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CREATING A PHENOLOGICAL DATABASE FOR COLLECTIBLE GENE POND OF MANGYSHLAK EXPERIMENTAL BOTANICAL GARDEN WITH USE OF SPECIAL COMPUTER «Feno-S» PROGRAMS

Abstract. The characteristic of the special computer program "Feno-S" created in the MEBS is intended to enter phyto-phenological information into the computer's memory for further operative search, mathematical processing, identification of pheno-indicators of plants, printing, building histograms and phenospectra, exporting to various text and graphic formats, compiling reports and lists for given taxonomic, bioecological, decorative and phenological parameters. A description of a simplified method of collecting, systematizing and preparing phenological studies for importing into electronic databases is given. Information is presented on the composition and structure of the database formed to date, including 130 information fields of symbolic, numerical, logical and temporary type and 3919 records by year for 533 taxa from 5 systematic departments, 8 classes, 11 subclasses, 24 superorders, 49 orders, 8 suborders, 52 families and 108 genera. Lists of the quantitative distribution of plants by morphologic and systematic groups, the most representative families and genus complexes are given.

Key words: phenology, databases, computer program, statistics of series of observations, correlation, histograms.

Introduction. Phenology, as a science,was based in the second half of the 18th century by the French scientist R. Reaumur and the Swedish scientist K. Linnem; it represents the system of knowledge of seasonal natural phenomena, terms of their beginning and the reasons, defining them [1]. Present days there are many interpretations of phenology, but the most objective definition was given last century by the famous Russian phenologist A.I. Rudenko at the first All-Union Phenological Meeting: "phenology is the science which studying regularities of seasonal development of a plant and animal life, and also the phenomena of the inorganic nature in their interrelation and interaction" [1, 2].

According with V.A. Batmanov [2] classification all researches of seasonal development of the most different objects can be subdivided into theoretical and applied phenology. Depending on objectives and the industry of the national economy the author includes agricultural, forest, hunting and transport phenology in the list of the 2nd type of phenology. According to sections of knowledge it is usually selected landscape, meteo,- zoo-, hydro- and plant phenology (phytophenology).

For botanical gardens the phenological observations are one of the principal directions the introduction test which have crucial scientific and practical importance for selection economic, valuable and adapting to a local conditions assortment; diagnostics of prospects, terms of the beginning and the end of vegetation period, blossoming and fructification; creation beautiful and constantly blossoming compositions of plants for purposes of the green buildings. Many scientists-botanists coordinate such major indicators of biological stability as winter hardiness, drought resistance, morphologic isomers of elevated bodies, qualitative and quantitative indices of the generative sphere with thephenological characteristics of introduced species [3-10]. The main criterion of introduction value of taxa is recognizing degree of compliance of dynamics of seasonal development to meteorological conditions of the area of cultivation in comparison with areas of natural origin. In this time collecting of phenological materials represents

very difficult research process caused by coverage of a large number of taxa, variety of the used concepts and terms; execution of a number of field and laboratory actions: visual observation, fixing of phenophases (until 22), filling of pivot tables, creation of phenoranges, the analysis of collected materials in connection with meteorological factors of specific year of researches and places of natural growth, etc. The most complex problem for an introductory is mathematical processing of phenological materials as all seasonal phenomena should be transferred to sequence number of day in a year, beginning from 1st of January (1st of March), and after calculation of statistical parameters to return back in a date format.

Due to the intensive development of IT-technologies in practice of plant introduction for the purpose of decrease in labor input need of translation of phytophenological researches into the modern electronic programming languages containing tens of special commands and functions of work with dates and allowing not only to create the full database (BD), but also to make different graphic and text reports, to carry out statistical processing of research material and to export it to different file formats, and also to make exchange of phenological information through Internet. Therefore, since 2018, on the base of Mangyshlak Experimental Botanical Garden (MEBG) within execution of the special grant project "Development of Scientific-Methodical and Computer-Information Bases of Carrying Out Phenological Observations in Botanical Gardens of Kazakhstan for the Forecast of Prospects of Plant Introduction, Effective Saving and Use of Their Biodiversity" (2018-2020), it carries out works on creation the multi-function phenological computer program, called "Feno-S", which would be compatible to modern operating systems, graphics and text editors and containing necessary Web-applications.

Materials and methodology. Subjects of thephenological observations were species, varieties and forms of plants of the MEBG collection fund, including 1270 taxa from 250 genera and88 families [11]. Researches of seasonal rhythms of development were based on the standard concepts and terms applied in phenology [1-2, 6-8, 12-16]: 1) subject of observation; 2) seasonal phenomenon; 3) phenological date; 4) phenological phase; 5) interphase period; 6) phenological interval and 7) phenological indicator.

In the botanical centers of Kazakhstan as the main recommendation "The technique of phenological observations in botanical gardens of the USSR" is accepted [17], which was included in 1987 in structure of the book "Techniques of the introduction researches in Kazakhstan" [18] and assumed fixing of seasonal rhythms of development separately in three morphological and systematic groups of plants: grassy, deciduous and coniferous woody plants. On this system of observations for each vegetative and generative body of introduced species during vegetation was registered data with a frequency at least two weekly; and within not less than 5 years the phenological formula is fixed which reflected a plant status. All phenophases which are observed at the moment time were fixed and quantitative parameters were noted by means of a mark by digits before designations of a phenophase: I - in case of the introduction in a phenophase less than 50% of samples; 2 – more than 50%. For researches, according to "A technique of phenological observations …" [17-18], was selected not less 5 model samples of each species. Studying of plants of different age and origin was carried out separately for reflection of intraspecific phenological heterogeneity.

