

# Światowit

ANNUAL OF THE INSTITUTE OF ARCHAEOLOGY  
OF THE UNIVERSITY OF WARSAW

VOL. VIII (XLIX)  
(2009–2010)

FASCICLE A

## MEDITERRANEAN AND NON-EUROPEAN ARCHAEOLOGY



WARSAW 2011

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**Światowit**  
**Annual of the Institute of Archaeology of the University of Warsaw**

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ISSN 0082-044X  
ISBN 978-83-61376-927

Cover design: Joanna Kalita  
English language consultant: Grzegorz Żabiński  
Typesetting: Jan Żabko-Potopowicz  
Printed by: Janusz Bieszczad, Warszawa, ul. Moszczenicka 2

Editorial address: Institute of Archaeology of the University of Warsaw,  
Krakowskie Przedmieście 26/28, 00-927 Warsaw

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ARKADIUSZ SOETYSIAK, ARNOLD LEBEUF

## POHUALLI 1.01. A COMPUTER SIMULATION OF MESOAMERICAN CALENDAR SYSTEMS

The calendar system used by peoples of Mesoamerica, at least from the times of origin of the Maya civilization, has been based not exactly on simple observations of movements of celestial bodies but rather on a mathematical model of solar, lunar and Venus synodical cycles. Because of this it can be very easily represented in the form of algorithm processed by modern computing machines. And actually, in the course of a dozen or so years numerous computer programs serving for calculations of Mesoamerican equivalents of Gregorian or Julian dates have come into existence (see the list at <http://archaeology.csumb.edu/Courses/Aztec/AztecLinks.htm>). However, most of them were written by scholars for personal use or for use of few colleagues, usually in order to solve a specified problem. For this reason these programs are usually characterised by simple interface, constant parameters of calendar cycles and one-way manner of data searching. Thus they are not suitable for more advanced purposes.

Consequently, we made up our mind to create a multi-variable and flexible system which could be useful especially in testing of all sorts of Mesoamerican calendrical hypotheses as well as in research on chronology, archaeology and astronomy; what is more – a system with simple and effective interface. This way from the end of 1995 till summer of 1996 a program named Pohualli (from Tonalpohualli – a Nahuatl name of the 260-day cycle) was being born in the Department of Historical Anthropology in the Institute of Archaeology of the Warsaw University. It was written in Turbo Pascal 6.0 with the use of Turbo Vision 1.0 for DOS. Thus the easy to learn and clear standard interface was applied. All variables and parameters are set up in dialog boxes logically well-ordered in unfolding menus. The status line at the bottom of the screen gives a short notice about current user's activity. Finally in the middle part of screen there is the place for numerous report, tool and help windows as well as for dialog and message boxes. Additionally, in each moment the contextual help may be shown by pressing the <F1> key. Messages, descriptions and topics are in Spanish since this language is valid in Mexico, the main center of studies on ancient Mesoamerican cultures.

The most important dialog box is displayed on the command [Calendario/Hoja de datos]. It contains general variables used in searching for dates: Julian Day Number, Julian and Gregorian dates, week day name, Long Count date, 260-, 365- and 9-day cycles, year bearer of the Mesoamerican calendar, parameters of the Moon orbit (a day of



Fig. 1. Sample screen of the Pohualli 1.01 program.

Ryc. 1. Przykładowy zrzut ekranu z programu Pohualli 1.01.

the synodical cycle and a position in days in relation to orbit nodes), a day of the Venus synodical cycle as well as the position of Sun in relation to constellations, to the conventional Zodiac and to the Earth (in Gregorian notation). Each variable, expressed in full days, must have its scope defined; in the report only these dates are placed for which all variables are contained inside the scope. It corresponds with the logical operator AND. The scope can be positive (the first value lower than the second) or negative (the first value superior). In addition, an interval between two examined dates can be defined, and one may also try to change reference points of some cycles (the cells in the column [Corrección]). After defining all variables and confirming these definitions, the program starts searching for required dates. Each experiment can always be interrupted by pressing <Esc>.

After the end of searching a report window is displayed which contains a full description of the experiment as well as a list of all days for which all variables had proper values. Three types of report are available: a table when one date occupies one line, a form when variables of one date are composed as a card; the last one is a file with records delimited by commas. This last type is assigned for exporting data to other applications: databases, spreadsheets or word processors.

During one session of the program, numerous report windows can be simultaneously placed on the screen; the sole restriction arises from the capacity of allocated operational memory. The commands collected in the menu [Ventanas] enable one to change the size and position of a selected window, to move from one window to another and to arrange all windows on the screen.

Each report is displayed automatically after the end of the session or the system suspension. Furthermore, one

can remove it from the screen and return to it later with the use of the command |Archivo/Abrir informe|. The reports (that is also the experiments) are marked by serial unique numbers. The command |Archivo/Guardar informe| allows to save specified report as a text file, the next one |Archivo/Imprimir informe| affords possibilities for printing a report, naturally if the printer is connected to a port chosen in the dialog box |Opciones/Impresora|.

The structure of a report is flexible, and all records in all three types of reports can be edited, removed or replaced by other ones. It also refers to the report header containing a report number and a description of the experiment. Lists of titles and parameters, separately for each header, table and form, as well as comma delimited records, may be modified in the menu |Opciones/Diseñar|.

