_r(a, b)$ that from $V(D)$ in the neighbourhood $H_r(a, b)$.

5.3. Dynasties of rulers. The real dynasty and the numerical dynasty. Dependent and independent dynasties. The small-distortion principle

We shall now describe a concrete problem for whose solution we introduce the measure λ. Let a historical text describing a previously unknown dynasty of rulers be discovered with an indication of the duration of their reigns. The question arises whether this historical dynasty is new and not mentioned in the known documents or whether it is one of the rulers' dynasties already known to us but described in a text in unusual terms (with the rulers' names distorted, etc.).

Consider n consecutive authentic rulers (kings). Let the true rule durations of these kings be $p_1, p_2, \dots, p_n$, respectively. We call this sequence a *real dynasty*. Note that the same real dynasty of rulers is often described in the primary sources from different standpoints by different chroniclers. But there exist more or less "invariant facts" concerning these rules, and their description depends little on the tastes of the author of a primary source (chronicler). Such facts include, for example, the duration of a king's rule, since there are usually no special reasons for which the chronicler should considerably and intentionally distort it. Nevertheless, chroniclers often encounter serious difficulties in calculating the regal rule duration, which leads to giving different values to the duration of the rule of the same historical character in different historical documents.

Thus, each author (chronicler), while describing a real dynasty $p = (p_1, p_2, \dots, p_n)$, calculates the duration a_i of a king's rule and obtains a certain sequence of numbers $a = (a_1, a_2, \dots, a_n)$. This sequence of numbers represented as an integral vector a in the space R^n will be called a *numerical dynasty*. Another chronicler, while describing the same real dynasty of kings, will possibly obtain another vector b from R^n, i.e., another numerical dynasty. Thus, one and the same real dynasty can be represented as different numerical dynasties in different documents.

As the set D described in 5.1, we take a sufficiently large set of real dynasties of length n, i.e., $D = \{p = (p_1, \dots, p_n)\}$. We formulate the following *theoretical model* (statistical hypothesis).

The small-distortion principle. *If two numerical dynasties are sufficiently close (in the sense of the measure λ), then they indeed represent the same real dynasty of kings, i.e., they are merely two different versions of its description.*

Such numerical dynasties will be called dependent. On the contrary, if two numerical dynasties represent two real dynasties of kings, known a priori as different, then the numerical dynasties are much different from one another (in the sense of the measure λ). Such numerical dynasties will be called *independent.*

Later in Section 5.4, before verifying this model experimentally, we shall give an exact description of the measure λ. Meanwhile, we identify the set of all numerical dynasties describing real historical dynasties from the set D in the space R^n (see above) with the set $V(D)$.

5.4. Basic errors leading to controversy among chroniclers as to the duration of kings' rules

We now point out concrete errors most often leading to the controversy among chroniclers as to the duration of the rules of kings.

(a) Permutation of the names of (or confusion between) two neighbouring rulers.

(b) Replacing two neighbouring rulers by one, the duration of whose rule was assumed to be equal to the sum of the rule durations of both.

(c) Computational error by a chronicler. The longer the duration of a king's rule, the greater the error that arises in its computation.

It turns out that these three basic types of concrete errors made by chroniclers can be sufficiently simply described by means of a suitable mapping, $V : D \to R^n$. Let p be a certain real dynasty in the set D. We call the dynasty (vector) c a *virtual variation (virtual vector) of the dynasty* p and write $c = v(p)$ if the following conditions are fulfilled, namely, each coordinate c_i of c coincides with one of the three coordinates of the original vector p, i.e., p_{i-1}, p_i, p_{i+1}, or with $p_i + p_{i+1}$.

It is clear that each of such virtual vectors, or virtual dynasties, can be regarded as a numerical dynasty and be obtained from a real dynasty p, because of chroniclers' errors of type (a) and (b).

Eventually, we take as $V(D)$ the union of all virtual vectors (virtual dynasties) $c = v(p)$, where p ranges over all the real dynasties of D. It remains to model an error of type (c).

Let a piecewise smooth, nonnegative function $\alpha(t)$ be given on the positive half-axis $t \geq 0$. In our case, the role of $\alpha(t)$ will be played by the probability density of a random variable η to be specified below. Put $h(t) = f(\alpha(t))$, where $f(s)$ is a certain monotonically decreasing function of a parameter s, given on the half-axis $s \geq 0$, and such that $\lim f(s) = +\infty$ when $s \to +0$. For example, as $f(s)$, we can take the function $\frac{\varepsilon}{s}$. If η is a discrete random variable with probability density $\alpha(t)$, then the quantity $h(t)$ becomes greater as η assumes the value t with lesser probability. In our problem, we take as η the duration of a king's rule in a dynasty. Let t range over all positive integers (i.e., possible values of the rule duration). If t is a certain fixed rule duration, or the value of η, then $\alpha(t)$ will mean the number of historical characters ruling for t years (see Fig. 12). We call $h(t)$ the error amplitude in measuring a rule t years long. The graph $\alpha(t)$ in Fig. 12 shows that short rules are most frequent, and, conversely, long rules are rare.

5.5. The experimental frequency histogram for the duration of the rules of kings

§4 showed the experimental frequency histogram I obtained for the rule durations of authentic kings (Fig. 12). If t is the value (rule duration) taken by the random variable η with large probability, then the amplitude of chroniclers' errors $h(t)$ decreases. In other words, the values of short rule durations of frequently mentioned kings have been calculated by the chroniclers better than long ones, which are rarely encountered. We now indicate the error function $h(t)$ of chroniclers, which we calculated for the probability density of the random variable, namely the "rule duration" (see §4).

Break the interval from zero to 100 on the integral axis t into smaller segments of the form $(10k, 10k+9)$, where $k = 0, 1, \dots, 9$. Then the amplitude $h(t)$ of the chroniclers' error has the following form, namely,

$$h(t) = \begin{cases} 2 & \text{when } 0 \le t < 20 \\ 3 & \text{when } 20 \le t < 30 \\ 5([\frac{t}{10}] - 1) & \text{when } 30 \le t < 100. \end{cases}$$

5.6. Virtual dynasties and a mathematical model for errors made by the chronicler in measuring the rule duration

Consider a rectangular parallelepiped $\Pi(a, b)$ in the space R^n and denote it simply by Π. Its orthogonal projections $\pi_i = a_i \pm (|a_i - b_i| + h(a_i))$ onto the coordinate axes in the space R^n will be given by intervals with the following endpoints, namely,

$$\pi_i = \begin{cases} a_i \pm (|a_i - b_i| + 2) & \text{if } 0 \le a_i < 20 \\ a_i \pm (|a_i - b_i| + 3) & \text{if } 20 \le a_i < 30 \\ a_i \pm (|a_i - b_i| + 5[\frac{a_i}{10}] - 5) & \text{if } 30 \le a_i < 100, \end{cases}$$

where $[y]$ denotes the integral part of the number y. Thus, if $0 \le a_i < 20$, then the rule duration a_i, and also b_i, of two kings numbered i in the dynasties compared, is considered by us only approximately, to the accuracy of ± 1 year. In other words, this is an error of the chronicler, made in measuring the rule duration. If $20 \le a_i < 30$, then the chronicler's error is already equal to ± 1.5 years, and so forth. We now fix two dynasties a and b.

It remains to model the fact that the assignment of a point (dynasty) c from the set of virtual dynasties $V(D)$ to the parallelepiped Π can be considered only approximately, with some allowance. Hence, we have to make the boundary of Π less distinct. Let r be a certain fixed number. Consider a real dynasty p from the set D. Assume that at least r coordinates p_i of this vector p, i.e., r values for the rule duration, have fallen onto the projections π_i of Π. We assume, in addition, that a certain virtual dynasty $c = v(p)$ of p has fallen entirely into Π. We say that such vectors (dynasties) p from D are r-close to the parallelepiped Π determined by the two fixed dynasties a and b.

Eventually, we define the neighbourhood $H_r(a, b)$ of a by considering the union of Π and all the virtual variations of dynasties (vectors) p from the set D, which happened to be r-close to Π (see Fig. 15(2)).

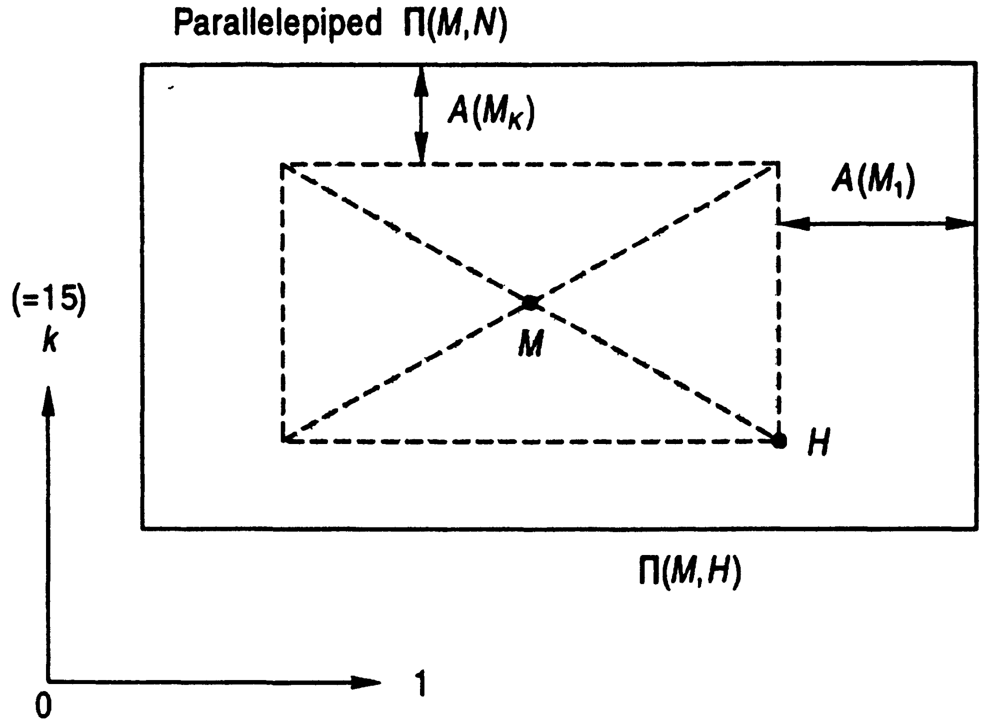


Figure 15(2). Parallelepiped determined by the two fixed dynasties M and N.

As a proximity measure for two dynasties a and b, we take the ratio of the number of dynasties (vectors) of the set $V(D)$, which are in the neighbourhood $H_r(a, b)$, to the total number of dynasties (vectors) in the set $V(D)$. In counting the number of dynasties in $H_r(a, b)$, we do not count the virtual variations of a and b, which are different from them.

The constructed number λ has an important probabilistic interpretation. Indeed, construct the function ϕ of the probability density for the random vector from the set $V(D)$ of all virtual dynasties, with the vector ranging over the dynasties. We divide the space R^n into standard cubes of sufficiently small size, so that no point of $V(D)$ has fallen onto any of their boundaries. If x is an interior point of some cube, then we take the following value as $\phi(x)$, namely,

$$\phi(x) = \frac{\text{number of points of the set } V(D) \text{ in this cube}}{\text{total number of points in the set } V(D)}.$$

However, if x is on the boundary of the cube, then we put $\phi(x) = 0$.

It is clear that the above measure $\lambda(a, b)$ is the integral of ϕ with respect to the set $H_r(a, b)$, provided that $H_r(a, b)$ consists of the cubes of our partition. Since we model here approximate calculations of the chroniclers, we can assume that this condition is fulfilled (if the cubes are sufficiently small).

Finally, the number $\lambda(a, b)$ can now be regarded as the probability of the fact that the random vector distributed in the space R^n with the density function ϕ has fallen into the neighbourhood H_r with its centre at a point (dynasty) a and the "radius" $|b - a| + h(a)$.

5.7. The small-distortion principle and a computer experiment

To verify the theoretical model of Section 5.3 (the small distortion principle), the chronological tables of J. Blair [1] and F. Ginzel [2] were used; they contain practically all the basic chronological data that survived for real historical dynasties. I have made a complete list of all dynasties of length $n = 15$ from the history of Europe, the Mediterranean region, the Near East, and Egypt from 4000 B.C. to A.D. 1800. The data have then been supplemented by information from 14 other chronological tables. The obtained list D turned out to represent certain real kings by several different numerical dynasties (due to the difference in the chroniclers' opinion). We now indicate the basic historical dynasties included in D.

Bishops and popes in Rome, Saracens, high priests in Judaea, Greeks in Bactria, exarchs in Ravenna, all dynasties of Pharaohs and other Egyptian rulers, dynasties of the Byzantine Empire, Roman Empire, Spain, Russia, France, Italy, the Ottoman Empire, Scotland, Lacedaemon (Sparta), Germany, Sweden, Denmark, Israel, Babylonia, Syria, Sicyon, Judaea, Portugal, Parthia, the Bosphorus, Macedonia, Poland, and England.

The total number of dynasties making up the virtual set $V(D)$ in the space R^{15} turned out to be approximately equal to $15 \cdot 10^{11}$. If, for some pair of virtual dynasties a and b, the number $\lambda(a, b)$ is sufficiently small, then the observable proximity of the dynasties a and b is a rare event; the rarer it is, the less is the coefficient $\lambda(a, b)$. As r in the numerical experiment, we have taken 11 equal to $1 + \frac{2}{3}n$ by the "two-thirds" rule.

The author then performed an extensive computational experiment to determine $\lambda(a, b)$ for different pairs of dynasties a and b. The result fully confirmed the model of Section 5.3. Namely, the coefficient $\lambda(a, b)$ turned out to oscillate for surely dependent numerical dynasties in the interval from 10^{-12} to 10^{-8}. If, on the contrary, the numerical dynasties a and b are surely independent, then the coefficient $\lambda(a, b)$ was not less than 10^{-3}. The great (5th-order) difference between surely dependent and surely independent dynasties is manifest. The remaining ones make up a small percentage of the total number of dynasties.

Obviously, the above result permits us to solve the problem of distinguishing dependent numerical dynasties.

5.8. Pairs of dependent historical dynasties previously regarded as independent

Our experiment has discovered several special pairs of historical dynasties a and b which previously had been regarded as independent in all senses; however, the value of the coefficient $\lambda(a, b)$ for them is the same as for pairs of *surely dependent dynasties*. There are only several dozen such special pairs among the 10^6 of dynastic pairs studied.

We shall illustrate this with some examples.

(1) The Roman Empire from 82 B.C. to A.D. 217 and the Roman Empire from 270 to 526, where $\lambda = 1.3 \cdot 10^{-12}$.

(2) The Holy Roman Empire of the German Nation from 962 to 1254 and the Habsburgs Empire from 1273 to 1619, where $\lambda = 1.2 \cdot 10^{-12}$.

(3) The Roman Empire from 270 to 553 (see example 1) and the Holy Roman Empire of the German Nation (see example 2) from 962 to 1254, where $\lambda = 2.3 \cdot 10^{-10}$.

(4) The Carolingians, the empire of Charlemagne from 681 to 887 and the Eastern Roman Empire from 333 to 527, where $\lambda = 8.25 \cdot 10^{-9}$.

5.9. The distribution of dependent dynasties in the "modern textbook" of ancient history

All the above results have been analyzed in the following manner. I have constructed the GCD for all the historical dynasties described in Section 5.7 (see also §4 and [3]), for which the rule duration periods for all the rulers of the indicated dynasties from list D and the dates of all basic events occurring in the time interval from 4000 B.C. to A.D. 1800 were marked off on the horizontal time axis (as horizontal intervals of different length).

The GCD was then subjected to the procedure of discovering duplicates, or dependent epochs. All the discovered historical dynastic pairs a and b, and the corresponding historical epochs, for which the coefficient $\lambda(a, b)$ turned out to be anomalously small, of the order from 10^{-12} to 10^{-8}, were marked on the GCD. We will call such dynasties (and also the epochs) duplicates.

Recall that the theoretical model of Section 5.3 has been confirmed by the results of the experiment performed, from which it follows that the anomalous small value of $\lambda(a, b)$ most probably indicates the dependence of the historical dynasties and their corresponding epochs.

We now describe the portion E of the GCD in the time interval from 1600 B.C. to A.D. 1800. We represent the result as a schematic line E made up of consecutive letters indicating on the time axis different dynasties and the corresponding epochs. Duplicate epochs will be represented by identical letters. Because of the enormousness of the data, we give here only a rough sketch of the GCD (for details, see Vol. 2 of this book). The letters in the numerator and denominator of a fraction represent simultaneous epochs. Thus, the epoch E has the form:

$$E = T\ KTH\ \ T\ T\ \ \frac{K}{P}\ \ T\ \ \frac{H}{C}\ \ T\ \ \frac{K}{P}\ \ T\ \ T\ \ \cfrac{K}{\cfrac{\Pi}{\cfrac{C}{P}}}\ \ T\ \ \cfrac{H}{\cfrac{\Pi}{P}}\ \ T\ \ T\ \ \frac{PT}{C}\ \ C$$

1600 B.C. 753 B.C. 82 B.C. A.D. 250 A.D. 962 A.D. 1619

It is obvious that E contains a repetition, duplicating each other's epochs. Besides, it decomposes into the sum of four almost identical copies of shorter chronicle lines (see Fig. 9). We can schematically write that $E = C_1 + C_2 + C_3 + C_4$. Line C_1 is obtained by gluing the chronicles C_0 and C' together.

Thus, all four chronicle lines C_1, C_2, C_3, and C_4 are practically identical, being only different in their position on the time axis.

5.10. Dependent dynasties in the Bible and parallel with European history

There are also other pieces (chronicles) in the GCD containing duplicates. Consider an example: the chronicle line B embracing the events from 4000 to 586 B.C., described in the Old Testament. We borrowed their chronology from Blair's traditional tables (Tables 1–7 in [1]; more precisely, see the data from Columns 1 and 2 of Tables 1, 2, and 3; Columns 1, 2, and 3 of Table 4; Columns 1 and 2 of Table 5; Column 1 of Table 6; and finally, Column 3 of Table 7). The historical events making up the chronicle line B have been described in Genesis, Exodus, Leviticus, Numbers, Deuteronomy, the Book of Joshua, the Book of Judges, the Book of Ruth, the First Book of Samuel, the Second Book of Samuel, the First Book of the Kings, the Second Book of the Kings, the First Book of Chronicles, the Second Book of Chronicles, the Book of Ezra, the Book of Nehemiah, and the Book of Esther. Traditionally, these events are believed to have occurred in the Near East, i.e., in a region different from that determined by the events composing the chronicle line E (Europe, the Mediterranean region; see above). The application of our method for duplicate recognition and those methods described in §4 lead to the discovery of duplicates in B, which are distributed as follows (for details, see Vol. 2).

$$B = T\ \ K\ \ T\ \ H\ \ T\ \ K\ \ T\ \ K\ \ T\ \ \cfrac{H}{\cfrac{\Pi}{P}}\ \ T\ \ T\ \ P\ \ T\ \ C_a,$$

where the epoch C_a is part of C. It is not accidental that we have employed the same symbols in describing the biblical chronicle B as for the European chronicle E. We see that B coincides with a certain part of E, i.e., overlaps it (there is parallelism of events). Namely, the following equality is valid:

$$E=T\;K\;T\;H\;T\;\frac{\left(T\;K\;T\;HT\;K\;T\quad K\;T\;\begin{array}[b]{c}H\\ -\\ \Pi\\ -\\ P\end{array}\;T\;T\;P\;T\;C\right)}{P\quad C\;\;P\quad T\;\begin{array}[t]{c}\Pi\\ -\\ C\\ -\\ P\end{array}},$$

or

$$E=T\;K\;T\;H\;T\;\;\frac{(\text{chronicle } B=\text{Old Testament})}{P\;C\;P\;T\;\begin{array}[t]{c}\Pi\\ -\\ C\\ -\\ P\end{array}},$$

The length of B equals *ca.* 2,300 years. Thus, the complete "textbook of modern history", i.e., the GCD, contains not only shortened redated chronicles of the forms E and B, but also parallel, or isomorphic, i.e., nearly coincident chronicles of considerable length. Meanwhile, they are traditionally treated today as chronicles describing different historical epochs.

The following general result is valid. The whole GCD, and not only the above chronicles E and B, can be completely restored from its lesser part C_0 describing the events placed to the right of A.D. 300, it being important that most of the events in C_0 are placed, in reality, even to the right of A.D. 960. In particular, the chronicle B can be practically completely restored from its lesser part which describes the events from A.D. 960 to 1400.

References

[1] Blair, J., *Blair's Chronological and Historical Tables from the Creation to the Present Time, etc.* G. Bell & Sons, London, 1882.

[2] Ginzel, F., *Handbuch der mathematischen und technischen Chronologie, etc.* Leipzig, 1906–1914.

[3] Fomenko, A.T., "On the computation of the second derivative of the moon's elongation", in *Controllable Motion Problems: Hierarchical Systems.* Perm University Press, Perm, 1980, pp. 161–166 (in Russian).

§6. A New Empirico-Statistical Procedure for Text Ordering and Its Applications to the Problems of Dating[1]

6.1. The chapter generation

This section presents one of the new methods for dating ancient events worked out on the basis of statistical principles which I initially formulated and verified in [1] and which I presented at the Third International Vilnius Conference on Probability Theory and Mathematical Statistics.

The goal of the method discussed in this section is to find a chronologically correct order of separate fragments of historical texts and to discover among them various duplicates, or repetitions, i.e., parts describing the same events.

We call the fragment of a historical text describing the events of (approximately) one generation a *chapter generation* (or simply *chapter*). Let a historical text X embrace the events in a sufficiently large time interval (A, B), i.e., from a year A to a year B. Assume that this text is broken (or can be broken) into separate chapters $X(T)$, where T denotes the number of a generation (historical characters) described in a fragment of the text $X(T)$. Meanwhile, we assume that numbering of the chapters $X(T)$ is determined by their order in the text X. The obvious question arises: Have these chapters been ordered chronologically correctly by the author? If, however, the correct (chronological) numeration of the chapters has been lost (is unknown or doubtful), how can it be restored? In other words, how can the events described in the chapters $X(T)$ be ordered chronologically correctly in time?

6.2. The frequency-damping principle

Let a time interval (A, B) described in a text be sufficiently large, i.e., tens of hundreds of years long. Then, as I discovered while quantitatively processing the information contained in a large set of concrete historical texts, the following important circumstance should be taken into account. It turns out that in the overwhelming majority of cases, different historical characters bear different full names in the text. This can be explained easily, though. As a matter of fact, a chronicler is interested in distinguishing between different historical characters in order to avoid any ambiguity. The simplest method to achieve this is to give different full names to different characters. The fact can be justified by checking experimentally.

We now formulate the theoretical *frequency-damping principle.*

In the chronologically correct ordering of chapter generations of a text X, the author changes historical characters while proceeding from the description of the events of one generation to those of the subsequent one. Namely, when describing those generations prior to a fixed one numbered T_0 for a given ordering of chapters, the chronicler mentions no characters of T_0. With

---

[1] First published as an article in *DAN SSSR*, **268**, 6(1983), pp. 1322–1327 (in Russian).

a chronologically correct ordering of chapters, this can be explained by the simple fact that these personages have not yet been born. Then, when describing T_0, the chronicler speaks of the historical characters of this generation most often in chapter $X(T_0)$. This is quite understandable, for the historical events described by the author are related to the personages born at that time. Finally, proceeding with the description of subsequent generations, the chronicler mentions the characters preceding the generation T_0 less and less, which is also natural, because the author describes the new historical events of subsequent centuries whose personages certainly overshadow the deceased characters and the memories of them.

Since, due to the above remark, we can assume that the "identity" *name = historical character* is valid (see above), we shall now investigate the totality of all full names of personages mentioned in a text under investigation. As a rule, the term "full" will be omitted.

Consider the set of the names of personages first appearing, for a given ordering of chapters, in a chapter T_0 of a text X. Denoting the number of mentions of all the names in the chapter $X(T_0)$ by $K(T_0, T_0)$, we count each name with its *multiplicity* and calculate the frequency of its being mentioned.

We then see how many times these names have been mentioned in a chapter $X(T)$ and obtain a certain number $K(T_0, T)$. We stress once again that if a certain name is encountered several times, then all these references are taken into account.

Thus, for each number T_0, we obtain a certain numerical graph $K(T_0, T)$, where the argument T is variable. We can now reformulate the *frequency-damping principle* as follows.

In numbering the chapters chronologically correctly (i.e., chapters describing the same events), with duplicates being absent among them, each graph of $K(T_0, T)$ must have the following (theoretical) form. The function $K(T_0, T)$ vanishes to the right of the point T_0 while reaching its absolute maximum at the point T_0 itself and decreasing monotonically to the right of T_0 (Fig. 16).

The experimental check has completely confirmed (on the average) this frequency-damping principle for several dozen historical texts with a prescribed chronologically correct ordering of chapters (see [5]).

6.3. The method of finding the chronologically correct order of chapters in a historical chronicle

We now describe the method of finding the chronologically correct order of chapters in a historical text X (or in a whole set of texts). Number all the chapters of the text X in a certain order, e.g., in which they occur in the text itself. We then determine the graph of $K(T_0, T)$ described above for each separate chapter $X(T_0)$. The number of these graphs will equal that of the chapters in the text X. All these values $K(T_0, T)$ (for the variables T_0 and T) are naturally organized into a square matrix $K\{T\}$ of order $n \times n$, where n is the total number of chapters in the text.

In the ideal (theoretical) case, the matrix $K\{T\}$ has the form shown in

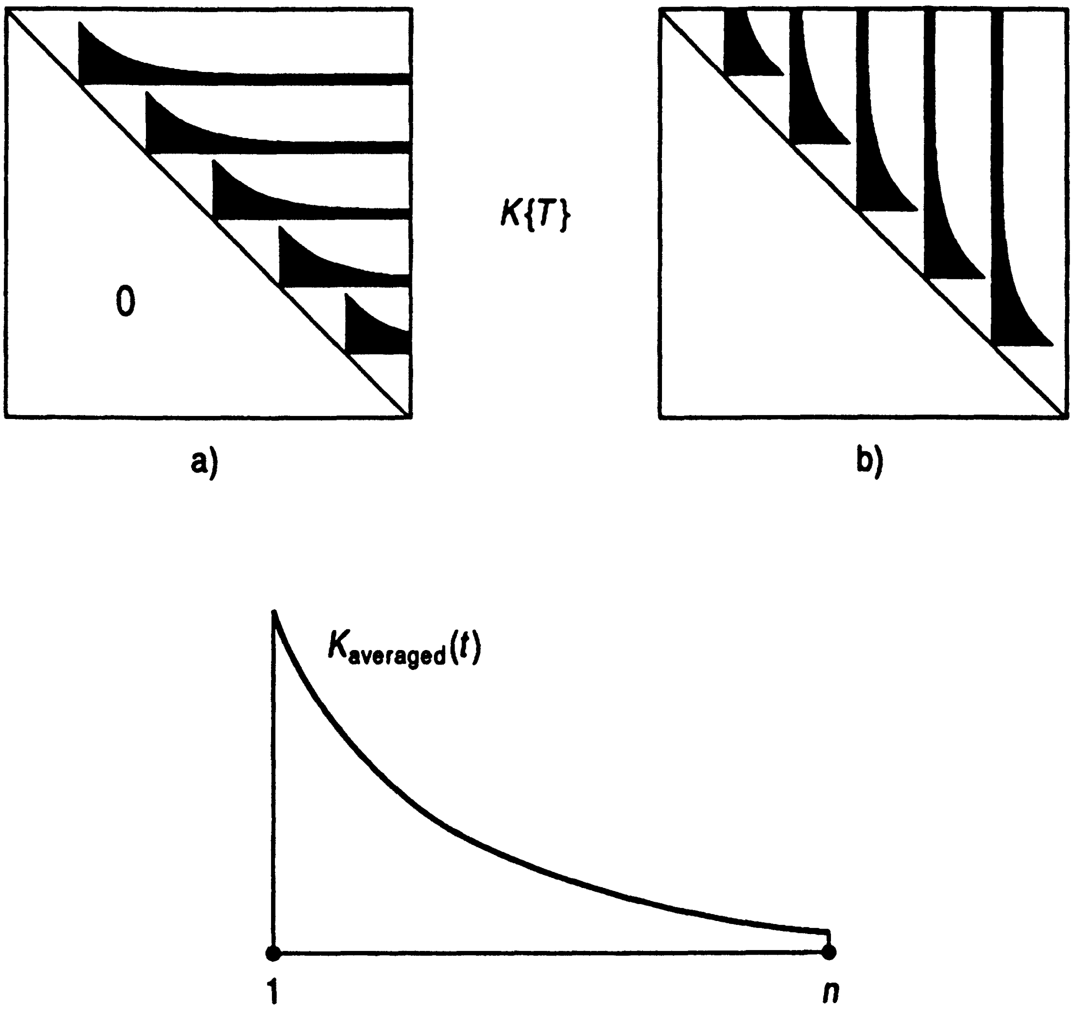


Figure 16. The frequency-damping principle (for the case of chronologically correct ordering of chapters in the chronicle).

Fig. 16a. Namely, all the absolute maxima (lines and columns of the matrix) are concentrated on the principal diagonal. Then, the farther off the principal diagonal, the smaller (monotonically) the values $K(T_0, T)$. The computational experiment has shown for real historical texts that, with a chronologically correct ordering of the chapters in a text X, the numbers $K(T_0, T)$ decrease, on the average, monotonically not only with respect to the rows of the matrix $K\{T\}$ but also to its columns (see Fig. 16b).

In other words, the frequency of names (personages) of prior origin, i.e., from the earlier chapters $X(T)$ mentioned in the fragment $X(T_0)$, gradually decreases as the generation T creating them moves farther away from the generation T_0 under investigation. It thus turned out that an increase in the age of a historical character (name) almost always causes a decrease in the frequency of references to this personage (name) in the subsequent chapters $X(T_0)$. To estimate the rate and character of the frequency-damping graph for the references to a name, we can make use of the following averaged graph, namely,

$$K_{\text{av.}}(t) = \frac{\sum_{i-T_0=t} K(T_0, i)}{n-t},$$

where $t = 0, 1, 2, \ldots, n-1$.

It is clear that it is obtained by averaging the square matrix $K\{T\}$ with respect to all diagonals parallel to the principal.

Certainly, the experimental graphs $K(T_0, T)$ may turn out not to be coincident with the theoretical graph for a concrete text.

It is obvious that, upon varying the original numbering of chapters $X(T)$, the matrix $K\{T\}$ and its entries also vary. As a matter of fact, there occurs a rather complicated redistribution of the names first appearing in a certain chapter $X(T_0)$. Let us change the order of chapters of the text X by means of various permutations, which we denote by σ. We also designate the new chapter numeration corresponding to a permutation σ performed by σT. While calculating the new matrix $K\{\sigma T\}$ for each of these chapter permutations, we will seek σ, i.e., an order σ of the text chapters, such that all or almost all frequency graphs of references to the names $K(T_0, T)$ will have the almost theoretical form shown in Fig. 16. In particular, we will try to make the graph $K_{\text{av.}}(t)$ maximally close to the ideal, monotonically damping graph in Fig. 16.

The order of the textual chapters, for which the deviation of the experimental matrix from the theoretical (damping) is the least, should be taken as chronologically correct and required.

This method of chapter ordering permits us to date ancient events. In fact, let a certain historical text Y be given for which it is only known that it describes some events from a historical epoch (A, B). Assume that we already have another dated text X describing the same epoch more or less completely. Let X be separated into the chapter generations $X(T)$. How can we learn which generation exactly has been described in the text Y in question? We shall make use of the text X. Add Y to the collection of chapters $X(T)$ of X, for which it suffices to assume that Y is a new chapter of X, and ascribe a certain number T_0 to it, i.e., insert the chapter Y in place of T_0 in the text X. Then, employing the above method, we find the optimal, i.e., chronologically correct order of all the chapters of the text X with the chapter Y added. Meanwhile, we shall therefore also find a chronologically correct place for the new chapter Y. The relative position which the text Y will occupy among other chapters of X should evidently be taken as the one desired. We thereby date the ancient events described in Y relative to the chapters of the text X.

This dating method has been checked against historical texts with an *a priori* known dating of the events described. The efficiency of the method has been fully confirmed (see [5]).

6.4. The frequency-duplicating principle and the method of duplicate recognition

We now account for a new *method of duplicate recognition* in a text and describe the *frequency-duplicating principle*. Let a historical epoch (A, B) be described in some text X which is divided into individual chapters $X(T)$. Assuming that they have been numbered generally in a chronologically correct manner, we suppose that there are two duplicates among the chapters, i.e., two chapters or fragments of the text, describing the events of one and the same generation. In other words, these chapters repeat each other, but are placed by the chronicler in different locations in the text X. Consider the simplest situation where the same chapter is repeated in X twice, numbered T_0 as a chapter $X(T_0)$ and C_0 as a chapter $X(C_0)$. We take $T_0 < C_0$.

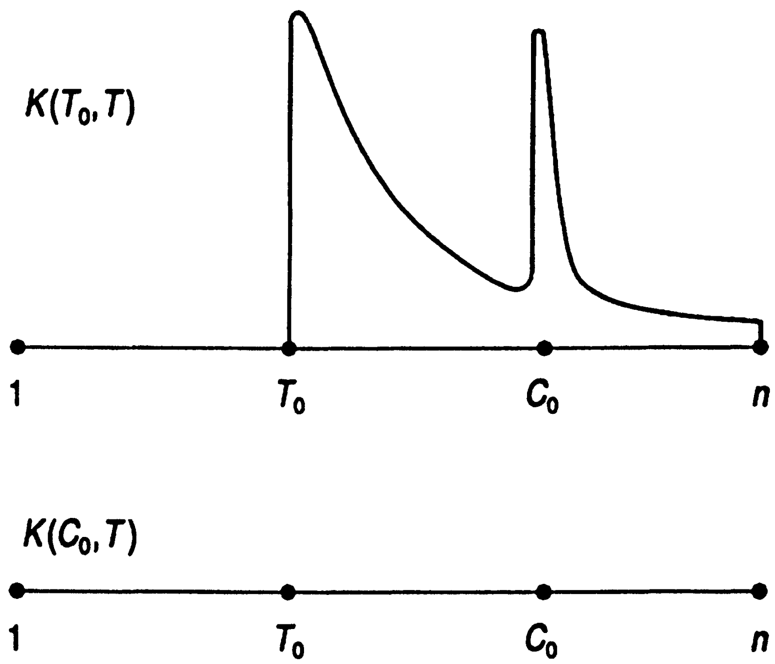


Figure 17. A new method of duplicate recognition (frequency-duplication principle).

It is evident that the frequency graphs $K(T_0,T)$ and $K(C_0,T)$ have the form represented in Fig. 17. The first graph $K(T_0,T)$ clearly does not satisfy the frequency-damping principle (two maxima). Hence, we have to permute the chapters of the text somehow to achieve better agreement with the theoretical damping graph in Fig. 16. Furthermore, we can see that the second graph vanishes, i.e., $K(C_0,T) = 0$, which is explained by the fact that there are no new names appearing in the chapter $X(C_0)$ for the first time (they all have already appeared in the earlier chapter $X(T_0)$). It then becomes evident that the best coincidence of the experimental frequency graph with the theoretical one in Fig. 17 is achieved when we juxtapose these two duplicates (i.e., chapters $X(T_0)$ and $X(C_0)$) or simply identify them.

Thus, if the chapters of the text, which in general are numbered chronologically correctly, contain two whose frequency graphs have the form approximately represented in Fig. 17, then they are probably duplicates and should be identified. This is exactly what we call the *frequency-duplicating principle.* A similar reasoning is also valid for the case of several duplicates in a text.

In the experiment which I performed, the discovery of such double peaks of the frequency graph (which correspond to the duplicates) occurred as follows. Let a_{ij} be an element of the matrix $K\{T\}$, placed in the ith row and the jth column. Consider the matrix $\{a_{\alpha\beta}\}$ consisting of the elements $a_{\alpha\beta}$, where $\alpha \geq i$ and $\beta \leq j$, i.e., part of the large matrix $K\{T\}$ bounded by the ith row and the jth column. We construct the averaged frequency graph $K^{ij}_{\text{av.}}(t)$ for it by averaging the values positioned in the matrix $\{a_{\alpha\beta}\}$ on the diagonals parallel to the principal one. We now assume that the ith and the jth columns of the frequency matrix $K\{T\}$ correspond to two duplicates $X(i)$ and $X(j)$, i.e., $T = i$ or $T = j$. Then the averaged frequency graph of $K^{ij}_{\text{av.}}(t)$ has the form represented in Fig. 17, i.e., it possesses two maxima.

Then, by marking all those elements a_{ij} (where $i < j$) in the large matrix $K\{T\}$ for which the averaged graph of $K^{ij}_{\text{av.}}(t)$ has such an anomalous form, we discover those chapters which may be duplicates. It was required in concrete computations that the averaged graph of $K^{pq}_{\text{av.}}(t)$, where $p = i+s$ and $q = j-s$, on the average should be monotonically decreasing if the positive integer s is sufficiently small compared to the difference $j - i$. For a more detailed statistical analysis, see Vol. 2.

6.5. The distribution of old and new duplicates in the Old and New Testament. A striking example: the Book of Revelation

For many an ancient historical text, commentators have performed the job of discovering repeating fragments, or duplicates. By a *repetition* (variant of a duplicate), we may understand not only a repetition of names (see above) but, more generally, the repeated description of some event in the text, and so forth. For example, in the Old and New Testament, all such individual repetitions (duplicates) discovered by the commentators have been indicated and collected in the so-called set of parallel passages. This list counts about 20,000 verses in the Old and New Testament. If some historical text X is supplied with the same (or similar) set indicating duplicates, then, for their correct chronological ordering, we can apply our method from Section 6.4. Meanwhile, we have to regard the repeating fragments of the text as repeating "names".

The method of text ordering and duplicate recognition is also applicable to the list of reciprocal citations in any closed collection of historical and other texts. In particular, I have applied all these methods to the Old and New Testament, which resulted in the discovery of new and previously unknown duplicates in addition to those known previously, such as the First and Second Book of Samuel, the First and Second Book of Kings, and the First and Second Book of Chronicles. The distribution of these duplicates in the sequence of the books of the Old and New Testament is represented in Fig. 18 by the line B, where all the discovered duplicates are denoted by identical letters.

It turned out, in particular, that the traditionally accepted order of chapter generations, and therefore books, of the Old and New Testament differs sharply from the one chronologically correct in the above sense, which has

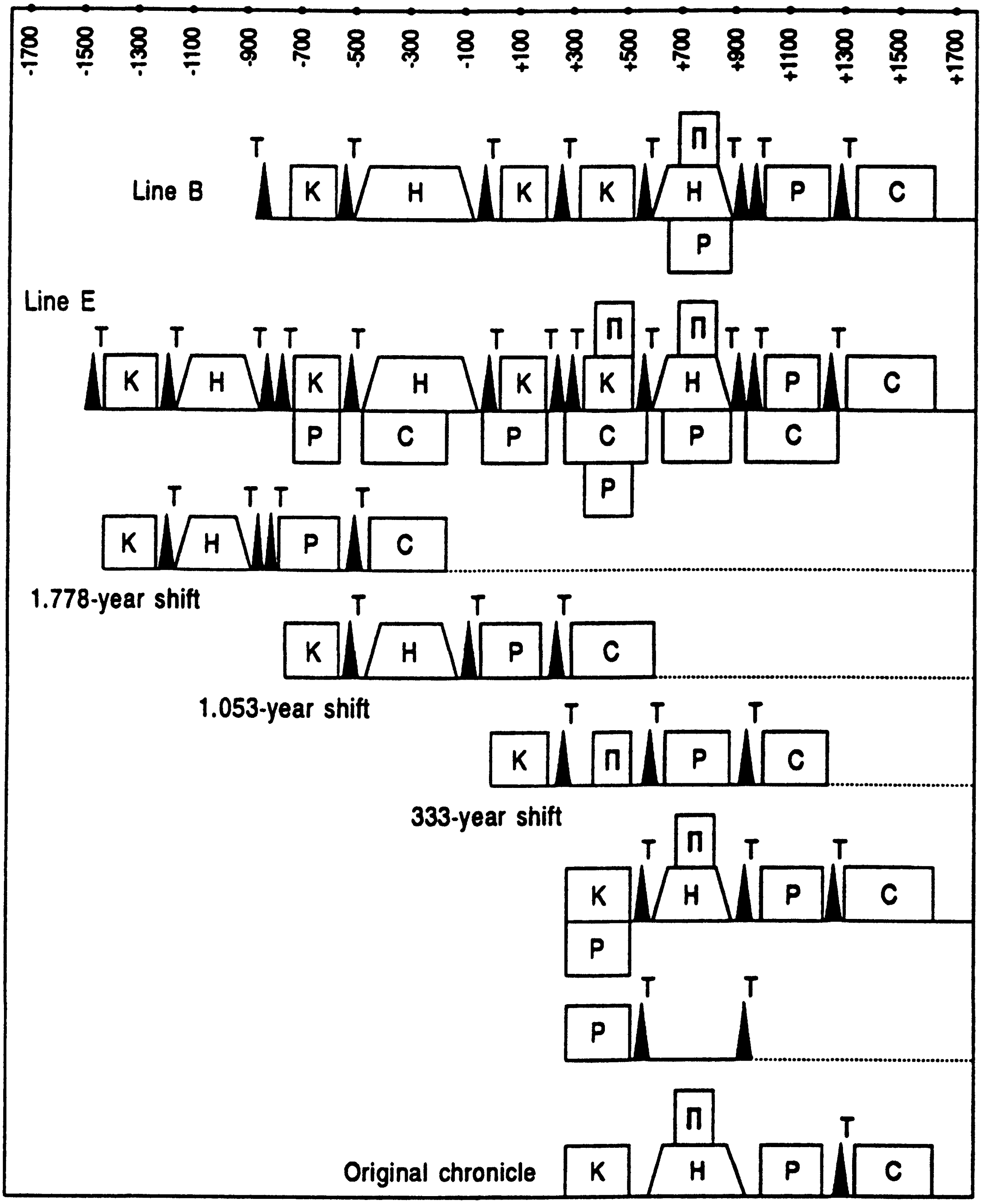


Figure 18. The distribution of duplicates in the Old and New Testament. Comparison with the duplicate system in European history.

been discovered by applying our method of text ordering. The averaged graph of $K_{\text{av.}}(t)$ constructed for all the books of the Old and New Testament was found to be monotonically decreasing, thus satisfying the frequency-damping principle in that and only that case where the separate chapters and books of the Old Testament are mixed up and permuted in a definite and rather intricate manner with those of the New Testament. Roughly speaking, the books of the Old and New Testament can be shifted toward each other.

Meanwhile, it is important that in about 88% of the cases, the mutual position of chapters and books is retained inside the shifted fragments.

A striking example can be given by the Book of Revelation in the New Testament, traditionally placed last in the Canon. If this traditional position were chronologically correct, then its frequency graph $K(T, T_0)$ (constructed from the frequency matrix column) would have to be of the form represented by the dotted line in Fig. 19.

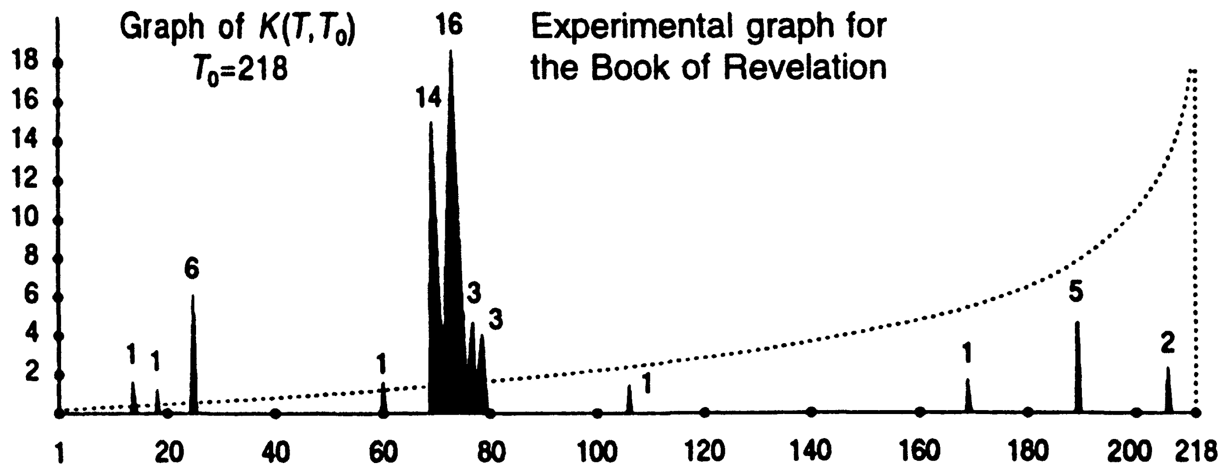


Figure 19. Strong disagreement between the real frequency graph for the Book of Revelation (solid line) and the theoretical frequency graph (dotted line).

However, the real frequency graph for the Book of Revelation (see Fig. 19), given by a continuous line, is sharply different from the theoretical one. Hence, to eliminate this discrepancy and to restore the correct chronological order, we should place the Book of Revelation near the Book of the Prophet Isaiah, the Book of the Prophet Jeremiah, the Book of the Prophet Ezekiel, Exodus and Leviticus (with the new ordering discovered by our method).

6.6. Duplicates of epochs in the "modern textbook" of ancient history

The same method has also been applied by the author to the written sources of ancient and medieval Europe, due to which all the ***duplicate-epochs*** schematically represented in Fig. 18 along line E (European history) by identical letters have been discovered. All these results are consistent with the decomposition of the GCD (see §5) into the sum of four chronicles, which I discovered on the basis of quite different statistical dating methods (see §4, §5, and [2]–[5]).

Line E in Fig. 18 schematically represents European history and chronology (the sequence of events with their traditional dating), while line B shows the history described in the Old and New Testament (see §5). The overlapping (parallelism) of the historical epochs described in the Old and New Testament and those entered along line E is represented in the listing given below. The events (epochs) designated in this list by identical letters are, wholly or partly, duplicates, or fibre into the sum of several duplicates.

Thus, we consecutively describe the basic events making up line E which, as noted above, in reality includes also the duplicate events from line B marked by the "=" sign. Thus, this is the table of possible parallelisms, where "=" means "duplicate".

(K) = The Trojan kingdom of seven kings, *ca.* 1460–1240 B.C.

(T) = The Trojan War, the fall of Troy, *ca.* 1236–1226 B.C.

(H) = The dynasties of the kings of ancient Greece, *ca.* 1226–850 B.C.