Complication the algorithms of mathematical processing of research material was based on G.F. Lakin's techniques [19] and B. A. Dospekhov [20]. For development of the computer program are used 4 programming languages: Microsoft Visual FoxPro 9 SP2, Visual Basic For Applications 7.0, HTML 4.0 and JavaScript API 2.1. At structure formation of DB saving of phenomaterials was provided in two formats: actually dates in 10 symbols (for example, 17.04.2019) and in numerical - as the number of calendar days before aphenophase from a reference point – (for example – 1st of January every year (98). It considerably simplified the procedure of a statistic treatment of material of researches. Correlation coefficients were calculated as the data between terms of approach of phenophases of the same plant in different years of observations, and with meteo-factors of point of an introduction.

In phenological databases taxonomical and registration information about plant was initially entered as the indication of Latin, Russian, Kazakh names, arrangements in the Garden, numbers of registration, the donor-organization, a type of initial reproductive material, etc. For simplification of input of taxonomical units in the computer program lists of genera according to R.K. Brummitt are used [21]. The phylogenetic system is used according to A.L. Takhtadzhyan's systematics [22].

Results of researches and discussion. During developing the computer program "Feno-S" two basic principles were strictly observed: 1) The phenological DB would be closely connected by identification

indicators with collection; 2) In all algorithms of program modules information processing on seasonal development would be conducted separately for three groups of plants (deciduous and coniferous woody, grassy) owing to distinction of their morphological, ecological and biological properties. For the purpose of the solution of objectives of account, registration and mathematical processing of phenodates the structure of the main menu of the program included 11 points: "File", "Editing", "Input", "Search", "Viewing", "Lists", "Phenology", "Range", "Databases", "Service" and "Reference" (figure 1).

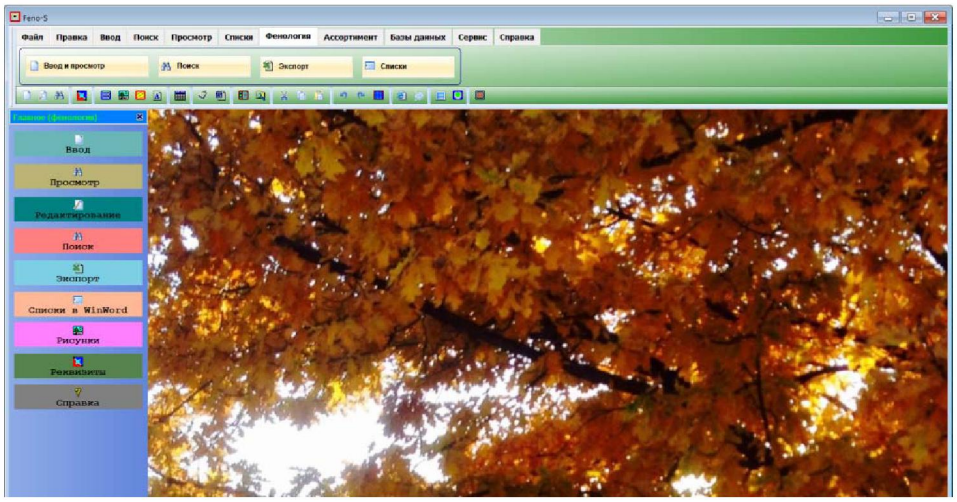


Figure 1 –The main menu of program «Feno-S»

The paragraph of Main Menu (MM) “File” includes a standard set of subparagraphs: "Open...", "My computer", "Printing", “Filer”, "Search of files", "Server", “Internet”, "Mail" and "Exit" is also intended for creation new and works with the available files, seals of information, sending it on the server and by e-mail and also an exit from the program.

The paragraph “Editing” is necessary for editing active text boxes of entry forms and viewing of information, and also for searching and replacement of words and expressions, setup of their font, color of letters and a background. From paragraph “Input” forms of filling of DB by new and editing already in-fed information are launched. "Search" allows looking for plants in DB in different options, including by any word or a fragment of a word from names.

"Viewing" is used for work with already in-fed information about plant with opportunities of its printing and export in external editors and programs in different formats - doc, docx, rtf, txt, pdf, xml, etc. Using the paragraph “Lists”, it is possible to create the most different reports about plants by taxonomical, morphological and other characteristics.

Actually four commands as "Input and Viewing", "Search", "Export" and "Lists" of point of MM “Phenology” realize a possibility of full work with information on seasonal rhythms of growth of plants as to the main objective of the “Feno-S program” (figure 1).

The paragraph of the Main Menu “Assortment” is included by three subparagraphs "On signs" "On value" and "On systematization" and is necessary for a conclusion from a DB some information on predetermined conditions. Point of MM “Data Base” is intended for implementation of the following commands: "Copying", "Restoration", "Export", "Import", “Re-indexing”, "Repair of indexes" and "Information about DB". In "Service" additional opportunities of "Feno-S" for its registration and a general setting, viewing of graphic materials and work with interactive maps on the Internet are collected.

