ANNALS OF THE NÁPRSTEK MUSEUM 24 • PRAGUE 2003

PRELIMINARY REPORT ON THE ANALYSIS OF THE PRAGUE CODEX

DEPOSITED IN THE COLLECTIONS OF NÁPRSTEK'S MUSEUM IN PRAGUE

Bohumil Böhm, Vladimír Böhm

The Prague Codex named after the place where it is deposited, namely in the collections of Náprstek's Museum in Prague, ranks with its character and overall design among four Maya codices, which are known as the Dresden Codex, Paris Codex, Madrid Codex, and Codex Grolier. Those are rare manuscripts, having their origin probably in the region of Yucatan, which had been written approximately in the 10th through 12th century.

The first analysis of the Prague Codex was made by Čestmír Loukotka who concluded that it was a clear fabrication produced approximately in the eighties or nineties in the 19th century. According to the author, the material the Codex is written on is mostly genuine and original (Liberecký kodex (Liberec Codex), Československá ethnografie, IV – 1956 – 1, pp. 68–79).

The analysis proper of the Prague Codex was started based on the experience collected during the studies and computer-aided assessment of hundreds of Maya data in the Dresden Codex and hieroglyphic inscriptions on monuments in church settlements.

The Codex is made of plant fibers coated with white plaster on which hieroglyphic text, data and accompanying pictures are painted using a fine brush. The Codex is 2834 mm long and folded in a pop-up form, consisting of eighteen pages of 155 x 265mm average size. The Codex is painted on both sides of the band, which means it includes 36 pages. The structure and design of the Codex supporting section, i.e. the fibrous material, surface layer, page size and degree of wear, are practically same as those of the Dresden Codex, Paris Codex, Madrid Codex, and Codex Grolier. The coloring of the base layer, which is designed for painting and record making, is slightly different on individual pages, being gray to yellowy, sometimes with pinkish tint, similarly, for example, to the Madrid Codex. Judging from the workmanship and external appearance, the Codex could be clearly considered as a monument of Maya provenance, dating back to the 9th up to 11th century. Even a higher shift to the history cannot be excluded.

Individual pages contain both horizontal and vertical bands of hieroglyphs, days of a twenty-day cycle, plus vertical columns of figures imitating the system of Maya counting and numerous color pictures with apparently Maya themes, which cover most parts of individual pages.

Fig. 1 – Sequence of Mayan Twenty-days cycles on page 1 of Prague Codex

Fig. 2 – Sequence of Mayan Twenty-days cycles on page 4 of Prague Codex

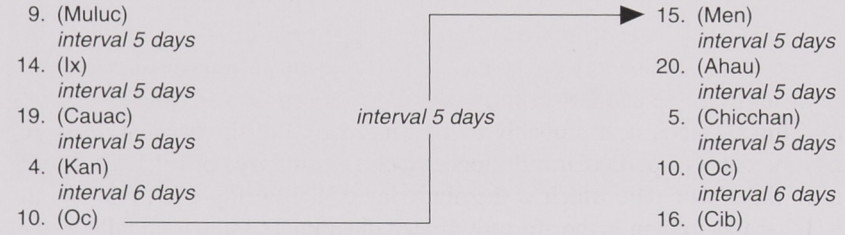
Color Pictures and Columns of Figures

The pictures and figures had been made after removal of part of the original Maya calendar and numeric records, possibly drawings, too, which probably were not attractive enough for the Codex holder. Several different original resources, certain motifs of which were repainted without major changes, had been used as a pattern. Those included, above all, the Madrid Codex and Dresden Codex, as well as certain motifs from Aztec codices and decorative elements of the Aztec calendar stone. The remaining blank surfaces had been filled up with numerous figures, apparently in the Maya numeric system, but frequently in incorrect combinations, which cannot really exist. The figures lack any mutual interconnection and relation to dates of the twenty-day cycle, the hieroglyphs of which accompany the columns of figures. In the Dresden Codex, for example, the mass of numeric data recorded in the Maya counting system are always connected to individual dates of the twenty-day cycle, sometimes even the 365-day cycle, which form integral part of calendar dates. The mixture of pictures from areas and sources, which are absolutely different in time and place, their almost Secession ornamental decoration and, simultaneously, use of incorrect records of non-existing figures demonstrate that it was a work of a non-professional in Maya themes. In this case, we probably cannot consider the Codex as forgery because the original was almost totally destroyed and repainted, probably for purposes of certain social representation of one of former holders. Should anybody wish to create a real forgery, which would be at least moderately credible, he would have had much more opportunities for that. That was not probably the case, however, of the Prague Codex. Č. Loukotka correctly identified the part of the Prague Codex as forgery.