(T) = The second version for dating the Trojan War (according to the ancient authors Hellanic and Damast), one or two generations before the founding of Rome, *ca.* 850–830 B.C.; landing of the former Trojans in Italy.
= Gn 1–3, Adam, Eve, and Expulsion from Paradise.

(T) = Romulus and Remus, the founding of Rome, the rape of the Sabines, *ca.* 760–753 B.C.
= Gn 4:1–16, Cain, Abel.

(K) = The regal Rome of seven kings (according to Livy), *ca.* 753–523 B.C.
= Gn 4:17–26; Gn 5:1–31, Enoch, Irad, Methusael, Lamech, Mahalaleel, and Jared.

(T) = The kings' exile from Rome, war with the Tarquins, the founding of republican Rome, 522–509 B.C.
= Gn 5:32, 6, 7, 8, Noah, the Flood, convenants for man to multiply and to fill the earth, Shem, Ham, and Japheth.

(H/C) = Ancient republican Rome and ancient Greece, the Persian Wars, the Peloponnesian War, the Punic Wars, Philip II (king of Macedonia) and the fall of Byzantium, the empire of Alexander the Great, commander Hannibal, the end of classical Greece, *ca.* 509–82 B.C.
= Gn 9, 10, Japheth's sons.

(T) = Fall of the republic in ancient Rome, Sulla, Pompey, Julius Caesar, Augustus Octavianus, civil wars in Italy, 82–23 B.C.
= Gn 11:1–9, building the tower of Babel, dispersing mankind all over the earth.

(K/P) = The Roman Empire from 82–27 B.C. to A.D. 217.
= Gn 11:10–32, Arphaxad, Shelah, Serug, Terah, Haran, and Abram.

(T) = Wars and crisis in Italy in the 3rd century A.D., the Gothic War, Roman "soldier" emperors, anarchy in the empire, Julia Maesa, A.D. 217–251.
= Gn 12, Abram, Sarai, struggle with the Pharaoh.

(T) = Restoration of the Roman Empire under Lucius Aurelian, civil wars in Italy, A.D. 270–306.

= Gn 13, Abram, Haran, separation into two kingdoms.

$(K/\Pi/C/P)$ = The Roman Empire from 306 to 526.

= Gn 14–38, Isaac, Esau, Jacob, Judah, Joseph.

(T) = The Gothic War in Italy in the middle of the 6th century A.D., the Persian War, fall of the Western Roman Empire, Justinian, Belisarius, Narses, Totila, A.D. 535–552.

= Gn 39–50, Exodus (rule of Moses), war with the Pharaoh, Leviticus (legal codification of Justinian), Numbers and Deuteronomy.

$(H/\Pi/P)$ = Medieval papal Rome in A.D. 553–900 and the Carolingians, the empire of Charlemagne from Pépin of Héristal to Charles the Fat, A.D. 681–887.

= Joshua, his aggressive wars, the Book of Judges 1–18, Israel under the judges.

(T) = Alberic I and Theodora I, war in Italy, A.D. 901–924.

= The Book of Judges 19–21, the Benjamites and the war with them.

(T) = Alberic II and Theodora II, Italy in A.D. 931–954.

= The Book of Ruth, First Book of Samuel, Second Book of Samuel, First Book of Kings 1–11, First Book of Chronicles, Second Book of Chronicles 1–9, Saul, Samuel, David, Solomon.

(P/C) = The Holy Roman Empire of the German Nation in Italy and Germany in 962–1250.

= The First Book of Kings 12–22, the Second Book of Kings 1–23, the Second Book of Chronicles 10–34, the kingdoms of Israel and Judah.

We now interrupt our listing of the events represented by lines E and B and stress the agreement of the overlapping of the dynasties indicated in item (P/C) and the results of another method of dynastic overlapping (see §5). Namely, according to these results, the dynasty of the ancient kings of Judaea and that of the medieval rulers of the Holy Roman Empire from 911 to 1307 (note that we take into account the German coronation dates for the Holy Roman emperors) are parallel to each other (overlap) with proximity coefficient 10^{-12}, which indicates their interdependence (see the definition of the proximity coefficient λ in §5). Besides, the dynasty of Israel's ancient kings and the medieval dynasty composed of the dates of the Roman coronations (and also of the rule durations) of the rulers of the Holy Roman Empire from 920 to 1170 are also parallel to each other (overlap) with proximity coefficient 10^{-8}. In both cases, overlapping indicates the dependence of these dynastic pairs in the sense of §5. In the block of historical events (P/C) which we are now discussing, the following overlapping occurs. Gregory VII Hildebrand (1020–1053–1073–1085) is parallel to Jesus (Gk. iēsūs). This overlapping results from shifting the dates by 1,052 years. For details, see Vol. 2.

The chronicle lines E and B then contain the following events.

(T) = The war in the middle of the 13th century in Italy, the fall of the German dynasty of the Hohenstaufen, establishment of the House of Anjou; Conrad, Manfred, Charles of Anjou, Conradin, 1252–1268.

= The Second Book of Kings 24–25, the Second Book of Chronicles 35–36, the war with the Pharaoh and Nebuchadnezzar, the fall of Judaea, the start of Babylonian (Avignon) captivity.

(C) = The Holy Roman Empire of the Habsburgs, 1273–1619, 70-year Avignon exile of the popes and pontificate from 1305 to 1376, the pontiffs' return from France to Italy. The traditional chronology of ancient history is created at the same time by J. Scaliger (1540–1609) and Dionysius Petavius (1583–1652). It is possible that Dionysius Exiguus (6th century) is the duplicate, i.e., the reflection, of Dionysius Petavius (16th century).

(C_a) = a part of (C) and the duplicate is as follows: The Book of Ezra, the Book of Nehemiah, the Book of Esther (which, taken all together, probably describe the period from 1305 to 1378), the Babylonian captivity lasts for 70 years, return to Jerusalem.

Thus, the entire GCD (§5) is practically completely restorable from its lesser parts describing the events only from A.D. 900 to 1650, which is done by shifting the indicated shorter chronicle backward by *ca.* 333, 720, 1,053, and 1,778 years (§5, and Fig. 18 of the present section).

For example, the chronological shift backward by 1,053 years (*ca.* 1,000 years) could have arisen when the chronologists later compared two different methods of counting and fixing dates.

(a) By the first method, the dates could have been written as follows, for example: 13th century A.D. = X.III = Christ 3rd century = christos–III, which might have indicated the 3rd century since the 11th century A.D., i.e., the 3rd century since the birth of Gregory VII Hildebrand (*cf.* also the canonical names of centuries in Italy: trecento, i.e., three hundred, the 14th century A.D.; quattrocento, i.e., four hundred, the 15th century A.D.) Similarly, the dates could have also been written thus: A.D. 1500 = I.500 = Jesus the year 500 = iēsūs–500, which might have indicated the 500th year since the beginning of the 11th century A.D., i.e., since the birth of Gregory VII Hildebrand.

(b) Finally, the second method of counting dates, namely, the years A.D.: It is possible that the letters X and I were originally supplied by the chroniclers not with a numerical value (one thousand), but with a meaningful one, i.e., they were abbreviations of the names "Christ" and "Jesus" (see above).

In conclusion, we make an addendum to the list of special pairs of dependent historical dynasties (see §5).

(1) The dynasty of the popes (pontifices) from A.D. 140 to 314 and that of the Roman popes from A.D. 324 to 532, where $\lambda = 8.66 \cdot 10^{-8}$.

(2) The Holy Roman Empire of the German Nation from A.D. 936 to 1273 and the ancient Roman Empire from 82 B.C. to A.D. 217, where $\lambda = 1.3 \cdot 10^{-12}$.

References

[1] Fomenko, A.T., "Informative functions and related statistical regularities", *Abstracts of Communications of the Third International Vilnius Conference on Probability Theory and Mathematical Statistics.* Institute of Mathematics and Cybernetics of AN LSSR, Vol. 2, 1981, pp. 211–212 (in Russian).

[2] Fomenko, A.T., "On the computation of the second derivative of the moon's elongation", in *Controllable Motion Problems: Hierarchal Systems.* Perm University Press, Perm, 1980, pp. 161–166 (in Russian).

[3] Fomenko, A.T., "On the properties of the second derivative of the moon's elongation and related statistical regularities", in *Problems of Computational and Applied Mathematics.* Vol. 63, AN USSR, Tashkent, 1981, pp. 136–150 (in Russian).

[4] Fomenko, A.T., "The jump of the second derivative of the moon's elongation", *Celestial Mechanics*, **25**, 1(1981), pp. 33–40.

[5] Fomenko, A.T., "New Experimental and Statistical Methods for Dating Events of Ancient History and Applications to Global Chronology of the Ancient World and the Middle Ages". Pre-print No. B07201 (dated December 9, 1981), Moscow, 1981, pp. 1–100 (English translation is catalogued in the British Library Department of Printed Books, Cup. 918/87).

CHAPTER 3

NEW EXPERIMENTAL AND STATISTICAL METHODS FOR DATING EVENTS OF ANCIENT HISTORY, AND THEIR APPLICATIONS TO THE GLOBAL CHRONOLOGY OF ANCIENT AND MEDIEVAL HISTORY[1]

This is a brief review of my book *Global Chronology of the Ancient and Medieval World: An Experiment in Statistical Research. Methods and Applications*, containing an account of the results I obtained from 1974 to 1982. The manuscript is about 6,000 typed pages long, and hence, due to the limited space, the present chapter is only meant to give the reader an idea of the essence of the problem, namely, the new methods for dating ancient events and the construction of the global chronological diagram, a "modern textbook" for ancient and medieval history, and its decomposition into the sum of three shifts of four identical chronicles.

I do not pretend to explain completely the problems of purely historical character. My hypothesis touching upon problems of history may turn out not to be final but, possibly, require further investigation.

§7. Introduction. N.A. Morozov and Modern Results

The first detailed investigation of today's problem to substantiate chronology was carried out by N.A. Morozov, who, between 1924 and 1932, published the fundamental work *Christ* [1], in which he gave a detailed criticism of the traditional chronology of the ancient world. The important fact discovered in this work is the remaining absence of any substantiation of the accepted concepts which form the basis for the traditional chronology of ancient times. Proceeding from the analysis of a large number of facts, Morozov proposed and

---

[1] First published as preprint No. B07201, Moscow, 1981, pp. 1–100 (in Russian).

partly substantiated his fundamental hypothesis that "traditional" ancient history had been artificially extended in comparison with "real" events.

Nikolai Aleksandrovich Morozov (1854–1946) is a remarkable universalist scholar, a well-known Russian scientist, revolutionary, and public figure (for details, see *Nikolai Aleksandrovich Morozov: A Universalist Scholar*. Nauka, Moscow, 1982 (in Russian); V.A. Tvardovskaya, *N.A. Morozov in the Russian Liberation Movement*. Nauka, Moscow, 1983 (in Russian); "Nikolai Aleksandrovich Morozov" in *Bibliography of Scientists of the USSR*, Nauka, Moscow, 1981; in Russian). In 1881, he was sentenced to life imprisonment for his political activity as a member of the revolutionary movement of the Populists. While in prison, he educated himself in chemistry, physics, astronomy, mathematics, and history. After his release, he engaged in scientific activities and was appointed to a professorship. After the October Revolution, Morozov took over as director of the Lesgaft Institute of Natural Sciences. This institute was totally reformed after Morozov left the post of director. In 1922, he was elected an honorary member of the USSR Academy of Sciences and was awarded the Order of Lenin and the Order of the Red Banner of Labour. From 1924 to 1932, Morozov published his work *Christ* [1] (the original title was *The History of Human Culture from the Standpoint of the Natural Sciences*), which stirred up an animated discussion in the press [33], [34], [35]. Although raising certain serious objections, the critical part of [1] as a whole was not disputed. In 1974, Prof. M.M. Postnikov read four lectures at Moscow State University, in which he gave a brief survey of Morozov's aforementioned work and thereby drew my attention to the problem of substantiating ancient chronology.

Here, I briefly substantiate the new results I obtained from 1974 to 1982 on the basis of my new methods of dating ancient events. These methods and certain applications to chronology were published in the scientific papers listed in the Bibliography.

§8. Problems of Historical Chronology

8.1. Roman chronology as the "spinal column" of European chronology

First, we shall give a short review of the present state of the chronology of ancient events. Being an important historical tool, chronology permits us to determine the time interval between any historical fact and the present if we translate the units of the chronological data of a document describing this fact into those of our calendar system, i.e., dates B.C. or A.D.

Many historical conclusions depend on the dates which are events described in a source under investigation. On changing the dates (e.g., if they are not uniquely determined), treatment and estimation of the events are also altered.

Present global chronology has been formed as a result of research by several generations of chronologists of the 16th–19th century. Accordingly, all important ancient events were assigned Julian dates. The facts described in any recently found old documents are now dated according to a procedure which we shall illustrate by the following example.

Suppose a Roman consul had been mentioned in some Roman text. Since the complete list of Roman consuls ranges over a period of more than 1050 years, from Lucius Junius, son of Marcus Brutus, and Tarquinius Superbus (509 B.C.) to Basil I (A.D. 541) [20], we can adjust the described events to the time scale by finding the appropriate consul's name and by referring to the dates which his consulate has according to the list.

This example is typical in the sense that most modern dating methods are based on the comparison of data in a document with those whose dating had been established earlier and is regarded as known and fixed. The above example was deliberately chosen from Roman chronology. As a matter of fact, "all the remaining dates in ancient chronology can be related to our calendar system by means of direct or indirect synchronizations with the Roman ones" ([7], p. 77). In other words, Roman chronology and history is the "spinal column" of the entire global chronology and history, and it is because of this fact that in the following we pay special attention to Roman history.

8.2. Scaliger, Petavius, Christian chronographers and secular chronography

The chronology of ancient and medieval history in its present form was created and completed to a considerable extent in a series of fundamental works of the 16th–19th century beginning with J. Scaliger (1540–1609), the "founder of modern chronological science" ([7], p. 88; [21]), and D. Petavius (1583–1652) [22]. We also recommend the chronological works of the 18th–19th century, which, though mostly obsolete, contain a lot of useful information [23]–[26].

However, the series of these (and other) works is not entirely complete, since, as the well-known chronologist E. Bickerman observes, "there is no adequate, full-scale treatment of ancient chronology" ([7], p. 96, Note 1).

The absence of a modern study which would contain strict scientific substantiation and the construction of a global chronology of ancient times and the Middle Ages, based on modern data and methods, may be explained not only by the enormous historical material still requiring further processing and revision, but also by objective difficulties mentioned by various authors investigating at different times the scientific substantiation of chronology.

First, let us point out the fact that the appearance, establishment, and initial development of chronology occurred within the Church and was completely under its control for a long time. Ancient chronology is given in the basic works of J. Scaliger and D. Petavius as a table without any substantiation, church tradition alone being its base. This is not surprising, since "for many centuries, history has predominantly been a church science, and was written, as a rule, by the clergy ... " ([8], p. 105).

It is assumed today that the foundations of chronology were laid by Eusebius Pamphili and Jerome (4th century A.D.). The work *Eusebii Pamphili Chronicorum* (Chronicle) and that of Jerome were discovered only in the late

Middle Ages. Moreover, "the Greek original (of Eusebius' work—A.F.) now exists only in fragments and has been completed by the free Latin translation made by Jerome" (see the Introduction to the Russian translation of the *History of the Church* by Eusebius, St. Petersburg, 1848, p. viii). It is curious that Nicephorus Callistus made an attempt in the 14th century to write a new history of the first three centuries, i.e., to follow Eusebius' steps, but "could do noting more than repeat what Eusebius had already said ([27*], p. xi). However, the work of Eusebius was published only in 1544 ([27*], p. xiii), i.e., later than that of Nicephorus; hence, the question arises whether Eusebius possibly based his work on Nichephorus Callistus. Beginning with Eusebius and Jerome, almost everyone of the chronologists until the 16th–17th century was often a staunch believer or occupied an official church post (archbishop Jerome, bishop Theophilus, archbishop J. Ussher, theologian J. Scaliger, etc.). That is why the numerical data contained in the Bible and a blind following of church authority originally formed the basis for the chronological approach. As a result of these cabalistic exercises, there appeared, for example, the following "basic dates" from which the entire chronology of the ancient world was then constructed: In the opinion of Ussher, the world was created early in the morning of October 23, 4004 B.C. (see [6]). Furthermore, "secular chronology", which appeared later, was completely based on church dogmas.

> "... the Christian chronographers put secular chronography into the service of sacred history. ... Jerome's compilation became the standard of chronological knowledge in the West...."

> "J. Scaliger, the founder of modern chronological science, aimed at reconstructing the work of Eusebius. ... The datings of Eusebius, often transmitted incorrectly (!—A.F.) in manuscripts, are of little use to us today..." ([7], pp. 87–88).

Following considerable ambiguity and doubtfulness of these cabalistic calculations, the "date of the creation of the world" varies over a wide range (we illustrate this with some basic examples): 5508 B.C. (Byzantine date), 5493 B.C. (Alexandrian), 4004 (Ussher, Hebrew date), 5872 B.C. (Septuagint), 4700 B.C. (Samaritan), 3761 B.C. (Jewish), 3941 B.C. (Jerome), 5515 (Theophilus), 5551 (Augustine), and so on ([7], p. 73). The amplitude of these dates spans 2100 years. The problem of the choice of a correct "date of the creation of the world" is not at all artificial; it is not accidental that it has received so much attention. As a matter of fact, the overwhelming majority of documents date the described events by years since the "creation of the world" without indicating, however, which "creation" they actually mean. Therefore, the existing multi-millennium discrepancy in the choice of this "date" considerably affects the dating of all documents of this type. The consecration of these "dates" by the Church prevented (up to the 18th century) any critical revision or analysis of the global chronology of ancient times. For example, Scaliger called Eusebius' works "divine" ([27*], p. viii). Being brought up in the spirit of unquestionable veneration of the predecessors' authority, the 16th- and 17th-century chronologists reacted strongly to any "outside" criticism. Scaliger himself clearly demonstrated his attitude toward scientific criticism in the following episode. F. Cîmpan writes,[2]

> "The philologist Joseph de Scaliger, the author of a chronological treatise much appreciated by the scientific community, has become a passionate quadraturist ... (name given to people attempting to construct a square which is equal in area to a given circle by means of compass and ruler; this problem is, as is generally known, insoluble—A.F.)" ([36], pp. 149–150).

Scaliger published a book in which he asserted to have established "true quadrature".

> "However hard the greatest mathematicians of the epoch—Viète, Clavius—did try to prove to him that ... his reasoning was not correct, everything was useless (it follows from his 'proof' that the perimeter of a regular 196-gon is greater than the length of the circumcircle containing this 196-gon, which is absurd—A.F.). ... Scaliger grouped his admirers, who passionately sustained their opinion, recognized nothing ... and addressed them ... with injuries and epithets full of contempt, affirming that all geometers had no notion of geometry" ([36], p. 150).

Scaliger first applied (together with Petavius) the astronomical method to the confirmation (but not at all to the critical verification) of the church chronology of the previous centuries. The contemporary historians believed that Scaliger thereby turned church chronology into "scientific" chronology. This shade of "scientific approach" in combination with church authority turned out to be sufficient for the 17th- and 18th-century chronologists to regard the chronological network of available and already considerably conservative data as completely reliable. By the 19th century, the chronological data had expanded so much that it caused respect *a priori*, at least by its very existence, so that the chronologists of the 19th century saw as their task only the introduction of small insignificant changes into the chronology of ancient times. In the 20th century, the problem is basically regarded as solved, and chronology has finally been perpetuated in the form moulded by the "scriptures" of Eusebius, Jerome, Theophilus, Augustine, Hippolytus, Clement of Alexandria, Ussher, Scaliger, and Petavius. For a historian of the 20th century, the very thought that chronologists have followed an erroneous scheme for several hundred years naturally seems to be absurd, for it contradicts accepted "tradition" and the cultural knowledge assimilated since childhood.

Nevertheless, with the development and liberation of chronology from church control, serious difficulties arose when new generations of historians attempted to find an agreement between many of the chronological data sources and the established traditional chronology. Thus, for example, it was discovered that Jerome had made an error of one hundred years ([7], p. 89). The so-called Sassanid tradition separated Alexander the Great from the Sassanids by a span of 226 years, and modern historians have increased it to 557 years (a gap of more than 300 years) ([7], p. 89).

---

[2]Translated from the Rumanian—tr.

As Bickerman notes, "The Jews also allotted only 52 years to the Persian period of their history, though 205 years separate Cyrus from Alexander" (according to traditional chronology—A.F.) ([7], p. 89). Egyptian chronology has also been fragmentarily retained by the Christian chronologists.

The aforementioned list of Manethonian kings has been preserved only in Christian summaries ([7], p. 82). Some readers probably do not know that "the Eastern Church avoided the use of the Christian dates, since the date of Christ's birth was debated in Constantinople as late as the fourteenth century" ([7], p. 73).

8.3. Questioning the authenticity of Roman tradition. Hypercriticism and T. Mommsen

Consider Roman chronology based on its leading role in the global chronology of ancient times. Extensive criticism of "tradition" and its chronology began as far back as the 18th century at the *Académie Royale des Inscriptions et Médailles* founded in 1701 in Paris.

In the 1720s, the general authenticity of Roman historical tradition began to be questioned (N. Fréret, L. de Pouilly). The accumulated material served as a basis for a more thorough criticism in the 19th century. The well-known historian T. Mommsen was one of the leading authorities in this branch of chronology, which was then called "hypercriticism". He wrote, e.g., that

> "King Tarquinius the Second, although he was already grown up at the time of his father's death and did not begin to reign till thirty-nine years afterwards, is nevertheless still a young man when he ascends the throne. Pythagoras, who came to Italy about a generation before the expulsion of the kings (509 B.C.—A.F.), is nevertheless set down by the Roman historians as a friend of the wise Numa (who died *ca.* 673 B.C.; the discrepancy amounts to at least 100 years—A.F.). The state envoys sent to Syracuse in the year 262 transact business with Dionysius the Elder, who ascended the throne eighty-six years afterwards (348)" ([9], Vol. 3, p. 190).

The traditional chronology of Rome rests on quite a shaky basis. For example, between the different versions of dating of such an important event as the foundation of Rome, there exists a divergence of 500 years ([9], Vol. 3, p. 190). This oscillation strongly accounts for the datings of a large number of sources counting years since the "foundation of Rome (City)" (e.g., the *History of Rome* by Livy). In general, "Roman traditional history has survived in the works of quite a few authors; undoubtedly, the most fundamental of them is Livy's" ([12], p. 3). It is assumed that Livy was born *ca.* 59 B.C. and described 700 years of Rome's history. Of 142 books, only 35 survive; the first edition came out only in 1469 and was based on a lost manuscript of unknown origin; only later a manuscript containing another five books was discovered in Hessia.

Theodor Mommsen wrote:

> "... the prospect should be still more lamentable in the field ... of the ... annals ... of the world.... The increasing activity of antiquarian research induced the expectation that the current narrative would be rectified from documents and other

trustworthy sources; but this hope was not fulfilled. The more and the deeper men investigated, the more clearly it became apparent what a task it was to write a critical history of Rome" ([9], Vol. 5, p. 495).

Moreover,

"The falsification of numbers was here (regarding Valerias Antias—A.F.) carried out down even to contemporary history.... He (Alexander Polyhistor—A.F.) ... took the first steps towards filling up the five hundred years, which were wanting to bring the destruction of Troy and the origin of Rome into the chronological connection (as a matter of fact, according to another version of chronology, different from today's, Troy had fallen immediately before the foundation of Rome, and not 500 years before it—A.F.) ... with one of those lists of kings without achievements which are unhappily common in the Egyptian and Greek chronicles; for, to all appearance, it was he who launched into the world the kings Aventinus and Tiberinus and the Alban *gens* of the Silvii whom the following times accordingly did not neglect to furnish in detail with name, period of reigning, and, for the sake of greater definitiveness, also a portrait" ([9], pp. 496–497).

A survey of this criticism can be also found in B. Niese [14]. The lengthy account of the ultrasceptical standpoint questioning the correctness of the "regal Roman" chronology and, in general, the validity of our knowledge regarding the first five centuries (!) of Roman history can be found in [28] and [29]. (For the difficulties concerning the agreement of Roman documents with traditional chronology, see [30].)

"As a matter of fact, Roman annals themselves do not survive; therefore, all our assumptions should be based on the Roman annalists. However, here, too, we face great difficulties, the main one being that the annalists' works are also in an unsatisfactory state" ([12], p. 23).

It is assumed that all ancient Roman dignitaries were recorded year after year in the Roman *fasti*. Regarding this, G. Martynov comments:

"But how can the constant controversy about the consuls' names and, moreover, their frequent omission or the perfectly random choice of their names be made consistent? ... It is sometimes impossible to understand the *fasti*, since they are full of ambiguities. Livy himself was aware of this particular weakness of his basic chronological principles" ([13], pp. 6–7, 14).

And G. Martynov assumes that

"... neither Diodorus nor Livy have correct chronology.... We cannot have any confidence in the 'canvas' books, from which Licinius Macer and Tubero drew quite contradictory conclusions. Apparently, upon scrutiny, the most valid documents could also turn out to have been forged much later ..." ([13], pp. 20, 27–28).

Bickerman states:

"As we have the complete fasti of the Roman consuls for 1,050 years ... we can easily assign Julian years to each of them, provided that the ancient dates are trustworthy ..." ([7], p. 81).

8.4. Difficulties in the establishment of Egyptian chronology

The essential discrepancy found between the chronological data of ancient sources and the global chronology of ancient times has been discovered in other ones of its branches too. Thus, considerable difficulties accompanied the establishment of Egyptian chronology, where a number of documents contradict each other chronologically. For example, while accounting for the history of Egypt in a consecutive and connected manner, Herodotus places the Pharaoh Rhampsinitus and Cheops next to each other by calling the former the latter's successor. As a modern commentary goes,

> "Herodotus mixes up the chronology of Egypt: Rhampsinitus (Ramses II) was Pharaoh of the 19th dynasty (1345–1200 B.C.), while Cheops was a pharaoh of the 4th dynasty from 2600 to 2480 B.C." ([31*], p. 513, Comm. 136).

Here, the discrepancy with today's chronological version attains 1,200 years. It should be noted that, according to H. Brugsch, Rhampsinitus is Ramses III, and not Ramses II ([11], p. 325). In general, it turns out that, from the modern standpoint, the following strange circumstance is valid.

> "The chronology of kings due to Herodotus does not correspond to that in the fragments of the Manethonian list" ([31*], p. 512, Comm. 108).

Usually, Herodotus' chronology is essentially "shorter". For example, immediately after a pharaoh of the 4th dynasty, he places another one from the Ethiopian dynasty, i.e., "he jumps from the end of the 4th dynasty (*ca.* 2480 B.C.) to the beginning of the Ethiopian rule in Egypt (*ca.* 715 B.C.)" ([31*], p. 516, Comm. 150), closing the 1,800-year "gap". Note that the choice of a particular chronological version from a number of mutually contradictory ones is not always obvious, which, *inter alia*, illustrates the rivalry between the adherents of the so-called shorter and longer chronology of Egypt, beginning in the 19th century. The famous Egyptologist H. Brugsch wrote that

> "German Egyptologists have attempted to fix the era when Mena, the first Pharaoh, mounted the throne, with the following results:

		B.C.			B.C.
Boeckh	...	5702	Lauth	...	4157
Unger	...	5613	Lepsius	...	3892
Brugsch	...	4455	Bunsen	...	3623

> The difference between the extreme dates is enormous, amounting to no less than 2,079 years! ..." ([11], p. 14).

Brugsch wrote further:

> "The most authoritative work and researches carried out by competent scientists in order to check the chronological succession of the Pharaohs and whole dynasties proved, meanwhile, the inevitable necessity to suggest simultaneous and parallel reigns in the Manethonian list, which considerably decreases the time required for the ownship of the country by thirty Manethonian dynasties. In spite of all the discoveries in this branch of Egyptology, the numerical data were still in a quite unsatisfactory state at the end of the 19th century" ([11], p. 14).

The modern tables also assign the coronation of Menes to different dates, namely to *ca.* 3100 ([15], pp. 28–29), *ca.* 3000 B.C. (see the Russian translation of Bickerman's *Chronology of the Ancient World*, Nauka, Moscow, 1975,

p. 176), and so forth. The total variation is 2,700 years. However, if we take into account the opinion of the other Egyptologists, the situation becomes still more serious. Namely, according to Champollion, Menes was coronated in 5867; according to Le Sueur, in 5770; according to A. Mariette, in 5004; according to F. Chabas, in 4000; according to E. Meyer, in 3180; according to T. Andrzejewski, in 2850, according to J. Wilkinson, in 2320; and to E. Palmer, in 2224 B.C., and so on. The difference between the dating of Champollion and that of Palmer is 3,643 years. In general, according to Chantepie-de-la Saussaye, Egyptology first "awoke" only 80 years ago. The results of the research were made public too soon; he spoke of the premature assurance of Egyptology; chronology was still hesitant at the time [37].

At present, a shorter chronology has been adopted; however, it is extremely self-contradictory, with the uncertainties still unresolved today.

Still more complicated is the situation with the list of kings, compiled by the Sumerian priests,

"... a sort of skeleton of history ... of our English schoolbooks, but unfortunately it did not seem to help.... The entire chronology is palpably absurd" ([32], p. 14).

Moreover, it turns out that the dynastic sequence was set arbitrarily ([32*], p. 107). The very ancient age ascribed today to these lists contradicts the archaeological data. In his description of the excavations of regal tombs in Mesopotamia, L. Woolley speaks of a series of golden toilet sets which were found, one of the best experts declaring that the things were made by the Arabs in the 13th century A.D.! And he cannot be censured for the blunder, adds L. Woolley condescendingly: No one could suppose the craft to be so skillful in the 3rd millennium B.C. ([32] and [32*], p. 61).

The well-known historian of science Otto Neugebauer wrote:

"With the use of an enormous learned apparatus, the author (Jeremiah—A.F.) develops the panbabylonistic doctrine which flourished in Germany between 1900–1914.... This school was built on wild theories about the great age of Babylonian astronomy.... A supreme disregard created a fantastic picture which exercised (and still exercises) a great influence on the literature concerning Babylonia" ([40], p. 138).

8.5. Competing chronological versions. De Arcilla, J. Hardouin, I. Newton and R. Baldauf

It turns out that simultaneously with Scaliger's and Petavius' versions of the global chronology still accepted today, another, competing hypothesis negating the first, and indicating the "youth" of the "written history" known to us, was born as early as the 16th century A.D. We illustrate this with the following citation from Morozov's book [1]:

"Professor de Arcilla of Salamanca University published two of his works *Programma Historiae Universalis* and *Divinae Florae Historicae* in the 16th century, where he stated that the whole of ancient history had been forged in the Middle Ages; the same conclusions were reached by the Jesuit historian and archaeologist J. Hardouin (1646–1729), who regarded the classical literature as written by the monks of the preceding, 16th century A.D. (see his books *Consiliorum Collectio regia* *maxima, Chronologiae ex nvmmis antiqvis restitvtae prolvsio de nvmmis Herodiadvm, Prolegomena ad censuram veterum scriptorum*). The German Privatdozent Robert Baldauf wrote his book *Historie und Kritik* in 1902–1903, where he asserted on the basis of purely philological argument that not only ancient, but even medieval history was a falsification of the Renaissance and subsequent centuries" ([1], Vol. 7, p. vii–viii, Introduction).

The famous Isaac Newton in his *Abrégés de la Chronologie*, containing the work of forty years of investigation, sharply criticized traditional chronology. Many events of Greek history were shifted by him forwards by 200–300 years, which coincides with the first chronological shift I discovered, and is described in my publications (see above). Many events of Egyptian history were "shifted forwards" by I. Newton by about 1,800 years, which again, quite suddenly, coincides with the third chronological shift of the author (see above). The enormous work performed by Newton was taken skeptically by his contemporaries.

W. Whiston wrote:

> "Sir Isaac Newton composed a Chronology, and wrote 18 copies of its first and principal chapter with his own hand ... which proved no better than a sagacious romance" ([89], p. 35).

8.6. Tacitus and Bracciolioni. Cicero and Barzizza

It is generally known that most of global chronology was initially constructed by analyzing the chronological references of ancient written sources; the question of their origin then becomes quite interesting. Unfortunately, modern historiography supplies no complete survey of the circumstances in which the ancient manuscripts appeared and only notes the general fact that the overwhelming majority of the documents were discovered as early as the Renaissance, years after the "dark ages". It is clear that the manuscripts often appeared in an environment which was not conducive to speeding up a critical analysis of the datings.

The two well-known 19th-century historians P. Hochart from France and J. Ross from England "proved" in 1882–1885 and 1878, respectively, that the *History of Tacitus Cornelius* had been actually written by the well-known humanist Poggio Bracciolini [38, 39]. Without discussing the authenticity of the *History* (in our opinion, it is authentic, has not been falsified, and describes authentic events), we note that the history of its discovery really led to considerable controversy. It was Poggio Bracciolioni who had discovered and published the works of Quintilian, Valerius Flaccus, Marcellus, Probus, certain treatises of Cicero, Lucretius, Petronius, Plautus, Tertullian, St. Marcellinus, Calpurnius Siculus, and so forth [38, 39]. Besides the original manuscripts, Bracciolioni traded in copies which he sold for enormous sums of money. For example, after having sold a copy of Livy, Bracciolioni bought himself a villa in Florence. The circumstances of these findings and the manuscripts' dating have never been made clear.

In the 15th century, Italy saw the arrival of the famous humanists Manuel Chrysoloras, Georgius Gemistos Pletho, Bessarion of Nicae, and others, who were first (!) to acquaint Europe with the achievements of the allegedly "ancient" Greek thought. The Byzantine Empire then gave the West almost all the preserved Greek manuscripts of antiquity. In Neugebauer's words:

> "The majority of manuscripts on which our knowledge of Greek science is based are Byzantine codices, written between 500 and 1500 years after the lifetime of their authors" ([40], p. 57).

According to traditional history, the whole of classical ancient literature became known only during the years of the Renaissance or immediately before this epoch [41]. Analysis shows that the vagueness of its origin and the absence of documented data regarding it in the preceding, so-called Dark Ages makes us suggest that the texts had been previously nonexistent [1].

For example, the oldest manuscripts of the so-called incomplete recension of Cicero's texts are those of the 9th and 10th century; however, the archetype of the incomplete recension had been "lost long ago" [42*]. In the 14th and 15th century, Cicero's works attracted more and more attention, and

> "... it came to the Milan Professor Gasparine Barzizza ... having undertaken in *ca.* 1420 A.D. the risky business of filling by himself gaps in the 'incomplete recension' to make it consistent (!—A.F.). No sooner had he finished the job than a miracle occurred: in the sleepy Italian town of Lodi, a lost manuscript with the complete text of all of Cicero's rhetorical works was found.... Barzizza and his disciples rushed onto the new find, deciphered its ancient script (probably of the 13th century A.D.), and, finally, made a copy which could be read easily. The transcripts were made from this one, and they are the ones which make up the 'complete recension'. ... Meanwhile, the incorrigible took place: the archetype of the recension, i.e., the Lodi manuscript, turned out to be neglected; nobody wanted to rack his brains over its difficult text; it was sent back to Lodi and lost there forever; since A.D. 1428, nothing has been known about its fate. The European philologists deplore the loss even today" ([42*], pp. 387–388).

Suetonius' *De vitis XII Caesarum* is also only available in much later transcripts, all originating from "one antique manuscript" allegedly possessed by Einhard, who, while creating his *Vita Karoli Magni* (Life of Charlemagne) in *ca.* A.D. 818, carefully reproduced the assumingly biographical stories of Suetonius [43]. The Codex Fuldensis and the first copies have not survived [43]. The oldest manuscript of Suetonius is that of the 9th century, but it became known only in the 16th century, whereas the others are dated to not earlier than the 11th century A.D.

8.7. Vitruvius and L. Alberti

Ancient sources were dated in the 14th–16th century on some unknown basis. The architect Vitruvius' *De architectura* was discovered only in 1497. In its astronomical part, he very precisely listed the sidereal (!) periods of the major planets ([1], Vol. 4, p. 624). Allegedly living in the 1st–2nd century A.D., Vitruvius knew them better than Copernicus. The period of Saturn differs from the contemporary value by only 0.0007; for Mars, the error is only 0.006, and 0.003 for Jupiter ([1], Vol. 4, pp. 625–626). Note the far-reaching parallels between Vitruvius' books and those of the remarkable 15th-century humanist L. Alberti [44]. (By the way, due to frequently assimilated "v" and "b", it may be even conjectured that the names themselves are close: Alb(v)erti–Vitruvius.) Like Vitruvius, Alberti (1404–1472) was famous as the greatest Italian architect, author of the well-known architectural theory which is related, in the closest manner, to the similar theory of Vitruvius [44]. Just like Vitruvius, he created a fundamental work including not only his theory of architecture, but also some information from mathematics, optics, and mechanics. It is strange that the title of Alberti's book *Di re aedificatoria* is similar to that by Vitruvius. It is now assumed that Alberti modelled his own treatise on Vitruvius' work [44]. The work of Alberti is wholly in "antique tones". Specialists have long ago constructed tables in which Alberti's and Vitruvius' works are juxtaposed (sometimes coinciding *verbatim*!).

Thus, the book of Vitruvius (as well as that of Alberti) absolutely naturally corresponds to the atmosphere and ideology of the 15th century. The overwhelming majority of Alberti's buildings were designed "in antique style". He erected a palace "after a Roman amphitheatre". Thus, the leading architect of the Renaissance fills the cities of Italy with antique buildings which are regarded now (but not at all in the 15th century) as "imitations of antiquity". Alberti wrote books in "antique manner", not giving any thought to that they could later be called "imitations of antiquity" by the historians. And it was only in 1497 that the book of the alleged "ancient" architect Vitruvius was discovered, which almost *verbatim* coincides with an earlier and similar book of Alberti. It is possible that the architects of the 14th–15th century did not regard their activities as an "imitation of antiquity", but created it. However, the theory of "imitation" will appear in the works of much later researchers. It is probably due to the chronological shift of some of the medieval documents, buildings, etc., into oldest antiquity. In particular, this could have led to "doubling" Alberti, trebling Pletho, and so forth.

8.8. "The chaos of medieval datings" (E. Bickerman). Medieval anachronisms and medieval concepts of time

The history of finding and publishing ancient scientific treatises in all its essential features is similar to that of manuscripts in the humanities. M. Ya. Vygodsky wrote:

> "No antique manuscript of the *Elements* by Euclid has survived. ... The most ancient of the manuscripts known to us is a copy made in A.D. 888. ... There are many manuscripts dated by the 10th–13th-century" ([87], p. 224).

I.G. Bashmakova informs us that, even before the first Latin translation of *Arithmetica*,

> "... the European scientists had made use of Diophantus' algebraic methods, not being familiar with his works" ([111], p. 25).

Bashmakova characterizes this situation just as "somewhat paradoxical". And I.N. Veselovsky says that the basis for all modern editions of Archimedes' works is a lost manuscript of the 15th century and the so-called Constantinople palimpsest found only in 1907. It is assumed that Archimedes' manuscripts first appeared in Europe after 1204 ([112], pp. 54–56).

> "The *Conics* of Apollonius were published only in 1537, his works having been published only after the death of Johann Kepler, who had discovered the importance of the described objects" ([94], p. 54).

The chronological version of Scaliger was not at all unique. In general, Bickerman deploringly speaks of "the chaos of medieval datings" ([7], p. 78). Besides, the analysis of ancient documents demonstrates that the earlier ideas of time were greatly different from the modern. Before the invention of the clock, time had been regarded as "anthropomorphic", and the character of its course depended (!) on the character of the events.

Until the 13th–14th century, devices for measuring time were a rarity and luxury [45].

> "The sundial ... sandpiece and clepsydra were common in medieval Europe, with the sundial being suitable only when it is fine, and the clepsydra remaining a rarity" ([8], p. 94).

At the end of the 9th century A.D., candles were widely used to measure time; for example, the king of England, Alfred, took candles of equal length when travelling, and ordered to light them one after another ([8], p. 95). The same time count was employed even in the 13th and 14th century, for example, at the time of Charles V.

> "The monks orientated themselves by the pages of the Sacred books or psalms read between two observations of the sky" ([8], p. 94).

For exact astronomical observations, a clock with the second hand was required, but

> "... even after the invention and wide use in Europe of the mechanical clock, it did not have the minute hand for a very long time" ([8], p. 95).

Otto Spengler in his *The Decline of the West* asserted that the mechanical clock had been invented *ca.* A.D. 1000 by A. Gerbert. However, A.Ya. Gurevich asserts that Gerbert only made the clepsydra more sophisticated, and that

> "... the mechanical clock was invented at the end of the 13th century A.D." ([8], pp. 134–135).

It is generally known that a precise time piece is required for astronomical observations. However, the following strange phenomenon occurred: Appearing in China, the Europeans acquainted the Chinese with some of their own inventions. The mechanical clock did interest the Chinese rulers, but not as a precise time piece—just as a funny toy! ([88], pp. 80–87). And it is traditionally believed that precise Chinese astronomy had blossomed thousands of years B.C.!

The most intricate chronological cabbala was born and developed in the Middle Ages in a paradoxical contrast with the inaccuracy of measuring real time. In particular,

> "... the same time intervals which are used for measuring earth ... time acquire quite a different duration. ... When used to measure biblical events ... Augustine equalized each day of the Creation to a millennium (!—A.F.) and attempted to determine the duration of the history of mankind..." ([8], pp. 109–110).

Such an intrinsic feature of medieval historiography as anachronism is very important for us.

> "The past is represented in terms of the same categories as in modern times. ... The biblical and ancient historical figures are dressed in medieval costumes. ... Depicting kings and patriarchs of the Old Testament with ancient sages and evangelical personages side by side on cathedral portals discloses the anachronistic attitude toward history best of all. ... The crusaders were convinced at the end of the 11th century that they castigated not the descendants of the Saviour's murderers, but the murderers themselves..." ([8], pp. 117–118).

Proceeding from traditional chronology, the modern historians believe that the Middle Ages "mixed up epochs and notions" on a very large scale, that the medieval authors identified ancient biblical epoch with that of the Middle Ages only because of their "ignorance". But, besides the traditional explanation (alleged inexplicable "love for anachronisms"), another point of view is possible, namely, that all these statements of medieval authors, which seem strange now, are authentic and are regarded as "anachronisms" only because we follow another chronology.

Traditional chronology (Scaliger's version) only fixed one of several medieval chronological conceptions. Along with the chronology adopted today, other versions existed earlier, too. For example, the 10th–13th-century Holy Roman Empire was regarded to have immediately followed the Roman Empire, which, according to the modern ideas, occurred in the 6th century A.D. ([46], Vol. 1, p. 16). Here are the traces of the strange medieval controversy (from the modern standpoint). Assumingly basing himself on a whole series of philological and psychological observations, Petrarch asserted that the privileges given by Caesar and Nero to the Austrian duchy (in the 13th century A.D.!—A.F.) were forged. (Then it had to be proved.) ([46], Vol. 1, p. 32).

For a modern specialist, the very thought that Caesar and Nero meant the Austrian duchy who began ruling only in A.D. 1273, i.e., 1200 years later, is absurd (*ibid.*). But Petrarch's 14th century opponents did not think so ("it had to be proved at that time" [46]. Regarding the same documents, E. Priester noted that all the interested people understood quite well that they had obviously been falsified and shamelessly forged (this being today's point of view); nevertheless, they "politely" turned a blind eye to this circumstance [17].

For example, the reader is accustomed to the thought that the famous gladiator fights took place only in "the far-away past". But this is not so. After writing about the gladiators' fights in ancient Rome, V.I. Klassovsky adds immediately that they also occurred in 14th-century Europe [47]! He also points to fights in Naples in *ca.* A.D. 1344 ([47], p. 212). As in antiquity, these medieval fights ended in the death of a fighter [47].

8.9. The chronology of the biblical manuscripts. L. Tischendorf

Dating of religious sources remains very much unclear. The chronology and dating of the biblical books are quite uncertain and are generally known to be based on the authority of the Christian theologians of the late Middle Ages.

> "The most ancient of more or less complete surviving copies of the Bible are the *Codex Alexandrinus, Codex Vaticanus, Codex Sinaiticus*. ... All three manuscripts ... are dated (paleographically, i.e., on the basis of comparing the 'handwriting style' of the manuscript with that of other manuscripts whose dating is taken as known *a priori*—A.F.) ... by the second half of the 4th century A.D. The language of the Codices is Greek. ... The lesser known is the *Codex Vaticanus*; in particular, it is not clear how and whence this source appeared in the Vatican in *ca.* 1475. ... It is known about the *Codex Alexandrinus* that ... the patriarch Cyrilles Lucaris presented it as a gift to the king of Great Britain and Ireland, Charles I, in 1628" ([48], pp. 267–268).

The Codex Sinaiticus was discovered only in the 19th century by L. Tischendorf ([48], pp. 268–270). Of the same type of sources are the *Codex Bezae* and *Codex Ephraemi Syri Rescriptus.* These are palimpsests, i.e., writing materials which were cleared and reused. A scribe erased the biblical text from a parchment allegedly somewhere between the 12th and the 13th century, and wrote instead the work of Ephraem Syrus (note how expensive the parchment was!).

It is due to this document that Tischendorf made a name for himself by "dating" it to the 5th century A.D.

Thus, all three of these most ancient codexes were actually discovered only after the 15th century. The reputation of these documents as being ancient was based on Tischendorf's authority, judging by the "handwriting style". However, the idea itself of paleographic dating assumes that the global chronology of other documents is known *a priori*; hence, this dating method is not independent.

Of the individual biblical works, the most ancient one is the manuscript of the Book of the Prophet Zechariah and that of Malachi, dated to the 15th century A.D. (also paleographically) [48].

We should also bear in mind the strange fact that "the most ancient of the surviving manuscripts of the Bible have been written in Greek" ([48], p. 270).

No Jewish manuscripts of the Bible dated to earlier than the 9th century A.D. (!) exist, though those of later times, mainly of the middle of the 13th century A.D., are kept in many national libraries. The most ancient Jewish manuscript containing the complete text of the Old Testament is referred only to A.D. 1008 ([48], p. 270).

The biblical Canon is assumed to have been established by the synod at Laodicea in A.D. 363; however, no acts of this and earlier synods survived [49]. In reality, the Canon was officially established only since the new Council of Trent had assembled in 1545 and lasted, with intervals, until 1563 (during the Reformation). By the order of the Council, many books were regarded as apocryphal, in particular, the *Book of the Kings of Judah and Israel* ([50], p. 76).

It turns out that most datings of biblical manuscripts are overwhelmingly based on paleography. We have pointed out that this depends on a global chronology assumed to be known *a priori*. We illustrate this with the following example.