The main entry form and viewing of phenological information is displayed in "Feno-S" at the same time with the list of Latin and Russian names of collection plants in alphabetical order (figure 2). During choosing the any taxa all information on a form is automatically updated. In the right part it is placed the list of years of the period of observations and control buttons intended for adding, copying and removal of the current year. In the lower part of a form a set of buttons for movement between years, export of information, permission of editing and saving of changes in the database is located. All phenoinformation as entered and estimated on this form is divided into 8 groups (pages): "Deciduous", "Coniferous",

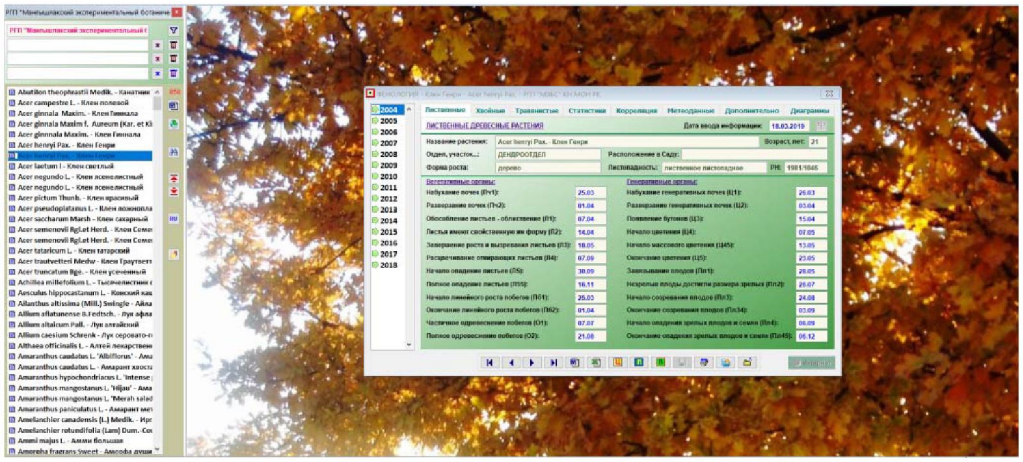
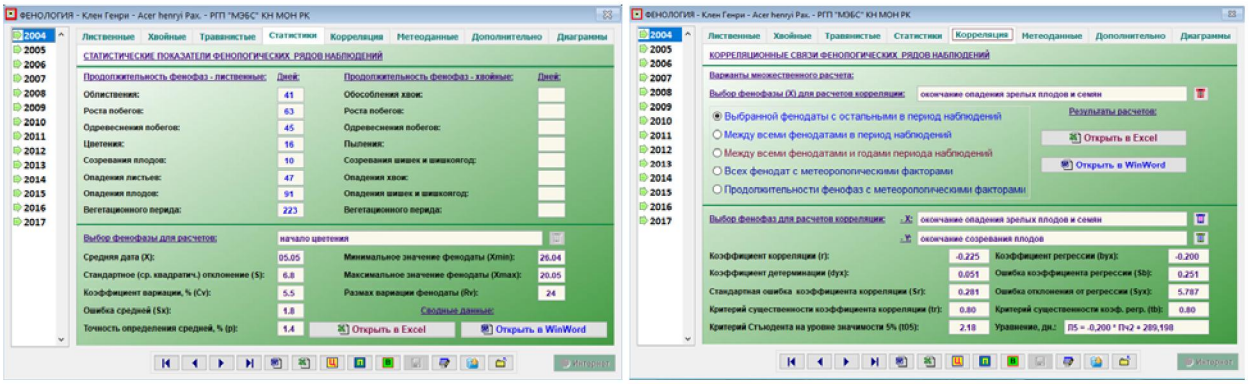


Figure 2 – Type of a form of input, viewing and processing of the phenological information ("Deciduous" page) with the list of names of plants

"Grassy", "Statistics", "Correlation", Meteodata", "In addition" and "Diagrams". On the first three pages it is implemented the opportunity for entering and editing information for each morphological and systematic group of plants.

On the fourth page (figure 3A) introduced in an electron shell algorithms allow to count sizes of duration of phenophases (leaf opening, blossoming, growth and lignification of shoots, maturing and subsidence of fruits, etc.) and also the main statisticians for the chosen phenological phase.



A – Page «Statistics» B – Page «Correlation»

Figure 3 – Theviewofsome pages of form input and viewing

Data on multiple statistical calculations can be obtained after pressing the corresponding buttons on the lower push-button menu. At the same time at choice in Microsoft Excel or Word the table containing the following indicators (table 1) will be created: number of observations (N, years); average date in numerical (X, days) and temporary formats (X, date); standard deviation (S); coefficient of a variation (Cv); error of an average (Sx); accuracy of definition of an average (p, %), minimum (Xmin) and maximum (Xmax) date and duration of phenophases and rank of a variation (Rv, days).