Horizontal and Vertical Lines of Twenty-Day Cycle Hieroglyphs

The hieroglyphs are mostly original components of the Codex that had not been destroyed, fortunately. If individual painted hieroglyphs of the twenty-day cycle are marked with numbers from one to twenty, then the sequence, algorithm and structure of numerous lines are exceptional into such an extent that the part could not have been painted by the author of the other re-paintings using the form of randomly chosen characters. That is because the author of re-paintings failed even to understand the simple way of numbering in the Maya calculation system. That is indicated by columns of numbers accompanying numerous pictures, which are written absolutely incorrectly from the value 20 upwards. In his analysis of the Codex, Č. Loukotka incorrectly considered the structure of vertical and horizontal lines of twenty-day cycle hieroglyphs to be illogical and insignificant, except for striking decoration.

All original lines of twenty-day cycle hieroglyphs forming the numeric structures will be included and assessed in a synoptic diagram forming part of a detailed study of the Prague Codex, which is being prepared. Let us review in this paper just a small section of page 1 and page 4. Individual Maya names of days are marked with numbers 1 up to 20 depending on their position in the twenty-day cycle (see the illustrated supplement). Page 1 includes two columns of hieroglyphs, the numeric sequence of which is as follows (see the illustrated supplement).



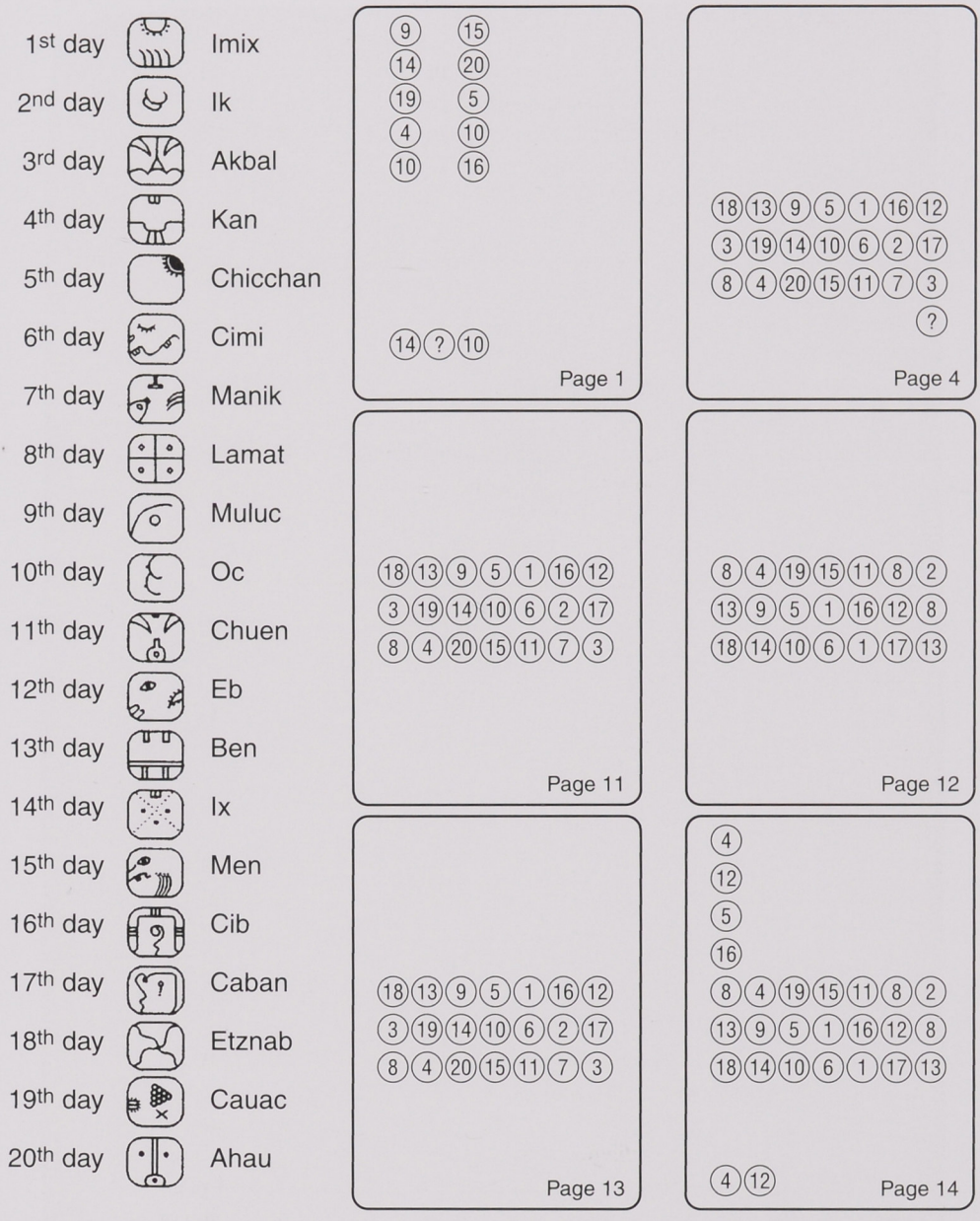


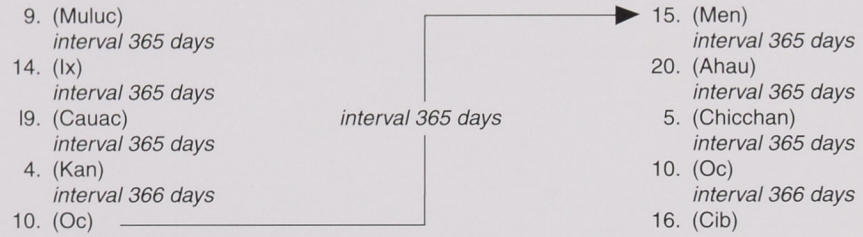
Fig. 3 – Mayan twenty-days cycle.