> "In 1902, the Englishman Nash bought in Egypt a fragment of a Jewish manuscript written on a papyrus, the dating of which the scientists cannot agree upon until today" ([48], p. 273).

Finally, it was agreed that the text referred to the turn of our millennium.

> "... after the Qumran manuscripts had been discovered, the comparison of the 'handwriting' on the Nash papyrus and the Qumran scrolls made it possible to establish at once that the latter were quite old" ([48], pp. 272–273).

Thus, one scrap of the papyrus, whose dating was not "agreed upon by everyone", influenced the dating of all the other documents. Nevertheless,

> "... dating the manuscripts (of Qumran—A.F.) led to much controversy among the scientists (namely, from the 2nd century B.C. to the time of the crusaders)" ([50], p. 47).

For example, the American historian S. Zeitlin categorically insists on the medieval origin of the texts ([48], p. 27). It is assumed today that the original dating of the Qumran scrolls to the turn of the millennium was confirmed by radiocarbon dating. However, as will be shown below, it is extremely unstable for comparatively small time intervals, and the application to events which are 2–3 millennia old is quite problematic due to the obtained "scattering" by up to about one thousand years (for the indicated time interval).

8.10. Vowels in ancient manuscripts

In the attempt to read and date most of the ancient, medieval, biblical, ancient Egyptian, and other manuscripts, certain basic problems are frequently encountered.

As soon as J. Sunderland started investigating the original language of the Old Testament, he, in his words,

> "... faced the fact of enormous and even startling importance. The thing is that the Jewish written language originally had neither vowels nor signs replacing them. The books of the Old Testament were written only with consonants" ([49], p. 155).

This is also typical for other languages. For example, an ancient Slavonic text was a chain of only consonants, too; sometimes even without signs replacing the vowels, or without division into words. Old Egyptian texts were also written in consonants only. According to E. Bickerman,

> "... the names of Egyptian kings are given in contemporary literature schematically, in a quite arbitrary, so-called scholastic manner adopted in school textbooks. These forms are often greatly different from each other; it is impossible to order them somehow, due to their arbitrary reading (!) which became traditional" ([7*], p. 176).

Probably, the rarity and high cost of writing materials in ancient times made the scribes save them, and omit the vowels, thereby essentially shortening the text. It is also possible that writing out all the words in a row, without intervals between them, pursued the same goal.

However, if we take the Jewish Bible or a manuscript today, we shall find in them the skeleton of vowels filled with dots and other signs denoting the missing vowels. These signs did not belong to the old Jewish Bible. The books were read by consonants, and the intervals were filled with vowels according to one's skill and the apparent requirements of the context and oral legends [49]. Imagine how exact the meaning of a word written in consonants can be if, for example, CLN can mean clean, clan, colon, and so forth!

According to T. Curtis, even for the priests, the content of manuscripts remained extremely doubtful and could be understood only by means of the authority of the legend ([49], p. 155). It is assumed that this serious shortcoming of the Jewish Bible had been eliminated not earlier than the 7th or 8th century A.D., when the Massoretes revised the Bible and added signs replacing the vowels; but they had no manuals, except their own reason, and a very imperfect legendary tradition ([49], pp. 156–157). S. Driver adds that, since the times of the Massoretes in the 7th–8th century A.D., the Jews have taken to keeping their sacred books with extraordinary care, but then it was too late to repair the damage already done. The result of such attentiveness was just the immortalization of the distortions, which were then placed on exactly the same level of authority with the original text ([49], p. 157).

The opinion reigning earlier was that the vowels had been introduced into the Jewish text by Ezra in the 5th century B.C. But in the 16th and 17th century, E. Levita and J. Capellus in France refuted this opinion and proved that the vowels had been introduced only by the Massoretes. The discovery created a sensation in the whole of Protestant Europe. Many people believed that the new theory would lead to disproving the religion completely. If the vowels were not a matter of Divine Revelation, but only a human invention, besides, a much later one, then how could we rely on the text of the Scripture? This discussion was one of the hottest in the history of the new biblical criticism and proceeded for more than a century, stopping only when the validity of the new point of view was acknowledged by everyone ([49], pp. 157–158).

8.11. Traditional biblical geography

Even if the vowels of common words are not that important, the situation changes completely when their combination meaning a city, country, the name of a king, etc., appears in an ancient text. Tens and hundreds of different variants of vowels for one term may be found, starting the "identifications" of the biblical vowel-free names of cities, countries, and others, made by traditional historians proceeding from the chronological version of J. Scaliger and the localization referring the biblical events to the Near East. As the archaeologist M. Burrows notes, the archaeological job generally leads to the undoubtedly strongest creed in the reliability of biblical information [48]. F. Kenyon of the British Museum insists as much categorically on archaeology refuting the "destructive skepticism of the second half of the 19th century". (W. Kelley has published a book with the remarkable title *Und die Bibel hat doch Recht*, asserting that the Bible was right anyway.)

But here is information reported by the well-known archaeologist G. Wright, who, by the way, is a staunch partisan of the correctness of orthodox localization and of dating biblical events. He wrote,

> "A great many findings do not prove or disprove anything; they fill the background and only serve as historical artifacts. Unfortunately, the desire 'to prove' the Bible permeates many works available to the average reader. Historical evidence may be used in an incorrect manner, whereas the conclusions drawn are often erroneous and only half correct" ([48], p. 17).

If we attentively examine the concrete facts, then we shall see that none of the books of the Old Testament contain any solid archaeological confirmation of their traditional geographical and time localization. The whole "Mesopotamian" biblical theory will be questioned [1].

I.A. Kryvelev wrote,

> "The traditional localization of the events described in the New Testament is no better. The reader interested in biblical archeology may be bewildered by the hundreds of pages speaking of excavations, landscapes, or artifacts, historical and biblical background. And, in conclusion, when it comes to the results of the whole job, there are only a number of indistinct and imprecise statements about the problem not having been completely solved, but that there is still hope for the future, and so forth. We may be absolutely sure that none of the stories of the New Testament contains any somewhat convincing archaeological confirmation (in terms of the traditional localization—A.F.). This is perfectly true, in particular, if applied to the figure and biography of Jesus Christ. Not a single spot traditionally regarded as the arena of a particular event occurring in the New Testament can be indicated with the slightest degree of confidence" ([48], pp. 200–201).

We note at the same time that, along with the traditional point of view which as we have seen has no sure confirmation, there also exist other, competing versions. For example, beginning with the 13th century A.D., the Catholic Church declared that, in the Italian town of Loreto, there was the very house where the Virgin Mary lived and where she met the archangel Gabriel ([48], p. 198). It turns out that "Loreto is a place of pilgrimage of Catholics up to the present day" ([90], p. 37).

8.12. Problems of geographical localization of ancient events

Considerable difficulties accompany the attempts of geographical localization of many of the ancient events and cities. For example, Naples (which means simply "new town") figured in many ancient chronicles in several images, and in essentially different geographical regions, namely, Naples in Italy, Carthage (which also means "new city") [51], Naples in Palestine [52], Scythian Naples, and others. One of the localizations of the famous city of Troy is near the

Hellespont (for which, though, there are also several quite different geographical localizations). It is for this particular reason that Schliemann ascribed the name of Troy to the city he excavated near the Hellespont. According to traditional chronology, Troy was completely destroyed in the 12–13th century B.C. [7]. But, in the Middle Ages, Italian Troy, which still exists today [53], enjoyed widespread fame. This is the celebrated medieval city which played an important role in many medieval wars; especially, in the well-known war of the 13th century. Many Byzantine historians also speak of Homer's Troy as of an existing medieval city, namely, Choniates Nicetas [54] and Gregoras Nicephoras [55].

Livy indicates the spot named Troy and the Trojan region in Italy ([56], Vol. 1, pp. 3–4, Bk. 1). Certain medieval historians identified Troy with Jerusalem ([57], pp. 88, 235, 162, 207), which embarrasses the modern commentators:

> "The book of Homer somewhat suddenly turned (in the medieval text, while describing Alexander's expedition to Troy—A.F.) ... into the book on the destruction of Jerusalem" ([57], p. 162).

Anna Comnena, speaking of Ithaca (homeland of Homer's *Odyssey*), declares that a large city called Jerusalem has been built on the island of Ithaca ([58], Vol. 2). The second name of Troy is Ilion, whereas the second name of Jerusalem is Aelia Capitolina ([1], Vol. 7). Thus, in the names of these cities, there is a similarity: Aelia—Ilion. Eusebius Pamphili told that two small Phrygian towns with totally different names were called Jerusalem ([1], Vol. 7, p. 893)! It is traditionally assumed that Great Greece always was on the Balkan Peninsula; however, in the Middle Ages, the south of Italy populated by Greek colonies was also called Great Greece [27]. It is also believed that the town of Babel was situated in modern Mesopotamia. Certain ancient texts are of a different opinion. For example, the medieval Serbian text of the *Romance of Alexander the Great* places Babel in Egypt; moreover, according to this text, Alexander the Great died in Egypt, whereas he is believed to have deceased in Mesopotamia according to the traditional version ([57], p. 255). Furthermore, Babel is the Greek name of a city located opposite the pyramids. During the Middle Ages, Cairo was sometimes called by this name. Nowadays, it is a suburb of Cairo [59]. The term "babel" has a meaningful translation (as have the names of many other cities); hence, it has been applied to different towns by different chroniclers. That Rome was called Babel in the Middle Ages was reported by Eusebius [27]. Moreover, by Babel, the Byzantine historians (in the Middle Ages!) more often than not meant Baghdad [60]. The medieval Byzantine author of the 11th century, Michael Psellus, speaks of Babel as of an existing and not at all destroyed city [60]. In many documents, there is a confusion between two Romes, namely, Rome in Italy and New Rome (i.e., Constantinople on the Bosphorus). Both Romes are the capitals of the two famous empires, the Western and Eastern ones. The citizens of New Rome stubbornly called themselves "Romans". A large percentage of Byzantine coins were supplied with Latin, and not Greek, inscriptions. The capital of the new empire was transferred both from Rome to

New Rome (by Constantine I, *ca.* A.D. 330) and, vice versa, from New Rome to Rome (attempt to transfer it in A.D. 663 by Constantine III) [1]. It is possible that the identification of Constantinople with Troy and the famous "Trojan war" is a partial reflection of the battle in A.D. 1204 between the crusaders and the Byzantine Empire (the fall of Constantinople in A.D. 1204).

The complete manuscript of *Histories* by Herodotus was first discovered only in the 15th century [31]. This famous manuscript was brought by the Byzantine scientists to Western Europe after the capturing of Constantinople by the Turks in 1453. The importance of Herodotus for traditional history cannot be underestimated. But he declares, quite unexpectedly, that the Nile flows parallel to the Ister, which is now identified with the Danube (and not the Dniester). It turns out that "the opinion that the Danube and the Nile are parallel reigned in Medieval Europe even up to the end of the 13th century". Thus Herodotus makes the typical error that is characteristic of medieval authors.

The identification of Herodotus' geographical data with the modern map entails great difficulties within the framework of the events described in traditional localization.

In particular, numerous corrections which the modern commentators are forced to introduce if they perform such identification show that "Herodotus' map" is, possibly, reversed with respect to the modern one (with East and West interchanged). Such orientation is typical for many a medieval map. The commentators are forced to assume on different pages of Herodotus' *Histories* the same names for quite different seas. For example, according to the modern commentators, to retain the traditional localization of events described by Herodotus, the following "identifications" should be made, namely, Red Sea = Southern Sea = Black Sea = Mediterranean Sea = Arabian Gulf = Our Sea = Indian Ocean.

The fact that Herodotus mentions Crestonia and Creston seems to be quite strange. For Herodotus, there exist even the whole region of Crestonia, the town of Creston, the country of Crossae, and the district of Crestonaei. According to Herodotus, the Crestonaei were invaders from other countries [31].

It is possible that all these references were related to the medieval Crusaders ("cross" is also a Crusader term used in the Middle Ages) flooding Greece in the 12th–13th centuries. (See also works asserting that 15.44 of Tacitus' *Annals* originally had *christianos* for *chrestianos*, which also assimilates Herodotus' terminology to the medieval one [38].

8.13. Modern analysis of biblical geography

Many strange phenomena occur in an unprejudiced analysis of biblical geography [1]. That many biblical texts describe volcanic activity has been stressed in history long ago.

"The Lord said to Moses, 'I am now coming to you in a thick cloud. ... But when the ram's horn sounds (when the cloud leaves Mount Sinai—A.F.), they may go up the mountain' ... there were peals of thunder and flashes of lightning, a dense cloud on the mountain and a loud trumpet blast. ... Mount Sinai was all smoking because the Lord had come down upon it in fire; the smoke went up like the smoke of a kiln ... and the sound of the trumpet grew ever louder" (Ex 19:9, 13, 16, 18).

"... all the people saw how it thundered and the lightning flashed, when they heard the trumpet sound and saw the mountain smoking ..." (Ex 20:18);

"... you stood ... at Horeb. ... The mountain was ablaze with fire to the very skies: there was darkness, cloud, and thick mist" (Dt:10–11).

The destruction of Sodom and Gomorrah has long been regarded in history to have been due to a volcanic eruption. For example:

"... and then the Lord rained down fire and brimstone from the skies on Sodom and Gomorrah. ... He saw thick smoke rising high from the earth like the smoke of a lime-kiln" (Gn 19:24,28).

Here is a list of apparent volcanic eruptions mentioned in the Bible (compiled by V.P. Fomenko and T.G. Fomenko): Gn 19:18,24; Ex 13:21, 22; 14:18; 20:15; 24:15,16,17; Nm 14:14; 21:28; 26:10; Dt 4:11,36; 5:19,20,21; 9:15,21; 10:4; 32:22; S 22:8–10,13; 1 K 18:38,39; 19:11,12; 2 K 1:10–12,14; Ne 9:12,19; Ps 11:6; Ps 106:17; Ps 106:18; Ezk 38:22; Je 40, 8:45, Lam 2:3; 4:11; Is 4:5; 5:25; 9:17,18; 10:17; 30:30; Jl 2:3,5,10.

To associate (as is done traditionally) all these descriptions with Mt. Sinai (and Jerusalem) seems doubtful; it is generally known that it has never been a volcano.

Where did the events occur then? It suffices to study the geological map of the Mediterranean area ([61], pp. 380–381, 461). There are no acting volcanoes in the Sinai peninsula, Syria, or Palestine; there are only zones of tertiary and quaternary volcanism, as, for example, near Paris. In the above-mentioned regions, where the biblical events are traditionally located, no volcanic activity has been discovered since the birth of Christ.

The only powerful, and by the way, acting volcanic zone, is Italy together with Sicily. Besides, Egypt and North Africa have no volcanoes [61]. Thus, we have to find

(1) a powerful volcano active in the historical era;

(2) a destroyed capital (see the book of the Prophet Jeremiah) near the volcano;

(3) two other cities destroyed by the volcano, namely, Sodom and Gomorrah.

There exists such a volcano in the Mediterranean, and it is unique, namely, the famous Vesuvius, one of the most powerful volcanoes in history. Famed Pompeii ("capital"?) and two destroyed cities Stabiae (Sodom?) and Herculaneum (Gomorrah?) are located nearby. We cannot but mention a certain similarity in the names of these Italian and biblical towns. It is possible that the name of Sinai for Vesuvius originates from the Latin *Sino* (sinus), and Horeb from the Latin *horribilis* (horrible).

The following analytic study worth mentioning, which permits to read the vowel-free text of the Bible, was performed in [1]. It took into account placing Mt. Sinai–Horeb–Zion in Italy. We illustrate by examples.

> "The Lord our God spoke to us at Horeb and said, 'You have stayed on this mountain long enough; go now, make for all Canaan...'" (Dt 1:7).

The theologicans supply the Hebrew KNN with vowels as Canaan and place it in the desert on the Dead Sea coast, but another solution is also possible, namely, KNN = GENUA (Italian Genoa), "... all Canaan and the Lebanon ..." (Dt 1:7).

The theologicans restore the Hebrew LBN with vowels as Lebanon; however *lebānôn* means "white", i.e., the same as Mont Blanc, or White Mountain: "... as far as the great river, the PRT" (Dt 1:7). The theologicans restore PRT with vowels and decipher it as the Euphrates; but, there is the large tributary of the Danube, the Prut, located in central Europe, as beyond Mont Blanc.

> "Then we set out from Horeb ... and marched through that vast and terrible wilderness" (Dt 1:19).

In fact, the famous Phlegraei, vast and burnt-out spaces filled with small volcanoes, fumaroles, and solidified lava streams are located near Vesuvius–Horeb. "... and so we came to KDS-BRN" (Dt 1:19). KDS–BRN is supplied with vowels as Kadesh–Barnea, which is, possibly, a town on the Rhône ([1], Vol. 2, p. 166). It is also possible that modern Geneva was meant: "... and we spent many days marching round the hill-country of Seir" (Dt 2:1). *Mount Seir* was left without translation; however, if it is translated, we obtain Devil's Mountain(s). And there is such a mountain near Lake Geneva, namely *Le Diableret* ("Devil's Mountain"). Then, the "Children of Lot" (Dt 2:9) met on the way can be identified with the Latins (LT) ([1], Vol. 2, p. 167); "... and cross the gorge of the Arnon ..." (Dt 2:24); but, this is the Italian river Arno: "Next we ... advanced ... to Bashan" (Dt 3:1). The town Bashan is often mentioned in the Bible. It is surprising that Bassano still exists in Lombardy. "... king of Bashan ... came out against us at Edrei" (Dt 3:1). Adria is still here, on the Po delta; the Po, by the way, has often been mentioned by ancient Latin authors (e.g., Procopius) and called the Jordan (in Procopius' *Eridanus*), which is very consistent with the biblical spelling of the Jordan, namely, *hay-yardēn* ([1], Vol. 2, p. 167). "... and we captured all his cities ... sixty cities ..." (Dt 3:3–4). Indeed, in the Middle Ages, there were many big cities in the region: Verona, Padua, Ferrara, Bologna, and others. "... from the gorge of the Arnon to Mount Hermon (= HRMN)" (Dt 3:8). But it is obvious that MNT HRMN can be supplied with vowels to be translated as the "German mountains". "Only the Og king of Bashan remained ... His sarcophagus of iron may still be seen in the ... city of Rabbah" (Dt 3:11). Here is mentioned not only Ravenna, but also the famous tomb of Theodoric of the Ostrogoths (Og = Goths?), built in A.D. 493–526. There follows TBRH (Taberah in biblical translation), which is naturally identified with the Tiber in Italy; ZN is Siena, southeast of Livorno; and HBRN, i.e. "Gorge du Rhône", a town on the Rhône ([1], Vol. 2, pp. 229–237). The slopes of Monte Viso are called Jebus (Jgs 19:10–11) in the Bible, and Rome is called Ramah (Jgs 19:14).

According to the statistical analysis of ancient texts (see details below), and if the vowels are left out, the following geographical identifications may be consistent: Assyria = Germany, France = Persia (PRS), Jerusalem = Rome or Pompeii, Media = Hungary. Furthermore, due to the impossibility of the European location of many of the biblical events and terms, we stress that the word Venetiae could have been read by the ancients both as Venice and Phoenicia (*Phoinikē*).

8.14. Ancient originals and medieval duplicates. Anachronisms as a common feature in medieval chronicles

The "Renaissance effect" of duplicating antiquity is vividly expressed in traditional chronology.

Plato is the founder of Platonism; his teachings were revived several hundreds of years later by another, the famous Neoplatonist Plotinus (A.D. 205–270). His name is almost identical to that of his teacher Plato. Neoplatonism then died, too, but was revived again in the 11th century by another famous Platonist, Pletho, a name which is again accidentally almost identical to Plato. Freed of all vowels, Plato, Plotinus, and Pletho are simply identical names.

It is assumed that Pletho revived ancient Platonism. Plato's manuscripts first appeared from oblivion just in the time of Pletho, i.e., in the 15th century [62]. Pletho organized the well-known Pletho Academy in Florence, an exact analogue of the ancient Platonic Academy [62]. He was the author of the famous utopia (both Plato and Pletho wrote utopias), the *Laws*, which, unfortunately, has not survived in complete form. But the text of Plato's *Laws* was preserved. Like Plato, the 15th-century Pletho put forward the idea of an ideal state, his theory being extremely close to that of Plato. "Imitating" them both, Plotinus also hoped that the emperor would help him found the town of Platonople in Campania (again in Italy), where he would introduce aristocratic and communal institutions "conceived by Plato" ([63], Vol. 4). The number of these strange "duplicates" in traditional chronology is quite large.

One of the basic reasons for at least two variants of dating ancient and "medieval" documents is due to the Renaissance, when all the antique (now regarded as ancient) branches of science, philosophy, culture, painting, etc., were revived. It is assumed that the "ancient and brilliant Latin language" degraded at the beginning of the Middle Ages into a rude and awkward tongue which started acquiring, and did acquire, its former brilliancy only during the Renaissance. This "Renaissance" of the Latin language (as also that of ancient Greek) did not start any earlier than the 8th–9th century [64]. Starting with the 10th–11th century, the famous medieval trouvères came to make use of the stories now called by the historians "the masquerade of classical remembrances" [64]. In the 11th century, *The History of Ulysses* appeared, in which the well-known (and allegedly Homer's) fabula was retold from the "medieval approach" (speaking of knights, ladies, tournaments, etc.); but on the other hand, all the elements which would later be regarded as intrinsic of any antique story had already been present ([64]; see also the "antique" activity of the famous medieval poet Homer (Angilbert), who lived at Charlemagne's court in the 9th century. He was "the most important member of the scientific community at the Aachen court" ([63], Vol. 5). According to J. Demogeot:

> "It was the end of the 12th or in the 13th century when ... the trouvères ... started to speak with a certain satisfaction, 'this story (i.e., the story of the Trojan War—A.F.) is not commonplace; nobody has yet written it'. For them, it was almost a traditional story" ([64], p. 110).[3]

As a matter of fact, the Franks regarded themselves as formerly having lived in Troy (!), whereas one author in the 7th century, Fredegarius Scholasticus, points out king Priam as a figure belonging to the medieval epoch [64].

The Argonauts' expedition was also claimed to have coincided with the Trojan War when the conquering Crusaders, analogues of the Argonauts, rushed into the far regions of Asia. Alexander the Great flooded France with compliments [64]. Speaking of the Trojan war, some medieval authors call Paris (Alexandros) a Parisian ([57], Comm. 76, p. 234) - French name.

The medieval authors believed that the emperor Heraclius (traditionally assumed to have reigned from 610 to 641) had reigned with Princess Semīramis in the Land of the Hellenes ([57], p. 107). If we place biblical Semīramis into the 7th century, we shall diverge from traditional chronology to the extent of several hundreds of years.

A.V. Sterligov, the author of *Ancient Plots in French Book Illustration at the End of the 14th–15th century* [91], for example, reports the following:

> "The greatest specialist in French medieval literature Gaston Paris wrote that the Middle Ages had never recognized themselves how far they had been separated fromm antiquity..."

> "Anachronism was a common feature in the numerous universal chronicles, and ancient historians' renderings where biblical; ancient and national historical characters and the contemporaries were depicted similarly. The Trojan heroes cannot be distinguished from King Arthur's knights and warriors of the Hundred Years' War, while the contemporaries of Charles VI pronounce phrases which Livy put in the mouth of Gaius Capuleius, a tribune living in the 5th century B.C. ... Ancient history, especially that of Troy, from which the French nation allegedly originated, was included in the French chronicles. Hence, say, during the famous 1330 tournament, the Parisians fought under the name of Priam and his 35 sons" ([91], p. 236).

> "The deeds of biblical, ancient Greek and Roman heroes merged into one history of knighthood, continuing before the eyes of contemporaries" ([91], p. 237).

Under the pressure of tradition and all these strange things, the historians are forced to believe that

> "... the medieval idea of chronological sequence had all but been confused: Monks with crosses and censers took part in the funeral of Alexander the Great; Catiline

---

[3]Translated from the French—tr.

in the liturgy ... Orpheus was in their eyes Aeneas' contemporary, Sardanapalus a Greek king, Julian the Apostate a papal chaplain. All in that world took fantastic colouring according to the modern historians.... The most glaring anachronisms and the strangest fantasies neighboured peacefully" ([113], pp. 237–238).

All the above facts (and thousands of others!) today have been rejected as "preposterous". However, we have to bear in mind that their seeming preposterousness only arises from the chronology traditionally accepted at present.

Long before the discovery of the allegedly "ancient" manuscript of the story of the Golden Ass, the "ass theme" had been widely exploited by medieval trouvères, and the "ancient" story (of Apuleius), which surfaced only during the Renaissance, resulted from the medieval sources. It is generally known that in the Middle Ages, much earlier than the "ancient" originals were discovered, all "ancient" stories had been exploited and embellished, with the alleged originals chronologically and evolutionally following their medieval predecessors [64].

The oldest biography of Aristotle is dated to A.D. 1300 ([86], p. 29). Furthermore, only 20 percent of what is now called the Aristotelian corpus belongs to Aristotle himself ([86], p. 64). In the 15th century, it was the propagandist Georgios Scholarios who fervently popularized Aristotle's works.

8.15. Names and nicknames. Handwritten books

It is important that people in antiquity did not have names in the contemporary sense of the word but only had nicknames meaningful in the original tongue. The father of a Roman consul in 169 B.C. had 13 names, and his son 38. The nicknames characterized a man; the more remarkable traits of character, the more nicknames. Different chroniclers gave an emperor the different nicknames under which he was known. Moreover, they sometimes knew the same emperor under different nicknames. Pharaohs bore one name before the coronation, and another after it. Since they were crowned several times in different regions, the number of "names" grew sharply. For example, these nicknames were strong, light, and so forth.

"The csar Ivan III had the name Timothy; Vassily III was Gabriel ...; the csarevitch Dmitry murdered in Uglich was Uar. One name was regal, and the other Christian" ([98], p. 22).

Traditional history believes that medieval names were different from ancient ones. However, textual analysis demonstrates that ancient names were quite often used in the Middle Ages. Nilus Ancyranus (who died in A.D. 450) wrote letters to the contemporary monks Apollodorus, Amphictyon, Atticus, Anaxagoras, Demophanes, Asclepiades, Aristocles, Aristarchus, Alcibiades, Antiochus, Apollos, and others [99]. An exceptionally large number of ancient names were used in the 12th- to 14th-century Byzantine Empire.

Handwritten books have long survived the beginning of printing, successfully competing with the latter throughout Europe ([94], pp. 19, 25). With a few exceptions, almost all Irish literature of the 7th–8th century "only exists in manuscript form" ([94], p. 28). Until 1500, 77 percent of all printed books were in Latin, since the Latin type was easier to make. However, the types of other languages were being introduced into the printing practice extremely slowly, because the technology of making special marks to denote accents, vowels, and so forth, was complicated. Therefore, for many years after printed books had appeared, "people copying Greek, Arabic and Jewish manuscripts did not remain unemployed...." ([94], p. 57). Especially many hand-written books of the book-printing era were made in Greece (!). It is possible that many of these manuscripts were later declared "ancient". All of the above facts make many of the paleographic instances of dating doubtful. It turns out that many manuscripts were copied from books already printed ([94], p. 120). Greek monasteries were especially famous for their scribes who copied printed books! To detect such manuscripts, one should compare the textual errors with those in printed editions. Most probably, in copying a book, the errors were copied, too.

§9. Astronomical and Mathematical Analysis of the Almagest

9.1. Morozov's analysis of the first medieval editions of the Almagest

The basics of traditional chronology were established by analyzing written sources. If we reconsider the datings, freeing them from the *a priori* accepted hypotheses regarding the age of the documents, we shall not find any serious contradictions, the typical example being the new dating of Ptolemy's *Almagest*, carried out in [1]. Its most important part is the star catalogue: The star coordinates are given with an accuracy of $1/6^\circ$. To obtain so much accuracy, a clock with a minute hand is required; however, such a clock was not invented until the 12th–15th century.

Morozov discovered that there was a reliable method to find out when the catalogue was actually made. Without going into details, we know that the stars' longitudes possess an annual precession of $50.2''$; hence, by dividing the difference between today's longitudes and those indicated by Ptolemy by $50.2''$, we derive at the year when the catalogue was compiled. The result is shocking: All the longitudes given in the first Latin edition could have been recorded in the 16th century, i.e., when the book was published (now regarded as "ancient", and assigned to the 2nd century A.D.). This fact had not been noticed earlier, since the astronomers studied the Greek edition. Allegedly, the Greek text is the original one but was published later than the above-mentioned Latin "translation". The (second) Greek edition supplies values for the longitudes, decreased by $20^\circ \pm 10'$, as if the stars had been observed in the 2nd century A.D, which is the traditional dating for the *Almagest*.

A hypothesis arises that the Latin text was the original and the Greek the secondary one, but not vice versa as in the traditional approach. But it is also possible that, in the 16th century, the *Almagest* was published as a treatise for practical use and not as a historical document; and since the data had become obsolete due to the precession and was of no purpose, the translator "refreshed" the catalogue by introducing the latest evidence.

This objection can be eliminated by taking notice of the fact that the most important star coordinates were improved considerably in the later Greek edition, compared with the Latin one. Thus, by "restoring" Ptolemy's data as far as precession goes, the editor also improved it in other respects, which is not consistent with the conjecture that the Greek text was the original.

It was noted in [1] that the following about the *Almagest* seemed to be very strange:

(1) The extraordinary state of preservation of the star catalogue and the whole text. The *Almagest* is traditionally believed to have been rewritten many times since the 2nd century A.D. But, in copying, numerous errors must have been made, which is not confirmed, however.

(2) The inexplicable accuracy of the catalogue and other observational data collected by Ptolemy and Hipparchus.

(3) The use of the spring equinox as the basic point for measuring the longitudes, which could only be done by overcoming certain difficulties (one started resorting to it only since the 10th–16th century).

(4) Dating the Latin edition (from the longitudinal precession) to the 16th century, agreeing with the date of the 2nd century A.D. (more precisely, by the rule of Antoninus Pius) given in the *Almagest* itself, is confirmed by the Greek text only if we take the value of the 16th-century precession, and is rejected if we replace it by a more precise one.

(5) The "improvement" of the star catalogue of the Greek edition consisting of (a) more precise star coordinates, and (b) a systematic correction of their latitudes, obviously due to taking refraction into account (a late medieval discovery).

(6) The systematic and considerable latitudinal shift discovered by the astronomer J. Bode, which puts any explanation of the *Almagest*'s traditional date to doubt.

(7) The choice of the North Star as the first star of the catalogue, which neither could have been substantiated astronomically in the 2nd century (when another star was near the north galactic pole) nor have been consistent with the ecliptical coordinate system adopted in the *Almagest*, but quite understandable if the observations were made in the 11th–16th century.

(8) The inclusion of the star Achernar, which could not have been seen in Alexandria in the 2nd century A.D., but was already visible in the 15th–16th century.

(9) The inclusion of Albrecht Dürer's engravings (astrographic charts) made only in 1515. As a matter of fact, many stars were localized on the map relative to these figures as being "in the leg of the constellation Pegasus", and so forth.

In my opinion, all these remarks made in [1] are very subjective and can be interpreted in different ways. We need some strong statistical method for dating the star catalogue. The difference between the Latin and Greek editions of the *Almagest* (see items 4 and 5) shows that we need to base our research on the ancient manuscripts of the *Almagest*. We base our work on the "canonical" version of the *Almagest*'s star catalogue as presented in the fundamental work of Peters and Knobel (*Ptolemy's Catalogue of Stars.* A revision of the *Almagest*, Carnegie Institute, Washington, 1915). They investigated all the main manuscripts of the star catalogue.

The attempts to date the catalogue on the basis of the displacement of individual stars such as Arcturus are not convincing. This motion is extremely slow, only several seconds a year. Recall that the astronomer Halley, on the contrary, calculated the value of Arcturus' proper motion, referring to star longitudes and the traditional dating of the *Almagest* to the 2nd century A.D. In reality, the values of the proper star displacements are small and of the order of the measuring errors; therefore, to date the catalogue reliably on the basis of individual displacements is complicated. (See details in the next section.)

Dating catalogues by the deviation from modern star coordinates should be generally very accurate. For example, it is on the basis of a *ca.* 20° difference between the longitudes in the Greek and the Latin editions that traditional chronology makes a conclusion about their having been observed in the 2nd century A.D. It is tacitly assumed, however, that both the ancient and medieval astronomers counted longitudes from the same "basic point". To give just one example, the famous *Theatrum Cometicum* by the 17th-century author Stanislaw Lubieniecki should be "dated" to the 5th century B.C.! This absurd conclusion is due to Lubieniecki's having counted the longitudes off the first stars of Taurus, which led to a large difference with the modern longitudes, and which is not accepted today. There are very many similar examples [1]. Methods of the computation of longitudes simply were diverse in the Middle Ages, and each author took different stars as initial reference points, resulting in a difference in the longitudes, and therefore not at all explained by precession.

9.2. On the statistical characteristics of the Almagest. The structure of the star catalogue

Sections 2–5 contain the results of a 1986 work by the author and G.V. Nosovsky:

The history of the *Almagest* is well known. It is assumed traditionally that its star catalogue was made by Ptolemy in A.D. 138 from his own observations in Alexandria, though the fact that the stars were observed by Ptolemy himself was denied by many researchers (e.g., in [102]). R. Newton's book presents some of the latest and quite fundamental research on the *Almagest*. Therefore, we only touch upon the history of the discovery of the catalogue in medieval Europe.

The catalogue's manuscript got into Rome from Byzantium in *ca.* 1450 (recall which 1453 is the year when Constantinople fell). It is assumed which its first translation into Latin was made by Georgios Trapezuntius in 1460 and that it was published with Dürer's maps only in 1528 in Venice (see [108], pp. 10–11). There are data indicating that the famous scientist and his contemporary, I. Regiomontanus, investigated the catalogue in 1464, which was published only in 1541 ([108], p. 220). Here is the list of the first editions of the *Almagest*: 1496 in Venice (?), abbreviated by Regiomontanus and G. Purbachi ([108], p. 218); 1515 in Venice, Liechtenstein's edition in Latin; 1528, in Venice, Trapezuntius' edition in Latin, with the star longitudes corresponding to those of the 16th century; 1537, in Basel, Trapezuntius' edition in Greek, which he called the "first" edition, with the ancient star longitudes.

The catalogue's structure was as follows: Stars are divided as in the constellations, each description consisting of four columns with the positions described as, for example, "in Pegasus' head", ecliptical longitudes, latitudes and magnitudes (with brightness being in inverse proportion to the magnitude). Sometimes, the description of a constellation is followed by that of the stars near it, but which are not in the corresponding figure. Today, all the stars are formally included into the corresponding constellations.

We now discuss each of the columns.

The position of a star in a constellation. This column is least informative. As a matter of fact, neither constellations nor the descriptions of the stars' positions had ever been standardized in the Middle Ages. In the 19th century, they were understood as simply being a certain region in the astrographic charts under a constellation; however, it was essential for the medieval astronomers that the stars should be well consistent with a particular figure. The forms of the constellations in medieval astronomical textbooks seem fantastic, and it is hard to understand which particular configuration of stars was meant (see examples in [1]). The first standard representations of the sky were given in Dürer's prints, published together with the *Almagest* in 1537, though they were not completely identified with the modern star atlas. The description of the stars in the constellations did not become standard after Dürer's maps either: The *Almagest*, Copernicus', and Tycho Brahe's catalogues are all different. It is only in the 17th century that the first sufficiently precise classification systems appeared, which made it possible to identify with certainty the stars mentioned in ancient catalogues with modern stars (i.e., with stars listed in modern catalogues.

Star coordinates. Two star coordinate systems were known in the Middle Ages, namely, ecliptical and equatorial systems. From now on, we refer the reader to [102] with respect to all problems of star astronomy. Beginning with the 17th century, only equatorial coordinates have been used in catalogues. Ecliptical coordinates are only seen in the *Almagest* and in 16th-century catalogues, the last of them being by Tycho Brahe. The reason for this is very simple: Equatorial coordinates are much easier to measure (to a greater accuracy at that) than ecliptical ones. On the other hand, at the time of Ptolemy and from the 15th to the 17th century, astronomers believed ecliptical coordinates to be "eternal", i.e., suitable at once for all epochs, with the latitudes being invariable in time, and the star longitudes varying at a constant rate (meaning the longitudinal precession). Therefore, the two principal questions discussed by astronomy in the 15–17th century were: Do stars possess their own movement, or is the configuration of the starry sky invariable, and what is the rate of precession? Both answers given by Ptolemy are wrong. He answered in the negative in the first case, though Arcturus' own movement was discovered in the mid-18th century. He determined the rate as 1° per 100 years, its modern value being 49.8s a year, i.e., 1.4° each 100 years. It is curious to see Tycho Brahe assert that Copernicus allegedly assumed that the precession was 1° a century, and Tycho Brahe ascribed the first refining of the figure to himself (see [104], pp. 377–396).

The division value for star coordinates in the *Almagest* is 10 minutes. More precisely, one-sixth of a degree, since the *Almagest* coordinates were given in degrees and their fractions with an extremely inconvenient (from the modern standpoint) method for the latter notation (e.g., see [102], [108]). The coordinate accuracy does not correspond to this value (see the analysis in [102] and in the following). Ptolemy declared that he had directly measured the ecliptical coordinates of all stars by means of an astrolabe, which is a rather complicated procedure [102]. Copernicus only refined the positions of several stars. Tycho Brahe rewrote the catalogue again, using the system of base stars and thus achieving the accuracy of one minute. His catalogue contains about 700 stars (against Ptolemy's 1022); however, after it had been published in the 16th century, the *Almagest* completely lost its scientific importance.

Magnitude of a star. The scale of magnitudes in Ptolemy's *Almagest* is made up of integers from unity (corresponding to the brightest stars) to six (corresponding to the faintest ones). He stated that he had observed all stars up to the sixth magnitude, which seems improbable from today's point of view, since many stars of magnitude 3 to 5 cannot be identified with them, whereas some of magnitude 6 can be identified at once. If we compare the magnitudes of Ptolemy's stars with the modern ones, we shall see that the magnitudes 1 to 2 were always determined correctly, whereas he often made mistakes in the interval of the magnitudes 3 to 6.

We now go on to the problem of dating the observations of the stars which formed the basis for the *Almagest* star catalogue. Its traditional dating is founded on Ptolemy's statement that the catalogue had been compiled in the second year of the rule of the emperor Pius. According to the Scaliger–Petavius chronology, this is the year A.D. 138, though the name "Pius" was common to some other Roman emperors, for example, the famous Maximilian I Pius (1493–1519), who reigned just at the time of the first *Almagest* editions (Fig. 9(2)). However, even Delambre noticed that the average error in the star longitudes was about 35 minutes; therefore, the catalogue supplies the coordinates not as they were in A.D. 138 but in *ca.* in A.D. 60. J. Bode speaks of the year 63, whereas F. Peters and E. Knobel of the year 58. In fact, the error variance for the longitudes of approximately 1,000 stars is about 40^2 minutes. Hence, the average error in longitude is a random variable with variance $\sigma^2 = 40^2/1000 = 1.6'$.

Since they must be distributed according to $N(0,1)$, the admissible average error in the longitude should not exceed 5 minutes, which permits us to determine the epoch to which the catalogue dates to the accuracy of 5–6 years. Thus, in the form it was published in Basel in 1537, the *Almagest* could not have been made from the observational data of A.D. 138. This last important remark by Delambre led to the hypothesis that Ptolemy had not observed the stars by himself, but rather updated the Hipparchus catalogue to A.D. 138, the latter being dated to 130 B.C. Meanwhile, making use of the incorrect precession value, he actually reduced the catalogue to A.D. 60 instead of A.D. 138. The authors of [105], [106], and [108] were of the same opinion. The important work [102] is devoted just to the proof of this hypothesis. Note that almost all of its conclusions are based on the assumption that the *Almagest* was written by an ancient astronomer. However, R. Newton's main argument based on the comparison of degree fractional part distribution for latitude and longitude of a star is not related to chronology [102]. In this connection, the investigation of the distributions of degree fractional parts in Ptolemy's catalogue, carried out by Newton, only permits us to state the fact that the catalogue was obtained from the original and is based on direct observations by adding an integral (possibly, negative!) number of one degree and forty minutes.

If, following [108], we assume that the *Almagest* is related to A.D. 58, and if we take precession into account, then the longitudinal shift through an integral multiple of one degree and forty minutes takes us to the following values for the epochs of observation, namely, ..., −207, −134, −62, 10, 92, 154, 227, 299, 371, 443, 515, 586, 660, 732, 805, 877, 950, 1022, 1094, 1166, 1239, 1311, 1383, 1456, 1528, 1600, ... (years B.C. are indicated by a minus sign).

The conclusion of Newton is that the Ptolemy star catalogue had been "corrected" according to the precession used by Hipparchus. On the basis of statistical investigations, he asserts that Ptolemy was a falsifier. The same thought was even expressed in the book's title, namely, *The Crime of Claudius Ptolemy*, and in the titles of many of the book's sections. For example, he speaks of equinoxes and solstices allegedly observed by Ptolemy, the fabricated solstice of 431 B.C., observations allegedly made by Ptolemy to determine the ecliptic's slope and Alexandria's latitude, four fabricated lunar eclipse "triads", the proof of a forgery, a swindler, falsifications of calculations and falsifications with oversights, falsification of data, falsification of the Venus data and exterior planet data, and so forth.

Newton writes that all the observations made by Ptolemy himself, so far as they can be checked, turned out to be a forgery, and that many observations ascribed to other astronomers were also part of the falsification. It then becomes clear that none of Ptolemy's statements can be accepted unless they have been confirmed by authors absolutely independent of his data. Be it history or astronomy, all research based on the *Almagest* should be performed again. Thus, Newton completes his thought, Ptolemy is not the outstanding astronomer of antiquity but a more unusual figure: a most successful swindler in the history of science (see [102]).

However, this estimation of Ptolemy's work by a well-known astronomer of modern times is only based on the hypothesis of the *Almagest*'s ancient origin. The attitude toward Ptolemy may become quite different if it turns out that we are dealing with a text written in the 10–16th century. We have already noted earlier that almost all of Newton's conclusions depend on the *a priori* dating of the catalogue to about the year A.D. 1, or the first two centuries before and after. Our goal is the *Almagest*'s analysis based solely on the star catalogue itself and the contemporary idea of the starry sky. Some steps in this direction are made in the sequel. We once again stress the importance of Newton's research and would only like to complete it by suggesting another interpretation.

Below, we have collected the data regarding the errors in the star catalogue.

9.3. The accuracy of the Almagest's star coordinates

Here, we discuss the accuracy of the *Almagest*'s star coordinates and the way Ptolemy measured them. Recall that the division value was 10 arc min., or one-sixth degree. Much work on identifying the stars in the *Almagest* catalogue with the stars of modern time was done by Bayer, Flamsteed, Bode, Baily, Peters, Knobel, and others in the 16–20th century. This was a very nontrivial job (for details, see [108], which gives a large number of versions of identification, with different authors identifying the same stars differently in the different *Almagest manuscripts*). Since not all the *Almagest* stars have been identified with certainty, we only consider the zodiacal stars. The zodiacal constellations were especially important for ancient and medieval astronomy and astrology. It is, therefore, reasonable to assume that their coordinates were measured more often than the coordinates of other stars. Hence, the coordinates of the zodiacal stars apparently make a homogeneous sample, whereas the sample of all the *Almagest* star coordinates is inhomogeneous, in particular, due to the different accuracy of determining longitudes in different latitudes (however, there may be other reasons, too; e.g., astrological, more important stars probably having been measured in a more thorough manner).

The *Almagest*'s zodiac consists of 350 stars. The average error in longitude is zero if A.D. 60 is taken as the observation epoch (more precisely, this is the epoch to which the catalogue is related, with it possibly being much different from the time when the actual observations were made; see above). The average error in latitude is $-2.4°$, the sample variance in the longitudes $\hat{\sigma}_\ell^2 = 47^2$ min. (recall that $1° = 60$ min.). Ten values exceeding 130 minutes were not taken into account. The sample variance in latitude was $\hat{\sigma}_b^2 = 26^2$ min., with one value of 136 minutes being rejected. We can draw two conclusions from comparing these and the division value of 10 minutes in the *Almagest*.

Apparently, the longitudes were recalculated after actual observations. In fact, since the accuracy of the longitudes is much worse than that of the latitudes (remember that this difference cannot be due to the proximity of the stars to the poles, considering only the zodiacal stars with latitudes within

20°), this circumstance is another argument for the recalculation of the longitude. In antiquity and the Middle Ages, calculations involved complex literal designations of integers and especially fractional parts, constructed from fractional units denoted in the same way as their denominator, but primed (see [102], [105]). It is natural that, in each recalculation, errors arose and the accuracy fell.

The variances of the catalogue errors are not consistent with the division value of 10 minutes. It turns out that, as a rule, Ptolemy's mistakes consisted of several divisions at once, which confirms Morozov's standpoint that the *Almagest* coordinates were obtained by a method quite usual for the Middle Ages and, possibly, for antiquity, namely, by measuring equatorial coordinates and subsequently recalculating them into ecliptical ones, done graphically on large atlases or special terrestrial globes with grids of both coordinates (see [1], Vol. 4, pp. 201, 264–265). However, it is assumed traditionally that Ptolemy observed ecliptical coordinates directly by means of a complex device, the astrolabe, adjusting it by the sun in the afternoon, and by calculating the correction for the shift of its plane due to the earth's rotation by a clepsydra. If we accept Morozov's viewpoint, then we derive at a natural and simple account for these "strange" average error graphs in determining the zodiacal star coordinates as the longitudinal function (stars are grouped with respect to their longitude, and the average error in longitude and latitude is calculated in each group; see the graphs in [108]). The graphs resemble two sine curves shifted with respect to each other approximately by one-fourth of the period. The fact can be easily explained by a small error (within 0.5°) in specifying the ecliptic's slope to the equator on the terrestrial globe (see also the discussion in [1], Vol. 4).

Thus, the coordinates of the *Almagest* stars are, most probably, a total of the following: (1) Measuring equatorial star coordinates, (2) recalculating equatorial into ecliptical coordinates graphically, and (3) adding a certain constant difference to the longitudes without altering the latitudes (possibly, it was done several times). In connection to the latter item, we once again stress the important investigation by Newton of the degree fractional parts distribution for the catalogue coordinates, showing that an integral multiple (possibly negative) of degrees and 40 minutes was added to the original longitudinal values (see [102]). This operation could have made the catalogue more ancient and shift it from the 10–15th century toward the turn of the first millennium.