The page "Correlation" (figure 3B) is intended for establishment of correlation of communication between various phenophases and meteorological factors. Here it is possible to set 5 options of correlation calculations: 1) the chosen phenodates with the others during observations; 2) between all phenodates (a correlation matrix); 3) between years of the period of observations for all phenodates; 4) all phenodates with meteorological factors (a correlation matrix) and 5) durations of phenophases with meteofactors.

The computer program in the automatic mode carries out all necessary calculations and can send at the same time the tabular report in editors of Microsoft Excel or Word with granting the following parameters (table 2): coefficients of correlation (R) and determination (D_{yx}); error of coefficient of

Table 1 – Statistics of terms of approach and duration of phenophases
for Henry's maple (*Acer henryi*Pax.) during period of observation - 2004 - 2018
(N – 15 years, T05 = 2.16)

Phenophases, duration	X, days	X, date	S	C_v	S_x	p	X_{min}	X_{max}	R_v
Phenological phases									
Vegetative organs									
ПЧ1–swelling of buds	94	04.04	6,9	7,4	1,8	1,9	25.03	18.04	24
ПЧ2–opening of buds	99	09.04	7,0	7,1	1,8	1,8	02.04	24.04	22
ЛІ1–opening of leaves	104	14.04	7,3	7,0	1,9	1,8	06.04	30.04	24
ЛІ2 - leaves have the form peculiar to them	109	19.04	6,7	6,1	1,7	1,6	10.04	03.05	23
ЛІ3 - completion of growth and maturation of leaves	140	20.05	5,6	4,0	1,4	1,0	12.05	31.05	19
ЛІ4–coloring of dying leaves	244	01.09	7,7	3,1	2,0	0,8	24.08	11.09	18
ЛІ5 –beginning of fall of leaves	270	27.09	5,4	2,0	1,4	0,5	20.09	13.10	23
ЛІ55 –full fall of leaves	315	11.11	8,6	2,7	2,2	0,7	25.10	19.11	25
ПБ1–beginning of linear growth of shoots	111	21.04	7,9	7,2	2,1	1,9	11.04	07.05	26
ПБ2–endoflinear growth of shoots	178	27.06	15,4	8,7	4,0	2,3	12.06	28.07	46
О1–partial lignification of shoots	201	20.07	16,5	8,3	4,3	2,2	07.07	20.08	44
О2–total lignification of shoots	242	30.08	12,0	5,0	3,1	1,3	20.08	23.09	34
Generative organs									
ЦІ1–swelling of generative buds	95	05.04	7,2	7,6	1,9	2,0	27.03	20.04	24
ЦІ2–opening of generative buds	102	12.04	7,2	7,2	1,9	1,9	05.04	27.04	22
ЦІ3 – blossoming	111	21.04	8,6	7,7	2,2	2,0	16.04	13.05	27
ЦІ4–beginning of flowering	126	06.05	7,4	5,9	1,9	1,5	26.04	20.05	24
ЦІ45 –mass flowering	130	10.05	7,5	5,8	1,9	1,5	28.04	22.05	24
ЦІ5 –end of flowering	139	19.05	8,4	6,1	2,2	1,6	03.05	28.05	25
ПІп1–infructescence	144	24.05	4,9	3,4	1,3	0,9	16.05	31.05	15
ПІп2 - unripe fruits reached the size of mature	207	26.07	2,0	0,9	0,5	0,2	22.07	30.07	8
ПІп3 –beginning of maturing of fruits	237	25.08	1,9	0,8	0,5	0,2	23.08	29.08	6
ПІп34 –end of maturing of fruits	250	07.09	4,4	1,7	1,1	0,4	02.09	16.09	14
ПІп4 - beginning of subsidence of mature fruits and seeds	254	11.09	5,1	2,0	1,3	0,5	04.09	21.09	17
ПІп45 - end of subsidence of mature fruits and seeds	335	01.12	8,6	2,6	2,2	0,7	14.11	09.12	25
Duration:									
- opening of leaves		35,7	3,3	9,2	0,8	2,2	31	41	10
- flowering		13,1	3,8	28,9	1,0	7,6	7	18	11
- growth of shoots		67,3	8,7	12,9	2,2	3,3	55	82	27
- lignification of shoots		41,4	4,8	11,7	1,2	2,9	32	46	14
- subsidenceofleaves		44,6	6,9	15,6	1,8	4,0	30	52	22
- maturing of fruits		13,2	3,8	28,6	1,0	7,6	8	22	14
- subsidence of fruits		80,9	12,1	15,0	3,1	3,8	61	96	35
- vegetation		210,8	13,7	6,5	3,5	1,7	189	227	38

Table 2 – Correlation communications of a phenophase of opening of buds (Pch2, X) of Henry's maple (*Acer henryi*Pax.) with other phenodates during observations - 2004 - 2018 (N – 15 years, T05 = 2.16)