There are numeric differences between individual days, which are 5, 5, 5, 6, 5, 5, 5, 5, 6 days. Naturally, such a sequence could not have appeared in the random drawing of individual characters of the twenty-day cycle. Only an expert in Maya calendar could do it, but not a painter from the late 19th century who did not even know the basic rules for writing Maya figures. There, it is probably an original record of the tropical year progress, specifically the dates of particular milestones, such as equinoxes or solstices. If 365 days are added to the Muluc day, which is the ninth day of the twenty-day cycle and the first day of the left-hand column in the aforementioned diagram, the sum total falls on the four-

Fig. 4 – Sequence of Mayan Twenty-days cycles on page 13 of Prague Codex

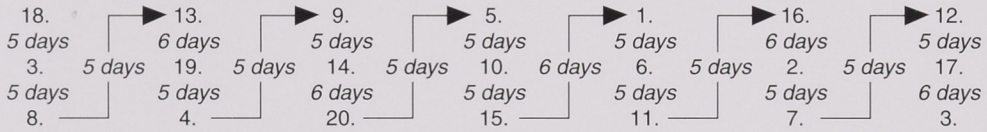
Fig. 5 – Sequence of Mayan Twenty-days cycles on page 14 of Prague Codex

teenth day, which is the Ix day as exactly marked in the given data set. That means the five-day and six-day intervals should be replaced by 365-day and 366-day cycles.



The sum total of all differences between individual days of the twenty-day cycle can be expressed by the following equation: (7 x 365 days) + (2 x 366 days) = 3287 days, which includes exactly nine tropical years (365.242199 days), the error being only – 0.18 days. Such a configuration of a numeric sequence could not have appeared in the random drawing of characters of the twenty-day cycle. The same counting system can be found in the Dresden Codex, too.

Page 4, similarly to the other pages of the Codex that follow, contains a configuration of columns consisting of three days with analogical relation to that on the first page. For illustration, names of days in the twenty-day cycle were again replaced by numbers in the sequence of their positions in this Maya cycle. Again, intervals between individual days in vertical columns are five or six days (see the illustrated supplement).