9.4. The problem of dating the Almagest from the individual stars' proper motion

We now dwell on the problem of dating the *Almagest* based on the individual stars' proper motion. Similar hypotheses were repeatedly made. We distinguished all those stars from the *Almagest* whose own motion is greater than one second a year, at least with respect to one of the coordinates α_{1900}, δ_{1900}, where α and δ are equatorial coordinates, right ascension and declination. The subscript indicates the epoch in which the coordinates were measured, i.e., the year in which the spring equinox was the origin of the coordinates. Note that the star's own motion in a historical period can be regarded as rectilinear and uniform.

It turned out that there were nine such stars: α in the constellation Boötes (= Arcturus), α in Canis Major (= Sirius), α in Canis Minor (= Procyon), i of Perseus, τ of Cetus, O^2 of Eridanus, γ of Serpens, η of Cassiopeia, and α of Centaurus, the latter having been rejected because it is too southern (it is hard to observe southern stars, because they do not rise high enough over the horizon in the Northern Hemisphere), and it is given in the *Almagest* with an error greater than 5°, which corresponds to its own motion in 5,000 years! Thus, eight stars remained, the first three of them being of magnitude one; therefore, their identification leaves no doubt, which cannot be said of the other five, since a convenient star from the *Almagest* can only be selected on the basis of the similarity of the star coordinates. In other words, we have to take the nearest *Almagest* stars.

These stars turned out to be actually identified with the modern ones, only because they were the nearest stars for certain ones from the catalogue and are visible by the naked eye. We shall make this important thought more precise. The 17th- to 18th-century astronomers were forced to identify many *Almagest* stars just in this way. Knowing their own motion, they calculated their position, or coordinates, with respect to the turn of the first millennium, and then looked for the nearest stars in the *Almagest*. Thus, the *Almagest* stars got their names. It is obvious that the hypothesis about the *Almagest* being a document dated to the start of the Christian era resides in the identification procedure itself. The rejection of this *a priori* hypothesis can lead us to quite different identifications. Finally, the star identification procedure on the basis of the coordinate similarity, first substantially depends on the *a priori* catalogue dating and, second, is not at all unique (e.g., in the case where at once several stars are equally eligible in position and magnitude). We stress once again that, since we here consider the stars being displaced noticeably with respect to a fixed star net, to compare them with the Ptolemy catalogue, we must know the time of the observations. Thus, the star O^2 in Eridanus was identified differently by different researchers (see [108] for the table of different identifications). Moreover, the star with which it is now traditional to identify O^2 in Eridanus (No. 779 in the Baily numeration, with Ptolemy not having given a consecutive numeration) has several versions. The thing is that different printed books and manuscripts supply different values for its coordinates. We consider the two basic values due to Baily (see [106], chosen on the basis of investigating printed books) and due to F. Peters and E. Knobel (see [108], chosen on the basis of the *Almagest* manuscripts). The situation is similar to the coordinates of Procyon and its identification, existing in two versions of the printed books, and of Baily (see [106]), and in some manuscripts and [108].

Thus, the question "who is who" in the Ptolemy catalogue is absolutely nontrivial for some stars, and its solution is substantially dependent on dating the *Almagest a priori*.

A point estimation of the time when it was observed by the least-squares methods was found for each of the considered stars. Namely, the perpendicular was dropped from the position of an *Almagest* star to the trajectory of the corresponding star's own motion in today's sky, and the year was found when the moving star was at the foot of this perpendicular, for which ecliptical coordinates were recalculated into equatorial ones, and reduced to the 1900 equinox. Meanwhile, the *Almagest* epoch was taken as A.D. 60 (see [105], [106]).

We now list the obtained estimates: (1) A.D. 800 for Arcturus, (2) A.D. 500 for Sirius, (3) A.D. 1850 for Procyon (according to Baily) or A.D. 1450 (according to Peters and Knobel), (4) 2000 B.C. for i in Perseus, (5) 150 B.C. for τ in Cetus, (6) A.D. 1800 for O^2 in Eridanus (according to Baily) or 150 B.C. (according to Peters and Knobel), (7) 1400 B.C. for γ in Serpens, and (8) 100 B.C. for η in Cassiopeia.

However, note that the roughest estimation of the accuracy of these dates is 600 years. It is obtained if the division value in the *Almagest*, i.e., 10 minutes, or 600 seconds, is divided by the rate of the star's own motion, or about 1 second a year. But, if we recall the *Almagest* star coordinate error variance (see above), then this value should be increased at least twice, though the low accuracy of the obtained estimates can already be seen from their scattering.

The trajectories of the above eight stars own motion in the equatorial coordinates α_{1900}, δ_{1900} are represented in Fig. 20 (1–7) and 21, the positions in 1900 are at the point where the axes meet. All bright stars (up to magnitude 6.5), falling into a given region, are also represented. The figure near a star is its magnitude, and its number in the catalogue of [107] is also given. Figures 20(5) and 20(6) explicitly demonstrate that the identifications of the moving stars with those from the *Almagest* are substantially dependent on its dating: If we assume that it was made, say, in the Middle Ages, then No. 779 is most probably associated with No. 1362 (or No. 1363) from the bright-star catalogue [107], whereas No. 265 from the *Almagest* with No. 35k Ser (Nos. of the *Almagest* stars are given according to Baily; see [106], [108]). Thus, dating the *Almagest* from the own motion of individual stars with the use of their traditional identification with the Ptolemy stars can still be false even if we neglect the accuracy of the datings obtained, since the traditional identifications were made in the 18–20th century, involving the rate of the star's own motion and the *Almagest's a priori* dating to the 1st century A.D., which can be seen especially well in Fig. 20(5). *We can find identifications corresponding to the medieval, and not at all ancient, observation epoch for both versions of the coordinates of No. 779 in the Almagest*, which is in Eridanus according to Baily, and No. 1362 (or 1463) from the bright-star catalogue according to Peters and Knobel [107].

Our first conclusion is an inconsistency between the characteristics of the star catalogue itself and the statements contained in Ptolemy's astronomical

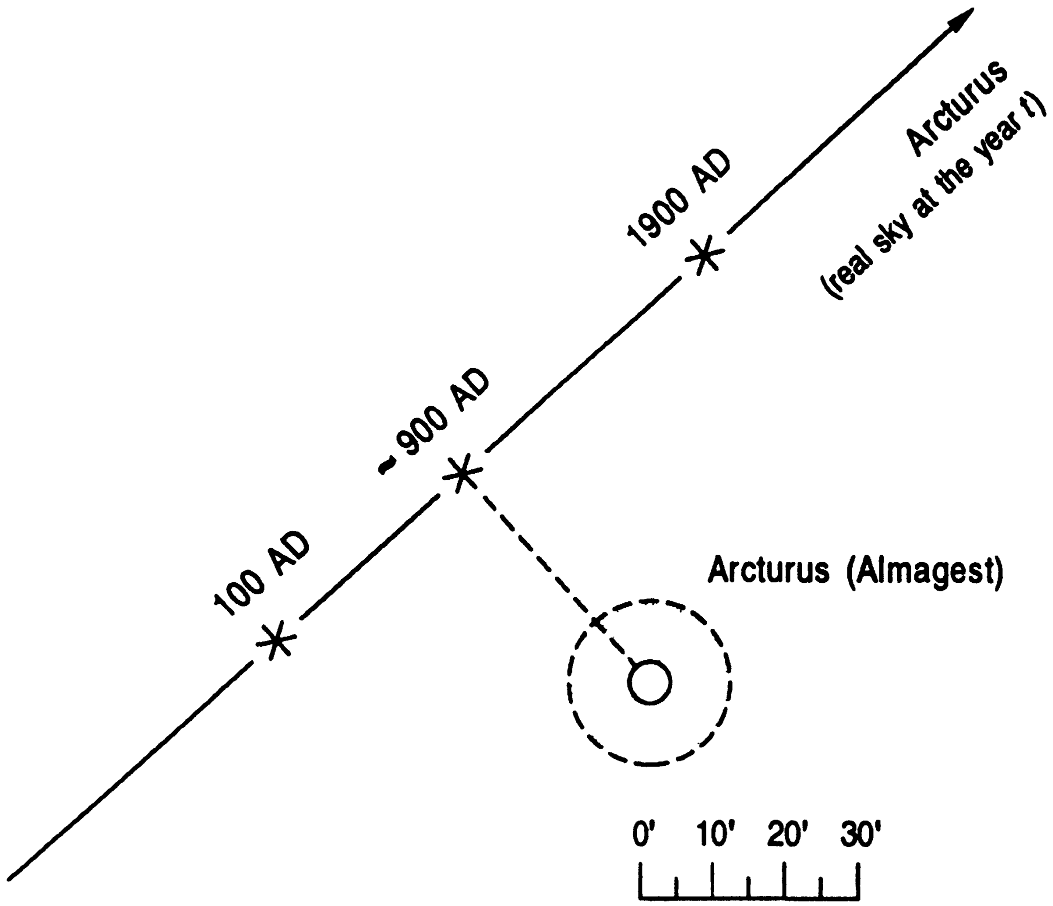


Figure 20(1). The real motion of Arcturus and its position according to the Almagest.

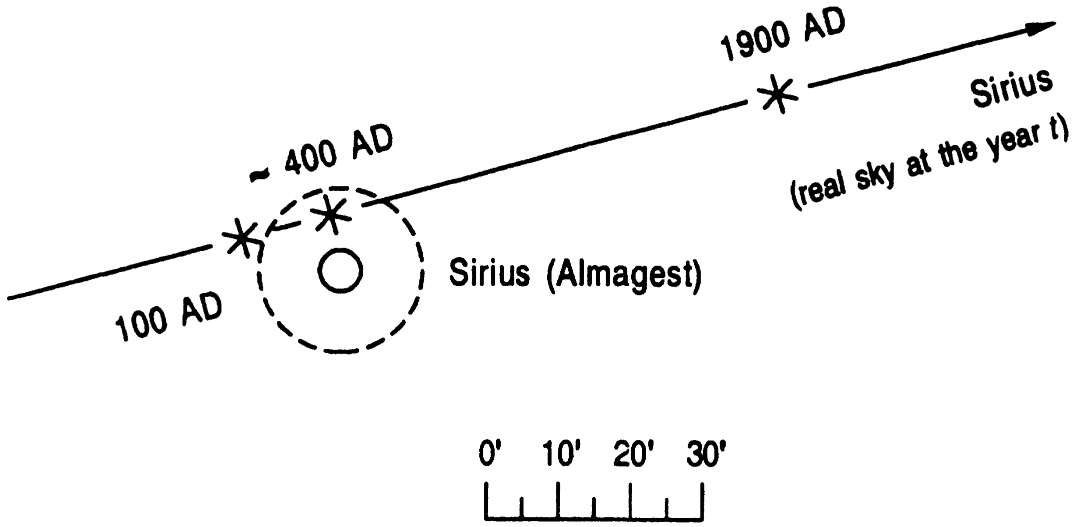


Figure 20(2). The real motion of Sirius and its position according to the Almagest.

treatise. The time of the observations according to Ptolemy, if dated traditionally, the 2nd century A.D., does not correspond to the catalogue longitudes. The descriptions of the observations themselves are extremely doubtful, since

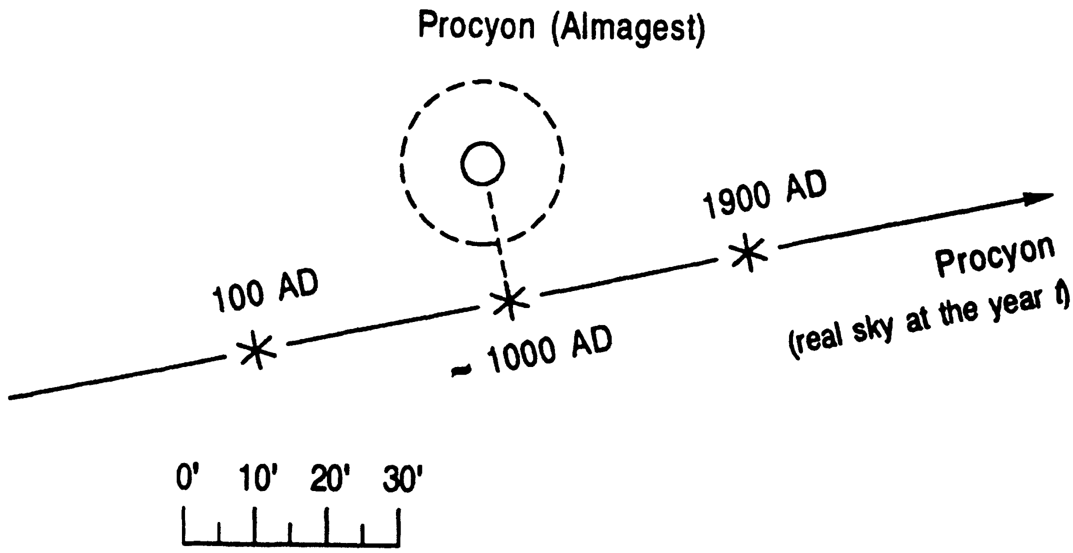


Figure 20(3). The real motion of Procyon and its position according to the Almagest.

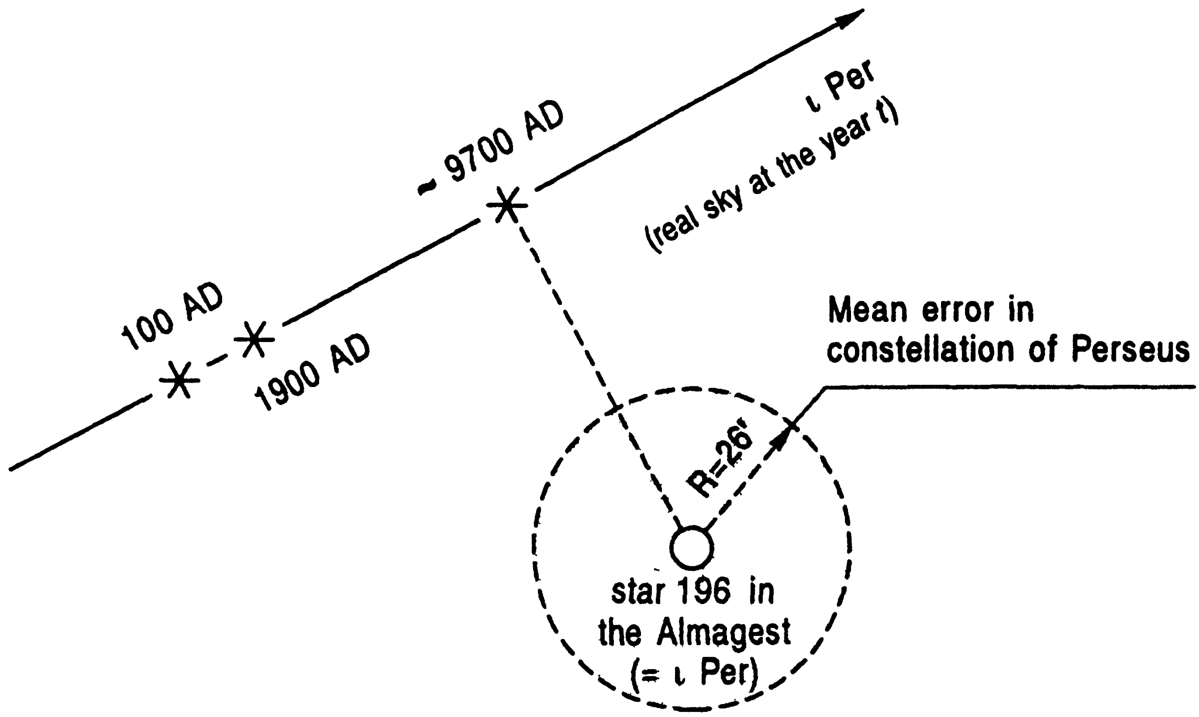


Figure 20(4). The real motion of the star ι Per and the position of the star 196 according to the Almagest.

they are not consistent with the catalogue's error distribution. Obviously, a more traditional method for measuring equatorial coordinates by means of wall circles was employed, and only then equatorial coordinates were recalculated into ecliptical ones on a special terrestrial globe.

Analysis of the distribution of the fractional parts in the catalogue coordinates and error variances has shown that the longitudes were recalculated after the measurement, which contradicts Ptolemy's statement that the catalogue

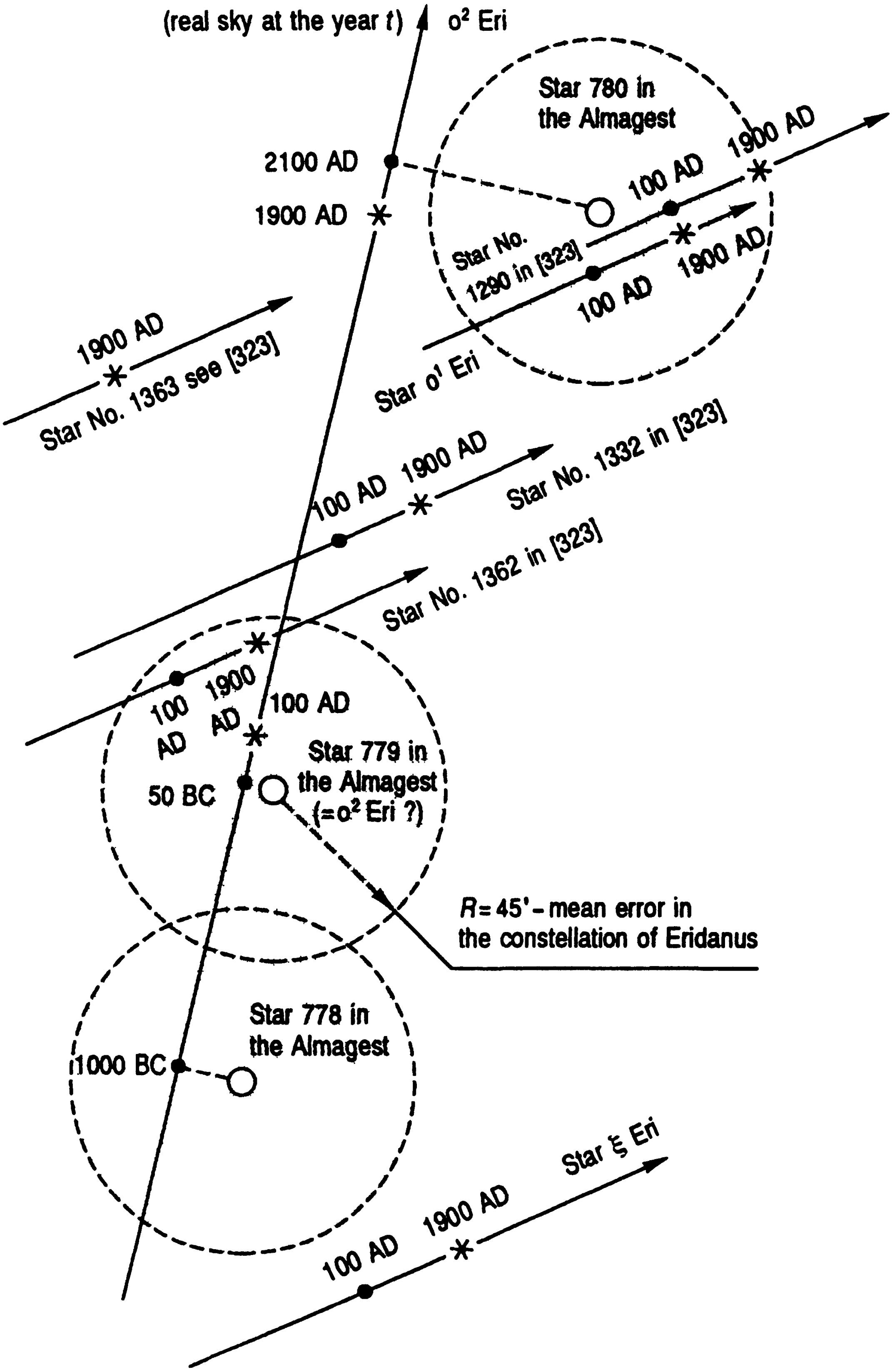


Figure 20(5). The real motion of the stars o^2 Eridanus, No. 1362, No. 1332, No. 1290, No. 1363 (numeration according to D. Hofflit [323]) and the position of the stars numbered in the Almagest as 778, 779, 780 (according to the Almagest).

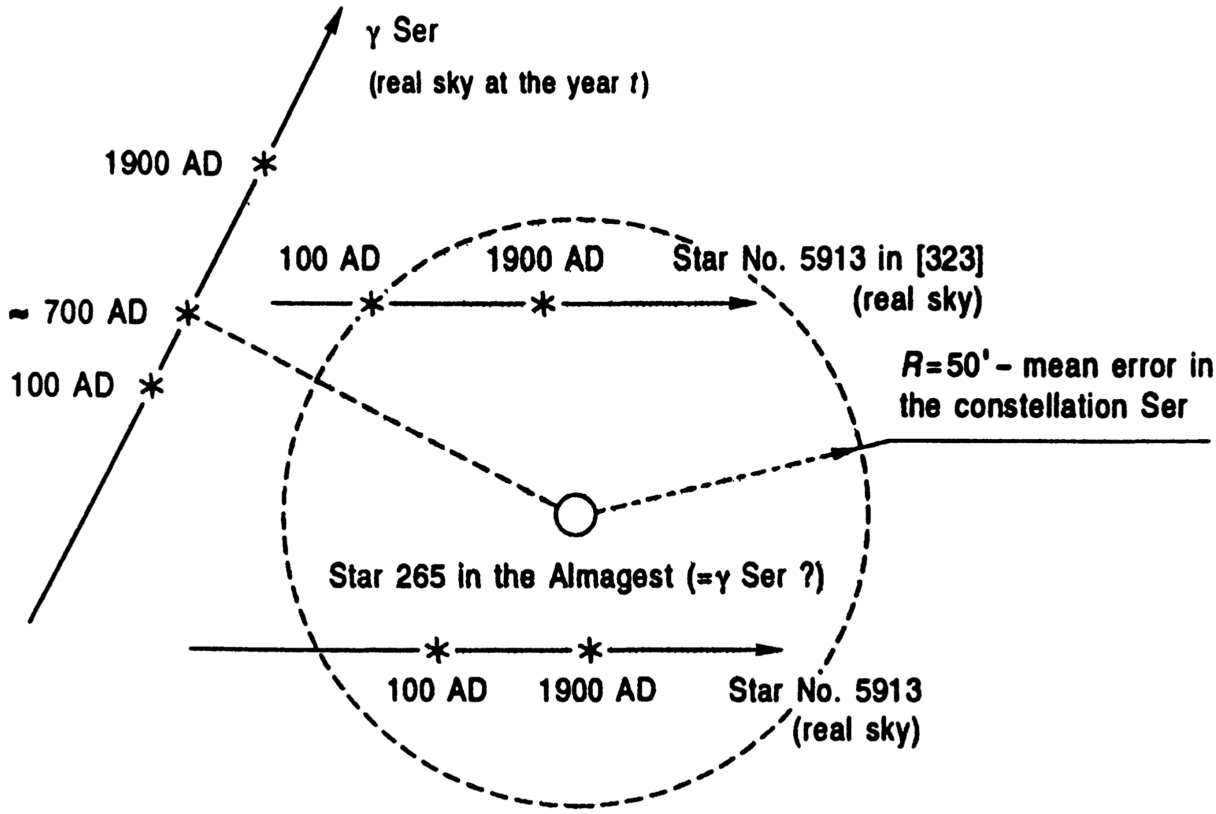


Figure 20(6). The real motion of the stars γ Ser, No. 5913, No. 5909 (numeration according to D. Hofflit [323]) and the position of the star No. 265 from the Almagest (according to the Almagest).

contains direct measurements (for a description of some other incoherences, see [102]).

Second, attempting to date the catalogue via the motion of individual stars, we discovered that for faint stars of magnitudes 3–6 which move appreciably, it was necessary to analyze the identifications of the stars of today's sky with the *Almagest*'s, since the traditional procedure already involved the data regarding the stars' own motion and the *a priori* dating the catalogue as belonging to the start of the Christian era. As far as the bright stars which move appreciably are concerned, the dates from A.D. 500 to 1800 are obtained. This enormous variance and, therefore, the low accuracy of estimation, are related to the fact that the rate of the stars' own motion is too small compared to the errors in the *Almagest* coordinates. Note that only five stars moving fast are included in the *Almagest*. The author and V.V. Kalashnikov, G.V. Nosovsky, V.M. Zolotarev, and I.S. Shiganov started investigating not with individual stars but with the whole collection of the moving ones for the purpose of calculating the date when they were observed on the basis of their totality. The results of the statistical investigation were published in the paper by A.T. Fomenko, V.V. Kalashnikov and G.V. Nosovsky, "When was Ptolemy's star catalogue in the *Almagest* compiled in reality? Statistical analysis". *Acta Applicandae*

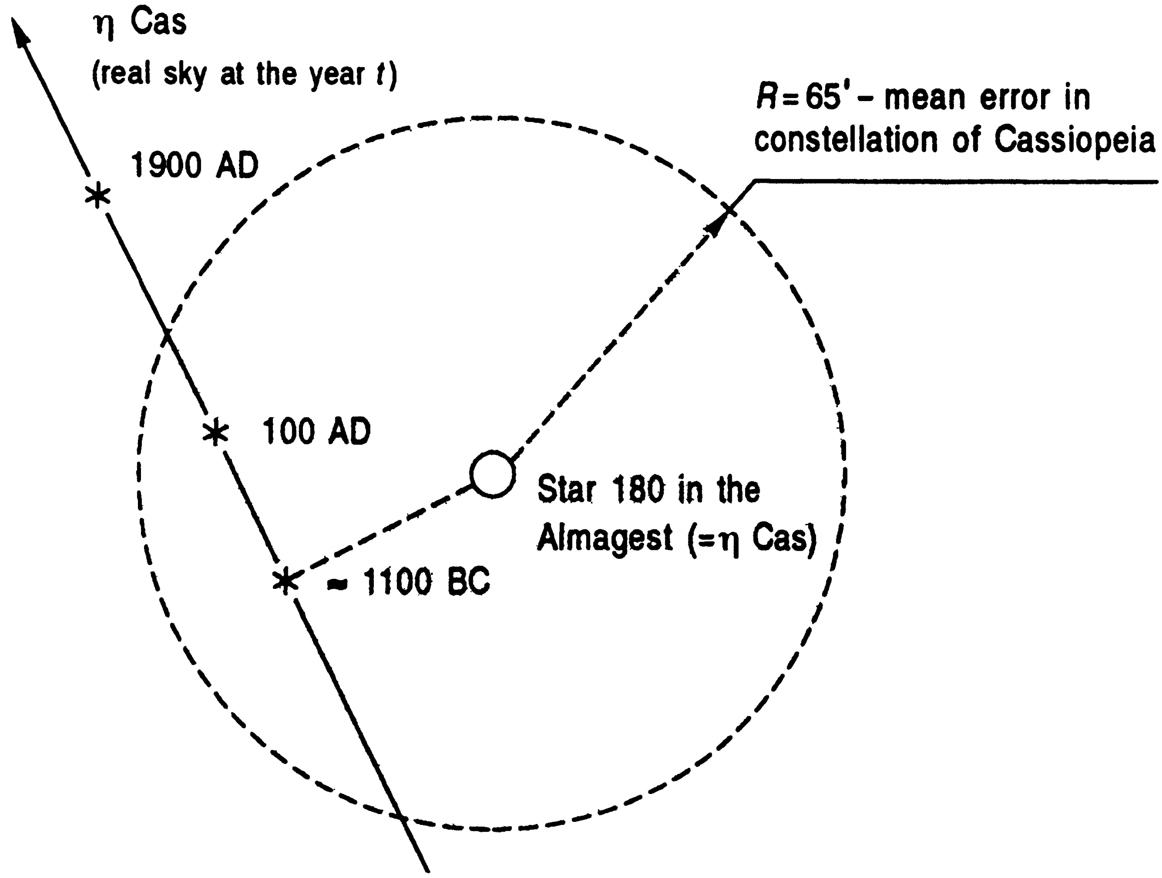


Figure 20(7). The real motion of the star η Cas and the position of the star 180 according to the Almagest.

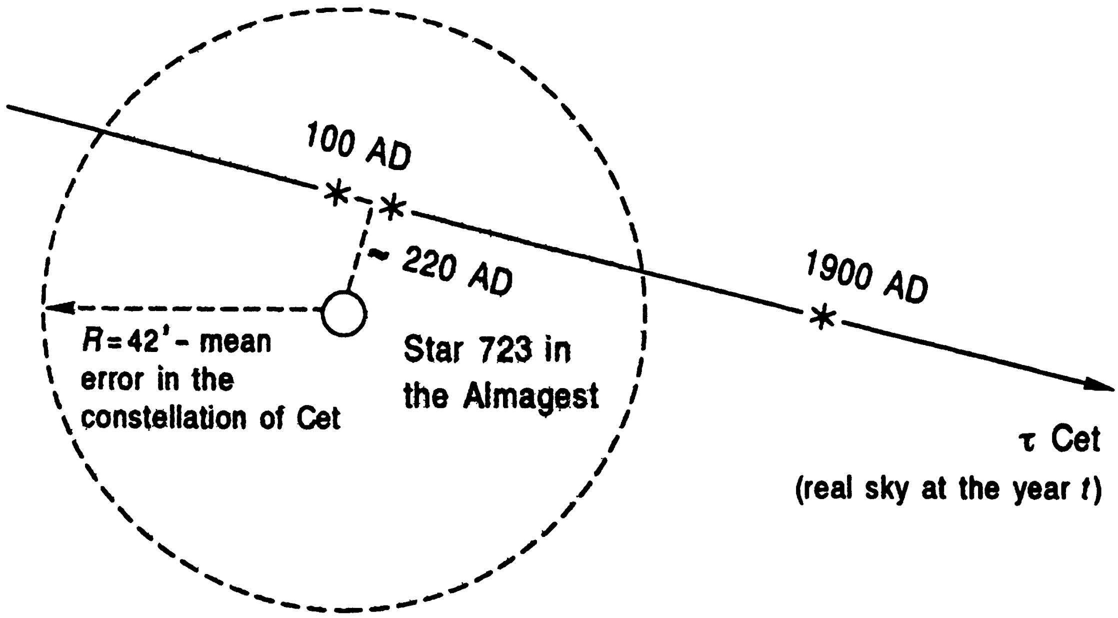


Figure 21. The real motion of the star τ Cet and the position of the star 723 according to the Almagest.

Mathematicae 17: 203–229, 1989. This work was devoted to describing a new statistical and geometrical procedure for dating ancient star catalogues by considering numerical data contained in these catalogues and the known real configurations of stars on the celestial sphere. The method was tested on several star catalogues whose dates are well known (Tycho Brahe, etc.) and on several artificially generated star catalogues. Then the same method was applied to the *Almagest*. The results obtained do not confirm the traditional dating of the *Almagest* (2nd century A.D. or 2nd century B.C.) but *shift its dating to the Arabian epoch*, i.e., to 600–1300 A.D.

The authors plan to publish the details of this research in a separate book.

Now, some concluding remarks about Halley's discovery.

9.5. Halley's discovery of the stars' proper motion and the Almagest

It is traditionally believed that the stars' proper motion was first discovered by Halley in 1718. Speaking of this fact, Kulikovsky says:

> "Comparing the positions of Arcturus, Sirius and Aldebaran with their positions in the Hipparchus catalogue, E. Halley (1656–1742) discovered their proper motion, and that their ecliptical longitudes changed by 60′, 45′, and 6′ in the last 1850 years, assuming that the catalogue was already dated as having been written in the 2nd century B.C." (namely, 1718 + 132 = 1850 years—A.F.) ([110], p. 219).

The first related question then is how he could have discovered Aldebaran's proper motion. It is because Aldebaran has shifted in the assumingly elapsed time (allegedly, *ca.* 2,000 years) by 6′, as we now know on the basis of modern knowledge. However, the division value both in the Ptolemy and Hipparchus catalogues was 10′! It is useless to discuss the phenomenon if this value does not exceed the accuracy of a measuring device, let alone the fact that the actual accuracy of measurements was much worse than 10′. How then could Halley have discovered Aldebaran's proper motion if it had shifted by only 6′ in 2,000 years? Another question arises: What motion did Halley ascribe to Arcturus and Sirius? Kulikovsky reports:

> "In 1738, Cassini (1677–1756) precisely determined Arcturus' proper motion, having compared his measurements with Richet's observations (?–1696) sixty years before" ([110], p. 219).

Therefore, Halley did not determine Arcturus' proper motion "precisely". Nor could he have determined Sirius' motion when it moved at a slower rate.

The natural and, to some degree, unexpected question arises: Did Halley, at least in principle, discover the stars' proper motion?

It will be appropriate to inform the reader that Halley was not at all the first one to pose the question whether stars were moving, the problem having been animatedly discussed in the 15–16th century. Moreover, within the framework of traditional chronology, this problem was investigated as early as antiquity, or approximately 2,000 years before Halley. Tradition assumes that this important problem was discussed by Ptolemy who came to the conclusion that all the stars were stationary (which we know is wrong). Thus, posing the problem cannot be ascribed to Halley.

Why did astronomers not compare the positions of the stars in the sky to the *Almagest* for the purpose of discovering their proper motion? As a matter of fact, the very idea of such a computation, or comparison, also dates back to Ptolemy and, therefore, was not at all new to a medieval astronomer. Such attempts would have been natural and could have led to the conclusion that the stars were moving: At least, the anomalous scattering in Ptolemy's star positions could have been taken as the stars' proper motion. We have already noted that the *Almagest's* accuracy is not consistent with the catalogue division value. Arcturus' and Sirius' motion could have been determined by the early 17th-century astronomers (100 years before Halley), as well as by Halley himself, on the basis of Tycho Brahe's catalogue, its accuracy being 1′ and dating to 1582–1588 if we compare it with the *Almagest*.

Imagine that we are 16th–18th-century astronomers. Only the following two points of view are possible.

(1) Assume that we are of Scaliger's and Petavius' opinion and associate the second year of Emperor Antonine Pius' rule, the date of the *Almagest's* observation time, with A.D. 138, in which case we should discover the stars' proper motion, resorting to the allegedly ancient, about 1,500-year-old catalogue, at least proceeding from Arcturus, the brightest star in the sky. However, these natural attempts were not fixed by the traditional history of astronomy in the 15–16th century, though they would have to make us conjecture that Arcturus was moving.

(2) Assume that we regard the *Almagest* as a comparatively recent document, say, of the 10th–15th century, or as a source with unknown dating, in which case the attitude toward the book would be quite different. If this catalogue is assumed to be medieval, then the *Almagest's* inaccuracy, which is well known to the professional astronomers, and, moreover, the large division value would simply not permit us to make such a recalculation (which could not be made either if the catalogue date was unknown).

Since the history of astronomy reports nothing of the 16th- and 17th-century astronomers' attempts to discover the stars' proper motion on the basis of the *Almagest*, we are forced to conclude that they did not regard it as a sufficiently ancient document.

Thus, a serious 16th- or 17th-century scientist should have made the conclusion that the accuracy of the coordinates in the *Almagest* did not permit him to discover the stars' proper motion if he regarded it as a medieval source. On the other hand, if the *Almagest* had been regarded as an ancient document, say, dating back to the 2nd century A.D., then the idea itself of using it to discover the stars' proper motion would have been very simple. It should be remembered that the problem of the stars' proper motion was important in ancient times. It seems completely improbable for the idea to be new in Halley's time.

We shall now try to explain why the conclusion regarding the proper motion of certain stars (e.g., of Arcturus or Sirius) could be made in Halley's time, though more or less precise values for their rate could not be found.

The first precise star catalogue to the accuracy of 1′ was made by Tycho Brahe in 1582–1588. Arcturus' and Sirius' displacements in the 100 years after Halley were about 3′ and a little more than 2′, respectively. With a precise catalogue of the star positions as was available in the 18th century, Arcturus' and Sirius' proper motion could already be suspected, though the catalogue's accuracy could not have as yet permitted one to determine the rates of motion. It turns out that such a catalogue was indeed available in the early 18th century. It was made by Flamsteed and was actually employed by Halley even before its publication (with Halley having taken some incomplete version from Isaac Newton, who was just investigating chronology).

Thus, in our opinion, Halley compared Flamsteed's and Brahe's catalogues, and made the conclusion regarding the existence of Arcturus', Sirius', and Aldebaran's proper motion.

Meanwhile, Aldebaran's motion indicated by Halley obtains the natural explanation: He made use of the incomplete variants of Flamsteed's catalogue in which the Aldebaran information was given erroneously. Flamsteed regarded his catalogue as not yet ready for publication at that time. It is known that Halley made Aldebaran's position more precise for the purpose (in his letter to A. Sharp on September 13, 1718; see [109]).

Why then did Halley refer to Ptolemy's *Almagest* as the basis for his computations, and not to Tycho Brahe's? Obviously, in Halley's time, the traditional *Almagest*'s date, A.D. 138, "calculated" by Scaliger and Petavius had already been canonized. To give his discovery more weight, Halley referred to the *Almagest*, and not to Tycho Brahe, for the simple reason that the star displacements discovered by him then looked more impressive. Calculating Arcturus' displacement from Brahe's catalogue, Halley obtained only three minutes, compared with the nominal accuracy of one minute in the former catalogue, whereas, repeating the procedure for Ptolemy's catalogue of (allegedly) A.D. 138, he naturally obtained a more substantial shift of about one degree. It is apparent that Halley compared the shift with the *Almagest*'s nominal accuracy of ten minutes, neglecting the problem of the actual accuracy of the coordinates of the *Almagest*'s catalogue.

This reasoning makes us think once again that the *Almagest* had not yet been regarded (in the 16th century) as an ancient, about 1,500-year-old document and its "antiquity" was assumed known and canonized only early in the 18th century.

Each of the above facts can also be separately "explained" within the traditional chronology framework, but, taken all together, they most probably indicate that the *Almagest* was written between the 10th and the 16th century. Still, in contrast to Morozov, I do not at all believe that the *Almagest* was fabricated. More than that, in my opinion, at any rate, its first edition is an original created in the 15th–16th century for immediate scientific purposes (see the substantiation below).

§10. Archaeological Dating Methods

10.1. Classical excavation methods

Certainly, the reader may ask how things are with the other methods of dating classical historical sources and monuments. Modern archaeologists painfully speak of "ignorant diggers" of the earlier centuries, who, hunting for valuables, mercilessly disfigured numerous monuments.

> "When the artifacts were delivered to the Rumyantsev Museum (excavations of 1851–1854—A.F.), they were, in the true sense of the word, a shapeless heap, without any indication from which excavated hill they came ... The grandiose excavations of 1851–1854 ... will be long deplored by science" ([65], 12–13).

At present, excavation methods have become more sophisticated; unfortunately, it is quite rarely that they apply to excavations of ancient historical spots, all of them having already been "touched" by earlier "diggers".

Here are, in a nutshell, the archaeological dating basics. Greek vessels of the Mycenaean culture were discovered in the tombs hailing from the Egyptian 18th and 19th dynasties. The dynasties and culture were, therefore, regarded by the archaeologists as having been simultaneous events. The same vessels, or "similar ones", were found along with clasps of special form in Mycenae, and similar pins in Germany, near burial urns. A similar urn was found in Germany, and in this urn a pin of a new form. A similar pin was then also found in Sweden, in the so-called hill of King Björn. Thus, this hill was dated to the 18th and 19th dynasties of Egypt [66]. It was meanwhile discovered that the Björn hill

> "... could not belong to Björn, king of the Vikings, and was made well two thousand years before" ([66], pp. 55–56).

It is not clear what should be understood by the "similarity" of the findings; hence, all these, and similar, methods are based on unlimited subjectivism and traditional chronology. The newly-found artifacts are compared with "similar" finds dated earlier on the traditional basis. A change in this "scale" will automatically alter the chronology of recent archaeological findings.

The excavations at Pompeii can be a good illustration of the problems which arise in dating archaeological material. The medieval author of the 15th-century *Sannazaro Jacopo* wrote that, as he approached Pompeii, its towers, buildings, theatres, and temples became visible, not touched by centuries!? ([47], p. 31). But it is impossible from the traditional point of view, because Pompeii is regarded to have been buried by the volcanic eruption of A.D. 79. Traditional history insists that Pompeii's ruins were completely covered by sand for many centuries till the 18th century. Hence, the modern archaeologists are forced to treat this citation from *Sannazaro* thus:

> "... in the 15th century, certain of the Pompeii buildings became visible in a layer of sand ..." ([47], p. 31).

Therefore, it is assumed that Pompeii was again (after the 15th century) "covered by sand", since its remains were discovered only in 1748 and Herculaneum's in 1711 ([47], pp. 31–32). The excavations were barbaric.

It is now hard to determine the extent of damages caused by the vandalism of the time. If a picture seemed not to be very pretty, then it was broken into pieces, thrown away as waste. Separate letters were taken off the bronze inscriptions of marble tables. Souvenirs for tourists were fabricated of sculptural fragments, sometimes even with the images of saints, certain of the "fabrications" possibly being originals [68].

There were obviously medieval pictures on Pompeii's walls, such as a hangman under a hood, a warrior with a cuirass, helmet and visor (!), and so on ([47], pp. 210–211). Surgical instruments indistinguishable from medieval ones, and of extremely high quality, were found. An emperor with the double name Valens-Nero (translation due to Morozov) was mentioned on one of the official inscriptions, though, according to traditional history, these are two different men separated by *ca.* 300 years [47].

The 20th-century archaeologists and historians paid much attention to a particular strange process. Most of the ancient monuments in the last 200–300 years, starting when continuous observations began for some reason or other, were destroyed much more than during the previous centuries or even millennia. In particular, they include the Parthenon, Colosseum, theatre of Epidaurus, Venetian buildings, Indian temples, and others. "Modern" industry is usually to blame, but nobody investigated thoroughly the influence of "modern" civilization on stone buildings. It is natural to suggest that they were not as ancient as asserted traditionally, and were being destroyed at a natural rate.

10.2. Numismatics

> "Numismatics as a science was formed comparatively late. The intermediate stage from simple collections to scientific research methods ... was presumably the very end of the 18th century" ([100], pp. 13–14).

The numismatics scale and dating and the relative chronological ordering of ancient coins on the time axis are wholly based on traditional chronology regarded *a priori* as known, and they were established earlier on the basis of written evidence.

> "Material was gathered from almost 200 years of numismatics in the collectors' hands, but no attempts to study it critically were made" ([100], pp. 13–14).

Most ancient coins were supplied with abbreviated formulas, or anagrams with ambiguous dating, and without detailed inscriptions. The dates on coins were sometimes based on calendars whose relation to the counting of the modern year is still suitable to a special study. It is assumed that, from the 8th until the mid-13th century, the medieval gold coins of Rome practically vanished in Italy. However, there were many much more ancient Roman gold coins. Our conjecture is as follows: these ancient coins are in reality the medieval gold coins, and minting them in medieval Rome possibly had not stopped. But the latest chronologists have shifted these medieval coins to the past.

10.3. The dendrochronological method

Certain physical procedures are applied to the dating, for example, of dendrochronology or the radiocarbon method. However, dendrochronological scales were established to account only for several hundred years backwards, which does not permit us to date ancient European buildings.

> "Many European scientists employed dendrochronology for dating.... But, it soon became clear that the matter was not so simple. Trees in European forests are no more than 300–400 years old.... The leaf-bearing wood is hard to analyze. Its blurred rings very reluctantly speak of past times.... Reliable archaeological data turn out to be unexpectedly insufficient" ([69], p. 103).

American dendrochronology based on the Douglas fir, bristlecone, and yellow pine is much better off, but deals with an area far away from the "areas of antiquity" ([69], p. 103). Moreover, there are always many completely unaccountable factors, such as local climatic conditions, soil composition, humidity variations, landscape, and others, which alter the graphs of the annual ring thickness essentially ([69], pp. 100–101). It is important that the construction of dendrochronological scales was carried out on the basis of already existing traditional chronology ([69], p. 105); therefore, any change in the chronology of documents will alter the dendrochronological scales.

The methods of dating by determining column deformation, river sediment accumulation rate, stone building surface layer weathering rate, sound propagation rate in bones, and others, remain extremely inaccurate and depend on traditional chronology assumed *a priori* as known, with the principal difficulty being the absence of a reliable absolute scale and the impossibility to "calibrate a method" for dating ancient artifacts.

10.4. The radiocarbon method

The most popular is the radiocarbon method claiming the independent absolute dating of antique monuments. However, as radiocarbon dates were accumulated, most serious difficulties arose; in particular,

> "... one had to think of another problem. The radiation piercing the atmosphere varies for many space reasons, the quantity of radiocarbon therefore changing time. It is then necessary to find a technique which would permit us to take them into account. Besides, ... huge amounts of carbon from burning charcoal, anthracite, oil, pect, shale and their by-products are continuously thrown into the atmosphere. What influence does this have on the rise of the radioactive isotope quantity? To achieve a method for determining the true age exactly, one has to compute the complicated corrections reflecting the changes in the composition of the atmosphere during the last millennium. Along with certain difficulties of technological nature, these doubts led to uncertainty regarding the accuracy of a lot of datings achieved by the radiocarbon method" ([69], p. 72).

Its inventor W. Libby has been absolutely sure of the correctness of traditional historical datings:

> "Throughout Roman and Egyptian history, we have no disagreements. We haven't had very many measurements to make (!—A.F.) because in general the archaeologists know the dates better than we can measure them, and it is usually as a favour that they give us samples (which are by the way, burned in the measuring process—A.F.)" ([70], p. 24).

This confession is significant, because traditional chronology revealed its difficulties particularly for the regions and epochs with only a few datings by the method. As to the small number of test measurements for antique artifacts, which, nevertheless, were taken, for example, in dating H. Breasted's collection (Egypt),

> "... our third object from Egypt turned out to be modern! It was one of the ... collections, supposed to be from the fifth dynasty (i.e., 2563–2423 B.C. according to [7], about 4,000 years ago—A.F.). This was a dark day" ([70], p. 24).

To "save" traditional chronology, the object was declared a fake ([70], p. 24), since no one had doubted the traditional chronology of ancient Egypt.

> "In support of the basic assumption, they (believers in the method—A.F.) list a series of indirect proofs, arguments, and computations whose accuracy is not high, treatment ambiguous, and the main proof given by test radiocarbon determination of samples with an *a priori* known age.... However, as soon as it comes to the discussion of the test results in dating the historical artifacts, everyone nods to the first experiments, a small (!—A.F.) series of samples ..." ([66], p. 104).

The absence (also recognized by Libby) of any representative test statistics for the objects whose reliable dating is known *a priori* and a divergence of many thousand years long make us question the appropriateness of applying the method to the time interval under consideration. It does not mean, however, that it cannot be applied for the purposes of geology, where errors of several thousand years do not matter.