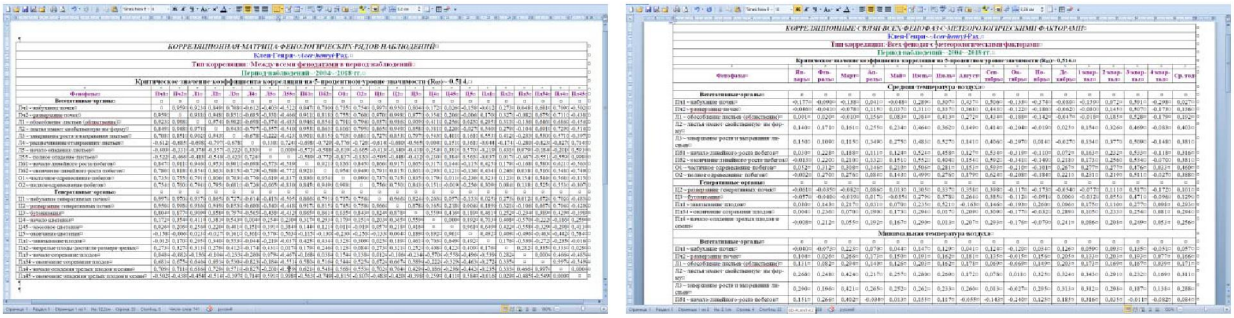
Phenophases - Y	R	D_{yx}	S_r	T_r	B_{yx}	S_b	S_{yx}	T_b
Vegetative organs								
Пч1 - swelling of buds	0,959	0,920	0,078	12,24	0,942	0,077	2,1	12,24
Л1–opening of leaves	0,988	0,975	0,044	22,66	1,018	0,045	1,2	22,66
Л2 - leaves have the form peculiar to them	0,948	0,898	0,089	10,71	0,896	0,084	2,3	10,71
Л3 - completion of growth and ripening of leaves	0,851	0,724	0,146	5,84	0,673	0,115	3,1	5,84
Л4–coloring of dying leaves	-0,685	0,469	0,202	3,39	-0,747	0,220	6,0	3,39
Л5 - beginning of subsidence of leaves	-0,331	0,109	0,262	1,26	-0,253	0,200	5,5	1,26
Л55 –endofsubsidence of leaves	-0,466	0,217	0,245	1,90	-0,571	0,301	8,2	1,90
Пб1–beginning of linear growth of shoots	0,911	0,831	0,114	7,99	1,028	0,129	3,5	7,99
Пб2–end of linear growth of leaves	0,818	0,669	0,160	5,12	1,793	0,350	9,5	5,12
О1 – partial lignification of shoots	0,755	0,571	0,182	4,16	1,775	0,427	11,6	4,16
О2 – total lignification of shoots	0,760	0,578	0,180	4,22	1,299	0,308	8,4	4,22
Generative organs								
Ц1 – swelling of generative buds	0,970	0,941	0,067	14,38	0,988	0,069	1,9	14,38
Ц2 – opening of generative buds	0,998	0,996	0,018	56,34	1,027	0,018	0,5	56,34
Ц3 – blossoming	0,877	0,769	0,133	6,58	1,067	0,162	4,4	6,58
Ц4–beginning of flowering	0,354	0,125	0,259	1,37	0,372	0,273	7,4	1,37
Ц45 –mass flowering	0,206	0,042	0,271	0,76	0,219	0,289	7,9	0,76
Ц5 –end of flowering	-0,006	0,000	0,277	0,02	-0,007	0,330	9,0	0,02
Пл1–infructescence	0,170	0,029	0,273	0,62	0,119	0,191	5,2	0,62
Пл2 - unripe fruits reached the size of mature	0,327	0,107	0,262	1,25	0,091	0,073	2,0	1,25
Пл3 – beginning of maturing of fruits	-0,082	0,007	0,276	0,30	-0,022	0,074	2,0	0,30
Пл34 – end of maturing of fruits	0,675	0,455	0,205	3,30	0,418	0,127	3,5	3,30
Пл4 - beginning of subsidence of mature fruits and seeds	0,711	0,506	0,195	3,65	0,513	0,141	3,8	3,65
Пл45 - end of subsidence of mature fruits and seeds	-0,438	0,192	0,249	1,76	-0,532	0,303	8,3	1,76

correlation (S_r); criterion of importance of coefficient of correlation (T_r); coefficient of regression (B_{yx}); errors of coefficient of regression (S_b) and a deviation from regression (S_{yx}); criteria of importance of coefficient of regression (T_b) and Student on significance value of 5% (T_{05}). Besides, in case of use of option of calculation "Chosen the phenodates with the others" along with the correlation analysis of "Feno-S" carries out removal of the equation of regression between phenodates which can be used in the future for the forecast of their approach.

The tables created as a result of export quite will approach after insignificant editing for writing of scientific articles and reports. As we see on Table 2 materials, even on the example of one species of wood plants (Henry maple - *Acer henryi*Pax.) and one type of correlation (chosen the phenodates with the others) the computer program provides to researcher considerable material for the scientific analysis.

In case of correlation calculations between all phenodates data are exported in the form of a matrix (figure 4A), and for assessment of importance of coefficients on the importance of 5% the critical value (R05) is removed them.

During calculating correlation of phenodateswith meteorological factors the program issues the tabular report on correlation communications with all 85 meteofactors in seasonal aspect, grouping them in lines on the average, minimum and maximum air temperature, relative humidity and an amount of precipitation. The report fragment in Microsoft Word on correlation of dates of approach of phenophases with average and minimum air temperature is given in figure 4B.