Using the same algorithm as that on the first page of the Codex, we can get five same groups with regular repeating time intervals between days of the twenty-day cycle, namely 5 days, 5 days, 5 days, 6 days. The five-day and six-day intervals are again replaced by 365-day and 366-day cycles, like with the data on the first page. The resulting sequence is 5 x (3 x 365 days + 1 x 366 days), which equals 7,305 days or 20 tropical years, the error being – 0.16 days. In this case it is a calculation of the exact duration of tropical year, as used nowadays also, that means adding leap year. After three 365-day years, Mayas also inserted a leap year with 366 days. The Mayas tried to express with such calculations the actual duration of tropical year (365.242199 days) using available means because they did not know decimal numbers. The calculation procedures were identified already in the analysis of calendar data in the Dresden Codex. Numerous researchers interpret incorrectly the conclusions of astronomic observations and calculations, claiming that the Mayas knew exactly the duration of one tropical year correct to three up to five decimal places. Undoubtedly, that is a wrong assumption. The Mayas only could determine very exactly the duration of twenty, fifty, one hundred or more tropical years in days. If the number of days determined in this way is divided by the tropical year lasting for 365.242199 days, a whole number really can be calculated very exactly. The aforementioned analysis of data on page 4 indicates that the sequence of days of the twenty-day cycle contains 7,305 days. If divided by the exact duration of the tropical year, the resulting value is 20.000427 years. That means the average duration of tropical year on page 4 is 365.25 days, meaning the same duration that is used for calculations in the present.

There are five-day and six-day intervals between days of the twenty-day cycle on page 4, which pertain to the progress calculation of tropical year. If horizontal lines are analyzed, the intervals between individual dates are 15 or 16 days (see the illustrated supplement).

Interval	Interval	Interval	Interval	Interval	Interval
18. *15 days*	13. *16 days*	9. *16 days*	5. *16 days*	1. *15 days*	16. *16 days*	12.
3. *16 days*	19. *15 days*	14. *16 days*	10. *16 days*	6. *16 days*	2. *15 days*	17.
8. *16 days*	4. *16 days*	20. *15 days*	15. *16 days*	11. *16 days*	7. *16 days*	3.

The same relations between days of the twenty-day cycle follow on next pages 5, 6, and 7, and then in one continuous line on pages 11, 12, 13, and 14 (see the illustrated supplement). The 15-day and 16-day intervals between days indicate that those are four subsequent cycles of the visible synodic circuit of the planet Venus, probably from one heliacal planet rise to the next one following four circuits. The fact that the Mayas had been looking for algorithms in the form of numeric abaci for the simultaneous expression of two or more planetary phenomena was found out already during the analysis of the Dresden Codex. The average duration of the Venus synodic circuit is 583.921394 days. The actual duration, however, is 577 up to 592 days. Not knowing decimal numbers, Maya astronomers used for their calculations the average value of 584 days and only 583 days after several circuits. After a couple of decades they received the exact duration of the planet synodic circuit. The 16-day interval between two adjacent days of the heliacal rise should be replaced by the cycle of 4 x 584 days, i.e. 2,336 days. The 15-day interval between adjacent days corresponds to the cycle (4 x 584 days) – 1 day, i.e. 2,335 days. The calculation of the exact duration of the Venus synodic circuit can be demonstrated on the first line of days of the twenty-day cycle. For illustration, it is rotated to the vertical position and accompanied with Maya names for individual days.

18. (Etznab)	
15 days => (4 x 584) – 1	= 2335 days
13. (Ben)	
16 days => 4 x 584	= 2336 days
9. (Muluc)	
16 days => 4 x 584	= 2336 days
5. (Chicchan)	
16 days => 4 x 584	= 2336 days
1. (Imix)	
15 days => (4 x 584) – 1	= 2335 days
16. (Cib)	
16 days => 4 x 584	= 2336 days
12. (Eb)	
Sum	**14014 days**

14,014 days contain exactly 24 synodic circuits of the Venus (583.921394 days), the error being – 0.113 days. Besides, the interval of 2.336 days is a typical duration of the period when the Venus is in conjunction with the Mars. It can be assumed that the table on page 4 and tables on pages 11–14 are designed for the calculation of the duration of tropical year, the Venus synodic circuit and, possibly, the conjunction between the Venus and the Mars (see the illustrated supplement).

Similar calculations for various astronomic phenomena were found by us in data from the Dresden Codex, which were presented and published by us in world congresses of archeology and protohistory (Bratislava, Slovak Republic 1991, Forli, Italy 1996, Liege, Belgium 2001) and in the annual report entitled AMERICA ANTIQUA III, which was published by VLAAMS INSTITUUT VOOR AMERIKAANSE KULTUREN, Belgium in

1999. In addition to numerous other examples, mentioned in this context can be pages D 30–37 from the Dresden Codex where there are 69 subsequent hieroglyphs of the twenty-day cycle in each of three lines, for example the days Kan – Imix. There is an interval of only 17 days between those days within the twenty-day cycle. Similarly to all other occurrences in the Codex, both days are supplemented with numbers from the thirteen-day cycle, meaning the numbers are in the format 6 Kan – 1 Imix. The combination of the twenty-day cycle days and thirteen-day cycle days makes up the sacred 260-day cycle – Tzolkin. Within the Tzolkin, there is the interval of 177 days between days 6 Kan and 1 Imix, which interval is directly marked between the two days using the Maya numeric system.