Libby writes:

> "There has been no serious shortage of materials back to about 3,700 years with which we could check the accuracy and reliability of dating by carbon-14 ... I would say, from talking with historians, that they would stake their lives on 3,750 years, but with anything older than that, they begin to shake a little bit" ([70], p. 24).

In other words, as the inventor himself recognizes, the radiocarbon method was widely applied in particular where the obtained results were hard or impossible to check against other written evidence.

> "Some archaeologists, while not doubting the scientific principles of carbon-14 dating, suggested that the method still involves a considerable margin of error due to factors which are not yet understood" ([70], p. 29).

Could it perhaps be that these errors still did not present obstacles to at least rough dating? As it turns out, the situation is more serious: The errors are too large and chaotic and attain a span of 1,000–2,000 years on dating objects that are 1–3-millennia old.

The radiocarbon dates led to

"... confusion among the archaeologists. Some have accepted the physicists' indications ... with characteristic admiration.... They hurried up to reconsider the chronological schemes (which, therefore, were not so firmly established?—A.F.) ... The first who declared himself openly against the radiocarbon method was Vladimir Milojčič ... not only storming at its practical applications, but also ... strongly criticizing the theoretical foundations.... Comparing individual measurements of modern samples with the average figure, he based his skepticism on a series of brilliant paradoxes. The shell of a living American mollusk with radioactivity level 13.8 turns out to be rather old, being about 1,200 years of age if we compare it with the average absolute norm, 15.3. Its radioactivity being 14.7, a blooming wild rose from North Africa will be 'dead' for as long as 360 years ... whereas an Australian eucalyptus of radioactivity 16.31 'does not exist' for the physicists at all, and will come into existence in 600 years. A Florida mollusk with 17.4 radioactivity units will be 'born' only in 1,080 years.... In the past, radioactivity level was no more uniform than today, and similar variations are also possible for ancient artifacts. Here are some examples: The radiocarbon dating of a sample from a medieval altar in Heidelberg ... showed that a tree employed to repair it had not grown at all! ... In a cave in Iran, the lower levels were dated to 6054 ± 415 and 6595 ± 500 years B.C., while the upper to 8610 ± 610 B.C. Thus ... they obviously were formed in reverse order, and the upper one turns out to be 2,556 years older than the lower. There are many similar examples to follows.... V. Milojčič calls on the physicists and their 'contractors', at least, to stop correcting 'critically' the radiocarbon dating results, and cancel the 'critical' censorship when the data are published. He asks the scientists not to reject the dates which seem improbable for some reason or other, and publish all the results without exception. He talks the archaeologists into ceasing the practice of acquainting the physicists with an approximate age of a find before its radioactive analysis, with holding the information until the figures are published! Otherwise, it will be impossible to establish how many radioactive dates coincide with the reliable historical ones, or determine how reliable the method is. Besides, on 'editing', the subjective attitude influences how the obtained chronological scheme looks. E.g., in Groningen, where the archaeologist Becker, a long-time supporter of the shorter chronology (of Europe—A.F.), is working, the radiocarbon results are also obtained to be low for 'some unknown reason', but Schleswig and Heidelberg, where Schwabdissen and others have long been inclined to the longer chronology, the radioactive dating of similar materials leads to much earlier dates" ([66], pp. 94–95).

In my opinion, any comment is superfluous.

In summary,

(1) Theoretical accuracy of carbon-14 dating, which can be achieved for comparatively "young" objects, equals about 1,000–1,500 years; hence, unfortunately, its application to dating antique artifacts seems to be doubtful. We should first investigate for as large a set of reliable data as possible the dependence of radiocarbon dates on the variation of carbon-14 content, intensity of cosmic radiation, distance to large water reservoirs and volcanoes, enormous quantities of various substances in the atmosphere, and so forth, with all this, in addition to other factors, essentially influencing the dating, as we have demonstrated above.

(2) Other physical methods are sufficiently less accurate and have been carried out, basically, for the purposes of geology; today, their application to dating antique artifacts is unreal.

Lastly, great successes in working out the radiothermoluminescent method permitting us to date ceramic artifacts and burned clay have been made. However, here, too, numerous effects influence the dating of truly old artifacts, which are now barely taken into account. In particular,

> "... one should know the quantity of radioactive elements not only in the substance of which an object is made, clay, but also in the environment surrounding it. If a piece of ceramics had been buried for centuries, then the quantity of uranium, thorium and potassium in the soil or rock should be known" ([92], p. 113).

In 1972, the physicist S. Fleming made the method substantially more sophisticated in order to eliminate the dependence of the dating on radiation in the environment, which, certainly, almost always remains unknown and is not subject to estimation. Nevertheless,

> "... dating authentic terracotta of the Renaissance by the method of thermoluminescent analysis is related to certain difficulties" ([92], p. 138).

> "Since the exhibits kept in variable environment were dealt with, the dose of external radiation was not simple to find" ([92], p. 139).

Still, the dating was carried out, but only because the researchers did possess authentic samples dated reliably as belonging to the Renaissance (from written sources). The samples dated questionably were compared just with these. It is obvious that the method cannot be applied to older, say, "antique" artifacts, without any independent and trust-worthy written information for dating them. Nor do we speak of a practically unrealizable opportunity to record the variable environment in which antique ceramics are kept in the museums (see above).

§11. Astronomical Dating. Ancient Eclipses and Horoscopes

At present, special tables, or astronomical canons, are available which list eclipse dates, umbra ranges, astronomical phases, and so forth, on the basis of the lunar theory. If an eclipse was given a sufficiently detailed description in antiquity, then the list of its observed (descriptive) characteristics can be compiled. Comparing them with the tables, we can attempt to find a suitable eclipse in the canon. We shall date the eclipse in question if we succeed. It may turn out that the textual description is satisfied not only by one, but already several eclipses from the astronomical canon, in which case the dating is not unique.

While taking up certain problems of celestial mechanics, I noticed a possible relation of this familiar jump in D'' to the results of Morozov, connected with the dating of ancient eclipses. My investigation of this problem, and a new calculation of D'', have shown unexpectedly that the new curve obtained for D'' is of another qualitative character; in particular, the enigmatic jump vanishes completely, while D'' oscillates about one and the same constant value coinciding with the modern one (see [3]). In short, this result is reduced to the following.

The earlier computations of D'' were based on the dates of ancient eclipses according to traditional chronology. All attempts to account for the strange jump in D'' did not touch upon the problem whether or not the dates of eclipses regarded today as antique and early medieval were determined correctly. In other words, how well do the parameters of an eclipse described in a document, and the computed characteristics of that authentic eclipse allegedly described in the text to be dated, correspond to each other? A method of independent dating was suggested by Morozov in [1], namely, that all possible eclipse characteristics are extracted from a text under investigation, and then the dates of all the eclipses with these characteristics are mechanically extracted from the astronomical tables (canons). He discovered that, under the pressure of the established traditional chronology, the astronomers did not consider the whole spectrum of dates obtained: they took only those dates which fit in the time interval *a priori* dictated by historical tradition. It turned out that this practice often led the astronomers to the impossibility of discovering in the required century an eclipse precisely answering to the description in the document, while being forced, in most cases, and still not questioning the whole system of chronology, to resort to doubtful solutions, for example, to indicate an eclipse no more than partly satisfying the description.

Revising the dating of supposedly ancient eclipses, Morozov discovered that the information about them could be separated into two categories:

(1) Short and vague reports without particulars, with it often being unclear whether an eclipse at all is described; in this category, the astronomical dating is either senseless or results in so many possible solutions that they can fall into practically any historical epoch.

(2) Lengthy and detailed reports, with often unambiguous astronomical solutions that admit only two or three versions. All the eclipses in this category turn out to have received nontraditional dating, which did not assign them to the traditional interval from 1000 B.C. to A.D. 400, but considerably later (sometimes, many centuries), i.e., to A.D. 500–1600. Nevertheless, Morozov did not analyze the latter, assuming that traditional chronology from 300 to 1800 was basically "true", and that no contradiction would surface.

Proceeding with the research initiated [1], I also subjected the eclipses from 400 to 1600 to an analysis. It turned out that the effect discovered in [1] for ancient eclipses could consequently be extended to those normally dated to A.D. 400–900, which means that two situations are realized: 1) there are many equivalent astronomical solutions (here astronomical dating is senseless); 2) there are only one or two solutions; in this case they fall into the years 900–1700. It is only since about A.D. 900, and not 400 as supposed [1], that the consistency becomes satisfactory for the traditional eclipse dates given in the canon [73] with Morozov's results and is reliable only since A.D. 1300. Thus, we obtain the shift of the dates of many "ancient" eclipses in the medieval epoch from A.D. 900 to 1600.

An analogous "forward date shift" was also discovered by Morozov for the so-called horoscopes [1]. Five planets are seen with the naked eye; moving along the ecliptic, they describe approximately the same circular path in the sky, called *zodiac* and divided into 12 sections. Astrology enjoyed enormous popularity in ancient times. A horoscope is the position of the planets with respect to the signs (constellations) of the zodiac. Fixing it, and knowing the sidereal periods at a particular point in time, we can calculate the planets' positions in the past or future by marking off their integral multiples backwards or forwards. However, the realization of this simple idea implies cumbersome calculations. Similar to the eclipse canons, there are special tables making dating of their ancient descriptions possible (we should not confuse them with those in the contemporary sense of the term). If the planets' position is given some textual description, then, as in the case of the eclipses, we can obtain the dates of all horoscopes with suitable characteristics from the tables.

Again similarly to the eclipses, it turns out that under the pressure of the traditional chronology already established, and unable to find a suitable horoscope "in the required epoch", the astronomers forcibly resorted to doubtful conclusions and deviations from the text. Morozov analyzed the most famous ancient horoscopes in [1] and discovered that all those with detailed descriptions (or graphic representations) obtained medieval or even late medieval datings if we employed independent methods for them.

We illustrate with some typical examples. Numerous attempts by P. Laplace, J. Fourier, A. Letronne, J. Biot, and K. Helm to find a suitable solution to a horoscope represented on the "round" and "long" zodiacs of the Dandarah temple in Egypt were not crowned with success ([1], Vol. 6, pp. 664–665, Figs. 672–673, Figs. 133, 135). The temple and its horoscopes are now dated to 30 B.C. and A.D. 14–37. Nevertheless, two exact astronomical solutions do exist. The first solution, A.D. 568 and 540, was discovered by Morozov [1]; the second solution, A.D. 1422 and 1394, was discovered recently by the Moscow physicists D.V. Denisenko and N.S. Kellin (for details, see Vol. 2 of the present book).

In 1857, H. Brugsch discovered an ancient Egyptian sarcophagus whose inner cover represented the starry sky with a horoscope ([1], p. 696, Fig. 139). The whole burying ritual, ancient demotic writing, and so forth, dated the find to not earlier than the 1st century A.D. The attempts by the astronomers to date the horoscope as having originated at around the turn of the millennium failed. However, not only does the exact solution exist again, but it is unique in the whole interval of history: namely, A.D. 1682!

In 1901, Flinders Petrie discovered a cave in Upper Egypt with an ancient Egyptian tomb and two horoscopes with the dates of the deaths of a man and his son buried there [1]. In the whole historic interval, there exists a unique solution ideally satisfying all the conditions of the problem, namely, A.D. 1049 (the father's horoscope) and 1065 (the son's horoscope). The son died 16 years after the father.

The dating thus described also explains an exceptionally fine state of these ancient Egyptian pictures made in watercolour. The above-mentioned work also dates the horoscopes described, for example, in ancient biblical texts. We can compile a vocabulary of the terms and standard phrases frequently occurring in the preserved medieval astronomical literature and used to denote planets, constellations, and so on. Then, when encountering an ancient verbal description involving any of these terms, an attempt can be made to date it, and spell it out, as a horoscope by means of this vocabulary. Apparently, the first author who mentioned that the Revelation of John contained the verbal description of a horoscope was E. Renan [74]. He was not an astronomer, however, and did not date it, though the solution of the question is of considerable interest due to the existing problem of dating the Revelation of John.

J. Sunderland declares that to take the end of the 1st century A.D. or even whatever other time as the date of the creation of the Revelation of John is to face great difficulties ([49], p. 135). However, it turns out that, though not unique, the exact solution does exist, too, namely, A.D. 395 and 1249 [1]. The date A.D. 395 differs from the traditional one for the Revelation of John by 300 years, whereas the second, A.D. 1249, differs already by 1,100–1,150 years. Accordingly, we stress that the bulk of Morozov's astronomical datings should be reconsidered. As a matter of fact, the assumption that traditional chronology since A.D. 300 is correct has often made him discontinue the computations and dwell, in most cases, on the first suitable solution discovered without turning to the late Middle Ages, which is vividly justified by the example of the Revelation of John. The second solution, A.D. 1249, was rejected by Morozov as "too late".

He wrote: "Hardly anyone will say that the Revelation of John was written on September 14, 1249 ..." ([1], Vol. 1, p. 53).

Our point of view is that we should investigate the whole spectrum of possible solutions, the more so because there are sound reasons to believe (see below) that traditional chronology until the end of the 13th century should be completely revised.

Another example is given by the dating of the famous eclipse accompanying the crucifixion according to the early Christian authors such as Synkellos, Phlegon, Aphricanus, Eusebius, and others. The traditional date of April 3, A.D. 33, cannot withstand even minimal criticism [1]. In spite of considerable controversy surrounding the characteristics of this eclipse, which is repeatedly discussed in the literature (e.g., [73]), we can try to date it. The first exact solutions (found by Morozov in [1]) turn out to fall between 200 B.C. and A.D. 800, namely, A.D. 368. The calculations in [1] were not extended to the later centuries for the above reasons. I did extend the computations to the whole interval of history up to A.D. 1600 and unexpectedly discovered another precise solution, i.e., April 3, A.D. 1075, which differs from the traditional one by one millennium, and by 700 years from that found in [1]. From the formal standpoint, the two solutions are equivalent, and we have to base ourselves on another argument in order to make a final choice. We recall once again that the agreement of the traditional astronomical dates with the calculated ones becomes satisfactory only beginning with the 10th century, and reliable only since the 13th century.

The horoscopes of the Old Testament turn out to be medieval, which is in startling contradiction with the traditional point of view referring to the events described in the Old Testament as having occurred hundreds of years before Christ [1].

§12. New Experimental and Statistical Methods of Dating Ancient Events

12.1. Introduction

In my opinion, the main goal is the creation of novel and statistically independent methods of dating ancient events. It is only subsequently that we can turn to the analysis of the whole of chronology on the basis of the obtained results. One method, even as effective as the astronomical one mentioned above, is absolutely insufficient for a profound analysis of the dating problem due to its exceptional difficulty and requires a cross verification of the dates by different techniques.

I attained this goal as follows.

(1) New experimental and statistical procedures for dating ancient events were worked out [2], [3], [4], and [5].

(2) Their efficiency was checked experimentally against a sufficiently large amount of information regarding medieval history, confirming the correctness of the obtained results.

(3) The methods were then applied to the ancient historical chronological data, which resulted in important laws in ancient and medieval chronology and history [2]–[5].

(4) The laws were collected and systematized as the global chronological diagram (GCD), which I briefly described in [2]–[5].

(5) The hypothetical mechanism of the origin of versions of the traditional chronological ancient and medieval history could be constructed from the GCD.

We shall now give a brief account of some of these methods.

12.2. Volume graphs for historical chronicles. The maximum correlation principle. Computational experiments and typical examples

Suppose that a certain period between the two years A and B of the history of a state is described annually in some sufficiently long text X by means of chronicles, annals, and so forth, which is broken, or could be broken, into pieces, "chapters" $X(t)$, each of which describes one year t. We can count their volume, for example, the number of words, signs or pages, and represent the obtained values graphically by marking the years t off on the horizontal, and the chapter volumes on the vertical scale (see Fig. 22).

In general, the corresponding graph will have a different form for another text Y, since the authors' propensities influence the volume distribution. For example, an art history and a military chronicle will place accents differently;

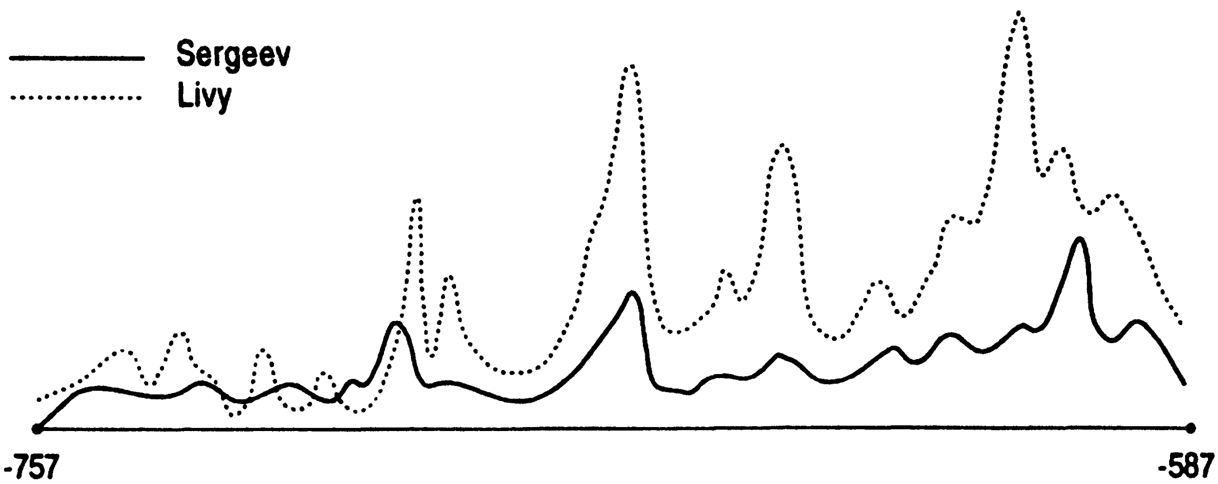


Figure 22. Maximum correlation principle for the volume functions of dependent historical chronicles.

the amount of information with respect to different years will be distributed differently, too. How essential are these differences, i.e., do there exist characteristics of the volume graphs which are only determined by the time interval (A, B) and the country Γ, and which uniquely characterize all (or almost all) texts describing them? The important characteristic of the volume graph turns out to be given by the years in which the graph shows peaks, i.e., attains local maxima. They indicate the years described in more detail. In general, different years will receive detailed descriptions in different, independent chronicles. Let $C(t)$ be the volume of all texts describing the events of a particular year t and having been written by contemporaries. According to our information-loss model, *there will be more information left from those years in which especially many texts were created.* It is difficult to verify the hypothesis in its present form, because the graph of $C(t)$ is unknown to us, and the texts and their information are gradually lost. However, we can check one of the corollaries, namely, later authors X and Y who were not contemporaries to those ancient events and who described the same period, had to make use of approximately the same collection of the preserved texts; therefore, they would "on the average" speak more of those years from which more texts survived, and less of those from which less was known. In other words, the authors "on the average" must have increased the number of particulars in writing about the time from which more texts were available. The maximum correlation principle can eventually be formulated as follows:

The volume graphs for the chapters of two dependent texts X and Y which describe the same period (A, B) and the state Γ must attain local maxima, or form peaks, simultaneously, i.e., years described in X and Y in detail should be close or coincide. Conversely, if two texts X and Y are known as undoubtedly independent and describe either different periods (A, B) and (C, D) of the same length or different states, then their volume graphs reach local maxima at different points if we let (A, B) and (C, D) coincide.

The principle will be justified if for most pairs of authentic and sufficiently large dependent texts depicting the same events, their volume graphs form peaks at about the same time. Meanwhile, the peaks themselves may be much different, and there must be no correlation between the peaks of the graphs for authentic independent texts. The simultaneity of the peaks of the volume graph should certainly be only approximate for concrete dependent texts. To estimate their nearness quantitatively, we shall calculate the square sum $\varphi(X,Y)$ of the distances φ_k in years from the point of a peak indexed by k of the volume graph for X to the kth peak of the volume graph for Y. If both graphs have peaks simultaneously, i.e., if the moments of the peaks with the same indices coincide, then all φ_k are equal to zero. Considering a sufficiently large fixed stock of different authentic texts H, and calculating $\varphi(X,H)$ for each of them, we then only select H with $\varphi(X,H)$ less than or equal to $\varphi(X,Y)$. Finding their part in the entire stock of H, we shall obtain a coefficient which (under the hypothesis regarding the distribution of the random vector H) can be interpreted as the probability $d(X,Y)$. If the coefficient is "small", the texts X and Y are dependent; if it is large, they are independent, i.e., they describe different events.

In 1978–1980, I performed a vast computational experiment in order to evaluate $d(X,Y)$ for several hundred pairs of concrete historical texts, including chronicles, annals, and so forth (see the details in [2]). It turned out that $d(X,Y)$ very clearly distinguished between dependent and independent textual pairs. I discovered that for all authentic texts (X,Y) under investigation and describing different events known *a priori* as such (or different historical epochs or states), i.e., for independent texts, $d(X,Y)$ varied from 1 to 1/100 (for ten to fifteen local maxima); conversely, if two texts X and Y were known *a priori* as dependent and described the same events, then $d(X,Y)$ did not exceed 10^{-8} (for the same number of maxima). A typical example is shown in Fig. 22. Namely, let X be Sergeyev's monograph *Essays on the History of Ancient Rome*, and Y be Livy's *History of Rome*. Then $d(X,Y)$ is $2\cdot 10^{-12}$, which implies the interdependence of the texts which are both describing the same period in Roman history. If, however, we take the first part of X as X', and the second half as Y', i.e., certainly independent texts, then $p(X',Y') = 1/3$.

We now give another example of undoubtedly dependent texts, namely, X is the *Nikiforovskaya chronicle* and Y is the *Suprasl'skaya* chronicle [19]. Both volume graphs for the time period from 850 to 1255 exhibit peaks practically simultaneously (Fig. 23) in the same years, and $d(X,Y) = 10^{-24}$.

The experiment compared ancient texts with ancient ones, ancient with modern ones, and modern with modern ones.

Along with the chapter volume graphs, other quantitative textual characteristics were investigated, namely, the quantity graphs of the mentioned names, given the number of textual mentions of individual years, other fixed text reference frequency graphs, and so forth [2]. The same maximum correlation principle turns out to be valid for all these characteristics: *The graphs of undoubtedly dependent texts form peaks almost simultaneously, and the peaks are*

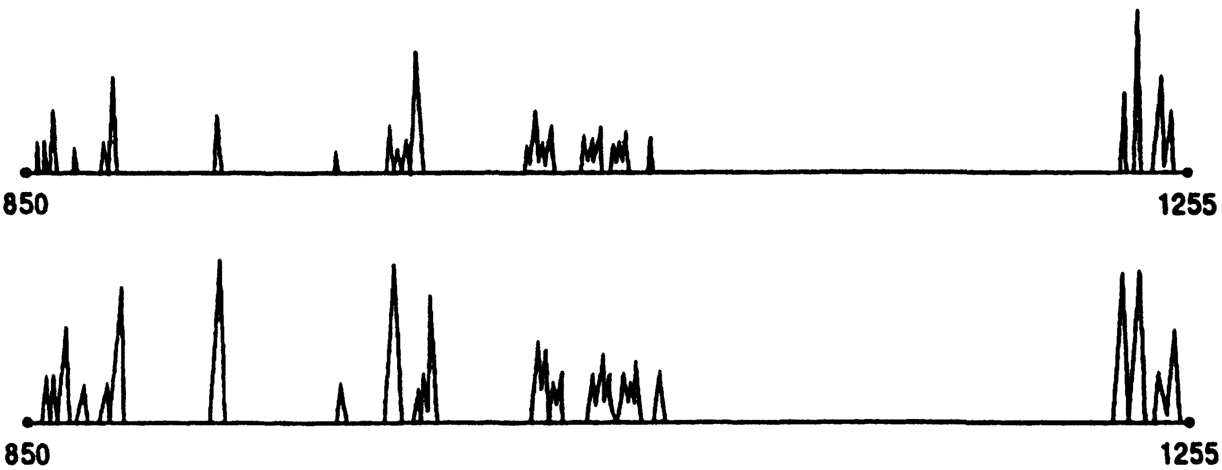


Figure 23. Volume functions of two dependent historical chronicles: the Nikiforovskaya chronicle and the Suprasl'skaya chronicle (Russian medieval history).

not correlated on the graphs of undoubtedly independent texts, which permits us to suggest a new dating method for ancient events.

Let Y be a historical text describing unknown events whose absolute dating has been lost. Let the years t be counted since an undated event of local importance, for example, the foundation of some city or the crowning of a king. We construct the volume graph for the chapters of Y and compare it with those of other dated texts. If among these texts, a text X with small $d(X, Y)$ is discovered which is of the same order as for pairs of dependent texts, i.e., if it does not exceed 10^{-8}, then we can conclude with sufficiently large probability, becoming greater as $d(X, Y)$ decreases, that the events described coincide.

The method has been verified experimentally for *a priori* dated medieval texts. The obtained dates coincided.

We illustrate this with the example where Y is the *Dvinsky* chronicle (the shorter version) describing the events in a 327-year-long interval [19]. Going through the list of chronicles in the Complete Collection of Russian Chronicles, we discover a text X whose volume graph forms peaks almost in the same years as that for Y (after the time intervals (A, B) and (C, D) have been made to coincide), where $d(X, Y) = 2 \cdot 10^{-25}$. It turns out that the text X is the complete version of the same *Dvinskaya* chronicle [19], with $(A, B) =$ 1390–1717. The obtained dating of the text Y coincided with its standard dating.

12.3. Method of recognition and dating the dynasties of ancient rulers. The small-distortion principle

Suppose a historical text has been found, describing an unknown dynasty of rulers with known rule durations. The question arises whether this dynasty is, in fact, new and unknown (hence, requiring a dating), or whether it is one of the known dynasties described in unusual terms, with the names of rulers altered, and so forth. The answer is given by the method described below (see its short description in [4] and [5]). Consider a sequence of authentic rulers in a state. We call this sequence an ***authentic dynasty***. Its members must not necessarily be relatives. The same authentic dynasty can often be described in different documents (by different chroniclers) and from different standpoints estimating the rule lengths differently, and so on. But there do exist "invariant" facts whose descriptions depend less on the propensities of the chroniclers, for example, rule durations. Normally, there are no special reasons for which a chronicler would considerably or intentionally distort this number. Nevertheless, chroniclers often face difficulties in calculating the duration of a king's rule. Naturally, for example, due to the incompleteness of information, distortions in the documents, and so on, they have sometimes caused different chroniclers to supply different figures which were, in their opinion, the rule of the same king. Such discrepancy can be characteristic, e.g., of the pharaohs in Brugsch's tables and [6]. Thus, describing an authentic dynasty, each chronicler calculates the durations of the kings' rules in his own way and obtains a sequence of numbers $(A_1, A_2, \dots, A_k)$, with A_p representing (possibly, with an error) the authentic rule of a king indexed by p, and with k being the total number of kings in the dynasty. This sequence (extracted from the chronicle) will be called a ***numerical dynasty***. While describing the same authentic dynasty, another chronicler will possibly ascribe other rule durations to the same kings and obtain another numerical dynasty $(B_1, B_2, \dots, B_k)$. Thus, the same authentic dynasty described in different chronicles can be represented as different numerical dynasties. We now formulate the "small-distortion principle":

If two numerical dynasties are "little" different from one another, then they represent the same authentic dynasty and are two variants of its description (in which case the numerical dynasties will be said to be ***dependent***); if, however, two numerical dynasties represent two different authentic dynasties, then they are "considerably" different from each other (in which case we call them *independent*).

In other words, chroniclers "little" distort authentic dynasties in writing a chronicle; at any rate, the discrepancy which can arise is less than that between different authentic dynasties. The above assertion should be verified. In case it is valid, we discover an important, and not at all obvious, property characterizing practically all chroniclers of antiquity, namely, numerical dynasties that arise from describing one authentic dynasty are different from each other—and also from the prototype—by less than two different authentic dynasties.

It turns out that to estimate the "nearness" of two dynasties, we can introduce a numerical coefficient $\lambda(M, H)$ similar to $d(X, Y)$, which still has the same meaning as probability. We describe it without going into details. It is convenient to represent a numerical dynasty as a graph by indicating the numbers of kings on the horizontal, and their rule duration on the vertical scale. We will say that a dynasty П is "similar" to the dynasties M and H if its graph differs from that of M by not less than the graph of H differs from that of M (see the details in [2], [4], [5]). We take as $\lambda(M, H)$ the part made up by the dynasties that are "similar" to M and H in the set of all dynasties, i.e., the ratio of the number of all dynasties "similar" to M and H to the total number of dynasties fixed in the chronicles. Rule durations may be determined wrongly by the chroniclers, and we actually extract only approximate values. The probability mechanisms leading to the errors can be described mathematically. Besides, we have then taken into account another two of the chroniclers' possible error, namely, mixing up neighbouring kings and their replacement by one whose rule duration equals the sum of theirs.

The small-distortion principle should be verified. In 1977–1979, I investigated J. Blair's tables [6] containing all the basic chronological data pertaining to the history of Europe, the Mediterranean, the Near East, and Egypt from 4000 B.C. to A.D. 1800. The data were checked and supplemented with the information from 14 more modern tables. For all the epochs in the history of the regions, a complete list of all 15-term dynasties was made, namely, of all groups consisting of 15 consecutive kings. Each could fall in several different 15-term dynasties, i.e., dynasties could "overlap".

We can compute $\lambda(M, H)$ or any two 15-term dynasties M and H. My computational experiment then showed that the small-distortion principle could be regarded as fully reliable, namely, for two *a priori* dependent dynasties, $\lambda(M, H)$ is always of the order of 10^{-12} to 10^{-8}, whereas, for *a priori* independent dynasties, the typical value of $\lambda(M, H)$ oscillates from 1/10 to 1/100 (and in some rare cases, amounts to 1/1000). The sharp difference (to the extent of several orders) between dependent and independent dynasties is obvious.

Thus, by means of $\lambda(M, H)$, we can reliably distinguish between dependent and independent pairs of dynasties. The important experimental fact is that the chroniclers have not made very "serious" mistakes; anyway, the errors are essentially less than the value for distinguishing independent dynasties, which permits us (within the framework of the experiment performed) to suggest a new method for recognizing dependent dynasties and dating independent ones. Proceeding from the analogy of the previous item; we calculate the coefficient $\lambda(M, D)$ for an unknown dynasty D, where M are known dynasties. If we find a dynasty M for which this coefficient is small, then we can assert that the dynasties M and D are dependent (with probability $\lambda(M, D)$), i.e., M and D are associated with a real one whose dating is already available (for M is dated). This method has been verified against medieval dynasties with *a priori* known dating. The efficiency of the method was fully confirmed.

12.4. The frequency-damping principle. A method of ordering texts in time

The present method permits us, for example, to discover a chronologically correct order for individual textual chapters and duplicates on the basis of the collection of proper names mentioned. As in the earlier methods, we strive for creating a dating technique based on the quantitative characteristics of the texts that are not requiring an analysis of the contents, which could be rather ambiguous and vague.

If a document mentions any "famous" historical figures known earlier from other, already dated chronicles, this permits us to date the described events. However, if such an identification is not immediately successful, and if, moreover, the events of several generations with a large quantity of historical figures previously unknown are described, then the problem of establishing the identity of personages with those known is made more complicated. In short, we call a fragment of a text describing the events of one generation "a generation-chapter". We shall assume that the mean duration of one "generation" is the average duration of the rule of authentic kings fixed in the available chronicles. This mean duration of a rule was computed by the author on the basis of the results obtained in processing the information contained in Blair's Tables [6] and the GCD (see above). It equals 17.1 years. In working with authentic texts, we face certain difficulties if we want to distinguish chapter generations from them; therefore, we have restricted ourselves only to an approximate partition of the text. Let a text X describe the events in a sufficiently large time interval (A, B) when several generations of historical figures have replaced each other. Suppose that X is broken into the chapter generations $X(T)$, where T is the ordinal number of the generation described in $X(T)$ relative to the numbering fixed in the text. The question arises: Have these chapter generations been enumerated (or ordered) in the text? Or, if this enumeration has been lost (or is doubtful), then how can it be restored? In other words, how can the chapters be placed in time with respect to each other? As it turns out for authentic historical texts, the following formula is valid, namely, full name = historical figure, which means that if a time interval described is sufficiently large (tens or hundreds of years long), then, as I verified when analyzing a large set of historical documents, in the overwhelming majority of cases, different personages have different full names in the same texts. A full name can consist of several words, e.g., Charles the Bald. In other words, the number of different persons with the same full names is negligibly small, compared with that of all personages, which is valid for all the several hundred texts I investigated and which describe Greece, Germany, Italy, Russia, and others. In fact, the writer of a historical text is interested in distinguishing between different historical figures in order to avoid ambiguity. The simplest method to attain this is to give different full names to different people, which is justified by calculation.

We now formulate the *frequency-damping principle* describing the chronologically correct order of chapter generations: *In the correct enumeration of chapter generations, the author of the text, while proceeding from the description of one generation to another, also describes other historical figures, namely, he does not speak at all of the personages of the generations (since they have not yet been born) belonging to those prior to a generation numbered* T_0*; then, in describing* T_0*, the author speaks of the historical figures of this*

generation more, since the described events are related to them most; and, finally, proceeding with the description of subsequent generations, the author mentions the prior historical figures still less and less, since new events with new historical figures drive out the dead.

Thus, each generation gives birth to new historical figures, who are replaced when generations are replaced. In spite of the apparent simplicity, this principle may be useful in creating a dating method. The frequency-damping principle can be reformulated equivalently. Since the personages are practically uniquely determined by their full names (name = personage), we will study the complete set of all the full names contained in a text. The term "complete" will be omitted. Consider a group of names first appearing in a text and a chapter generation T_0. We will call them T_0-names, and the corresponding personages T_0-personages. The quantity of all mentions (taken with their multiplicities) of all the names in this chapter will be denoted by $K(T_0, T_0)$. We then count how many times the same names have been mentioned in a chapter T. The obtained number will be denoted by $K(T_0, T)$. Meanwhile, if the same name is repeated several times, then all these mentions are counted. Construct the graph by marking the numbers of chapters on the horizontal scale, and $K(T_0, T)$, where T_0 is fixed, on the vertical scale. For each T_0, we obtain its own graph. The frequency-damping principle is then formulated as follows:

In the chronologically correct enumeration of chapter generations, each graph of $K(T_0, T)$ should vanish to the left of T_0, attain an absolute maximum at T_0, and then gradually dampen (see Fig. 24).

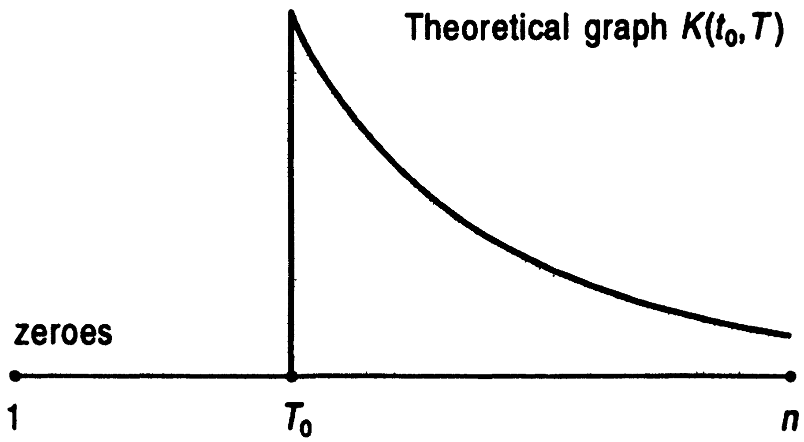


Figure 24. Ideal graph illustrating the frequency-damping principle.

We call this graph *ideal*. The formulated principle must be checked experimentally. If it is true, and the chapters are ordered chronologically correctly, then all experimental graphs should be close to the ideal. The experimental verification I performed has fully fustified the frequency-damping principle. We illustrate this with several typical examples.

12.5. Applications to Roman and Greek history

Example 1. Livy's *History of Rome*. All the graphs of $K(T_0, T)$ for the part describing the years 750–293 B.C. and 510–293 B.C. turned out to be almost identical with the ideal, i.e., most of the names first appearing in one generation most often appear in the description of just this generation, and then gradually vanish. Therefore, the principle is confirmed, and the order of chapter generations is chronologically correct in these parts of the *History of Rome*.

Example 2. *Liber Pontificalis* by Mommsen and *Gestorum Pontificum Romanorum* [95]–[96]. We single out portions describing A.D. 300–560, 560–900, 900–1250, and 1250–1500. It turns out that all the graphs of $K(T_0, T)$ practically coincide with the ideal here, too, which also confirms the principle.

We should draw our attention to one of the corollaries to the performed experiment, namely, no fashion for names was traced in considerable time intervals (which is not at all obvious). Certainly, some names used in antiquity are also in use today (Peter, Mary, and so forth); however, as was made clear, these names are either incomplete or their percentage is small in comparison with the whole mass of dying names. The availability of the surviving names signifies that the experimental graphs of $K(T_0, T)$ occur in moving from left to right, not up to zero, but up to a certain nonzero constant.

Example 3. The following set of primary sources has been taken as a text X describing A.D. 976–1341 in Byzantine history: (1) Psellus, M., *The Chronographia of Michael Psellus*; (2) Anna Comnena, *The Alexiad of Anna Comnena*; (3) Cinnamus, Joannes, *Epitome rerum ab Ioanne et Alexis*; (4) Aconiates, Nicetas, *Historia*; (5) Acropolita, Georgius, *Chronicon Constantinopolitanum*; (6) Pachymeres, Georgius, De Michaele et Andronico Palaelogo, lib. 1–8; (7) Gregoras, Nichephorus, *Byzantinae Historiae*.

The above set contains tens of thousands of full names (taking their multiplicities into account). All the graphs $K(T_0, T)$ turned out to be practically identical with the ideal.

Example 4. Gregorovius' *History of the City of Rome in the Middle Ages*. The fragments describing A.D. 300–560, 560–900, and 1250–1500 were extracted from this text, each of which was divided into chapter generations, and the total collection of the names counted several tens of thousands of mentions. It turned out that the frequency-damping principle was also valid and the ordering of chapters in each of these fragments chronologically correct. A similar result was also obtained for the monograph of Kolrausch *History of Germany*, in which three pieces describing A.D. 600–1000, 1000–1273, and 1273–1700 were distinguished.

Several dozen historical texts were investigated; in all the cases, the frequency-damping principle was confirmed. Hence, we have a method of ordering textual chapter generations chronologically correctly if this order was disturbed or unknown. Consider the totality of chapter generations in a text

X and enumerate them somehow. For each chapter $X(T_0)$, we than plot the graph of $K(T_0,T)$. All the values $K(T_0,T)$ with variable T_0 and T can be naturally organized into a square matrix $K\{T\}$ of order $n \times n$, where n is the number of chapters. In the ideal theoretical case, the matrix $K\{T\}$ has the form shown in Fig. 25 and possesses zeroes below the principal diagonal and the absolute maximum in each of its rows.

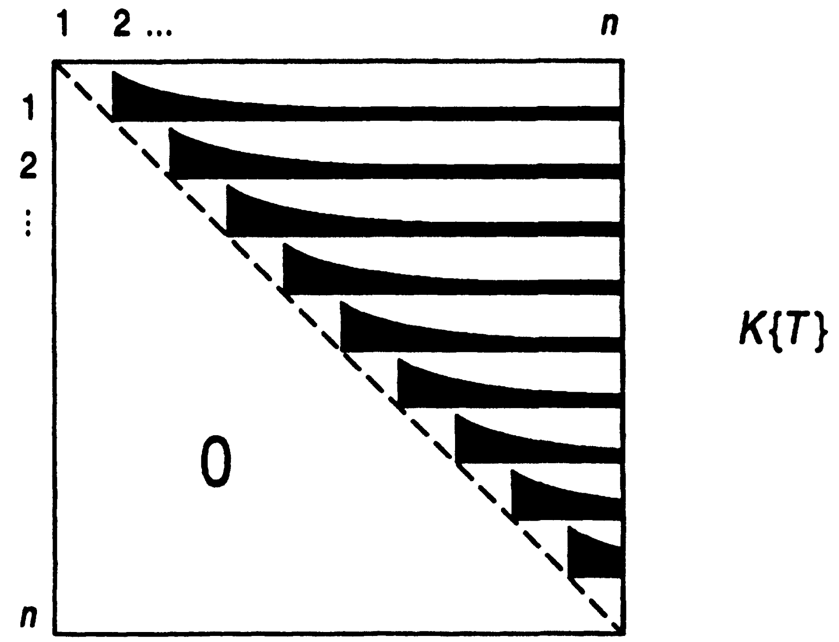


Figure 25. The square matrix corresponding to the frequency-damping principle.

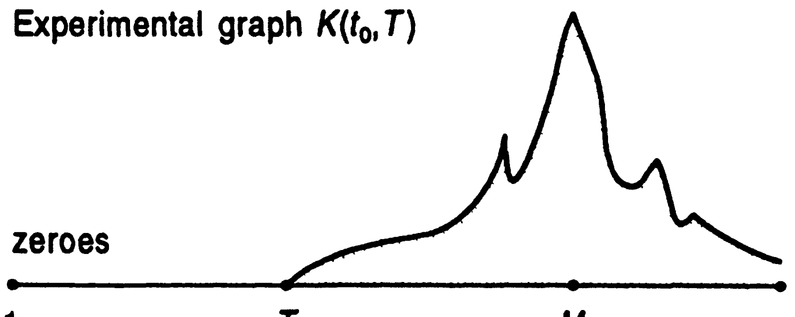


Figure 26. Experimental graphs may not coincide with the theoretical one.

Each graph decreases monotonically and vanishes in every row. It goes without saying that experimental graphs may not coincide with the theoretical one (see Fig. 26). Now, if we alter the chapter enumeration, then $K(T_0,T)$ will be altered, too, because of a rather complicated redistribution of the "names appearing for the first time". Hence, the matrix $K\{T\}$ and its elements do vary. Changing the order of the chapters by means of various permutations and calculating the new matrix $K\{\sigma T\}$, where σT is the new enumeration corresponding to a permutation σ, we will seek their order such that all or almost all graphs will be of the form shown in Fig. 24, and the experimental matrix $K\{\sigma T\}$ will be closest to the theoretical in Fig. 25. That order of chapters for which the deviation of the experimental matrix from the theoretical is the least should be taken as chronologically correct and required. The description of the "proximity criterion" is omitted.

The method also permits us to date events. Suppose it is only known about a given text Y that it depicts some events of an epoch (A, B) already described in the chapter generations of a text X, their order being chronologically correct. How can we learn what generation precisely is described in Y if we only make use of quantitative textual characteristics and do not consider the possibly ambiguous contents admitting different interpretation.

The answer may be given by adjoining the text Y to the chapters of X, treating Y as a new chapter, and ascribing a certain number T_0 to it; we then find an optimal order of the chapters, which must be chronologically correct. Meanwhile, we also determine a correct place for the new chapter Y. In the simplest case, having constructed the graph of $K(T_0, T)$, we can make it as close to the ideal as we please by placing Y appropriately. The position which Y occupies relative to the other chapters should be taken as the required. We thereby date the events described in Y. This technique may be also applicable when we consider only a few names, e.g., certain "famous" ones.

Let us verify our method against texts with *a priori* known dating.

Example 1. Consider the period from 500 to 20 B.C. in Greek history. We take Plutarch's *Parallel Lives* as a text X. Making use of the above method, we see that all chapter generations are placed correctly in it. As Y, we select the *Pyrrhus*, describing the events usually dated to have occurred from 319 to 272 B.C. Looking for its correct position among the other chapters, we find that it should be placed at the end of the 4th or at the beginning of the 3rd century B.C., which is quite consistent with the earlier dating. We obtain a rougher result, since we deal with chapters describing whole generations, and not separate years, but then we have dated the *Pyrrhus* without turning to its contents.

Example 2. We have considered and dated (by our method based on the above-mentioned medieval Byzantine chronicles) the following Byzantine texts describing the Crusades: X is the *Histoire anonime de la première croisade (Gesta Francorum et aliorum Hierosolimitanorum)* whose traditional dating to A.D. 1099 coincided with the one we obtained, namely, the end of the 11th century; and Y is Robert de Clari's *La Conquête de Constantinople*, traditionally dated to A.D. 1204, was also related by us to the beginning of the 13th century. Thus, the efficiency of the method was confirmed in employing medieval texts with *a priori* known dating.

12.6. The frequency-duplication principle. The duplicate-discovery method

The present method is, in a certain sense, a special case of the previous one; however, because of its importance, we have distinguished the duplicate-discovery method separately. Let an interval (A, B) be described in a text X which is divided into the chapter generations $X(T)$. Suppose they were in general enumerated chronologically correctly, with two duplicates among them, i.e., two chapters speaking of the same generation, and repeating each other. Consider the simplest situation where the same chapter is repeated in the text X twice, namely, numbered T_0 and C_0. Our method makes it possible to discover and identify these duplicates. It is clear that the graphs of $K(T_0, T)$ and $K(C_0, T)$ have the form shown in Fig. 27. The first graph explicitly does not satisfy the frequency-damping principle; hence, we have to permute the chapters in X in order to achieve a better agreement with the theoretical graph. All values $K(C_0, T)$ vanish, since there are no "new names" in the chapter $X(C_0)$; they all have already appeared in $X(T_0)$. It is obvious that the best coincidence with the graph in Fig. 24 will be attained if we juxtapose these two duplicates or simply identify them. Thus, if among the chapters generally enumerated correctly, we have discovered two whose graphs have approximately the form of those in Fig. 27, then these chapters, most probably, are duplicates (i.e., tell of the same events) and should be identified. All the aforesaid can be transferred to the case where there are several duplicates (three or more).

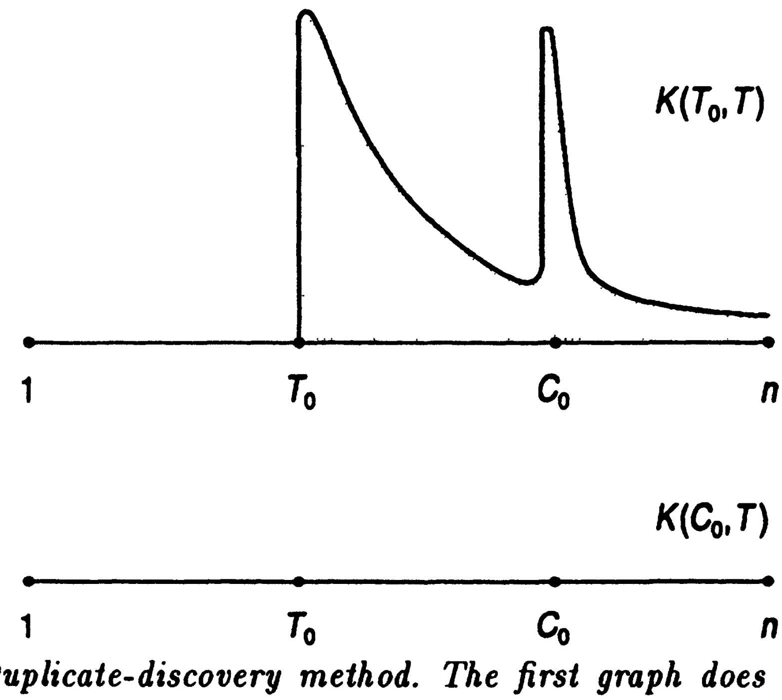


Figure 27. Duplicate-discovery method. The first graph does not satisfy the frequency-damping principle.