A – Between all phenodates B – All phenodates with meteo-factors

Figure 4 – Reports in format WinWordabout correlative bond between all phanodates and meteo-factors of *Acerhenryi*Pax. forperiod from 2004 to 2018 (N – 15 years)

The group of signs "Meteodates", forms of input and viewing serves for input of sizes of temperature, humidity of air, an amount of precipitation, etc. On the page "Addition" there are fields of indicators of introduction value of plants, notes, names of the organization-user and performers. Points of prospects are required for establishment of correlation communications with phenological indicators of value of introduced species. On the last page of a form (figure 5) automatic creation of Gant Diagram and histograms of duration of 8 phenophases with simultaneous graphical representation in a special container is made.

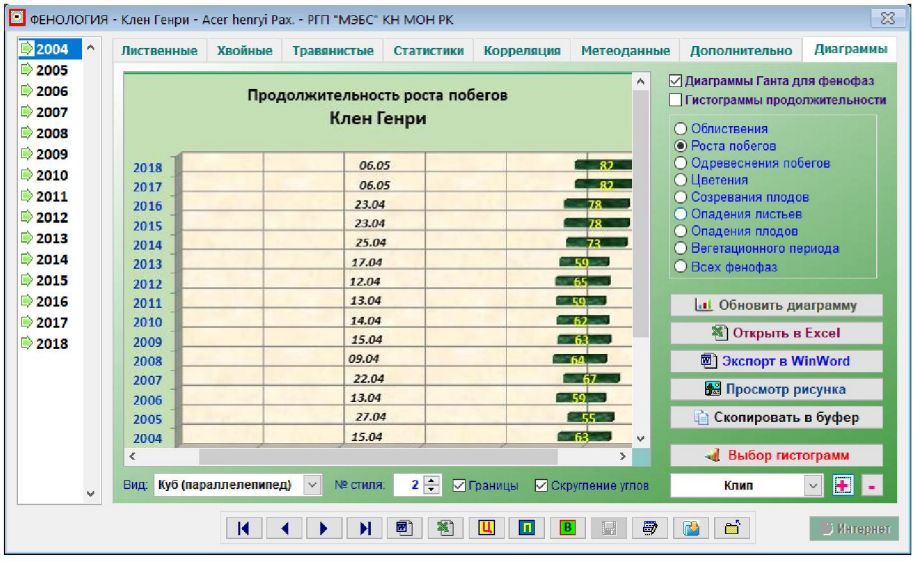


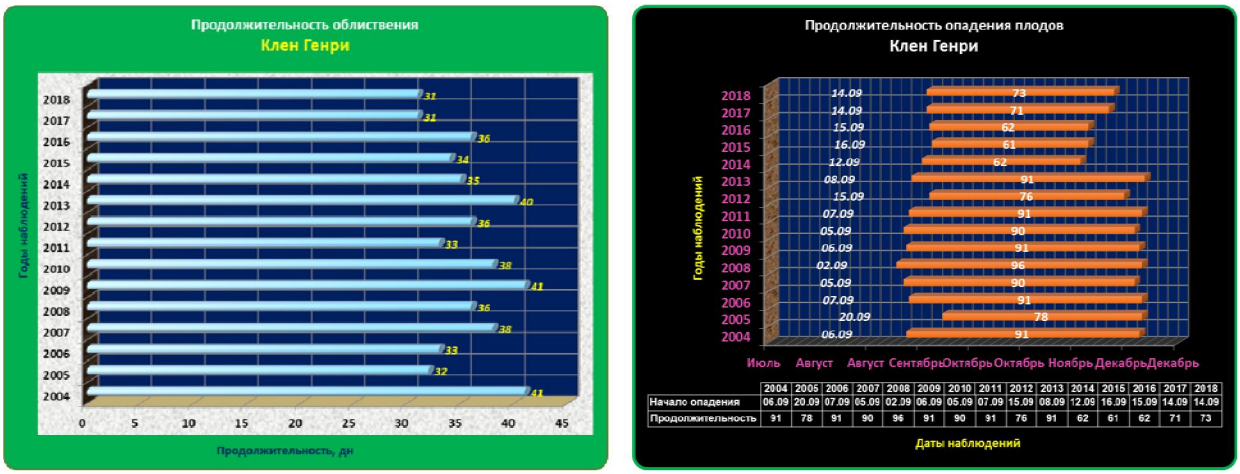
Figure 5 – Page «Diagram»

On the page "Diagram" is realized also the possibility of copying of graphic reports in a clipboard of Windows, viewing in the external editor and a conclusion in Microsoft Excel and Word.

Depending on belonging taxon groups of coniferous, deciduous or grassy plants the program can create till 17-19 graphic reports on duration of seasonal rhythms of development: leaf ability, growth and lignification of shoots, blossoming, leaf fall, maturing and subsidence of fruits, vegetative period and all phenophases (fig. 6A-6B). Here by means of button "Choice of Histograms" it is possible to start special subject to creation of chartof "FoxCharts" which allows, without leaving the program to adjust style, type of figures, color and fonts of graphic reports on phenology and also to keep them in different formats of files, including web-focused – ".html" (figure 7).