6 Kan – *177-day interval* – 1 Imix

The interval of 177 days is the period of time from one eclipse of the sun to the next one.

In addition to the aforementioned numeric interval of 177 days between two adjacent days, there is also the quantification of all past days (long number) from the beginning of Maya chronology to the day 6 Kan and, 177 days later, to the day 1 Imix. There are numerous cases in the Dresden Codex of marked intervals of tens up to thousands of days inserted between days of the twenty-day cycle, although just three days, for example, would suffice from one day to the next one within mere twenty days. Unfortunately, such a situation cannot be found in the Prague Codex because the necessary additional numbers of calendar data, or the long number, were artificially removed. Maintained are only lines of days of the twenty-day cycle with their mutual time intervals expressing certain other regular cycles, which are by no means accidental, such as repeating intervals of 5, 6, 15, and 16 days. As discussed below, the accompanying data within the Maya counting system, which clarify and supplement relations between days of the twenty-day cycle, had been removed as uninteresting from the Codex and replaced by meaningless pictures with seemingly Maya themes. The analysis of meanings of the intervals lasting for 5, 6, 15, and 16 days and the structure of their arrangement indicate that the intervals pertain to astronomic phenomena. The mathematical analysis revealed that those are most probably calculations of the exact duration of tropical year and, possibly the duration of the Venus synodic circuit and duration of the conjunction between the Venus and the Mars. Pages 1, 4, 6, 7, 11 through 14, 24, and 35 of the Prague Codex are exceptionally important as they prove the genuine base of this very rare Maya monument. Evidently, the algorithm of the day alternation in the twenty-day cycle in the Prague Codex excludes any chance, which would have necessarily been applied by the imitator featuring such low professional qualities like the author who had repainted original parts in the Codex. Control modeling of random number structures of the same configuration as those on Prague Codex pages and probability analysis of mere random occurrence of the aforementioned phenomena result in such a low probability that it cannot be practically defined – less than 10^{-9}.

The more detailed analysis of groups of lines and columns of data in the twenty-day cycle revealed that part of the records, i.e. paintings of individual days, were created in a slightly different graphical way rather than the characters in the evidently original lines and columns of days. The probably original lines and columns consist of groups of characters each of which is marked off by a contour in the form of more or less a square with round-

ed corners. Part of characters that had been painted, in our opinion, later on, i.e. simultaneously with the repainting of the original Codex, feature almost round contours and smaller area rather than the original square hieroglyphs representing individual days. The oldest original records can be found especially on pages 1, 4, 6, 7, 11, 12, 13, 14, 24, and 35, describing evidently the aforementioned planetary phenomena. Forged Maya characters for days are most probably on pages 17, 18, 21, 27, 29, 30, and 34. It was not possible to clearly determine whether or not certain lines and columns were genuine. Interestingly, the original calculations of the tropical year duration in the Prague Codex are formally – meaning, with regard to the selected calculation numeric method – analogical to those found out before in the Madrid Codex on pages M13 through M18. Algorithms consisting of four lines are used to express durations of tropical year using dates of the twenty-day cycle in the Madrid Codex. Those are optically different structures rather than those painted in the Prague Codex where only three-line sets are used (see the illustrated supplement). The tropical year duration is recorded in four lines of days of the twenty-day cycle only on page 35.

The results of the analysis of original date sequences in twenty-day cycles are as follows:

Page 01 – 2 columns of related dates. Those are probably a pattern illustrating the way of tropical year calculations on next pages. There, nine tropical years are described, correct to mere 0.18 day.

Page 04 – 7 columns of dates, 3 lines. 20 tropical years in columns, correct to 0.16 day. The first and second lines contain 24 synodic circuits of the Venus, correct to 0.11 day. The third line contains 24 synodic circuits of the Venus, correct to 0.89 day.

Page 06 – 7 columns of dates, 3 lines. 20 tropical years in columns, correct to 3.8 days.

Page 07 – Since one character is illegible, only the first four columns of dates can be used. The columns describe a total of 8 tropical years, correct to 0.06 day. Three (shortened) lines describe 24 synodic circuits of the Venus, correct to 0.11 days.

Page 11 – 7 columns of dates, 3 lines. 20 tropical years in columns, correct to 0.16 day. The first and second lines contain 24 synodic circuits of the Venus, correct to 0.11 day. The third line contains 24 synodic circuits of the Venus, correct to 0.89 day.