This method has been checked against experimental material. As a simple example, we took a Russian edition of the *History of Florence* by Machiavelli, supplied with detailed commentary. It is evident that the commentary can be regarded as a series of chapters duplicating the text of Machiavelli himself. It was divided into chapter generations, which permitted us to construct a square matrix $K\{T\}$ also taking into account the commentary. The matrix has the form shown in Fig. 28, where the blocks filled with maxima are shown in thick lines, which means that our method does discover duplicates which are, in our case, made up of the commentary to the text of the *History of Florence.*

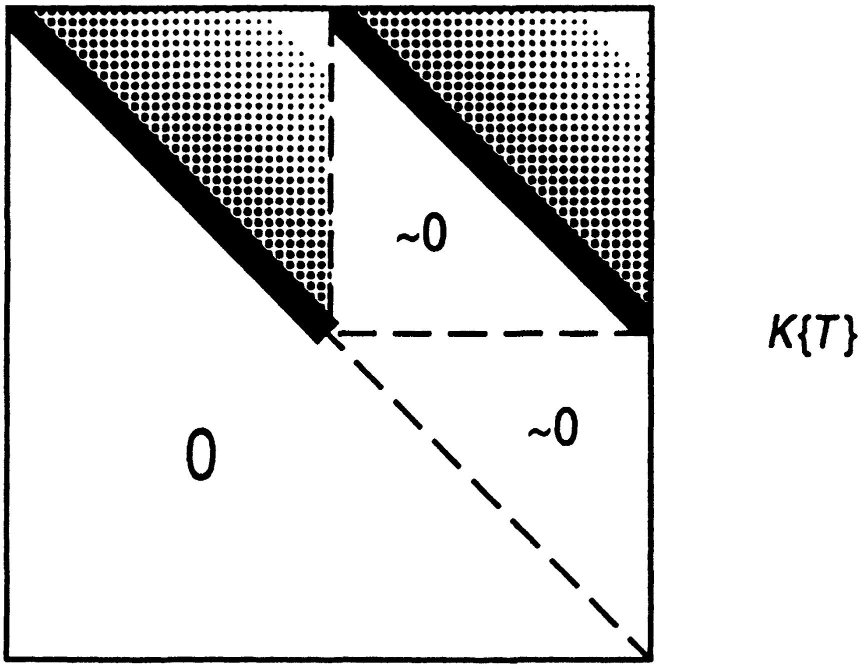


Figure 28. Frequency matrix for the "History of Florence" by Machiavelli.

12.7. Statistical analysis of the complete list of all the names mentioned in the Bible

The following example is very important for the analysis of global chronology. The Bible contains tens of thousands of names. It is generally known that there are two series of biblical duplicates, namely, each generation described in the First and Second Book of Samuel, the First and Second Book of Kings, and then again in the First and Second Book of the Chronicles.

I have divided the Old and New Testament into chapter generations as shown below. For reference, the canonical division into standard chapters and verses was retained, which certainly does not coincide with the division into chapter generations. Each of the chapter generations listed here (of course, approximately) describes only one generation of personages, due to which the following division of the Bible was obtained. We indicate the biblical fragments which compose individual chapter generations. The division of Genesis into chapter generations is given first, namely,

(1) 1–3 (Adam, Eve);

(2) 4:1–16 (Cain, Abel);
(3) 4:17 ("Then Cain lay with his wife ...");
(4) 4:18 ("Enoch begot Irad ...");
(5) 4:18 ("... Mehujael begot Methushael ...");
(6) 4:18 ("... Methushael begot Lamech");
(7) 4:19–24 ("Lamech married two wives ...");
(8) 4:25–26 ("Adam lay with his wife again");
5:1–6 ("This is the record of the descendants of Adam");
(9) 5:7–11 ("After the birth of Enosh ...");
(10) 5:12–14 ("Kenan ... lived eight hundred and forty years ...");
(11) 5:15–17 ("Mahalalel ... lived eight hundred years ...");
(12) 5:18–20;
(13) 5:21–27;
(14) 5:28–31;
(15) 5:32, 6, 7, 8;
(16) 9;
(17) 10:1;
(18) 10:2;
(19) 10:3;
(20) 10:4;

⋮

(48) 10:32;
(49) 11:1–9;
(50) 11:10–12;
(51) 11:13–14;
(52) 11:15–16;
(53) 11:17–19;
(54) 11:20–21;
(55) 11:17–19;
(56) 11:24–25;
(57) 11:26–27;
(58) 11:28;
(59) 11:29–32;
(60) 12;
(61) 13;
(62) 14–24;
(63) 25:1–2;
(64) 25:3;
(65) 25:4;
(66) 25:5–10;
(67) 25:11–18;
(68) 25:19–26;
(69) 25:27–34;
(70) 26–33;

(71) 34–36;
(72) 37, 38;
(73) 39–50.

Genesis ends here.

(74) Exodus; (75) Leviticus; (76) Numbers; (77) Deuteronomy; (78) The Book of Joshua; (79) The Book of Judges 1; (80) The Book of Judges 2;...; (96) The Book of Judges 18; (97) The Book of Judges 19–21; (98) Ruth; (99) The First Book of Samuel 1–15; (100) The First Book of Samuel 16–31; (101) The Second Book of Samuel; (102) The First Book of Kings 1–11; (103) The First Book of Kings 12; (104) The First Book of Kings 13;...; (112) The First Book of Kings 22; (113) The Second Book of Kings 1; (114) The Second Book of Kings 2,...; (135) The Second Book of Kings 23; (136) The Second Book of Kings 24, 25; (137) The First Book of the Chronicles 1–10; (138) The First Book of the Chronicles 11–29; (139) The Second Book of the Chronicles 1–9; (140) The Second Book of the Chronicles 10;...; (166) The Second Book of the Chronicles 36; (167) The Book of Ezra; (168) The Book of Nehemiah; (169) Esther; (170) The Book of Job; (171) Psalms; (172) Proverbs; (173) Ecclesiastes; (174) The Song of Songs; (175) The Book of the Prophet Isaiah; (176) The Book of the Prophet Jeremiah; (177) Lamentations; (178) The Book of the Prophet Ezekiel; (179) Daniel; (180) Hosea; (181) Joel; (182) Amos; (183) Obadiah; (184) Jonah; (185) Micah; (186) Nahum; (187) Habakkuk; (188) Zephaniah; (189) Haggai; (190) Zechariah; (191) Malachi; (192) Matthew; (193) Mark; (194) Luke; (195) John; (196) Acts of the Apostles; (197) A Letter of James; (198) The First Letter of Peter; (199) The Second Letter of Peter; (200) The First Letter of John; (201) The Second Letter of John; (202) The Third Letter of John; (203) A Letter of Jude; (204) The Letter of Paul to the Romans; (205) The First Letter of Paul to the Corinthians; (206) The Second Letter of Paul to the Corinthians; (207) The Letter of Paul to the Galatians; (208) The Letter of Paul to the Ephesians; (209) The Letter of Paul to the Philippians; (210) The Letter of Paul to the Colossians; (211) The First Letter of Paul to the Thessalonians; (212) The Second Letter of Paul to the Thessalonians; (213) The First Letter of Paul to Timothy; (214) The Second Letter of Paul to Timothy; (215) The Letter of Paul to Titus; (216) The Letter of Paul to Philemon; (217) A Letter to Hebrews; and (218) The Revelation of John.

Thus, the Old Testament has been broken into 191 chapter generations. The New Testament consists of Chapters 192–218. We shall now consider only Chapters 1–170. Meanwhile, Genesis 4:18 was divided into three generation chapters. The other subsequent chapters (including the New Testament) will not be required for the present and are therefore omitted.

In 1974–1979, V.P. Fomenko and T.G. Fomenko carried out the enormous job of compiling the complete list of all the names mentioned in the Bible, taken with their multiplicities, and exactly distributing the names in generation chapters. It turned out that altogether about 2,000 names are mentioned, whereas, the number of references with their multiplicities amounts to tens of thousands. Accordingly, all the graphs of $K(T_o, T)$ were constructed, where the number T ranges over all the chapters listed. The graphs constructed for the chapters from the First and Second Book of Samuel and the First and Second Book of Kings turned out to have the form of the graph in Fig. 27, i.e., names first appearing in these chapters are then given "birth" again in the corresponding chapters from the First and Second Book of the Chronicles. The corresponding part of the matrix $K\{T\}$ is shown in Fig. 29. Two parallel diagonals filled with the absolute maxima of the rows are marked with two thick lines. Thus, our method has successfully discovered and identified those duplicates in the Bible which were also known earlier as such.

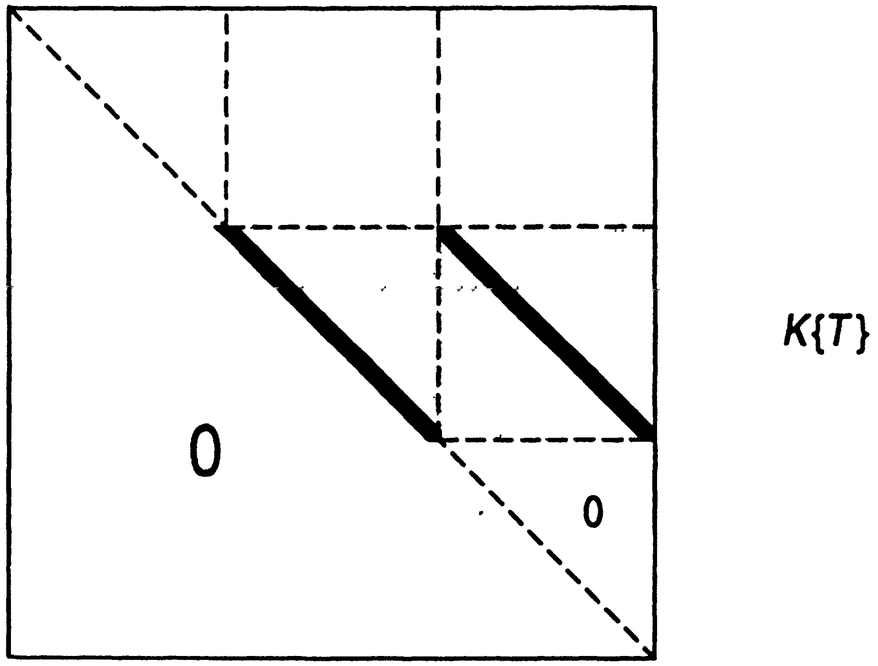


Figure 29. Part of the square frequency matrix for the Bible. Duplicates: (1–2 Samuel + 1–2 Kings) and 1–2 Chronicles.

12.8. Statistical analysis of the complete list of all parallel passages in the Bible

The application of these methods is sometimes made easier by the fact that, for many a historical text, the commentators have revealed the repeating fragments. By a "repetition", we mean not only a repetition of a name, but also a repeated description of a particular event, and so forth. For example, the same descriptions, lists of names, religious formulas, and so on, are encountered in the Bible many times. All of them have been discovered in the Bible long ago and were systematized and mentioned in the list of parallel passages; namely, close to certain verses, it is indicated which verses of this or other books of the Bible are regarded as "repetitions" (which are "parallel"). If a text X under investigation has been supplied with this, or a similar, list of parallel passages, then we can apply the duplicate-discovery method, regarding the repeated fragments as "repeated names".

We illustrate this with an example. Consider the books of the Bible from Genesis to the Book of Nehemiah. The partition of the Bible into chapter generations has been given above. We now enumerate them in the order in which they replace each other in the canonical ordering. The list of "parallels" contains approximately 20,000 repeated verses. We count in each $X(T)$ the number of verses which have not yet appeared in the preceding chapters $X(T)$ (i.e., first appearing in $X(T_o)$). We denote their number by $\Pi(T_o, T_o)$. We then count how many times these verses repeat in the subsequent $X(T)$. We denote the obtained quantities by $\Pi(T_o, T)$. All graphs of $\Pi(T_o, T)$ have been constructed (altogether 169 graphs). They differ from those of $K(T_o, T)$ only in dealing with verses instead of names, and names instead of verses. The verses which are not repetitions of each other or some other verse are regarded as "different names".[4]

Hence, in the correct chronological order of chapter generations, with duplicates being absent, the verse repetition graphs $\Pi(T_o, T)$ should have the form of that shown in Fig. 24. Similarly to the case of employing names, the author of a text (for the correct order of the described events) says nothing of the events of the generation T_o in the preceding chapters (these events have not yet occurred), says a lot while describing the events of the generation T_o, and recalls them still less and less in the subsequent chapters, i.e., the graph possesses an absolute maximum at the point T_o, vanishes to the left of T_o, and decreases monotonically to the right of T_o. An experimental check which I performed has justified the frequency-damping principle for all the fragments of the Bible, listed below, namely, (1) Genesis 1–5; (2) Genesis 6–10; (3) Genesis 11; (4) Genesis 12–38; (5) Genesis 39–50; Exodus; Leviticus; Numbers; Deuteronomy; The Book of Joshua; The Book of Judges 1–18; (6) The Book of Judges 19–21; Ruth; The First and Second Book of Samuel; The First and Second Book of Kings 1–23; (7) The First and Second Book of the Chronicles; The Book of Ezra and Nehemiah. It turns out that all the graphs of $\Pi(T_o, T)$ are of the form of the theoretical graph in Fig. 24 for each of these texts, which means that the frequency-damping principle is valid in this case; besides, the order of the chapters is chronologically correct, while duplicates are absent.

If all the chapters of a text are enumerated correctly as a whole, then the duplicates can be discovered by plotting the "verse repetition graphs" of $\Pi(T_o, T)$. If two chapters $X(T_o)$ and $X(C_o)$ are duplicates, then the graphs of $\Pi(T_o, T)$ and $\Pi(C_o, T)$ are of the form demonstrated in Fig. 27. This method has also been experimentally checked for the above example, namely, [the First Book of Samuel + the Second Book of Samuel + the First Book of Kings + the Second Book of Kings] duplicate [the First and Second Book of the Chronicles]. The construction of the graphs of $\Pi(T_o, T)$ revealed that the duplicates were just those chapters from [the First and Second Book of

---

[4] This entire enormous job was carried out by V.P. Fomenko and T.G. Fomenko.

Samuel + the First and Second Book of Kings] and [the First and Second Book of the Chronicles], which were duplicates from the standpoint of the graphs of $K(T_o, T)$, thus indicating the complete consistency of the results of the application of both methods. Meanwhile, it should be noted that the list of parallelisms is not identical with that of repeated names, since, for example, many fragments (verses of the Bible) not containing names at all are regarded to be "parallel".

12.9. Duplicates in the Bible

We now continue with a short description of the results of applying our methods to the antique and medieval chronological data. In doing so, duplicates traditionally regarded as different, and dated today to substantially different years, have been discovered unexpectedly.

We have applied the duplicate-recognition method (on the basis of the graphs of $K(T_o, T)$ and $\Pi(T_o, T)$) to the Bible, namely the Old Testament from Genesis to Esther. The obtained results will be represented as a line (= chronicle) B in which duplicates (i.e., fragments of the Bible speaking of the same events, as follows from the verification described above of the frequency-duplication principle) have been denoted by identical symbols (letters). Thus, the line

$$B = T\ K\ T\ H\ T\ K\ T\ K\ T\ \begin{matrix} H \\ - \\ \Pi \\ - \\ P \end{matrix}\ T\ T\ P\ T\ C_a,$$

which means that the entire "historical part" of the Old Testament consists of several fragments, namely, T, K, H, Π, P, C_a, with some of them repeating several times, and placed differently in the Canon, thus yielding the above line B. In other words, many of the fragments (indicated in B) of the Old Testament actually describe the same events, thus contradicting the traditional ideas according to which the different books of the Bible (except the First and Second Book of Samuel + the First and Second Book of Kings and the First and Second Book of the Chronicles) describe different events. Let us decode the symbols of the chronicle B. Indicating a symbol, we list the corresponding fragments of the Bible in brackets. Thus, B equals T (Genesis 1–3) K (Genesis 4–5) T (Genesis 6–8) H (Genesis 9–10) T (Genesis 11:1–9) K (Genesis 11:10–32) T (Genesis 12) K (Genesis 13–38) T (Genesis 39–50, Exodus) $H/\Pi/P$ (Leviticus, Numbers, Deuteronomy, The Book of Joshua and the Book of Judges 1–18) T (The Book of Judges 19–21) T (Ruth, the First and Second Books of Samuel, the First Book of Kings 1–11) P (the First Book of Kings 12–22, the Second Book of Kings 1–23) T (the Second Book of Kings 24) C_a (the Second Book of Kings 25, the Book of Ezra, the Book of Nehemiah, Esther).

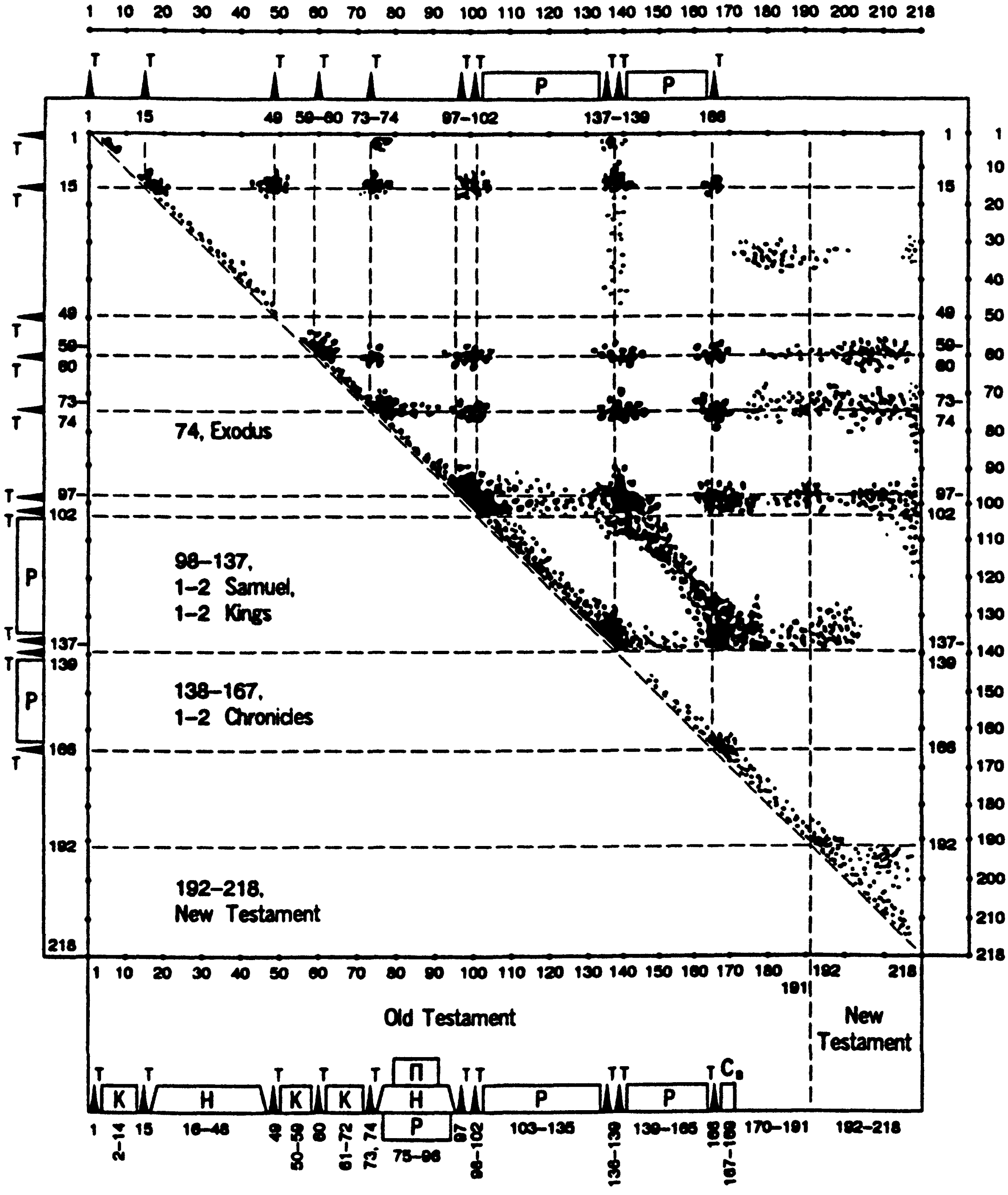


Figure 30a. Square matrix of biblical names (detailed diagram). The most essential concentrations (duplicates) are shown.

Besides, the sequence $TPTC_a$ (at the end of the line B) was also described in the First and Second Book of the Chronicles. The two latter series of duplicates, which were known before, are unique. The other duplicates exhibited above were unknown earlier and were discovered on the matrix $K\{T\}$

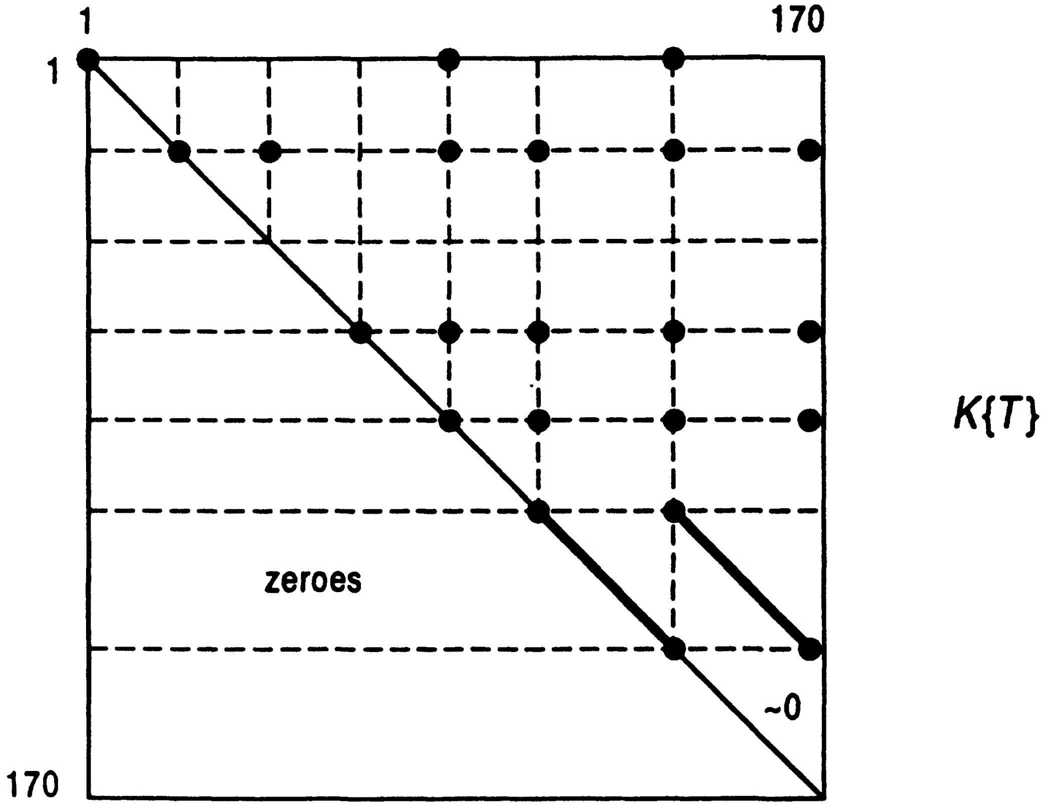


Figure 30b. Part of the square matrix of biblical names (rough diagram).

of the biblical Chapters 1–170 as follows. Two earlier-known duplicate series, (namely, Chapters 98–137 and their duplicates, Chapters 138–167) imply that, along with the maxima filling the principal diagonal, there is another diagonal also composed of maxima and parallel to the principal in rows 98–137 (see Figs. 30(a), 30(b)). These diagonals are represented as black oblique segments. Rows 138–167 practically consist solely of zeroes.

The other duplicates could be discovered by approximately identical local peaks placed in the intersections of the corresponding rows and columns. The duplicates of the series T, as encountered in the Old Testament most frequently, are represented in Fig. 30a, b (see the particulars below).

12.10. The enquête-code or formalized "biography" method

Ancient literature used to resort to clichés and borrowings, for example, in the description of some particular rulers. Sometimes, the chroniclers ascribed the character and deeds of ancient kings to other rulers. To detect and study these clichés and duplicates, I have introduced the concept of *enquête-code*, or formalized "biography". An authentic ruler described in the chronicles will thereby acquire a "historical literary biography", which might have nothing to do with the authentic one and can be legendary. On the basis of the investigation of a large number of historical biographies, a table called an *enquête-code* was worked out, hierarchically ordering the facts of the biography with the decrease of their invariance relative to the personal attitudes of the authors.

An enquête-code consists of 34 items, each of which contains several subitems, see Chapter 4.

How can we know, without resorting to the analysis of the contents of the chronicles, whether or not these chronicles describe the same authentic dynasty? If the rule durations are indicated in the chronicles, then we can apply the numerical dynasty recognition method (see Section 12.3 above). However, if such numerical data are not available, then the problem gets more complicated. Thus, how can the same authentic dynasty be distinguished from the set of all enquête-codes? To solve the problem, a method based on the *small-distortion principle* (see above) has been worked out. In this case, it is formulated thus:

If the enquête-codes of two dynasties differ "little" from each other, then they represent the same authentic dynasty; however, if two enquête-codes represent different dynasties, then they are "far" from one another.

Here, we omit the description of the numerical coefficient similar to $\lambda(M, H)$ and permitting us to separate reliably the "dependent enquête-codes" from the "independent" ones (see the particulars in [2]). The experimental check has confirmed the validity of the small-distortion principle in this case, too: It turned out that the enquête-codes representing the same dynasty were much less different from each other than those of different authentic dynasties. It is obvious that this circumstance permits us to date the enquête-codes of dynasties in accordance with the above procedure.

12.11. A method for the chronological ordering of ancient maps

I also developed a method for the chronological order of ancient maps. Any geographical map reflects the state of geoscience of the period when the map was made. With the development of scientific ideas, maps improve more and more, i.e., the amount of incorrect information decreases, and that of reliable data increases. An optimal map-code permitting us to represent any map (given graphically or described verbally) as a table similar to an EC was worked out and based on the analysis of concrete ancient maps. The list of items of this table will be omitted here. An experimental check performed in 1979–1980 permitted us to formulate and justify the following "chart-improvement principle".

If a chronologically correctly ordered sequence of maps is given, then, in the transfer from old charts to new ones, two processes occur, namely, incorrect features which do not correspond to real geography vanish and no longer appear on the maps, i.e., "errors are not repeated", and the correct ones which have been introduced, e.g., availability of a channel or river, profile of the bank, are fixed and retained in all subsequent charts.

Due to the role which maps always played in sea-faring, and so forth, this chart-improvement principle has been introduced because of the urgent requirements arising from practice. The principle has been verified according to the procedure used in the previous items. We establish a certain order of the charts, construct the graph of $L(T_o, T)$ for each T_o where $L(T_o, T_o)$ equals the number of features first appearing on a map T_o, whereas $L(T_o, T)$ indicates how many of them remained on the chart T. We should assume an ordering of the charts to be chronologically correct if all the graphs of $L(T_o, T)$ are close to that represented in Fig. 24 (and incorrect otherwise). In particular, charts which seem to be visually close turn out to be close in time, too: Each epoch is characterized, as can be seen, by its unique set of maps. The verification of the principle has been made more complicated by the fact that few ancient charts survived up to the present time. Nevertheless, a sufficient number of charts permitting us to verify the model were collected.

Those of the 3rd–4th century turned out to be quite primitive and rather far-fetched; their quality then improves steadily until, in the 16th century, we encounter sufficiently correct maps, and even globes dating from the 17th century. Meanwhile, the quality improved extremely slowly. For example, the geographical knowledge of 16th-century Europe was still very far from that of today. One map signed in 1522 by T. Occupario represented Europe and Asia in proportion sharply contrasting to the modern Europe: Greenland is a European peninsula there, Scandinavia elongated into a thin strip, the Bosphorus and Dardanelles greatly extended, the Black Sea distorted vertically, the Caspian Sea drawn in horizontal direction and literally made unrecognizable, and so forth. The only region reflected more or less correctly is the Mediterranean; still, Greece is represented as a triangle without the Peloponnese. The ethnographical data on this and other maps of the time are yet much farther from those fixed by traditional history. For example, Dacia and *Gottia* (land of the Goths?) are placed in Scandinavia, Albania on the Caspian Sea, and China is completely absent, the *Judei* are in Northern Siberia, and so forth. A map of Cornelius Niccolai (1598) abounds in similar distortions, but now to a lesser degree. Finally, a globe of the 17th century in the Moscow History Museum already reflects the true geographical position quite well.

The method permits us to date maps, including "ancient" ones, according to the procedure described above. The obtained results may be quite unexpected. We illustrate this with some typical examples.

(1) The famous chart from the *Geography* by Ptolemy, ed. Basileae, 1545, which is regarded today as ancient, does not fall into the 2nd century, but the 15–16th century, i.e., the time when Ptolemy's book was published. This fact makes us recall quite a similar situation with the *Almagest* (see above).

(2) The no less famous ancient chart *Tabula pentingeriana* (see e.g., [1], pp. 232–233, Fig. 48) falls not at the turn of the millennium, i.e., time of Augustus, but into the 11–12th century. The divergence from the traditional dating is more than 1,000 years.

(3) Series of ancient maps (which are, though, later reconstructions from verbal descriptions in ancient texts; see [75]) by Hesiod (dated traditionally to the 8th century B.C.). Hecataeus (6–5th century B.C.), Herodotus (5th century B.C.), Democritus (5–4th century B.C.), Eratosthenes (276–194 B.C.),

the "globe" of Crates (168–165 B.C.) if dated by the above method, then fall into the 7–13th century.

§13. Construction of the Global Chronological Diagram and Certain Results of Applying the Dating Methods to Ancient History

13.1. The "textbook" of ancient and medieval history

In 1974–1980, I carried out the analysis of the global chronology of the ancient and medieval history of Europe, the Mediterranean, Egypt, and the Near East. The historical and chronological data of J. Blair's [6] and 14 other tables (see above) were completed with the information from 222 texts, chronicles, annals, and others, containing together the description of practically all basic events occurring in the indicated regions from 4000 B.C. to A.D. 1800 if dated traditionally. All this information (wars, kings, basic events, empires, etc.) was then represented graphically as the *global chronological diagram (GCD)* constructed on the horizontal "time" axis. Each epoch with all its events was represented in detail by the lists and dates at the corresponding place on the time axis.

We then applied the dating of events and duplicate-recognition methods described above and in [2]–[5] and, in particular, computed the values $d(X, Y)$ for different pairs of surveying historical texts X, Y embracing large time intervals. The quantity $\lambda(M, H)$ for the different dynasties M, H from the GCD, the coefficients $L(P, H)$, and values measuring the enquête-code proximity were also calculated. This extensive experiment unexpectedly led to the discovery of pairs of epochs regarded as independent by traditional history, but for which the coefficients $d(X, Y)$, $\lambda(M, H)$, etc., turned out to be extremely small and characterizing necessarily dependent epochs, texts, dynasties or enquête-codes. We illustrate this with an example.

13.2. Duplicates

It was discovered that the history of ancient Rome in 753–236 B.C. overlapped with that of the medieval one in A.D. 300–816. More precisely, the epoch (A, B) from 300 to 816 was described, for example, in the fundamental work of F. Gregorovius, *History of the City of Rome in the Middle Ages*; the epoch (C, D) from the year 1 to 517 since the foundation of Rome (which occurred, as is thought today, in 753 B.C.) is described in the following two texts.

The *History of Rome* by Livy from the year 1 up to 459 since the foundation of Rome; Livy's text breaks off at that point, and the other books are lost. Therefore, the end of the period (C, D) from the year 459 to 517 since the foundation of Rome was "covered" by the monograph of V.S. Sergeev *Essays on the History of Ancient Rome* by extending Livy's text. Meanwhile, we have based ourselves on the discovered strong correlation of Sergeev's text with that of Livy with the proximity coefficient $d = 2 \cdot 10^{-12}$ (see above and Fig. 20).

The computation of $d(X,Y)$, where X is the text of Gregorovius (medieval Rome), and Y the sum of Livy's and Sergeev's (ancient Rome) texts, yields $d(X,Y) = 6 \cdot 10^{-11}$. However, if we drop Sergeev's text and compare the text X' = part of Gregorovius' text from 300 to 758 and the text Y' = part of the *History of Rome* by Livy from the year 1 to 459 since the foundation of Rome, then we can compute that $p(X',Y') = 6 \cdot 10^{-10}$. Both results indicate the dependence of the two epochs described in the modern textbook, namely, the antique and the medieval one; more precisely, dependence of the primary sources describing them (on which all the later texts are based). This dependence is expressed vividly and is of the same character as that between the texts describing the same events (see Fig. 31).

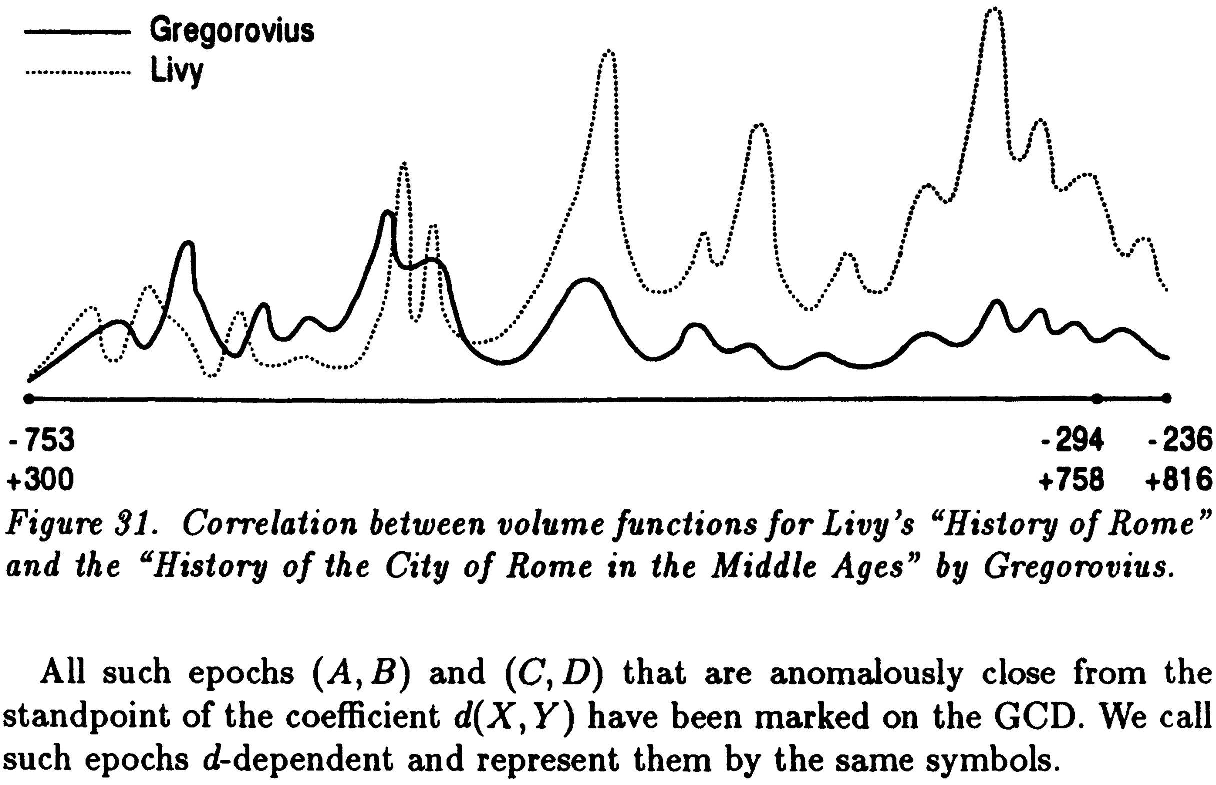


Figure 31. Correlation between volume functions for Livy's "History of Rome" and the "History of the City of Rome in the Middle Ages" by Gregorovius.

All such epochs (A,B) and (C,D) that are anomalously close from the standpoint of the coefficient $d(X,Y)$ have been marked on the GCD. We call such epochs d-dependent and represent them by the same symbols.

13.3. Dependent dynasties

An independent experimental investigation of the GCD was then also carried out on the basis of the dependent dynasty recognition method, for which lists of all the rulers from 4000 B.C. to A.D. 1800 for the indicated regions have been made (see [6]). The method described in Section 3 was applied to this collection (each of the dynasties consisting of 15 kings). The experiment has unexpectedly led to the discovery of the special pairs of dynasties M and H earlier regarded as independent (in all respects), but for which the proximity coefficient $\lambda(M,H)$ is of the same order as for *a priori* dependent dynasties, i.e., it oscillates from 10^{-12} to 10^{-8}.

Let us give several examples. By a dynasty, we understand a sequence of actual rulers of a country without regard to their titles and relations. Due to the existence of co-rulers, difficulties in arranging dynasties in a row sometimes arise; the simplest principle of their ordering, i.e., with respect to the midpoints of the periods of their rules, has therefore been adopted. We call a sequence of rules in the history of a state a ***dynastic stream***, and its subsequences obtained by rejecting some particular co-rulers ***dynastic jets***. It was required of a jet that it should be monotone (i.e., the midpoints of the periods of the rules making up a jet should be monotonically increasing) and complete (i.e., gap-free and covering the whole period embraced by the stream, with overlapping being permitted). Understandably, these requirements may not always be satisfied in real situations. For example, a chronicler's story may omit the year between two rules, and so forth. Therefore, we should admit insignificant gaps (no more than one year long) and the three types of errors described and modelled in [5]).

There is another reason for which a precise formal picture can be distorted: It is sometimes difficult to establish with certainty the start of a rule (e.g., to count from the moment of actually starting the rule or formally ascending the throne), whereas there are usually no difficulties about its end: In most cases, it is the ruler's death. For example, sources supply different dates for the enthronement of Frederick II, namely, 1196, 1212, 1215 and 1220, thus making it necessary to "double" the king or to consider him even in a larger number of versions, all included in the general dynastic stream. Meanwhile, it was required that no jet should contain two different variants for the same ruler.

We now give examples of dependent dynasties.

(1) M = Roman Empire actually founded by Lucius Sulla in 82–83 B.C. and ending with Caracalla in A.D. 217; H = Roman Empire restored by Lucius Aurelian in A.D. 270 and ending with Theodoric in A.D. 526 ($\lambda(M,H) = 10^{-12}$); the dynasty M is obtained from H by shifting the latter backwards by *ca.* 333 years).

(2) M = Dynasty of kings of Israel in 922–724 B.C., described in the First and Second Book of Samuel and the First and Second Book of Kings; H = Jet from the Roman Empire in A.D. 300–476 ($\lambda(M,H) = 1.3 \cdot 10^{-12}$).

(3) M = Dynasty of the kings of Judah in 928–587 B.C., described in the First and Second Book of Samuel, and the First and Second Book of Kings; H = Jet of the Eastern Roman Empire in A.D. 300–552 ($\lambda(M,H) = 1.4 \cdot 10^{-12}$).

All the pairs discovered by our method turned out to be close to those given in [1], though ours are sometimes substantially different (especially in the case of the third dynasty) from those suggested there on the basis of a simple selection. The fact that the three pairs of [1] did not turn out to be optimal in the sense of $\lambda(M,H)$ is related to Morozov's basing his conclusions on the "visual similarity" of the dynasty graphs. Our analysis has demonstrated that several dozen such and even more "outwardly similar" and necessarily independent pairs of dynasties can be exhibited; hence, the problem arose of finding a quantitative method for separating dependent pairs from clearly independent ones.

All the other pairs of dependent dynasties listed below, and also those indicated in the GCD, were unknown earlier, and I discovered them while investigating the material of the GCD by means of the above methods.

(4) M = Dynasty of popes in 140–314; H = Dynasty of popes in 324–532; $\lambda(M,H) = 8.66 \cdot 10^{-8}$. This pair is perfectly consistent with pair 1.

(5) M = Empire of Charlemagne from Pippin of Heristal to Charles the Fat, i.e., in 681–887; H = Jet of the Eastern Roman Empire in 324–527, $\lambda(M,H) = 8.25 \cdot 10^{-9}$.

(6) M = Holy Roman Empire in 983–1266; H = Jet of the Roman Empire in 270–553; $\lambda(M,H) = 2.3 \cdot 10^{-10}$. The dynasty H is obtained from M by shifting the latter backwards by *ca.* 720 years.

(7) M = Holy Roman Empire in 911–1254; H = German Roman Empire of the Habsburgs in 1273–1637(!); $\lambda(M,H) = 1.2 \cdot 10^{-12}$. The dynasty M is obtained from H by shifting the latter backwards by 362 years as a solid block.

(8) M = Holy Roman Empire in 936–1273; H = Roman Empire from 82–217; $\lambda(M,H) = 1.3 \cdot 10^{-12}$.

(9) M = Dynasty of the kings of Judah in 928–587 B.C. (First and Second Books of Samuel and First and Second Books of Kings; see also Pair 3); H = Jet of the Holy Roman Empire in 911–1307(!), $\lambda(M,H) = 10^{-12}$.

(11) M = Dynasty of the kings of Israel in 922–724 B.C. (First and Second Books of Samuel and First and Second Books of Kings); H = Formal dynasty of the Roman coronations of German emperors in Italy in 920–1170(!); $\lambda(M,H) = 10^{-8}$, meaning the Roman coronations of the emperors of the Saxon, Salian, Frankish, and Swabian (of Hohenstaufens) of the German dynasties.

The two latter pairs are especially startling, since they signify an overlapping of the history in the Old Testament with the medieval Roman–German history in the 10th–14th century. This overlapping differs by *ca.* one thousand years from that suggested in [1], and by two thousand years from traditional chronology.

Other examples of special dynasty pairs are demonstrated in the GCD (see below). Thus, for example, we cannot help stressing the striking overlapping of the history of medieval Greece in 1250–1460 with part of the history of ancient Greece in 510–300 B.C.

13.4. The agreement of different methods

After all dynasty pairs in the GCD have been investigated, all the special (dependent) dynasty pairs M and H, such that $\lambda(M,H)$ is of the same order as for certainly dependent dynasties, i.e., from 10^{-8} to 10^{-12}, have been denoted by identical symbols. The GCD with this additional structure turned out to coincide with the one on which all pairs of epochs proximal in the sense of the coefficient $d(X,Y)$ have been marked. An extremely important fact is valid, namely, the application to the GCD of all dating methods worked out leads to the same result: Though obtained by essentially different methods, the dates are consistent. In particular, epochs close in the sense of $d(X, Y)$ are also close in the sense of $\lambda(M, H)$, and also in the sense of the coefficient measuring the proximity of the dynastic enquête-codes. Moreover, the obtained results are consistent with astronomical dating; they are also fully consistent with the forward shift of "ancient" eclipses, discovered in [1].

By way of example, we describe part E of the GCD from 1600 B.C. to A.D. 1700 for Italy, Germany, and Greece. The result is given as the line E, in which historical epochs have been denoted by letters. Here duplicates ("repetitions"), i.e., epochs duplicating each other (i.e., close in the sense of our methods) are denoted by identical letters. Due to the very extensive data, we give only a rough sketch; (see also Fig. 32 with a time scale).

This chronicle line E (part of the "modern textbook" GCD) contains obviously repeating duplicate epochs and can be resolved into a simple composition of three shifts of four practically identical chronicles. Thus, we can write schematically that $E = C_1 + C_2 + C_3 + C_4$.

13.5. Three basic chronological shifts

It is important that all four lines, each of which represents a certain chronicle made up of fragments of the "modern textbook" GCD, are almost identical.

One of the explanations of this basic result we obtained can be the fact that the "modern textbook" of ancient and medieval European history is a "fibred" chronicle derived by gluing together the four practically identical replicas of the shorter chronicle C_1. The other three chronicles C_2, C_3, and C_4 are obtained from C_1 by shifting it as a rigid block backwards by 333, 1053, and 1778 years. In other words, the entire "modern textbook" can be completely restored from its lesser parts C_1 or C_o wholly placed to the right of A.D. 300. Moreover, practically all information in the chronicle lines C_o and C_1 turns out to be situated to the right of A.D. 960, i.e., each epoch of history, placed to the left (below) of A.D. 960, is a "reflection" of a certain later historical epoch wholly placed to the right of A.D. 960, and which is the "original" of all the duplicates generated by it. The fragments K, H, and Π of the original line C_o contain very little information, and the principal part of C_o is concentrated in the fragments P, M, T, and C placed to the right of A.D. 920–960.

The principal result of the research I carried out in 1974–1980 is that this assertion is valid not only for the line E (reflecting the history of Europe), but also for the whole GCD.