Along with drawing up a program algorithm the work on collecting, systematization and preparation for input were carried out to the spreadsheets Microsoft Excel of the long-term material of phenological researches which is saved up for the last 20 years (1999-2018) for 710 species, varieties and forms of

collection plants of a botanical garden from 58 families and 131 genera. The maximum quantity of the processed information on phenology is the share of non-local deciduous plants (dendrology department) – 417 taxa (58.7%), including 398 species, 1 variety, 12 forms and 6 hybrids. Many phenodata are systematized and prepared for a rosary (100 species and varieties, 14.1%) and department of fruit plants (83 species and varieties, 11.7%). Among families prepared for input in the editor by Excel are considerably prevailed *Aceraceae*Juss. (17 taxa), *Berberidaceae*Juss. (28), *Caprifoliaceae*Juss. (52), *Fabaceae*Lindl. (42), *Oleaceae*Hoffm. (39), *Ranunculaceae*Juss. (19), *Rosaceae*Juss. (326) and*Vitaceae*Juss. (28).



A – Histogram of duration of leaf opening B – Gant diagram of duration of subsidence of fruits

Figure 6 – Examplesofbuildingofgraphicreportsfor duration of phenophases of *Acerhenryi*Pax.

The structure of a phenological DB was developed from the used special SQL commands of the Microsoft Visual FoxPro 9 SP2 programming language and was combined with simultaneous import of the phenodata entered into the tables Excel. Initially complicated algorithm assumes selection of necessary taxonomical and registration fields from the collection database, further there is a combination

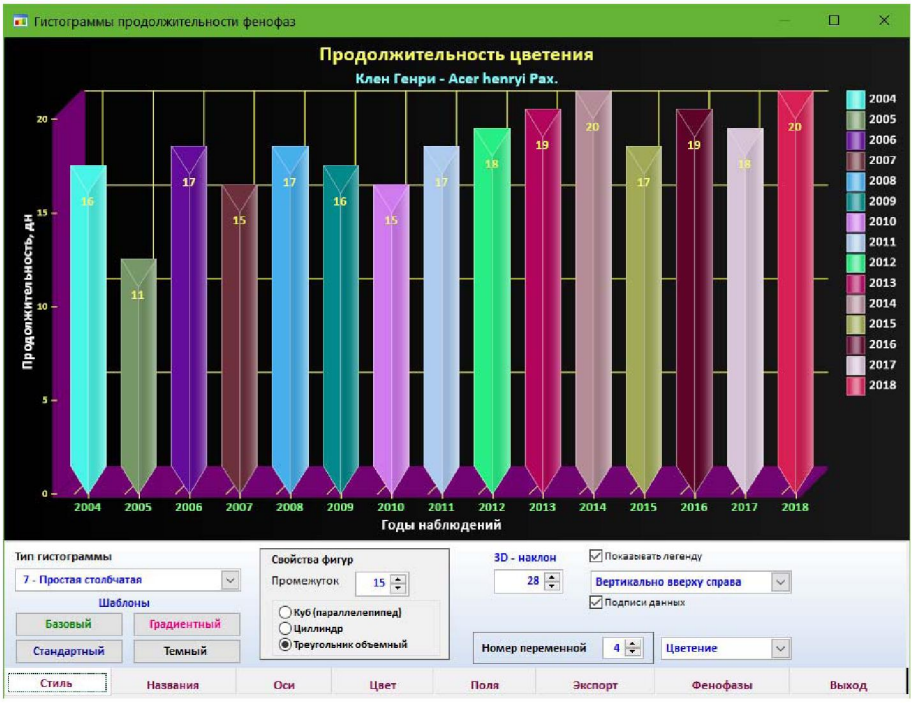


Figure7 – Form with an objects «FoxCharts» for work with histograms

of the intermediate cursor with the completed data sheet from Excel and at the last stages by a command way fields of duration of phenophases and validation of their input are added. As a result in structure of DB on phenology are created 130 fields of information of character, numerical, logical and temporary types with a total length of 2290 signs, including 6 – identification, 12 – registration, 8 – taxonomical, 33 – statistical and 60 – phenological. 11 fields are intended for characteristic of introduction value of plants on a regional complex scale. In DB for deciduous wood plants is provided storage of phenological information for 26 vegetative and generative phenophases, coniferous woody plants – 21 and grassy plants – 12. The accepted names by fields on phenophasesare corresponding to their abbreviated names according to technique of observations (the beginning of blossoming – "Ц4").

Nowadays the database contains 3919 records of phenological information by years for 533 taxa(for the period from 1 to 18 years), including 267 representatives of a dendrology department, 21 - department of Gymnospermous plants, 10 - local flora, 83 – fruit department, 100 – rosary, 31 - section of climbers and 21 – flower-decorative plants. They include 5 systematic departments, 8 classes, 11 subclasses, 24 super orders, 49 orders, 8 suborders, 52 families and 108 genera. The overwhelming quantity of taxa are species (374 - 70.2%) and varieties (138 - 25.9%). From other intraspecific ranks there are 1 subspecies, 11 forms and 9 hybrids.