Page 12 – 7 columns of dates, 3 lines. 20 tropical years in columns, correct to 0.16 day. The first and second lines contain 24 synodic circuits of the Venus, correct to 0.11 day. The third line contains 24 synodic circuits of the Venus, correct to 0.89 day.

Page 13 – 7 columns of dates, 3 lines. 20 tropical years in columns, correct to 0.16 day. The first and second lines contain 24 synodic circuits of the Venus, correct to 0.11 day. The third line contains 24 synodic circuits of the Venus, correct to 0.89 day.

Page 14 – 7 columns of dates, 3 lines. 20 tropical years in columns, correct to 0.16 day. The first and second lines contain 24 synodic circuits of the Venus, correct to 0.11 day. The third line contains 24 synodic circuits of the Venus, correct to 0.89 day.

Page 24 – 7 columns of dates, 4 lines. One piece of data in the last line is illegible; therefore the line is not analyzed. The first line contains 24 synodic circuits of the Venus, correct to 0.11 day. The second line contains 24 synodic circuits of the Venus, correct to 0.11 day. The third line contains 24 synodic circuits of the Venus, correct to 10 days. Tropical year is not monitored.

Page 35 – Only the last 5 columns of dates and 4 lines are complete. Those include 20 tropical years, correct to 0.84 day. The Venus is not monitored.

Photographic Method and Determination of the Prague Codex Genuineness

When photographing the Prague Codex, bulbs with light spectrum expanded into the ultraviolet radiation were used in addition to normal ones. Due to the special way of copying positives by means of overexposure, residues of original numeric lines in the Maya calculation system and, probably, calendar dates are slightly visible on many photos. There is even the character for zero in one case and a couple of original hieroglyphs, which had been removed and repainted. Having analyzed the structure of lines of hieroglyphs in the twenty-day cycle, we managed to learn their system and reveal traces of original records on certain pages. Judging from the findings, we consider the Codex as clearly genuine. Since pages probably contained only calendar data accompanied with characters of the twenty-day cycle, without any depictions as known from the other Maya codices, the monument was not probably too precious for its holder. The character of pages could remind of page D 38 of the Dresden Codex, which page contains only numeric intervals between days of the twenty-day cycle depicted by hieroglyphs without any accompanying pictures. The imitator had probably washed off the surface layer of the plaster, maintaining just certain lines of attractive hieroglyphs of the twenty-day cycle, and painted on the resulting blank places motifs taken over from other original sources. Then, the result had been supplemented with columns of Maya figures, sometimes in the combinations that cannot exist. Again, we can conclude that the oldest and, consequently, original records of hieroglyphic lines of the twenty-day cycle are on pages 1, 4, 6, 7, 11, 12, 13, 14, 24, and 35. Forged characters for days are most probably on pages 17, 18, 21, 27, 29, 30, and 34. The arrangement of days within the twenty-day cycle is chaotic, lacking any inner system. The handwriting of characters is slightly different from that of characters on pages that are considered as original and genuine. The aspect of genuineness could not be clearly determined in certain lines and columns of hieroglyphs.

The pictures are based partially on motifs from the Dresden Codex and, mainly, Madrid Codex. Pages 21 and 23 draw from adapted Aztec motifs including frequent framing of days of the twenty-day cycle. Lines of pictures are mere fantasies of their author. No motifs from the Paris Codex were found. We can also determine the approximate time when the Codex had been repainted, which fact must be called barbaric. Most motifs were taken from the Madrid Codex. Its first part entitled Troano had been published in 1869. The second part, known as Codex Cortesianus, had been published in 1883. It was probably after that year when the original contents of pages were removed and pictures repainted. It is possible that qualified changes and re-paintings had been made in the Prague Codex as early as in the Maya cultural era, which fact was demonstrated in the Dresden Codex, too.

Conclusion

The Prague Codex being, unfortunately, a victim to stupidity, cultural arrogance and snobbery, is basically an original of exceptional significance. Since 1739 when the Dresden Codex was found as the first one, it is only the fifth original Maya manuscript. We should be pleased that such an important cultural monument bearing the name of our capital is part of collections in one of the top Czech cultural and scientific institutions – Náprstek's Museum in Prague. A detailed analysis of the Codex using state-of-the-art photographic methods in different light wavelengths is being prepared. The analysis could possibly help to reveal, at least partially, the original contents of its individual pages.