Recall that the epochs designated by the same symbols are duplicates, i.e., consist of the "same" events. For example, this can also be applied to the following wars, namely, the Trojan war, the war with the Tarquins in Rome, the war between Sulla, Pompey, and Julius Caesar in Italy, the Gothic war in the middle of the 6th century A.D. in Italy, the war in Italy in the middle of the 13th century (fall of the Hohenstaufen dynasty, establishment of the House of Anjou). This latter war and the fall of Constantinople in 1204 (the

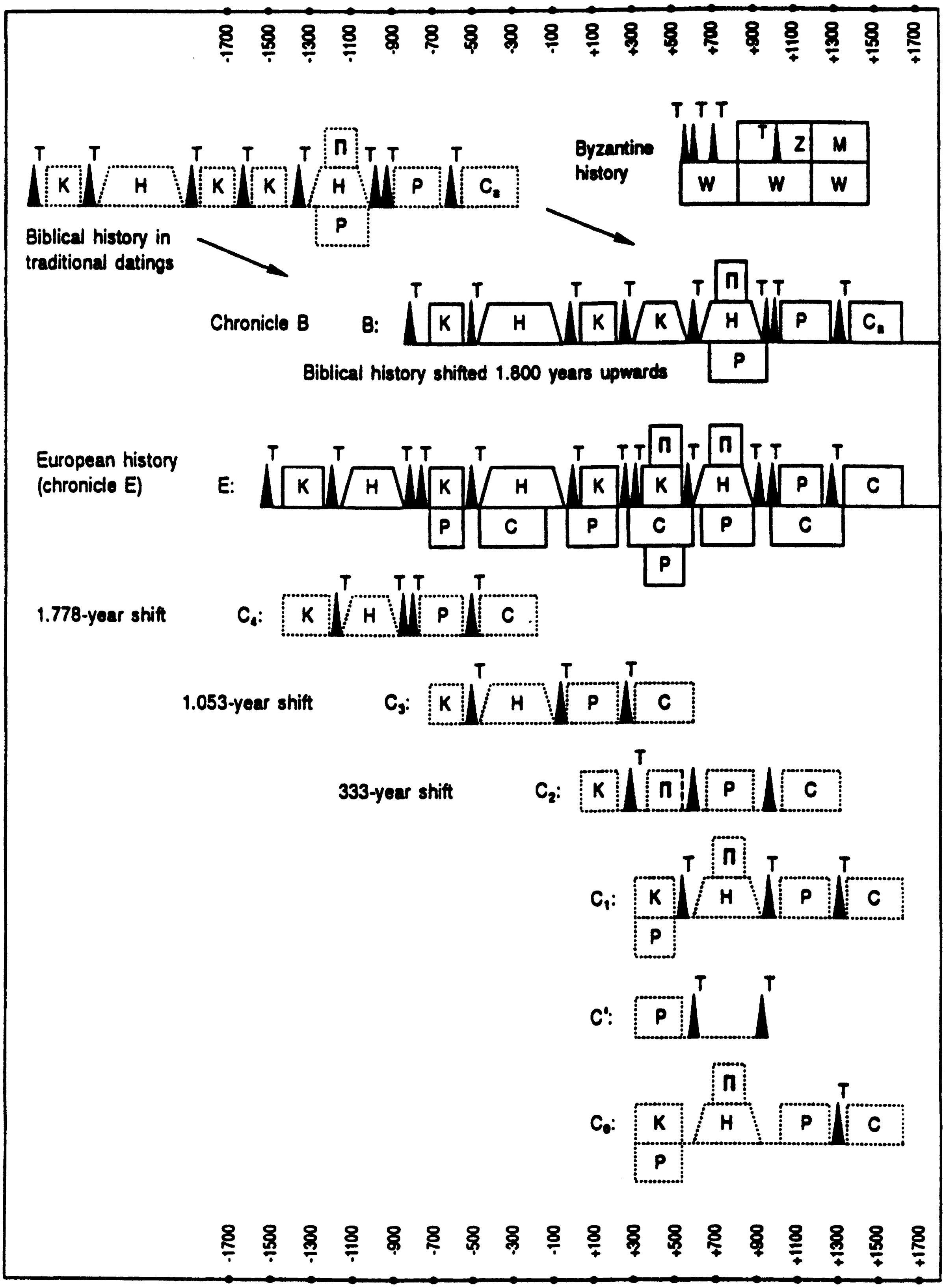


Figure 32. Global chronological diagram of the ancient and medieval world. Three chronological shifts.

Fourth Crusade) are probably the "original" of all the other wars denoted on E by the symbol T.

In my opinion, the resolution discovered in the GCD into the sum of the three shifts can be explained naturally. The process of creating the global chronology and history of ancient times started in the late Middle Ages: The historical data accumulated until that time was ordered for the first time, namely, it was separated into chronicles, annals, and so forth; however, while "patching" all these pieces together into a unique diagram, an error was made, namely, the four replicas of the same chronicle (C_1 or C_o; see above), in general describing the same history of Europe and the Mediterranean, were regarded by the chronologists as being different, i.e., speaking of different events, due to which they were "patched" together not in a parallel fashion as it should have been done, but in series, with shifts of 333, 1053, and 1778 years.

The "shorter chronicle" C_1 has thus been converted into the "longer chronicle" E, i.e., the "modern textbook" of ancient and medieval history. I made clear the reasons which might have led to such a confusion and which generated just these and not any other shifts. Since the analysis of the material requires lengthy digressions into history and is far outside the framework of the present treatise, it is omitted here (for details, see Vol. 2).

13.6. Biblical history and European history

13.6.1. Volume graphs for the Old Testament and the "European textbook" for 850 B.C. to A.D. 1400. The "modern textbook" GCD also possesses other portions that differ from E, contain duplicates and are resolvable into the sum of several "shifted chronicles". This can be applied to biblical history, too. We have already mentioned above that the Bible contains many duplicates (see the line B).

It was not accidental that in the description of B we had used the same letter symbols as for the "European" line E. As a matter of fact, B turns out to be completely coincident (identical) with the part of E, describing Roman–Greek–European ancient and medieval history. More precisely,

$$\begin{array}{lr} E = T\ K\ T\ H\ T & \underline{(\text{line } B)} \\ & P\,C\,P\,\Pi\ C \\ & \bar{C} \\ & \bar{P} \end{array}$$

This overlapping of B and part of E, if the time scale is taken into account, is shown in Fig. 32.

It can be seen that the line B (Old and New Testament) overlaps with the part of the "European textbook" E from 850 B.C. to A.D. 1400. However, since the Bible contains many duplicates, the entire Old Testament as well as the "modern textbook" E can be completely restored from its lesser part, namely, be placed to the right of A.D. 300.

Moreover, in reality, practically all of the Old Testament, just as the whole Bible and line E, can be restored from its part describing the events traditionally dated by 960–1400.

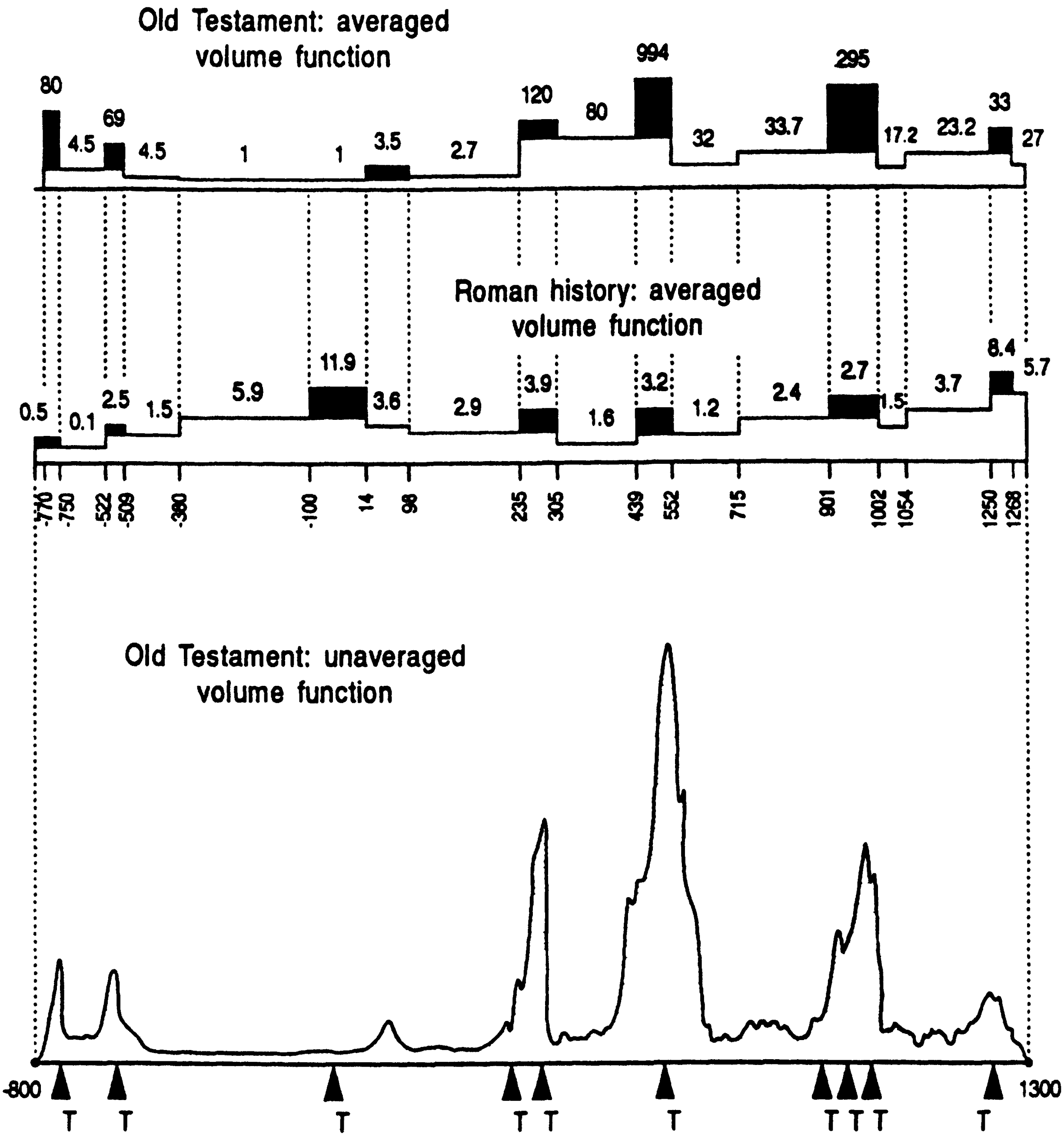
Meanwhile, the New Testament probably describes the events occurring in the 11th century in Italy. It follows from the structure of the discovered duplicates that, in particular the epoch of Jesus, the turn of the millennium is a duplicate of the "epoch of Hildebrand", the famous Gregory VII (11th century). It is precisely "Hildebrand's epoch" that opens the Crusaders' era marked by the famous separation of the churches in A.D. 1054 and begins the new, Reformation Church in Europe.

Overlapping of the line B (Old Testament) with part of line E was obtained by me by formally applying the above methods. We shall demonstrate this by the volume graphs compared by means of the coefficient $d(X,Y)$ (see above). Consider the interval from 800 B.C. to A.D. 1300 in Italian and European history. We take the sum of two fundamental monographs, namely, Niese [14] from 800 B.C. to A.D. 552 and Gregorovius [53] from A.D. 300 to 1300. Combining the two sources, we obtain a text X now describing the whole interval (A,B). We then break X into the union of fragments $X(T)$, which permits us to construct the volume graph for the chapters $X(T)$ in the whole interval from 800 B.C. to A.D. 1300, i.e. 2,100 years long.

We now consider the Old Testament (Chapter generations 1–170). The Chapter volume graph should be constructed and compared with the corresponding graph for X, the difficulty being that the Bible has no time scale which would be sufficiently detailed. However, as has already been indicated, the Bible admits a practically unique decomposition into the chapter generations $B(T)$, where the ordinal number T varies from 1 to 218. Consider the first 137 chapter generations, i.e., from Genesis to the Second Book of Kings. Since the First and Second Books of Samuel and Kings duplicate the First and Second Books of Chronicles, Chapters 138–167 duplicate Chapters 98–137; therefore, we are not interested in them now. Chapters 103–137 have been described in the First and Second Books of Kings with detailed chronological indications, which permits us to determine the length of the described time interval to rather considerable accuracy: It is 341 years (see also how the same interval has been measured in [7]). Such circumstantial chronological information for the remaining Chapters 1–102 is absent in the Bible; hence, to find the time interval described, we have to do it in a rather rough manner. The analysis of Chapters 1–102 has shown that while describing the events of one generation, almost every one relates the latter to some principal historical figure, i.e., a "ruler", whose "rule" can be taken as the "duration" of the generation. We have already said earlier that the mean duration of a rule equals 17.1 years in the whole of ancient and medieval history fixed in written sources, i.e., approximately 17 years. Basing ourselves on this mean value, we obtain that the period "covered" by 102 generations can be estimated to be approximately $102 \cdot 17 = 1734$ years long. Thus, we can assume that the period described in the "historical part" of the Old Testament (without moralistic texts) is $1734 + 341 = 2075$ years. We see that this figure turns out to be extremely close to 2,100 years, i.e., the period described in the text X (see above). Therefore, we can compare the chapter volume graphs for X and the Old Testament, for which we have to refer the texts to one and the same scale. The simplest of them may be the partition of the whole $(A, B) =$ 800 B.C. to A.D. 1300 into 19 line segments, arising if we single out in (A, B) all the epochs T discovered above while analyzing the GCD.

The bounds of the obtained 19 segments are 800, 770, 750, 520, 509, 380, 100 B.C., and A.D. 14, 98, 235, 305, 493, 552, 715, 901, 1002, 1054, 1250, 1268 and 1300. Since the line segment (A, B) may overlap, because of the same length, with the period described in the Old Testament, we obtain the corresponding division of the Chapter-generation sequence 1–170 in B into the following 19 groups, namely, the period from 800 to 770 B.C. is not described, that from 770 to 750 B.C. corresponds to Chapter Generation 1, from 750 to 520 B.C. to Chapters 2–14, from 520 to 509 B.C. to Chapter 15, from 509 to 380 B.C. to Chapters 16–23, from 380 to 100 B.C. to Chapters 24–39, from 100 B.C. to A.D. 14 to Chapters 40–46, from A.D. 14 to 98 to Chapters 47–50, from A.D. 98 to 235 to Chapters 51–59, from A.D. 235 to 305 to Chapters 60–62, from A.D. 305 to 493 to Chapters 63–73, from A.D. 493 to 552 to Chapters 74–78, from A.D. 552 to 715 to Chapters 79–88, from A.D. 715 to 901 to Chapters 89–97, from A.D. 901 to 1002 to Chapters 98–102, 141, 142, from A.D. 1002 to 1054 to Chapters 143-147, from A.D. 1054 to 1250 to Chapters 148–162, from A.D. 1250 to 1268 to Chapter 163, and from A.D. 1268 to 1300 to Chapters 164–167.

At the end of the list, we made use of the fact that Chapters 141–167 duplicate Chapters 103–137. Thus, we introduced the same time scale in both texts X and B. After having calculated the volumes of fragments which described each of the 19 intervals, they were averaged, i.e., divided by the length (in terms of generations) of the interval. For example, the volume of Chapters 2–14 describing Interval 1 equals 59 verses, whereas the length of the interval spans 13 generations, and the average value of the volume per one generation equals $59 \div 13 = 4.54$ (see the graphs in Fig. 33, top). All the local maxima (peaks) of both volume graphs are indicated in black. It is extremely surprising that all of them, except one, occur at the same points. It is also important that all epoch duplicates of the series T, designated by triangles in Fig. 33 (bottom), almost coincide with the peaks of the unaveraged volume graph constructed for the biblical Chapters which were determined for Generations 1–137. It can be seen that all the triangles are placed close to the basic peaks of the volume graphs. In particular, all these duplicate epochs of the series T immediately stand out from the entire quantity of the biblical chapter generations at least because their volume graph exhibits local jumps, or peaks. Duplicates of the form T are those described best of all among the Chapters on line B. Following the method of [2] for calculating



Figs. 33-34. Top: Correlation between the volume function for Roman history and the volume function for biblical history (Old Testament). Bottom: Original (unaveraged) volume function for the Old Testament.

$p(X, Y)$, we can estimate the nearness of these two series of peaks for both graphs quantitatively.

Let us calculate the lengths of the intervals into which they break the sequence of Chapter-Generation groups $1, 2, \dots, 19$. We obtain $d(X, Y) = 1.4 \cdot 10^{-4}$, which indicates that the texts X and B are dependent for eight maxima.

This proximity is sq close that it is the least possible for two noncoincident vectors in the discrete model (see [2]), since they diverge in only one coordinate. Hence, within the framework of the maximum correlation principle, X and B describe the "same" events, which certainly sharply contradicts today's view of the contents and relative historical epochs.

13.6.2. The overlapping of some biblical and European events. Babylonian captivity and Avignon exile. Overlapping of the described historical events, occurring in X and the Old Testament, implies, in particular, that of the kingdom of Israel and Judah, described in the First and Second Book of Samuel and Kings, the First and Second Book of the Chronicles, coincides with part of the Holy Roman Empire in 962–1300, which is ideally consistent with the independent overlapping obtained above on the basis of the independent duplicate dynasty recognition method. These dynasties overlap due to the anomalous smallness of the coefficient $\lambda(M, H)$, which indicates a dependence of the dynasties.

Let me stress once again that all the chronological results obtained by the described methods are perfectly consistent with each other, which is a serious argument for the objectivity of the duplicate system discovered.

Overlapping of biblical and European (in particular, Italian and German) events leads, *inter alia*, to the following identifications. The famous events under King Zedekiah (war with Pharaoh and Nebuchadnezzar, the fall of the kingdom of Judah, capture of Jerusalem and Babylonian captivity) overlap with those at the end of the 13th century in Italy, namely, the war in Italy, capturing of Rome, transfer of the pontificate to Avignon, and complete subordination of the papacy to the French crown ("exile of the popes"). The biblical 70-year-long Babylonian captivity is a reflection (duplicate) of the 70-year-long Avignon exile of the popes in 1305–1376 [6].

The medieval authors in the 14–15th century confirm our conclusion, calling the Avignon exile of the popes "Babylonian captivity" (see, e.g., [81] p. 112). In particular, Dante wrote in a letter to the Roman king Henry, dated April 16, 1311, discussing the Avignon exile of the popes, that the heritage, which, being deprived of it, they continued to be feel sorry for, will be returned to them fully. And, similarly to their yearning for holy Jerusalem (Rome?), the Babylonian exiles (in Avignon!) having become citizens, will joyfully remember the suffering of the turbulent years.

The further biblical events described in Ezra, Nehemiah, and Esther (return to Jerusalem, "restoration of the temple") are reflections of the corresponding events in Italy in 1376–1410 (return of the pontificate to Rome).

For the convenience of comparing the biblical and European events, we decode the letter symbols of line B (Bible), indicating the plot of the corresponding biblical legend for each of them. Thus, $B =$

T: legend of Adam and Eve;

K: Cain and Abel, Enoch, Irad, Methushael, Lamech, Seth, Enosh, Canaan, Mahalalel, Jared;

T: Noah, the Flood, destruction and rebirth of mankind;

H: Shem, Ham, Japheth, "sons of Japheth;"

T: Babylonian captivity, dispersing mankind all over the world;

K: Arphaxad, Shelah, Eber, Peleg, Reu, Serug, Naher, Ferah, Abram;
T: Abraham and Sarah, fighting the Pharaoh;
K: Abraham, Haran, separation into two kingdoms, major biblical patriarchs Isaac, Esau, Jacob, Judas, Joseph;
T: Joseph in Egypt, his serving the Pharaoh, the legend of the "woman";
T: Moses, war with the Pharaoh, the Exodus, making the laws of the Israelites;
$H/\Pi/P$: Moses' death, Joshua, war and settling in the Promised Land, story of the "Judges";
T: sons of Benjamin, war; T: Ruth, Saul, Samuel, David;
K: kingdoms of Israel and Judah;
T: war with the Pharaoh and Nebuchadnezzar, fall of the kingdom of Judah, beginning of Babylonian captivity (analogue of the Avignon exile), destruction of Jerusalem;
C_a: Babylonian captivity, return after 70 years, new "foundation" of the temple.

To identify these events with the corresponding European ones, we have to turn our attention to Fig. 32, in which line B is represented above, and compare its symbols with the corresponding expansions of the "European" symbols.

It follows from the decomposition of the GCD into the sum of four chronicles that nearly all of the "modern textbook", referring to dates earlier than A.D. 900, consists of duplicates whose "originals" occurred in A.D. 900–1600. In particular, each event described in the "modern textbook" before A.D. 900 is the sum of several (mainly, two, three, or four) later events. To find the authentic dates when these events did occur, we have to draw a vertical line and mark those events which it cuts out of the four chronicle lines C_1, C_2, C_3, and C_4.

In other words, the "modern textbook" is a fibred chronicle glued together from the four pieces shifted with respect to each other and being practically identical. The GCD contains no duplicates, starting only with the middle of the 13th century and later.

13.7. The beginning of "authentic" history in *circa* the 10th century A.D.

Duplicates may already be found in A.D. 900–1300, e.g., block C (see Fig. 32), whose inverse image (preimage) is the Empire of the Habsburgs, and placed above A.D. 1300. In particular, the part of the "modern textbook" from 900 to 1300 is the "sum" of two chronicles, namely, a certain authentic chronicle describing actual events in 900–1300 (probably, rather poorly), and another authentic chronicle shifted backwards by *ca.* 300 years and describing the events of the time of the Habsburgs, 1300–1600.

Global chronology was created at the end of the 16th century or at the beginning of the 17th century, where the last period C "dropping" backwards due to chronological errors and generating duplicates "in antiquity" (see the letters C in the GCD) ends just here, which is very important and means that no events subsequent to the times of Scaliger and Petavius were shifted backwards. On the other hand, many events up to this epoch were dropped backwards. It is probable that the last event dropping backwards was the activity of the creator of chronology Petavius, or *Petit.* Translated from the French, it means "little", i.e., Dionysius Petavius is Dionysius the Little, the famous chronologist who lived in the 6th century A.D. It is probably he who may be called the "reflection" of Dionysius Petavius in his being dropped backwards by *ca.* 1,000 years.

The whole of the GCD is a fibred document; many events regarded as ancient are the sums of several later events described in the chronicles C_2, C_3, and C_4 glued to C_1. The application of our methods to A.D. 1300–1900 did not lead to the discovery of any duplicates at all, which demonstrates the validity of the historical scheme from 1300 to 1900. The "textbook" GCD arose from the shorter chronicle C_1 (or C_o) not due to some global falsification, but, probably, due to three simple chronological errors, one of which was the confusion between the dates of the foundation of two Romes, namely, in Italy and on the Bosphorus (Constantinople = New Rome). The resolution of the GCD into the sum of four chronicles supplies the answer to the two fundamental problems, namely, what "authentic" history was, and how the "modern textbook" was obtained from it.

Apparently, "authentic" history starts with *ca.* the 10th or 11th century A.D. (or even later); before the 10th century, there are quite insignificant data referring to A.D. 300–1000. All the other epochs mentioned in the "modern textbook" as dated to earlier than the 10th century A.D. are various reflections of the events in the 10–17th century. Biblical New and Old Testament history is placed in the interval from the 10th to the 15th century.

13.8. The chronological version of Morozov and the author's conception

The author's conception is different from the version of Morozov as much as his theory differs from the traditional one. For example, according to Morozov, the basic biblical events occurred in the 3rd–5th century, which is approximately 1,000 years later than the traditional dating, whereas, due to the results obtained by our methods, they occurred in the 10–15th century, i.e., *ca.* a millennium later.

My conception given here completely rejects the hypothesis formulated in [1] that most of ancient texts are allegedly Renaissance fabrications. As seen from the GCD, all those written just before and during the Renaissance describe the authentic contemporary events and are in no way fabrications; for example, Ptolemy's *Almagest.* Morozov's main accusation that the book had been forged was that it had been speaking of the astronomical observations under the Roman emperor Antonius Pius, whereas the authentic data (we mean here the Latin text; see above) explicitly point to the 16th century. However, there is no contradiction. The Roman emperor Antoninus Pius turns out to be placed in 1524–1547 (whereas dated traditionally, his rule was in 138–161 [6]) under the total forward GCD shift by 1,053 + 333 = 1,386 years (see Fig. 32). It is surprising that "Antoninus Pius" is placed exactly in the epoch of the first editions of the *Almagest*, the Latin one in 1537, the Greek one in 1538, and the "translation" of George of Trebizon in 1528, published under "Antoninus Pius", who was mentioned in the text. The author of the Latin edition deceived no one, writing into the book the name of the ruler at the time of the observations. We have a remarkable opportunity to verify the result by another independent technique. With the Roman Empire in the 1st–3rd century being overlaid on the 10–13th century and the Habsburgs (see the GCD), we can attempt to directly indicate a Habsburg whose name was "Pius". The epoch just before the first edition of the *Almagest*, the beginning of the 16th century, is "covered" by Emperor Maximilian I (1440–1519). At least part of the astronomical observations had to be made just in his time if the edition of the book followed immediately after it had been written. The complete name of this emperor turns out to contain the names Kaiser, Pius, and Augustus (Fig. 9(2)). The epochs of Alberti and Vitruvius ideally coincide upon shifting the GCD in the indicated manner [1].

We now describe the mechanism of a possible error which led to the "modern textbook" being obtained from the shorter chronicle C_0.

13.9. The confusion between the two Romes

The first chronologist (possibly, in the 13th or 14th century) possessed several documents of approximately the same contents, describing the same Roman history, e.g., several versions of the type of Livy's *History of Rome*. Written by different people and from different points of view, in different languages, with the use of different names or nicknames for the same historical figures (kings), these chronicles were outwardly sharply different. The natural problem of relating these documents to each other arose; in particular, the chronologists faced the problem on which basis such a relation should rest. One of the suggested methods was, probably, as follows. In many chronicles, years were counted from the "foundation of the City (Rome)"; see, e.g., Livy's *History of Rome*. Therefore, to relate documents of this type to medieval chronicles, it sufficed to calculate the date of the "foundation". However, many medieval documents confuse the two Romes, namely, in Italy and on the Bosphorus. It is assumed that Constantine I transferred the capital in *ca.* 330 A.D. from the Italian Rome to the settlement Byzantium on the Bosphorus, which was officially named "New Rome" [76]. It is only later that New Rome was called Constantinople [76]. Both Romes were the capitals of great empires. It had been stressed long ago that the citizens of New Rome stubbornly called themselves Romans (they were allegedly called the Romaics by other people); hence, the Romaic Empire is the Roman Empire (as well as the Italian one). Along with the legend about the capital's transfer from the Italian Rome to the Rome on the Bosphorus, a similar legend speaks about transferring the Empire's capital from the Bosphorus to Italy. This attempt was allegedly made in A.D. 663 and again by emperor Constantine (but now Constantine III and not I), who did not complete the enterprise, because he was murdered in Italy [1]. It is generally assumed that the Rome on the Bosphorus was the Greek capital. However, a large percentage of Byzantine coins had Latin, not Greek inscriptions (so did Italian coins). As the famous legend about the foundation of Rome has it, two cities were indeed founded: one by Romulus, and the other by Remus (see Livy). Both founders have similar names; then Romulus "killed" Remus, and only one Rome remained, i.e., the capital (Livy, Bk. 1, 1), which possibly reflects the confusion between the two Romes; so much so that certain ancient chronicles called the founders of both capitals Romulus and Rome, but not Romulus and Remus, which almost identifies the founders' names [51]. See also the Russian edition, 1911, p. 18.1, B. 170–175.

It is assumed today that it is always the Rome in Italy that is understood to be the "City" from whose foundation years were counted in Roman documents. But the medieval authors in the 12–14th century were not so categorical. Moreover, in the words of Villehardouin,[5]

> "... the city which was sovereign over all the others, and which the Byzantines willingly called simply 'the City' (!—A.F.), i.e., the city par excellence, the unique city" ([93], p. 14).

Thus, counting years from the foundation of the City may imply Rome on the Bosphorus in many a document. It is assumed that Constantine I transferred many institutions from Rome to Constantinople and ordered the construction of palaces precisely copying the senators' Roman homes. The Byzantine Empire continued to be called the Roman Empire [93].

On the contrary, the backward "influence" of New Rome on the Rome in Italy was great:

> "... 7–13th-century Rome was a semi-Byzantine city ... the Greek customs were practiced everywhere; the Greek was the official and even habitual language of the country ... they continued to resort to Greek for the official acts as well as for correct usage.... The Norman kings were proud to bear the magnificent costumes of Byzantine emperors ..." ([93], p. 19).

The so-called fiction onto which the Byzantines stubbornly held for centuries, claiming that they were authentic Romans, has repeatedly been noted in traditional history. The Byzantine emperors continued to look upon themselves as the only legitimate Roman emperors. With all the Byzantine historians, all the Greeks turned out to be "Romans". Fearing ambiguity, they arbitrarily [!?—A.F.] called the Byzantine Empire *Romaic*. The name Romania was transferred from the Byzantine Empire to the Ravenna exarchate [77].

It is not accidental that we have discussed the confusion between the two Romes in such a detailed manner. Assume now that an ancient chronicler has

---

[5] Translated from the French—*tr.*

made a natural mistake ("without malice") and mixed up the "foundation" of New Rome in A.D. 663 with that in 330 (see above). Then, by making the foundation of Rome in A.D. 330 on the chronicle C_1 (see the GCD) coincident with that in A.D. 663 on C_2, he let C_2 drop 333 years backwards with respect to C_1 (because $333 = 663-330$). Then, by patching these two chronicles together, he obtained a "longer" history with duplicates. That was, probably, the reason for the first shift back by 333 years, which led to the creation of "authentic" history. Similar reasons can be indicated also for the other two shifts by 1,053 and 1,778 years. However, we should note that the latter two shifts can, in reality, be generated by the 333-year one. As a matter of fact, certain chronicles in the GCD turn out to have been shifted not by 333, but by 360 years (a difference in 27 years equals the duration of the war (T), the most frequent duplicate in the GCD). The shift by 1,053 years can then be represented as $1053 = 360+360+333$, whereas $1053+720 = 720+720+333 = 1773$, which all but coincides with the 1,778-year shift. Thus, it is possible that the three basic shifts are multiple ones, i.e., repetitions, of the first one by 333 (or 360) years.

13.10. A universal mechanism which could lead to the chroniclers' chronological errors

The author's paper *New Empirico-Statistical Methods of Ordering Texts and Applications to Dating Problems* [97] offers the following, possibly universal, mechanism which could lead to the chroniclers' errors and result in the three basic chronological shifts. Probably, the primary basic dates from which the chroniclers started counting years were written with the literal symbols making up a short verbal formula. The original meaning was soon forgotten. Afterwards, the chronologists decoded the old dates by formally replacing the letters by figures (it is generally known that figures mean letters in ancient languages), following the standard rules, namely, $A = 1$, $B = 2$, etc., and could obtain totally different results.

For example, the abbreviation "XIIIth century A.D". could originally have meant X.III, i.e., the "3rd century since Christ", where X is the well-known anagram of Christ. Substituting formally, we obtain a 1,000-year backward shift. Similarly, A.D. 1500 = I.500, i.e., the "500th year since Jesus". Meanwhile, the original count was probably made since the times of Gregory VII Hildebrand (11th century A.D.). Consider two other important dates related to him, namely, 1073, the year of his election as pope, and 1075, Cencius' conspiracy and the lunar eclipse at the Crucifixion. Recalculating and translating them into those since the Byzantine creation of the world, we obtain $1073+5508 = 6581$, and $1075+5508 = 6583$. Writing the figures in letters according to the usual rules, we obtain $6581 =_{\ddagger} S\Phi\Pi A$, $6583 =_{\ddagger} S\Phi\Pi\Gamma$. The sign $\ddagger$ is only regarded today as the sign for "one thousand". However, it may have been a distorted form of the letter "I", i.e., an abbreviation of the word "Jesus". Φ was written in the same manner as Θ, and we obtain two quite meaningful word dates, namely, $6581 = IS\Theta\Pi A$, $6583 = IS\Theta\Pi\Gamma$. Indeed, ISΘΠA = Jesus God Pope Augustus, and ISΘΠΓ = Jesus God Pope Gregory (or Hildebrand), where IS = Jesus, Θεον = God, Π = Pope, and A = Augustus. Repeating the procedure in reverse order, we discover the reason which makes the chronologists believe that the "creation of the world" occurred in 5508 B.C. They just did not recognize the abbreviations of certain important word symbols.

A similar mechanism might possibly lay the foundation for the shift of 333 or 360 years. The dates from the end of the 15th century to the beginning of the 16th century, i.e., during the rule of Emperor Maximilian I (1493–1519), could be written by the chronologists, for example, as follows: MCL.III, which originally meant the "3rd year since Maximilian", where M.C.L. might be spelt out as Maximus Caesar Leo, or Great Kaiser Leo. During a later substitution of figures for Latin letters, an erroneous "date" was obtained, namely, 1153, which differed by 343 years from the authentic one, since 1493 = 1493+3, and 1496−1153 = 343. Thus, the documents using the abbreviated formula M.C.L. at their later decoding were automatically shifted backwards by *ca.* 340 years. A similar natural "verbal" formula is also the basis for the third chronological shift by *ca.* 1,800 years. We stress that the letters in the dates are, in fact, separated from each other by periods in certain ancient documents, e.g., on Dürer's prints.

After all the ancient chronicles have been "returned home" and placed properly in the 10th–17th century, we obtain that the history of Europe, the Near East, and Egypt is known approximately as much as that of the so-called "young cultures" such as Scandinavia, Russia, or Japan. It is probable that this cultural "alignment" reflects the natural fact that existing civilizations and developing ones were born more or less simultaneously in different regions.

13.11. Scaliger, Petavius, and the Council of Trent. Creation of traditional chronology

We have noted above that the GCD duplicates were discovered only for periods preceding Scaliger's epoch, but not for later ones. Thus, we again see that the times of Scaliger and Petavius are somehow related to the discovered effects in ancient chronology and history. Recall that it was the group of Scaliger and Petavius which had fixed "historical tradition" which laid the foundation of the "modern textbook", the GCD. Scaliger's version happened to be created within the animated chronological controversy at the end of the 16th century and the beginning of the 17th century. Moreover, Scaliger's version turned out not to be unique at all. It confronted some other points of view whose partisans have lost the fight. For example, here are some facts regarding certain events of those turbulent times, the epoch of the 30-year European war, chaos and anarchy.

> "It suffices to recall the famous chronologist Joseph Scaliger opposing the Gregorian reform" ([78], p. 99).

Its preparation started in A.D. 1514 during the Lateran council. It is assumed today that the principal problem related to the reform was a shift of the equinox. But it is only one of many serious issues debated in connection with the calendar revision. One of the items leading to the greatest controversy was Scaliger's so-called Julian period. The "great" indiction is a 532-year period, which was called *indiction* (as believed today) in the Byzantine Empire, and the *great circle* in the West.

> "It is difficult to determine with sufficient accuracy when and where this period first came into use" [78].

It is believed (the originals of the documents having been lost) that it was known to the paschalists of the council of Nicaea in the 6th century A.D. There also exists a modification of this "Great Indiction", namely, a period of 7,980 years, also regarded as "ancient". However, as suddenly becomes clear,

> "... it happened so that this ancient cycle was accepted by the science of chronology only at the end of the 16th century A.D., and then ... said to be 'Julian'. It was introduced into science by the outstanding scientist and erudite J. Scaliger (1540–1609) in his *Opus novum de emendatione temporum*.... This work saw the light in 1583, almost simultaneously (!—A.F.) with the Gregorian reform whose adversary of principle the scientist remained until his death. (Here, the creation of a global-chronology ancient-world calendar is already meant—A.F.) Referring to the Byzantine works, Scaliger insisted on the Julian calendar as the only chronological system being capable of supplying a continuous year count in world chronology" ([78], p. 106).

Controversy surrounded the chronology and the whole of Scaliger's conception:

> "It is paradoxical in this sense that the very period (of Scaliger—A.F.) indispensable for ... the chronology of our times was looked upon by pope Gregory XIII as unsuitable for calendar purposes" ([78], p. 107)

The famous Council of Trent (1545–1563) took place at the same time. Among other things, the biblical Canon and the famous chronology "since the creation of the world" were fixed just then. In general, the whole epoch is characterized by the struggle with Protestantism.

> "The central tribunal of the Inquisition was created in Rome ... and the index of banned books issued.... The Council of Trent played an important part in these reactionary measures taken by the Catholic Church.... All Protestant works and their teachings were anathemized.... The importance of the Council of Trent for the subsequent activities of the Catholic Church was extreme" ([79], Vol. 2, pp. 107–108).

Scaliger's chronological work, playing an important role in substantiating the authority and old age of the institutes of the Catholic Church, which grew out of Roman history, was published just at that time. In my opinion, it is necessary to study the archives of the Council of Trent and to revise all the surviving documents of those turbulent years, which might cast light on the controversy surrounding Scaliger's chronology.

§14. The "Dark Ages" in Medieval History

14.1. Medieval Italy and Rome

As can be seen from the GCD and its decomposition into the sum of three shifts, almost all documents regarded today as ancient, and describing the events traditionally dated to earlier than A.D. 900, probably duplicate the originals which supplied the account of the 10–17th-century events. The question arises whether the "ancient world" can be placed in medieval history, i.e., whether we shall not find the position of the allegedly old texts in the Middle Ages, since they are closely packed with the medieval events already known to us. But, as detailed analysis shows, this is not so. First, certain epochs earlier regarded as different should be identified (for example, we need to overlap several dynasties on one another; see Section 4). The similarity of these duplicates has previously been unobserved. Second, many periods of medieval history are in the dark due to the complete (or partial) absence of the corresponding documents "shifted backwards". Their removal and shifting into "ancient times" have immersed many periods of the Middle Ages into artificial darkness. In the 18–19th century, a peculiar point of view spread among the historians that the Middle Ages had been "dark ages".

> "The great achievements of antiquity were allegedly forgotten, scientific thought descended to the 'cavemen's level', great literary works of the ancient times lay as a dead weight, and became known only during the Renaissance" ([80], p. 161).

Most of the upper clergy were allegedly illiterate ([80], p. 166). Coin minting stopped, architectural art fell into oblivion, culture everywhere was "running wild", and so on ([80], p. 167). In our opinion, we face not the degradation of the "great heritage of the past", but the birth of civilization gradually creating all those cultural and historical treasures partly dated earlier in the past due to certain chronological errors, mistakingly leading to the illusion of enlightened "antiquity", and leaving some periods of the Middle Ages bare. For example, the existing medieval history of Rome reveals an enormous quantity of obscure passages, contradictions, and obvious absurdities if we consider it at close range, and which can be explained by the distorted chronological idea of the role of the Middle Ages.

Due to the leading role of Roman chronology (see above), we now describe in a nutshell the situation of the history of Rome.

> "With the overthrow of the Gothic kingdom begins the ruin of the Italy and Rome of antiquity. The laws, the monuments, even the historic recollections of the past fade from memory"([53], Vol. 2, p. 1).

The removal of secular chronicles (e.g., Livy's *History*) from Roman medieval history has turned Rome into a wholly spiritual city if we look at it from the modern standpoint:

> "The metropolis of the universe was converted into a spiritual city" ([53], Vol. 3, p. 3).

F. Gregorovius says that this transformation of the "civil Rome" into the "religious City" was declared a great and remarkable metamorphosis in the history of mankind.

Speaking of the end of the 6th century A.D., Gregorovius, the author of the most fundamental work [53], declares:

> "The following years are hid in obscurity. The chronicles of the time, monosyllabic and dismal as itself, speak of nothing but the havoc ..." ([53], Vol. 2, P. 1, p. 24).

He continues about the middle of the 9th century:

> "The papal archives contained the innumerable acts of the church and the regesta" ([53], Vol. 3, P. 1, p. 141).

And then all these documents were lost in the 12th–13th centuries, leading to the large gap in our knowledge about this epoch.

> "Did we but possess these regesta, the history of Rome from the seventh to the tenth century would live anew" ([53], Vol. 3, p. 141, note).

> "The history of the city, its remarkable transformation since the days of Pipin and Charles, found not a single analyst, and while Germany and France, and even Southern Italy ... produced numerous chronicles, the indolence of Roman monks allowed the events of the city to remain shrouded in profound obscurity" ([53], Vol. 3, p. 147).

From time to time, the medieval chronicles report about "ancient" facts as of contemporary ones. The historians then start speaking of resurrected remembrance, reminiscences, imitation of the old customs, and so forth. For example,

> "... the Romans of the tenth century are frequently designated by curious-sounding names. These names arrest our attention, recalling as they do the monuments of antiquity" ([53], Vol. 3, p. 381).

The discussion of the problem regarding the existence of a senate and consulship in medieval Rome has burst out in traditional history many times. Some believe that all these institutions (regarded as "ancient") also existed in the Middle Ages, whereas the others declare that medieval Romans followed these "ancient customs" under their own momentum, not giving them their earlier meaning.

Gregorovius wrote:

> "... the aristocrats, the citizens, the militia ... summoned to their aid from the already myth-enshrouded graves of antiquity the ghosts of consuls, tribunes, and senators, who seem to have haunted Rome throughout the entire Middle Ages...." ([53], Vol. 2, p. 417).

> "... the title consul is very frequent in documents of the 10th century" ([53], Vol. 3, p. 450, note).

And moreover, Emperor Otto (in the 10th century) tried to recover "ancient" and "forgotten" Roman customs. Speaking of the description of medieval Rome, which was given in the famous medieval book *Graphia*, Gregorovius shamefacedly declares that the *Graphia* mixes antiquity and medieval reality:

"The *Graphia* still calls it Templum ... and relates the legend of the earth being piled up" ([53], Vol. 3).

Medieval chronicles very often speak of the facts which are contrary to traditional chronology; this confirms the three shifts we discovered in the GCD.

Thus, it turns out that

"Noah founded ... a city near Rome, which bore the name of the founder ... his sons Janus, Japhet, and Camese built the town of Janiculum on the Palatine.... Janus dwelt on the Palatine, and aided by Nimrod ... built the city of Saturnia on the Capitol" ([53], Vol. 3, p. 526).

"In the Middle Ages a monument in the Forum of Nerva was called Noah's Ark" ([53], Vol. 3, p. 527, note).

All these "absurd" things (from the standpoint of tradition) precisely correspond to the overlap of the kingdoms of Israel and Judah and the Empire of the 10–13th century A.D. in Italy.

In general,

"And it is solely by means of this antique character—a character which dominated the city throughout the entire Middle Ages—that many historic phenomena can be explained" ([53], Vol. 3, p. 537).

It turns out that the first lists of Roman monuments were made only in the 12th century and are assumed today to be "... a curious medley of true and false names" ([53], Vol. 3, p. 543). For example,

"The church was dedicated not only to S. Sergius, but also to S. Bacchus, a saint, who, curiously enough, appears on this ancient Pagan site. His appearance, however, was not singular in Rome, where the names of ancient gods and heroes are again found among Christian saints, as S. Achilleus, S. Quirinus, Dionysius, Hippolytus, Hermes ..." ([53], Vol. 3, p. 544).

The history of the world-known architectural monuments of Rome can be more or less reliably traced to not earlier than the 10th or 13th century A.D. For example,

"... for a long time past (after antiquity—A.F.) we have not once heard its name (Capitol). It had vanished from history (at that time, it had not even been built—A.F.)" ([53], Vol. 3, p. 546).

The chaos leading to the complete confusion among "ancient" and "medieval" names reigns over the medieval names of Roman monuments. For example,

"The Temple of Vesta was formerly made into the Temple of a Hercules Victor; the archaeologists have now dedicated it to Cybele; this Goddess will, however (?—A.F.), soon have to withdraw to make room for another divinity, until the latter is in turn banished by an archaeological revolution" ([53], Vol. 3, p. 561).

This more resembles a game than a science.

"Night, however, veils the most exalted spot in history (the Capitol and its suburbs—A.F.) for more than five hundred years.... It was merely the inextinguishable tradition of all that the Capitol had once signified which now raised it from obscurity, and which, as soon as the spirit of civic freedom was awakened, made it once more (!—A.F.) the political head of the city. As early as the eleventh century the Capitol appears as the centre of all purely civic affairs (among the ruins? Traditional history assures us that the Capitol was destroyed as early as the most ancient past, and has been standing in this practically erased form until the present day—A.F.). The recollection of the sacred spot was revived; the ruins of the Capitol (!—A.F.) reanimated by the assemblies of the nobles and people now usurped the place of the Tria Fata ... at the disturbances on the election of a prefect, at the acclamation of the election of Calixtus II, it was again from the Capitol that the Romans were summoned to parliament or to arms. It would also appear that the city prefect dwelt on the Capitol, since the prefect, Henry IV ..., had a seat there ... and a palace on the hill was used for tribunals ... (also among the ruins?—A.F.) ..." ([53], Vol. 4, P. 1, pp. 464–465).

Can we accept, even as a hypothesis, that all these assemblies, meetings, elections, arguments, discussions of documents (and keeping them), making responsible state decisions, signing official papers, and so on, had taken place in overgrown ruins and not in special buildings erected just for this purpose, and just at this time, whereas they were destroyed much later, since there were enough "waves of destruction" in 11–13th-century Rome. The mist of orthodox conception veils Gregorovius so densely (he being one of the most serious historians of Rome and the Middle Ages, whose works are always well documented) that he continues his story, apparently not feeling the absurdity of the described picture, which contradicts elementary common sense:

"Sitting on the prostrate columns of the Temple of Jupiter, or within the vaults of the office of the State Archives, among mutilated statues and inscriptions, the monk of the Capitol, the rapacious Consul, or the ignorant Senator might gaze in wonder at the ruins and meditate on the capriciousness of fortune ..." ([53], Vol. 4, p. 465).

Without noticing the comical improbability of such legislative assemblies under popes claiming world supremacy, Gregorovius continues:

"The Senators who went to and fro among the ruins, wearing tall mitres and gold-brocaded mantles, had but a dim idea that here in former time Statesmen had framed laws, orators had made speeches.... There is no more bitter satire on all the most exalted things on Earth ... goat herds already clambered over the marble ruins (and among the Senators sitting on them—A.F.); a part of the Capitol had even received the degraded name of Goat-hill (Monte Caprino) in the same way that the Forum had been transformed into the Campo Vaccino (not for the Senators?—A.F.) ..." ([53], Vol. 4, P. 2, p. 467).

In confirmation, Gregorovius adds the medieval description of the Capitol, the only primary source up to the 12th century. It is most striking that this text occupying a whole page of a large-format modern book, printed in brevier, reports no destruction and describes the medieval Capitol as a functioning political centre of medieval Rome. Magnificent buildings, temples, and so forth, are mentioned, but no word is spoken about the goat herds lonely wandering among this golden luxury.

In the Middle Ages, the *Basilica Constantini* was called the temple of Romulus (!). Ricobald asserted that the famous "ancient" equestrian statue of Marcus Aurelius had been cast and erected by the order of pope Clement III (and it all was in the 12th century A.D.) ([53], Vol. 4, p. 586, Comm. 74). Gregorovius dejectedly comments:

"This is the erroneous statement of Ricobald" ([53], Vol. 4, p. 698, Note 2).

The argument is that a similar work of bronze could not have been made in the Rome of the time, with its very low level of artistic development ([53], Vol. 4, P. 2, p. 666).

The medieval chronicles very often speak of the ancient way of contemporary Roman life. For example, about the 13th century, it is said:

"As in ancient times, in the days of Camillus and Coriolanus, they (the Roman people—A.F.) undertook conquering expeditions against Tuscany and Latium. The Roman insignia, the ancient initials S.P.Q.R. ... were seen once more in the field" ([53], Vol. 5, P. 1, p. 164).