The most widely taxa in the phenological database are representatives of the following families: *Aceraceae*Juss (11), *Berberidaceae* Juss. (27), *Caprifoliaceae* Juss. (32), *Fabaceae* Lindl. (15), *Oleaceae* Hoffm. (16), *Rosaceae*Juss. (291) and *Vitaceae* Juss. (24). The most numerous genera are *Acer* L. (11), *Amygdalus* L. (7), *Armeniaca* Mill. (18), *Berberis* L. (27), *Cotoneaster* Medik. (39), *Crataegus* L. (30), *Juniperus* L. (8), *Lonicera* L. (19), *Malus* Mill. (38), *Pyrus*L. (12), *Rosa*L. (111) and *Vitis* L. (18).

For carrying out correlative calculations also meteorological database is created which structure consists of 103 fields of information, 85from them are intended for data storage on meteofactors, one – actually for a year of observations and 17 - for registration and geographical indicators of the organization-user and the region of an introduction. Variables for the minimum, maximum, average temperature, relative air humidity and an amount of precipitation, as on months, and quarters and on average for a year of meteorological observations are provided in the database.

At present day works on creation of programming modules of "Feno-S" are carried out. BD is intended for identification of phenoindicators of prospects of plants, creation of phenoranges and classification of introduced species by phenorhythm type, complication of reports with multiple mathematical processing on large taxonomical units.

Conclusion. Further improvement and implementation of the phenological computer program in practice of the botanical researches considerably will simplify creation of informative databases and mathematical processing of seasonal rhythm of plant development, will allow quickly to carry out search of taxa and also will lower costs of selection of the most decorative and biologically steady range of introduced species differentiated by types of green buildings.

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ФЕНОЛОГИЯЛЫҚ ДЕРЕКТЕР БАЗАСЫН ҚҰРУ МАНГЫШЛАК ЖИНАҒЫ ГРАНТТЫҚ ОРТАЛЫҒЫ БАРЫСЫНДАҒЫ ЭКСПЕРИМЕНТТІК БОТА БАСҚАРМАСЫ АРНАЙЫ КОМПЬЮТЕРДІ ПАЙДАЛАНУ «Feno-S» БАҒДАРЛАМАЛАРЫ

Аннотация. MEBS-де жасалғанарнайы «Feno-S» компьютерлік бағдарламасының сипаттамасы компьютердің жадында фитофенологиялық ақпаратты одан әрі жеделіздестіру, математикалық өңдеу, өсімдіктердің әлеуетті феноиндалитиктерін анықтау, басыпшығару, гистограммалар мен феноскраттарды анықтау, әртүрлі мәтіндік және графикалық пішімдерді, есептерді және берілген таксономикалық, биоэкологиялық, сәндік және фенологиялық параметрлері үшін тізімдерді құрастырады. Деректер базасына импорттау үшін фенологиялық зерттеулерді жинау, жүйелеу және дайындаудың жеңілдетілген әдісі сипатталған.

5 жүйелі бөлімнен, 8 сыныптан, 11 кіші сыныптан, 24 суперартраннан, 49 тапсырмадан, 8 семестрден бастап 533 таксаға арналған символикалық, сандық, логикалық және уақытша типтегі 130 ақпараттық саланы қоса алғанда, бүгінгі таңда қалыптасқан деректер базасының құрамы мен құрылымы туралы ақпарат ұсынылған. жұбайлар, 52 отбасыжәне 108 генерал. Морфо-жүйелік топтар бойынша өсімдіктердің сандық үлестірілу тізімдері, ең өкілетті отбасылар мен тұқымдық кешендер тізімі берілген.

Түйін сөздер: фенология, дерекқор, компьютерлік бағдарлама, бақылау сериясы статистикасы, корреляция, гистограмма.

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СОЗДАНИЕ ФЕНОЛОГИЧЕСКОЙ БАЗЫ ДАННЫХ ДЛЯ КОЛЛЕКЦИОННОГО ГЕНОФОНДА МАНГЫШЛАКСКОГО ЭКСПЕРИМЕНТАЛЬНОГО БОТАНИЧЕСКОГО САДА С ИСПОЛЬЗОВАНИЕМ СПЕЦИАЛЬНОЙ КОМПЬЮТЕРНОЙ ПРОГРАММЫ «Feno-S»

Аннотация. Дается характеристика созданной в МЭБС специальной компьютерной программы «Feno-S», предназначенная для ввода и хранения в памяти компьютера фитофенологической информации для дальнейшего ее оперативного поиска, математической обработки, выявление феноиндикаторов перспективности растений, вывода на печать, построения гистограмм и феноспектров, экспорта в различные текстовые и графические форматы, составления отчетов и списков по заданным таксономическим, биоэкологическим, декоративным и фенологическим параметрам. Приводится описание упрощенной методики сбора, систематизации и подготовке для импорта в электронные базы данных многолетнего материала фенологических исследований. Представлена информация по составу и структуре сформированной к настоящему времени БД, включающей 130 полей информации символьного, числового, логического и временного типа и 3919 записей по годам для 533 таксонов из 5 систематических отделов, 8 классов, 11 подклассов, 24 надпорядков, 49 порядков, 8 подпорядков, 52 семейства и 108 родов.Приведены списки количественного распределения растений по морфолого-систематическим группам, наиболее представительным семействам и родовым комплексам.

Ключевые слова:фенология, базы данных,компьютерная программа, статистики рядов наблюдений, корреляция, гистограммы.

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