Except the main data sheet, the program also comprises some more dialog boxes. These enable the user to set up less important calendrical and astronomical variables and to fix correlations between Mesoamerican and European calendars as well as between particular components of the calendar. All these commands are collected in the menu |Calendario/Variables|. The first one (|Establecer referencia|) enables one to change shifts of 260-, 365-, 9-day cycles and the Long Count date in relation to the Julian Day Number. In the following ones we have a possibility of:

- setting up the reference point (a day in 365-day cycle) of the year bearer;
- setting up the first month in the year (command |Portador del año|);
- fixing the scope of external and internal numbers of the 819-day cycle;
- defining the shift of the 819-day cycle in relation to the Julian Day Number;
- fixing the scope and shift of the cycle of Direction/Color;
- fixing the scope of digits of the Long Count date, each of them individually (command |Otros ciclos|);
- fixing the scope of synodical cycles of Mercury, Mars, Jupiter and Saturn (command |Otros planetas|).

The next option |Ciclos opcionales| is very important for these who seek to proof various hypotheses concerning other calendar cycles than these which are already included in the program. The dialog box displayed by this command consists of a table with six columns and three lines; particular lines contain in turn the definition of integer (i.e. calendar), the real (i.e. astronomical) and the repeated cycle. The last one is composed of up to twelve digits, and is used analogically to the Long Count notation, but with the unrestricted range of each digit. In the line one must designate the following variables:

- switch of activity (on or off);
- the first Julian Day Number of the first cycle (integer value, in the case of the astronomical cycle one must choose a day when the beginning of the cycle happens with smaller fractional part of JDN);
- the length of the cycle (respectively integer, real and

repeated value);

- the scope of the cycle (two variables);
- the correction (or shift) of the beginning of the cycle in relation to the Julian Day Number.

When a certain cycle has been switched on, after confirmation the dialog boxes with definition of report would be called automatically.

The last dialog box in the menu |Variables| enables one to set up automatically the shifts of Mesoamerican calendar variables according to a given date (e.g. from an inscription). All variables are divided into three groups: European dates, more important Mesoamerican cycles, additional Mesoamerican cycles. In the beginning, the dialog box is empty. One can fill up one or more cells but bearing in mind some principles. Namely, at least one date in the two first groups must be given. Additionally, in some cases if too many dates are input in the two last groups, counting must be done twice or divided into two stages (e.g. when one can try to set up simultaneously 260-, 365-day cycles and the year bearer).

In the program two equiponderant calendar systems are implemented, the Maya and the Nahuatl. They are switched from one to the other by the command |Opciones/Lenguaje|. They differ from each other not only in the names of months in the 365-day cycle and days in the 260-day cycle, but also in several important details. In the Maya system the first day of the month has the number 0, in the Nahuatl system – the number 1. What is more, in the Maya calendar the first day after the 5-day month is the year bearer reference point, while in the Nahuatl calendar it is the last day before.

Furthermore, the menu |Opciones| contains three other dialog boxes enabling one to set up the system options: colours of all views of the program, with a palette depending on the current display mode, the port of printer as well as the type of report. In the submenu |Utilidades| one can find three useful tools too: the Gregorian calendar, an ASCII characters table and a 15-digital calculator. The changed options may be saved in a file or loaded from a file. The same concerns other variables, and separately the description of the experiment and the designs of report types.

In the Pohnualli program the contextual help system is applied. A window with explanation always becomes visible in the lower right quarter of the screen. References to other topics are usually applied in the text. One of them can be appointed using the tabulation key and displayed by <Enter>. Up to 256 last topics are memorized in the buffer.

The above short description mainly refers to the visible part of program, but the invisible mechanisms are at least of just the same importance. Of course, a user of the program is not forced to know all algorithm details. However they are some subjects that must be explained because of a possibility of mistakes and errors. The first of them is the manner of report storing during the work of the program. After each experiment at least three temporary files are placed in the current directory: the first with



a description of the experiment, the second with found dates, and the last one with the report. For this reason, when the current directory has changed, one can not open reports from before the change. Instead, in the case of a system crash, if the temporary files have been saved, all lost reports are automatically shown on the screen.

Another problem is connected with all astronomical variables. Because of using median values of synodical cycles, all of them have a limited precision:  $\pm 1$  day in historical times, adequately more when later in the future or in the past. Thus we recommend to check up obtained values in astronomical tables. Relatively the best situation is in the case of Venus where a linear calibration is applied, but care is also recommended here.

The version 1.00 of the Pahualli program was presented during the V<sup>th</sup> Oxford Conference on Archeoastronomy held in Santa Fe, NM, USA, from 3<sup>rd</sup> to 10<sup>th</sup> August 1996. The new version 1.01 comprises only some

minor corrections, mainly in the help file. Also one error in algorithm has been removed. It consisted in the unsuitable week day scope when Friday was entered into the input line. The full free version of the Pahualli program (version 1.01) is available in Internet, at the address: <<http://www.le.ac.uk/has/cr/oldrug/aa/progs/pahualli.html>>

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#### POHUALLI 1.01. KOMPUTEROWA SYMULACJA MEZOAMERYKAŃSKICH KALENDARZY

System kalendarzowy używany przez ludy prekolumbijskiej Mezoameryki oparty był nie na prostych obserwacjach ruchów ciał niebieskich, lecz raczej na matematycznym modelu cykli widoczności Słońca, Księżycy i Wenus. W związku z tym można go dość łatwo przekształcić w algorytm wykorzystywany przez program komputerowy. Taki właśnie program, nazwany Pahualli, został opracowany w latach 1995–1996 (wersja 1.00) w Zakładzie

Antropologii Historycznej IA UW jako rodzaj elastycznego narzędzia do testowania rozmaitych hipotez dotyczących korelacji poszczególnych elementów mezoamerykańskiego kalendarza z różnymi cyklami astronomicznymi. Poprawiona wersja 1.01 jest dostępna w Internecie pod adresem: <<http://www.le.ac.uk/has/cr/oldrug/aa/progs/pahualli.html>>