The important question arises: What was the Christian cult before Gregory Hildebrand (11th century A.D.)? The study of this problem demonstrates that it coincided with the "ancient" bacchanalian cult. Traditional history retained many traces of this Christian bacchanalian religious service. For example, the medieval papacy and clergy are believed today to have sunk into perversion (famous "agapes", nights of love, which were devoted not to friendly boozing together, but to bacchanalian orgies). Certainly, it was not simple to abolish the bacchanalian cult (due to its attractiveness); Hildebrand gave many years of his life to the purpose. Afterwards, the Inquisition was summoned. The famous medieval descriptions of the "witches' sabbath" imitate the same "agapae" now turned into a "devilish plot" (from the point of view of the Church reformers after Hildebrand). It is natural that the new, Reformation Church, which had originated in the 11th century under Hildebrand, shifted the responsibility for the bacchanalia to the devil in order to stifle in the flock the recollection of its own quite recent cult. In spite of the success of Hildebrand's reforms, the Christian bacchanal cult was still in force for a long time in Western Europe. Here is, for example, Champfleury's *Histoire de la Caricature au Moyen Age* (see [1] for its analysis). Normally, cartoons resort to certain real features in order to exaggerate them.

"Singular rejoicings took place in the cathedrals and convents apropos the great feasts of the Church during the Middle Ages and Renaissance. At Easter, and especially Christmas, it was not only the low clergy that took part in songs and dances, but the great dignitaries of the Church. In the cloisters, the monks danced with the nuns of neighbouring convents; the bishops went to look for the religious women to engage themselves in their joy" ([101], p. 53).[6]

Champfleury then presents a picture of the monks' meal and their lovers from a Bible (!) of the 14th century, which is kept in the Bibliothèque Impériale in Paris (n° 166), as the most modest example of a comic cartoon! But how can a "comic picture"—if it is, in fact, a caricature—get into the Bible, a holy

---

[6] Translated from the French—tr.

book? Holy texts have not been made for jokes or laughs; the more so that the other miniatures of this edition do not at all manifest a joker in the illustrator. The miniature presents a typical bacchanalian situation, namely, one of the monks in front is engaged in amorous escapades with a nun, and the same is repeated in the background, but now by a number of monks. There were a great many "caricatures" in the medieval texts and Bibles. By the way, pope Pius II, for example, was the author of a number of pieces of erotic literature and an extremely indecent (from the modern standpoint) comedy *Christ* ([81], p. 156). We also have to mention the famous Song of Songs included in the biblical Canon, which is pervaded with transparent eroticism (treated as a certain "allegory" by the modern theologians).

Trying to accommodate the life of the medieval monks to modern morality and our modern ideas of the religious life of that time, Champfleury assures us that all these pictures and texts should be regarded not as illustrations of something that has really occurred, but as a warning against similar deeds. It sounds strange, because the "warning" is pictured in a very attractive manner. For example, who would warn people against perversion by circulating magnificently illustrated pornography? Most probably, this would have the opposite effect. Moreover, if the warnings had been in earnest, then some particular unpleasant consequences of such practice would have been represented. But there was nothing of the kind there! Similar illustrations (including biblical ones) are only possible in the case where they picture the usual way of life of the medieval priesthood, a fact which at the time of the Middle Ages was regarded as normal by all; and if a painter had made it with the purpose of condemning the customs which had already lost the approval of the new ideology, then, as noted by Morozov, he would have represented the revels in some hideous form, with devils carrying sinners to Hell, with atrocious consequences of terrible diseases, and so on. Instead, many medieval Bibles were illustrated not only with representations of bacchanalia, but also with "antique pictures", namely, vines being climbed by angels indistinguishable from antique cupids, and so forth. I am referring to my personal familiarity with old Bibles (e.g., in the Library of the Moscow Planetarium or Museum of Rare Books at the Foreign Languages Library in Moscow).

The synod of Châlon-sur Saône forbade women to sing indecent songs in church. Gregory of Tours protested against the monks' masquerades at Poitiers, which were extremely licentious.

Champfleury wrote:[7]

> "In 1212, the council of Paris forbade the nuns to celebrate the *fête des fous*. 'From feasts, where the phallus is accepted, everyone should abstain; still more, monks and nuns are prohibited'" ([101], pp. 57–58).

The ban helped very little, since a Reformation bishop visiting the Roen monasteries in 1245 reported that nuns in many numbers indulged in illegal

[7]Translated from the French—tr.

pleasures at the feasts. Such a bacchanal still continued in Besançon between 1284 and 1559. Charles VII again forbade this religious *fête des fous* at the Cathedral of Troyes in 1430. The new evangelical papacy founded by Hildebrand was driving out the deep-rooted bacchanalian cult with extreme difficulties (and for how long!).

> "More than once I have looked at the cathedrals, searching for the secret of their disturbing ornamentation, and each motif which I have taken to clarify my text seemed taken from an unknown language."
>
> "What to think of a strange sculpture hidden on a pillar of the underground cathedral of Bourges?" ([101]).

This sculpture represents a man's buttocks made thoroughly and expressively, and protruding from a column. It is placed in a spot convenient for love games. How could the priests and believers who regularly came to this temple for prayer tolerate such a sculpture when it had not yet been established as an artifact left from times long past? Attempts to account for these effigies (and there are many!) as "caricatures", hewn in stone in holy temples, by those who preach in them cannot be regarded as serious.
We quote again from Champfleury:

> "It is possible to find an imagination paradoxical enough to determine the relation of enormous facetiae (joke!—A.F.) with the place where they are displayed, and should we not admit the Caprice which has not stopped the worker from the execution of a similar detail?"
>
> "On the walls of certain religious monuments is seen the representation of sexual organs which are displayed complacently in the middle of religious details: echoes of antique symbolism, these priapic symbols were sculptured with innocence by some naive stonemason.... These ithyphallic remembrances of diverse cathedrals in the centre of France are numerous in Gironde, and are characteristic of Bordeaux. Léo Drouyn showed me curious specimens shamelessly displayed in the churches of his province and which he hides in the bottom of his folders.
>
> "Our excess of pudery deprives us of important knowledge. The silence which the modern historians keep with respect to the symbolism of reproductive organs continues to keep a veil over the attitude of those who want to establish the parallel between the monuments of antiquity and those of the Middle Ages. Serious books on the cult of the phallus, important drawings in its support, would vividly clarify the question and would show the thinking of workers in the Middle Ages who were not embarrassed by being reminded of ancient pagan cults" ([101], pp. 239–240).

All these effigies were in no way a humiliation of the Church and pursued the same purpose of attracting new believers—before wide repression of the old cult was waged by the Gregorian church—as the pictures of foaming tankards on the doors of pubs. The famous "antique" pornographic images discovered, for example, in Pompeii [47] are practically indistinguishable from the Christian sculptures and pictures. And again "prudery" hinders wide scientific circles from becoming familiar with a great number of effigies of the sort. It turns out that

> "... those of the pictures, which represent clearly erotic or indecent scenes so much appreciated by the ancients (and also in the Middle Ages—A.F.) are kept under lock

and key.... Somebody secretly ... scraped off the obscene frescoes at night.... All the pictures and effigies in Pompeii, incompatible with the modern ideas of decency, have been recently placed in the secret department of the Bourbon museum" ([47], p. 76).

Houses with stone phalli at their entrances were discovered in Pompeii ([47], p. 120). The relation of phallic images with the Christian cult cannot be traced exclusively to the European temples.

"In Egypt, too, phalli of monstrous size were hewn of granite.... They were placed at the doors of the temple" ([47], p. 122).

V. Klassowski suggests that these giant stone effigies were placed there for the "pilgrims' edification" (?) ([47], p. 122).

The erotic sculptures of the Christian cult can be found on the capitols of the cathedral in Magdeburg, on the walls of the Nôtre-Dame in Paris, finished in the 12th century, and so on.

It is generally known from the archaeology of medieval Rome that practically each of the most important Roman Christian churches was allegedly built on the "ruins" of earlier pagan temples, with these "pagan sanctuaries" being erected approximately for the same purpose and even bearing the same name as the Christian (and "later") temples [53]. In my opinion, by declaring its bacchanalian past (until the 11th century) "erroneous", and by moving on to a new evangelical phase (in the 10th–12th century), the Christian Church simply *renamed* its prior pagan bacchanalian temples and declared the pagan gods "new" evangelical saints.

Certain of the consequences of the three basic chronological shifts which I discovered were stressed by different authors at different times. For example, Gregorovius noted a certain parallel between the ancient and medieval events. The following important statement is valid, namely, *that all the instances of the parallel, indicated by him, precisely correspond to the three chronological shifts.* We illustrate this by a simple example. Gregorovius directly points to the parallel between the Gothic war in the 6th century A.D. and the war in Italy in the 13th century, being perfectly right in identifying the parallel personages.

"The gloomy Charles of Anjou appeared on the ancient battleground of the Romans and Germans like Narses (!—A.F.), while Manfred assumed the tragic aspect of Totila (!—A.F.) ... for although the relations of powers were different, the conditions remained essentially the same (!—A.F.).... The Swabian dynasty fell as that of the Goths (!—A.F.) had once fallen. On one and the same classic stage the impressive overthrow of two dominions and their heroes adorned history with a twofold tragedy, of which the second seemed, as it were, to be merely the precise repetition of the first(!—A.F.)" ([53], Vol. 5, P. 2, p. 365).

14.2. Medieval Greece and Athens

The situation with the history of medieval Greece is considerably worse, in the sense of completeness of information, than that of Rome. Like the history of other antique cities, that of Athens is characterized by blooming in ancient times followed by immersion into medieval darkness from which the city started to emerge only halfway through the Middle Ages, and later than Rome. Gregorovius wrote that, as to Athens proper, its medieval fate is covered by such impenetrable darkness that the most outrageous opinions have been expressed about the city, such as claiming that Athens turned into an uninhabited coppice in the 6–10th century, and finally, was burnt out by the Barbarians. Very valid proofs were supplied of the existence of Athens in the gloomiest epoch. Let us note the remarkable fact that special proof should be required only to prove at least the existence of the most glorious city in the historical country. This fact serves as the startling confirmation of the complete vanishing of Athens from the horizon of history [77].

These details about the situation in medieval Athens were first stated by Fallmerayer in the 19th century. To somehow account for this enigmatic "catastrophe", he suggested that the Avars and Slavs massacred all of ancient Greece. However, no sources confirming this are available. Starting with the 7th century A.D., Greece becomes so unimportant for history that the names of Italian towns are much more often mentioned by the Byzantine annalists than Corinth, Thebes, Sparta, or Athens. However, afterwards, too, none of the chroniclers hinted with a single word at the capture or devastation of Athens by invading peoples. Athens did become impoverished, its marine power and political life fell into decay as well as the life of Hellas on the whole. However, the fame of the medieval city was in the hands not as much of the wise men as of honey-merchants. Athens and Hellas were covered by profound night. The "ancient" Parthenon was strikingly turned into a Christian church! The Virgin Mary had already started her victorious war with ancient Pallas over the possession of Athens. The 10th-century Athenians built a beautiful church and erected the image of the Mother of God, whom they called Athene (!—A.F.). Moreover, giving the name of the Mother of God is the same as to give the name of Athene the same name which was later given to the image of Panaghia Athene highly revered in the medieval Pathenon. Thus, besides the identity Athenae = Mother of God, we discover that the Parthenon was devoted to the Mother of God, or Athene [77].

Gregorovius continues that the noblest of all cities on earth was hopelessly immersed in the gloomiest Byzantine epoch. With ever-increasing contempt, New Rome on the Bosphorus came to look down on the fallen guiding star of Greece, the small provincial town of Athens. As to the fate of Athens' monuments, they, as a rule, remained in oblivion. For hundreds of years, the Greeks were sitting in total obscurity under the shelter of the ruins of their grey-haired antiquity. Certain of the most beautiful ancient buildings lured the Christians of Athens into rebuilding them into churches. We know nothing of the day when this happened for the first time, and when a temple in Athens was first turned into a Christian house of worship. The history of Athens' churches is very uncertain. Speaking of the Parthenon, Gregorovius adds that the Christian religion drew its attention to the great sacred spot, i.e., the Parthenon, of the antique city goddess on the Acropolis, doing no harm to the temple at all. In the entire history of the transformation of ancient beliefs and holy concepts into Christian ones, you will find no example of such an easy and complete substitution as occurred to Athene Pallas when she was replaced by the Virgin Mary. The people of Athens did not even have to alter the nickname of their divine virginal protectress, for the Virgin Mary was now called Parthenos by them [77].

Medieval Athens first appeared on the arena of history after many years of nonexistence as a small Byzantine fortress allegedly "restored" by Justinian as early as the 6th century A.D. in the territory fully populated by the Avars and Slavs. No traces of "ancient" Greek Hellenes could as yet be found. In general, according to Gregorovius, the whole Acropolis turned into a holy shrine of the Virgin Mary. We do not possess any factual proofs of existence in Athens of either schools or public libraries. The same darkness veils Athenian civic rule in that epoch.

Why did the classical thought "evaporate" from Greece? Where did the "classical" Greeks go? Why did the famous "ancient" marine potential of Athens vanish (by the way, "restored" in the Crusaders' epoch during the 12–13th century)? The documents indicate that the Byzantines did not persecute science, and they report nothing of the Inquisition. "Closing" the famous Academy in Athens occurred quietly, as Gregorovius stated perplexedly. The term "Hellenes" itself appeared very late in reliable history. According to Gregorovius, it is only in the 15th century that Laonicus Chalcocondylas, hailing from Athens, again christened his compatriots the "Hellenes" after many hundreds of years of nonexistence [77]. Were the Hellenes, as stated by traditional history, slavonized in Greece originally populated only by them, or, on the contrary, were the Avars and Slavs living there in the late Middle Ages hellenized? Theories of slavonizing the ancient Greeks are only based on guesswork. On the other hand, the 10th-century Byzantine historian P. Šafařík directly declares that almost all of Epirus and Hellas, the Peloponnese, and Macedon were populated by the Scythian Slavs. Gregorovius continues that, due to similar Byzantine evidence, the slavonization of the ancient Greek lands should be accepted as a historical fact. The Slavonic names of towns, rivers, mountains, and so on, densely covered medieval Greece (e.g., Goritza, Krivitza, etc.), and it is only since the 13–15th century that Greek Hellenic names appeared and were later declared "ancient".

Greece first (!) appears on the real political arena as a country of mutiny and with a mixed, more than a half Slavonic population, only in the 8th century. Nevertheless, again after empress Theophano has fallen, Athens, as well as the rest of Hellas, disappears from the historical arena, so that it is even hard to come upon a mention of the city. And only the Peloponnese, where the Slavs settled most firmly, was a pretext for the Byzantines to interfere with Greek affairs. There is still very little information about Greece in the 8–10th century. Gregorovius declares that neither history nor legend violates the silence enshrouding the fate of the glorious city. This absence of facts is so complete that those who investigate the signs of life (!—A.F.) in the famous city during the centuries described will be glad to encounter, as if a discovery, at least some most insignificant detail similar to that given in St. Luke's biography about a thaumaturgist's visit to Athens [77].

Greece and Athens emerge from darkness only in the 15th century. Greece becomes especially important during the Crusades in the 12–13th century. Possessing a good port, and being a Venetian ally (there are many reasons to believe that Venice should be identified with Phoenicia), Athens advances to one of the top positions. It is important that chronological dates were indicated in Greece with reference to the Christian era and in Arabic numerals starting only in A.D. 1600. Gregorovius adds that the influence of time and climate made decoding of these few inscriptions very complicated. They did not even cast any light on Athenian history in the Christian era. The investigator of the medieval Roman past finds himself in an uncomparably more advantageous position (we have already spoken of Rome). The annals of the dead, hewn in stone, are totally absent in Athens. Few tombstones, one or two sarcophagi without any statues, plus several inscriptions are all that is left from the past (not counting the so-called ancient ruins). There are several contradictory versions in traditional history regarding Athens in the 12–14th century. According to one, the city and Greece were still in the dark. According to another, Athens gradually started acquiring importance as a big cultural centre [77]. For example, British scientists studied there. The Crusades were not so much great religious and military ventures as important secular events. The expeditions were headed by high European nobility (see the lists in [77]). Greek territory was converted into the mosaics of feudal states whose role is estimated today essentially from the negative point of view. It is assumed that cruel and ignorant conquerors buried the great heredity of Greece. On the other hand, Gregorovius (just having accused the Crusaders of vandalism) unexpectedly informs us that its new history was just discovered by the Latins, and turned out to be as multifarious as ancient. The Venetian *nobiles* lusting for adventures set for the Greek seas, turning themselves into the 13th-century Argonauts (later described by "ancient" poets—A.F.) [77]. Although the history of the Frankish Crusaders' 13–14th-century states in Greece is known fragmentarily, there was a time when fairy tales and legends turned into life. The House of Villehardouin Gottfried II was famed even in the West as a school of most refined customs. The Genoese merchants stayed in Thebes and Athens and successfully competed with the Venetians. This was the era of a remarkable golden age for literature and the arts, of which, though, almost nothing remains. In my opinion, the 13–14th century was the only epoch of "ancient" Greece, which ended in 1453 with the conquering of the Byzantine Empire by the Arabs. As Gregorovius puts it, the situation of the Frankish states in Greece could not be called favourable at the beginning of the 14th century. The Latins led the brilliant life of knights, which can be proved by the convening of the parliament in May 1305 in Corinth. The isthmus, where in the times of old the Poseidon games were staged, has become the arena of knights' tournaments in honour of beautiful women [77].

It is important that the Frankish barons decorated their palaces with Greek inscriptions (!). Adherents to historical tradition themselves stress a great deal of "parallels" between the medieval and ancient Greek states. We will not be able to give their list here, for this will necessitate a chain of extensive tables made while investigating the GCD. We shall illustrate this only by one representative example. Dante's contemporary, Ramon Muntaner, recounted the following event, absolutely neglecting the fact that this event and its dating strongly contradicted traditional chronology and history (though this was established only after his death). According to Muntaner, one Trojan outpost was situated on Atracia, a promontory in Asia Minor, not far from the island of Tenedos, where noble men and women of Romagna used to revere a divinity. When Helen, the consort of the duke of Athens, went to that place accompanied by hundreds of knights, she encountered the Trojan king's son Paris, who killed every one of her suite of knights and abducted the beauty [77]. I advise the reader to refer to the GCD to discover that the "original" of the famous Trojan war occurred, in fact, in the middle of the 13th century in Italy or at the beginning of the 13th century in Constantinople.

It is important that the history of the Greek Frankish states was first studied only in the 19th century. According to W. Müller, the archives give us only the plot of this romantic drama whose theatre had been Greece for 250 years from the 13th to the 15th century. In the 13th century, the Parthenon served as a "Latin" temple of the Virgin Mary of Athens, "as if it had just been built" (W. Müller) [1]. The famous statue of the Catholic Virgin Mary is placed in the Parthenon as a copy (!) of the world-known statue of the pagan Athene by Phidias (whose loss has been deplored by traditional history). The statue was made in the 13th century. Another "ancient" temple devoted to the virgin, and now called the Erechteon, was also built in the 13th century and is still acting as if it has just been built, and so forth ([1], Vol. 4).

Gregorovius tells us about the famous Byzantine George Gemistus (Pletho), "a resurrected ancient Hellene" living at the court of Theodore II. George was a great worshipper of ancient gods. It was just at that time that the "Hellenistic idea" of calling for the medieval Greeks to unite against conquerors gained ground [77].

Archaeology in Athens began in A.D. 1447, i.e., when Cyriacus of Ancona appeared in the city. He was the first to introduce the world of ruins of Athens to the field of Western science. Cyriacus compiled the first catalogue of inscriptions and local names of monuments. These documents were lost, but the contemporary historians are familiar with his data from a rendering by 15–16th-century authors [77].

According to Gregorovius, the original names of most ancient Athenian monuments now lying in ruins, were forgotten in the course of time. The fantasy of antiquity lovers was anxious to relate them with the names of outstanding men of the past. The remains of the Olympieion were called a "basilica" in those centuries because, according to Gregorovius, nobody (!) knew that these were the ruins of the formerly world-famous temple of Zeus at Olympia.

Cyriacus called these vast ruins the palace of Adrian as did the citizens of Athens themselves (who, therefore, erred, and only the later historians found the truth and "corrected" the mistake). As early as 1672, Babin did not know where in Athens the temple of Zeus was located. Several years later, J. Spon was just as bewildered. The ruins of the Stoa were attributed to belong to the palaces of Themistocles or Pericles; within the walls of the Odeum, the palace of Herodes Atticus was thought to belong to Miltiades, and other ruins of unknown buildings were assumed to be the houses of Solon, Thycidides, and Alcmaeon. In 1647, Poentelle was shown the ancient ruins of Pericles' palace, and the Tower of the Winds was called "Socrates' tomb". The remembrance of Demosthenes was related to the Monument of Lysicrates. This monument was called "Demosthenes' lamp". The Academia, the Lyceum, the Stoa, and Epicurus' garden vanished without leaving a trace. In the times of Cyriacus, one group of basilicas, or vast ruins whose foundations are now impossible to find, were called the "Academia". The *didascalia* of Plato "in the garden" was also shown; it seems to be a tower in the Gardens of Ampelocypi. Rumours about some of Caisarini's schools on this mount circulated. The lyceum or *didascalia* of Aristotle was placed in the ruins of Dionysius' theatre. The Stoa and Epicurus' school were even transferred to the Acropolis, into those big buildings which were, probably, part of the Propylaea, and the temple of Nike seems to have been the one taken over by the Pythagorean school.

We do not continue, because the state of archaeological chaos has now become clear, and the list occupies several pages. To think that all this happened in the 16th–17th century!

The Byzantine Empire fell in 1453. The last Franks defended the Acropolis for some time; however, infuriated by the stubborn resistance of this strong fortress, Omar ordered artillery to shell (!) the Acropolis and its surroundings, due to which its temples, and the Acropolis itself, were turned into ruins [77].

The powerful destruction of many a wonderful monument of the crusaders' epoch led to the Athenian ruins then declared to be "ancient".

Gregorovius writes that after the 15th-century Turkish invasion, Athens was again (and how many times it was!) immersed into darkness. During the Turkish yoke, the historian of Athens and Greece faces a problem as difficult as ungratifying. He sees a desert before him [77]. The West has accepted the fall of Greece, and almost forgot it. A German humanist confined himself to a note in 1493 that the city of Athens was most glorious in Attica, from which only few traces remained. In the 16th century, it became necessary for science to possess exact information regarding the fate of the glorious city, which found its expression in the problem whether Athens existed at all. The question was raised by one German philhellene, Martinus Crusius. By rediscovering Athens he made himself immortal. He sent a letter to Zugomalas Theodosios, chancellor of the patriarch of Constantinople in 1573, asking to inform him whether the mother of all knowledge, as stated by the German historians, does exist, that the city of Athens was effaced, with just a few sailors' huts in its place. The reply of the enlightened Byzantine together with the later letter of an Acharnian were the first exact data which calmed the German scientist as regards the existence of the city. For the first time, they cast a dim light on the state of its monuments and the flora of its people (in which, according to traditional history, the legend is enrooted that the Parthenon was erected by the architects Ictinus and Callicrates under the statesman and *strategos* Pericles, the popular leader of the democratic party created in Athens as far back as the 5th century B.C. and who died of the plague in 429 B.C. together with its leader, although it is unknown in which month—A.F.) [77].

The scientific archaeology of Athens started only in the 17th century when Scaliger's chronology had already been created with the works of Jean le Maire from the Netherlands [77]. Nevertheless—let me refer to Gregorovius again—even in 1835, one German scientist expressed the opinion that an uninhabited desert had remained in place of Athens for four hundred years. Compared with the study of the city of Rome, the archaeology of Athens was about two centuries late.

The prejudice firmly enrooted in Europe that Athens did not exist, as it were, could be eliminated only with one's own eyes: This was to the credit of the French Jesuits and Capuchins, who first appeared in Athens in 1645 [77]. In the second half of the 17th century, the French monks made the first (!) maps of the city. The continuous and more or less scientific study of Athens began only at this moment when traditional chronology had been almost created, and the Greek monuments had already been dated on the basis of the distorted chronology of Rome, which also led to lengthening Greek history artificially.

14.3. The history of religions

In conclusion, we shall briefly discuss the situation of the history of religions. It is assumed traditionally that each chronological epoch has had its own religious cults separated by centuries and millennia. At the same time, the 19th-century historians and ethnographers did the enormous job of comparatively studying the world religions and cults. They found that the religions traditionally believed to be separated by hundreds and thousands of years admit an extraordinary large number of "parallels" (sometimes even identical coincidences). This fact engendered numerous theories of influence, borrowing, infiltration, and so forth. However, they all rest on traditional chronology and are generated only by it. A change of chronology will make the scientists revise the prior point of view. Since we do not have the space here, we only indicate some typical examples:

A so-called Celtic monument found in 1771 is regarded as the traditional representation of the pagan pre-Christian forest-god of the Gauls [37]. However, the inscription ESUS carved out over the divinity's head could be seen explicitly. Nevertheless, traditional chronology makes the historians believe that this is the pre-Christian "God Jesus". The well-known historian and specialist in comparative religion A. Drews wrote that he considered mythological parallels between Christianity and paganism very important. Those who do not see the generally known relation of the Gospel's paschal history to the myths and cults of the religion venerating Attis–Adonis–Osiris, and others, those who affirm that the myths of Attis and Adonis say nothing of Sunday burials, who hope to prove that Jesus' death was different from the deaths of his relatives in Asia Minor, who cannot recognize the Virgin Mary in the numerous Indian, Anatolian, and Egyptian mother-goddesses Maia, Māriamma, the mother of the "Messiah" Cyrus, weeping Semiramis, Myrrha, and Mera, should be left out of the discussion of questions of religion and history. Drews lists a great many parallels identifying the Christian "holy family" with other "holy families" of the Anatolian and Egyptian gods allegedly separated from the turn of the millennium by many centuries. Rejecting the traditional approach, we see that all the parallels simply point to the simultaneity of these cults, which are different only in national character because of their origin.

For example, the principal holy shrine of Mithras had been in the Vatican in the place of today's San Pietro. Mithras–Attis was then called "father's father". The high priest serving this god was also called "father" (father's father) just as the Roman pope is still called the "Holy Father" [82]. Mithraism as well as Christianity accepts the tenet of purgatory, use of a holy-water basin, and the ritual of crossing oneself. The rituals of public service, Mass, host, wafer of consecration, communion bread, and so forth, are perfectly the same [82]. Mithras' and Christian cults are practically indistinguishable, and the difference between them in hundreds of years is noted only by traditional chronology. It turns out that the mixed cult of the Egyptian goddess Isis, whose worshippers had matins, liturgies, and vespers surprisingly similar to the Catholic and even partly Orthodox religious services, is nearly coincident with the medieval Christian cult [82] .

Without putting traditional chronology to doubt, which has moved the Isis–Osiris–Serapis cult into hoary antiquity, the historian of religions N. V. Rumyantsev had to declare that

> "... this coincidence of prayers of the Egyptian religious service with Christian liturgical prayers is too complete and striking to be accidental" ([83], p. 72).

The "land of crosses" is traditionally believed to be ancient Egypt. The same Christian crosses were spread in ancient India, Mesopotamia, and Persia. A great deal of the Egyptian images of gods contained the anagram of Christ [83. Summarizing his study, Rumyantsev wrote:

> "A series of suffering, dying and resurrecting gods of the ancient world have passed before us; we saw their myths, grew familiar with the holidays, rituals, and so forth, devoted to them. In spite of the difference in their names, myths, birthplaces or historical arena, it can still be felt, even against one's own will, that they all have something in common. Moreover, the people of antiquity noticed this fact, too.... In fact, if we look at the recent centuries before and after the so-called Nativity, then we shall notice a curious thing. All the divinities listed above have been closely linked with everything related to them, even sometimes indistinguishably. Osiris, Tammuz, Attis, Dionysius, and others, formed some unique, common, and conjoint image, thus creating a certain syncretic (mixed) divinity almost undividedly reigning over the whole vast territory of

the Roman state.... The divinities, in fact, turned into one Savior with many names. This tight conjunction occurred especially in the epoch of the Roman Empire and, in particular, in Rome itself" ([83], pp. 44–45).

Egyptian chronology yawns with enormous gaps and is a set of separate fragments quite unrelated to each other or even completely independent. As in the history of Europe, the "restoration" effect can be made manifest in Egyptian history during the Saite restoration when the cults, customs, written language, and so on, forgotten long ago were revived again. Being intimately related with Biblical and Roman chronology, the whole of Egyptian history also undergoes "glueing together" (of "different" Egyptian epochs) and "compression". As a result, the ancient and medieval Egyptian history became shorter, similarly to the history of Europe (see the GCD). The forward shift is consistent with the results obtained independently even by Isaac Newton while investigating the chronology of Egypt [67].

14.4. Indian history and chronology

Oriental history is also linked with that of Europe and Egypt. For example, let us give a short quotation by N. Guseva pertaining to the chronology of India:

"The science of history faces in India such difficulties that cannot even be imagined by the investigators studying the ancient history of other countries and peoples (this was written in 1968—A.F.). The most difficult one of them is the complete absence of dated sources" (see the Russian translation of D. Kosambi's book *The Culture and Civilization of Ancient India in Historical Outline* [84]).

All the basic chronological milestones in Indian history were established by the comparison with Roman, Greek, and Egyptian chronology. D. Kosambi writes:

"India has virtually no historical records worth the name.... In India there is only vague popular tradition, with very little documentation above the level of myth and legend. We cannot reconstruct a complete list of kings.... What little is left is so nebulous that virtually no dates can be determined for any Indian personality till the Muslim period.... This has led otherwise intelligent scholars to state that India has no history" ([84], pp. 9–10).

The medieval authors sometimes placed India in Africa and even in Italy (!). Similarly to Europe, at the beginning of the millennium, India "suddenly" happens to be at a "barbaric stage of its development", again starting its way to the top level of civilization [84]. The golden age of the Sanskrit Indian literature is dated only to the 11th century! Indian medieval history is also rich in chronological gaps as long as a century, being intricate and chaotic.

"Thus, brahmin indifference to past and present reality ... only erased Indian history.... For historical descriptions of ancient Indian scenes and people ... we have to rely upon Greek geographers, Arab merchant travellers.... Not one Indian source exists of comparable value" ([84], pp. 174–175).

Thus, Indian chronology and history are completely dependent upon those of Rome and Greece and are restructured following the former.

Remark. I cannot at all agree with the hypothesis of Morozov, according to which most literary works of antiquity are fabrications of the Apocrypha of the Renaissance, which would mean that what we know today as ancient history is actually the result of premeditated falsification. This thesis formulated in [1] caused justified criticism. My standpoint is different, namely that, due to the results of the application of the new dating methods (see above), almost all surviving ancient documents (of antiquity or the Middle Ages) are authentic and were written for the purpose of perpetuating real events rather than leading future historians astray. More than that, certain of numerous examples of the GCD and its decomposition (and also the new version of chronology I suggested) justifying the authenticity of many a document (e.g., of the *Donation of Constantine*, the *Almagest* of Ptolemy, etc.) were given above, i.e., many of the documents regarded today as adulterated turn out to be originals, which are extremely consistent with the new version of chronology, following from the GCD and its decomposition into the sum of three shifts. For example, this refers to the "privileges" given by Caesar and Nero to the Austrian duchy (see above). In my opinion, practically everything described in the old documents did, in fact, occur. The problem is when and where? The confusion discovered earlier, which led to the lengthening of authentic history due to the natural chronological error (e.g., because of mixing up the dates of the foundation of the "two Romes"), only took place in solving it. The new version of chronology which I have suggested (and which is essentially different not only from the traditional, but also from Morozov's version) makes us redate the old documents and does not at all deny their validity as true witnesses of the past events.

References

[1] Morozov, N.A., *Christ.* Moscow and Leningrad, 1926–1932 (in Russian).

[2] Fomenko, A.T., "Certain statistical regularities of information density distribution in texts with scale", in *Semiotika i Informatika*, Vol. 15, VINITI, Moscow, 1980, pp. 99–124 (in Russian).

[3] Fomenko, A.T., "On the computation of the second derivative of the moon's elongation", in *Controllable Motion Problems: Hierarchal Systems.* Perm University Press, Perm, 1980, pp. 161–166 (in Russian).

[4] Fomenko, A.T., "Informative functions and related statistical regularities", *Abstracts of Communications of the Third International Vilnius Conference on Probability Theory and Cybernetics of AN LSSR*, Vol. 2, 1981, pp. 211–212 (in Russian).

[5] Fomenko, A.T., "A method of duplicate recognition and some applications", *DAN SSSR* **258**, 6(1981), 1326–1333 (in Russian).

[6] Blair, J., *Blair's Chronological and Historical Tables, from the Creation to the Present Time, etc.* G. Bell & Sons, London, 1882.

[7] Bickerman, E., *Chronology of the Ancient World.* Thames & Hudson, London, 1968.

[7*] Bickerman, E., Russian translation of [7], Moscow, 1975.

[8] Gurevich, A.Y., *Categories of Medieval Culture*. Iskusstvo, Moscow, 1972 (in Russian).

[9] Mommsen, T., *The History of Rome*. Macmillan & Co., London, 1913.

[10] Kendall et al., eds., *The Place of Astronomy in the Ancient World: Joint Symposium of the Royal Society and the British Academy*. Oxford University Press for the British Academy, Oxford, 1974.

[11] Brugsch, H., *Egypt Under the Pharaohs; A History Derived Entirely from the Monuments*. J. Murray, London, 1891.

[12] Radtsig, N.I., "Starting the Roman Chronicle", *Uch. zap. Mosk. Univ.*, vol. 32, 1901, pp. 1–147 (in Russian).

[13] Martynov, G., "On the origin of the Roman Chronicle", *Uch. zap. Mosk. Univ.*, vol. 32, 1904, pp. 1–53 (in Russian).

[14] Niese, B., *Grundriß der römischen Geschichte nebst Quellenkunde*. München, 1923.

[15] Kuzishchin, V.I., ed., *History of the Ancient East*. Vysshaya Shkola, Moscow, 1979 (in Russian).

[16] Golenishchev-Kutuzov, I.N., *Medieval Latin Literature of Italy*. Nauka, Moscow, 1972 (in Russian).

[17] Priester, E., *Kurze Geschichte Österreichs*. Globus, Wien, 1946–.

[18] Neugebauer, O., *The Exact Sciences in Antiquity*. Acta Historica Scientiarum Naturalium et Medicinalium, Vol. 9, Copenhagen, 1957.

[19] *Complete Collection of Russian Chronicles*, Vol. 33. Leningrad, 1977; Vol. 35, Moscow, 1980 (in Russian).

[20] Broughton, T. *The Magistrates of the Roman Republic*. American Philological Association, New York, 1951–1952.

[21] Scaliger, J., *Opus novum de emendatione temporum*. Lutetiae, 1583.

[22] Petavius, D., *Opus de doctrina temporum divisum in partes duas, etc.* Lutetiae Parisierum, 1627.

[23] *L'Art de Vérifier les Dates des Faits Historiques, etc.* G. Desprez, Paris, 1750; 2d éd., 1770; 3d éd., A. Jambert Jeune, Paris, 1783–1787.

[24] Ideler, L., *Handbuch der mathematischen und technischen Chronologie*. A. Rückner, Berlin, 1825–1826.

[25] Mommsen, T., *Die römische Chronologie bis auf Caesar*. Weidmann, Berlin, 1859.

[26] Ginzel, F., *Handbuch der mathematischen und technischen Chronologie, etc.* Leipzig, 1906–1914.

[27] Eusebius, Pamphili, *History of the Church*. London, 1890.

[27*] Russian translation of [27], St. Petersburg, 1848.

[28] Beaufort, L. de, "A dissertation upon the Roman history during the first five hundred years", Paris, 1740.

[29] Lewis, G.C., *Untersuchungen über die Glaubwürdigkeit der altrömischen Geschichte. ...* Hannover, 1858.

[30] Pauly, A., *Real-Encyclopädie der classischen Alterthumswissenschaft in alphabetischer Ordnung*. Stuttgart, 1839–1852.

[31] Herodotus, *The Histories of Herodotus, etc.* Everyman's Library, London and New York, 1964.

[31*] Russian translation of [31], Nauka, Leningrad, 1972.

[32] Woolley, C., *Excavations at Ur; A Record of Twelve Years' Work.* E. Benn, London, 1955.

[32*] Russian translation of [32], Moscow, 1961.

[33] Ern, V.F., *The Revelation in Thunder and Storm: A Critical Survey of the Book by N.A. Morozov.* Moscow, 1907 (in Russian).

[34] Nikolsky, N.M., "Astronomical revolution in historical science (*a propos* the book *Christ* by N.A. Morozov)", *Novy Mir* **1**(1925), pp. 157–175 (in Russian).

[35] Morozov, N.M., "Astronomical revolution in historical science (*a propos* the article of Prof. N.M. Nikolsky)", *Novy Mir* **4**(1925), pp. 133–143 (in Russian).

[36] Cîmpan, F. *Istoria Numărului π.* Bucuresti, 1965.

[37] Chantepie de la Saussaye, P., *Manual of the Science of Religion.* Longmans, Green and Co., London and New York, 1891.

[38] Hochart, P., *De l'Authenticité des Annales des Histoires de Tacite ...* Paris, 1890.

[39] Ross, J., *Tacitus and Bracciolini. The Annals Forged in the XVth Century.* Diprose & Bateman, London, 1878.

[40] Neugebauer, O., *The Exact Sciences in Antiquity.* Harper & Bros., New York, 1962.

[41] Vasilyev, A.A., *History of the Byzantine Empire.* Academia, Petrograd, 1923–1925 (in Russian).

[42] Cicero, Marcus Tullius, *Works.* Harvard University Press, Cambridge, Mass.; Heinemann, London, 1977.

[42*] Russian edition of a selection of [42], Nauka, Moscow, 1972.

[43] Suetonius Tranquillius, C., *History of Twelve Caesars.* AMS Press, New York, 1967.

[44] Alberti, L., *Complete ed.* Phaidon, Oxford, 1977.

[45] Thorndike, L., *A History of Magic and Experimental Science*, Vol. 2. Macmillan, New York, 1929.

[46] Egorov, D.N., *Introduction to the Study of the Middle Ages.* Higher Women's Courses, Moscow, 1916 (in Russian).

[47] Klassovsky, V.I., *Pompeii and Antiquities Discovered There.* St. Petersburg, 1856 (in Russian).

[48] Kryvelev, I.A., *Excavations in Biblical Countries.* Sovetskaya Rossiya, Moscow, 1965 (in Russian).

[49] Sunderland, J., *Holy Books in the Light of Science.* Severno-Zapadnoye izdatelstvo, 1925 (in Russian).

[50] Lentsman, Ya.A., *Origin of Christianity.* AN SSSR, Moscow, 1958 (in Russian).

[51] Malalas, Ioannes, *Chronicle of John Malalas.* University of Chicago Press, Chicago, 1940.

[52] Eusebius, Pamphili, *Eusebii Pamphili episcopi caesariensis Onomasticon urbium et locorum sacrae scripturae.* Bertolini, 1862.

[53] Gregorovius, F., *History of the City of Rome in the Middle Ages.* G. Bell & Sons, London, 1900–1909.

[54] Aconiatus, Nicetas, "Historia" in J.P. Migne *Patrologiae cursus completus.* Series graeca, t. 140, Paris, 1857–1886.

[55] Gregoras, Nichephorus, "Byzantinae historiae" in J.P. Migne *Patrologiae cursus completus.* Series graeca, t. 148, 149, Paris, 1857–1886.

[56] Livius, Titus, *Works.* Harvard University Press, Cambridge, Mass.; Heinemann, London, 1914–.

[57] *Alexandria: Romance of Alexander the Great.* Leningrad, 1966 (in Russian).

[58] Comnena, Anna, *The Alexiad of Anna Comnena.* Penguin, Harmondsworth, 1969.

[59] Lauer, J.-Ph., *Le Mystère des Pyramides.* Presses de la Cité, Paris, 1974.

[60] Psellus, M., *The Chronographia of Michael Psellus.* Routledge & Kegan Paul, London, 1953.

[61] *Shorter Encyclopaedia of Geography,* Vol. 1. Soviet Encyclopaedia Publishing House, Moscow, 1960 (in Russian).

[62] Diehl, Ch., *History of the Byzantine Empire.* Princeton University Press, Princeton, N.J., 1925.

[63] Weber, G., *Outline of Universal History from the Creation of the World to the Present Time.* London, 1851.

[64] Demogeot, J., *History of French Literature.* Rivingstons, London, 1884.

[65] Amalrik, A.S. and Mongait, A.L., *What Is Archaeology?* Prosveshcheniye, Moscow, 1963 (in Russian).

[66] Klein, L.S., "Archaeology argues with physics", *Priroda* **2**(1966), pp. 51–62; **3**(1966), pp. 94–107 (in Russian).

[67] Newton, I., *The Chronology of Ancient Kingdoms Amended. To Which Is Prefix'd a Short Chronicle from the First Memory of Things in Europe, to the Conquest of Persia by Alexander the Great.* J. Tonson, etc., London, 1728.

[68] Kosidowski, Z., *Gdy Słońce byłobogiem.* Warszawa, 1962.

[69] Oleinikov, A.N., *The Geological Clock.* Nedra, Leningrad, 1975 (in Russian).

[70] Libby, W., "Carbon-14, nuclear clock for archaeology", *UNESCO Courier,* July 1968, pp. 22–30.

[71] Newton, R., "Astronomical evidence concerning non-gravitational forces in the Earth–Moon system", *Astrophys. Space Sci.* **16**, 2(1972), pp. 179–200.

[72] Newton, R., "Two uses of ancient astronomy", *Phil. Trans. Roy. Soc.,* Ser. A **276**(1974), pp. 99–116.

[73] Ginzel, F., *Spezieller Kanon der Sonnen- und Monfinsternisse für Ländergebiete der klassischen Alterthumswissenschaften und der Zeitraum von 900 vor Chr. bis 600 nach Chr.* Berlin, 1899.

[74] Renan, J., *Renan's Antichrist.* The Scott Library, 1899.

[75] Ditmar, A.B., *Geography in Antiquity.* Moscow, 1980 (in Russian).

[76] Jalal, A., *Constantinopole de Byzance à Stamboul.* Paris, 1909.

[77] Gregorovius, F., *Geschichte der Stadt Athen im Mittelalter.* Stuttgart, 1889.

[78] Zelinsky, A.N., "Constructive principles of the ancient Russian calendar", in *Context*, Vol. 62–135, Gorky World Literature Institute, Moscow, 1978 (in Russian).

[79] Skazkin, S.D., ed., *History of the Middle Ages.*Vysshaya Shkola, Moscow, 1977 (in Russian).

[80] Udaltsov, A.D., Kosminskii, E.A., Vainstein, O.L., *History of the Middle Ages.* Ogiz, Moscow, 1941 (in Russian).

[81] Lozinsky, S.G., *History of the Papacy.* Gaiz, Moscow, 1934 (in Russian).

[82] Drews, A., *The Christ Myth.* T. Fisher Unwin, London and Leipzig, 1910.

[83] Rumyantsev, N.V., *The Death and Resurrection of the Saviour.* Ateist, Moscow, 1925 (in Russian).

[84] Kosambi, D., *The Culture and Civilization of Ancient India in Historical Outline.* Routledge & Kegan Paul, London, 1965.

[85] Fomenko, A.T., "On the properties of the second derivative of the moon's elongation and related statistical regularities", in *Problems of Computational and Applied Mathematics*, Vol. 63. AN USSR, Tashkent, 1981, pp. 136–150 (in Russian).

[86] Zubov, V.P., *Aristotle.* Moscow, 1963 (in Russian).

[87] *Historical and Mathematical Investigations*, Vol. 1. Moscow and Leningrad, 1948.

[88] Cipolla, C., *Clocks and Culture, 1300–1700.* London, 1967.

[89] Whiston, W., *Memoirs of the Life and Writings.* London, 1753.

[90] Sheynman, M.M., *The Belief in the Devil in the History of Religion.* Nauka, Moscow, 1977 (in Russian).

[91] Sterligov, V.V., *Ancient Plots in French Book Illustration at the End of the 14–15th cc.* (in Russian).

[92] Vaganov, P.A., *The Physicists Fill Gaps in History.* Leningrad University Press, Leningrad, 1984 (in Russian).

[93] Diehl, Ch., *Les Grands Problèmes de l'Histoire Byzantine.* Librairie Armand Diehl, Colin, Paris, 1947.

[94] *Hand-written and Printed Books.* Nauka, Moscow, 1975 (in Russian).

[95] Mommsen, T., *Liber Pontificalis*

[96] Mommsen, T., *Gestorum Pontificum Romanorum*

[97] Fomenko, A.T., "A new empirical and statistical procedure for text ordering and its applications to the problems of dating", *DAN SSSR* **268**(1983), pp. 1322–1327 (in Russian).

[98] Nikonov, V.A., *Name and Society.* Nauka, Moscow, 1974 (in Russian).

[99] Saint Nilus Ancyranus, "Opera quae reperiri poteurunt omnia", in J.P. Migne *Patrologiae cursus completus*, Vol. 79. Paris, 1859–1887.

[100] Kazamanova, A.N., *Introduction to Ancient Numismatics*, Moscow University Press, Moscow, 1969 (in Russian).

[101] Champfleury, J., *Histoire de la Caricature au Moyen Age*. Paris, 1867–1871.

[102] Newton, R., *The Crime of Claudius Ptolemy*. Johns Hopkins University Press, Baltimore, London, 1977.

[103] Kurbatov, G.L., *History of the Byzantine Empire*. Vysshaya Shkola, Moscow, 1984 (in Russian).

[104] Brahe, T., *Tychonis Brahe Dani Opera Omnia*, I.L.E. Dreyer, ed. Hanniae, 1913–.

[105] Ptolemaeus Claudius, *Beobachtung und Beschreibung der Gestirne und der Bewegung der himmlischen Sphäre*. Fr. Nicolai, Berlin and Stettin, 1795.

[106] Baily, F., *The Catalogues of Ptolemy, Ulugh Beigh, Tycho Brahe, Hevelius, Deduced from the Best Authorities*. London Society, London, 1843

[107] *The Bright Star Catalogue*. Yale University Observatory, New Haven, Conn., 1982.

[108] Peters, G. and Knobel, E., *Ptolemy's Catalogue of Stars: Revision of the Almagest*. The Carnegie Institution of Washington, Washington, 1915

[109] Baily, F., *An Account of the Life of Sir John Flamsteed*. London, 1835

[110] Kulikovsky, P.G., *Star Astronomy*. Nauka, Moscow, 1978 (in Russian)

[111] Russian edition of the *Arithmetica* by Diophant, Nauka, Moscow, 1974

[112] Russian edition of the *Works* by Archimedes, Fizmatgiz, Moscow, 1962

[113] *Italien Life and Culture*, Vol. 1. Moscow, 1914.

INDEX

CONTENTS OF VOLUME II