

WingsDig, version 2.1.0

User manual


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1. Purpose of the program ↑

The software is designed for digitizing bee wings. The program uses a number of system modules that are installed with all versions of Microsoft Office, and needs VBA support option to be enabled (Visual Basic for Applications). Otherwise, you will need to download and install these modules from the vbrun60sp6.exe installation package. You can download it from the Microsoft website - <https://www.microsoft.com/en-us/download/details.aspx?id=24417>.

For users who are familiar with the morphometric program tpsDig2, it should be noted that, in general, the modes of operation and the set of commands are very similar, although the philosophy of WingsDig is quite different, and the functionality is narrowed down to what is necessary for bee wing morphometry. The tpsDig2 program is quite powerful and well-known tool in morphometry in general. However, in the work on the digitization of bee wings, it has some disadvantages. This is especially noticeable when working with high-resolution scans, where at a certain point the tpsDig2 program begins to significantly "slow down". Also, it is rather inconvenient to work with a large number of images of individual wings, which we receive with the help of a USB microscope. They have to be stitched into a single image, which creates the problem already described above. All this prompted the development of a new, highly specialized software product - WingsDig.

In the WingsDig program, there is always an internal "TPS object" (template of the future TPS file), which is created when the program is loaded, or created by the command  ("Create TPS document"), called as "Untitled". When loading a previously created TPS file, the existing template is destroyed (if it is empty), or it is suggested to save it to the computer disk. The program allows you to process samples with a volume of up to 100 wings.

Program WingsDig, in combination with its plug-in software MorphoXL, forms a complete software complex for morphometric research of bees, with the aim of determining breed affiliation and breeding suitability.

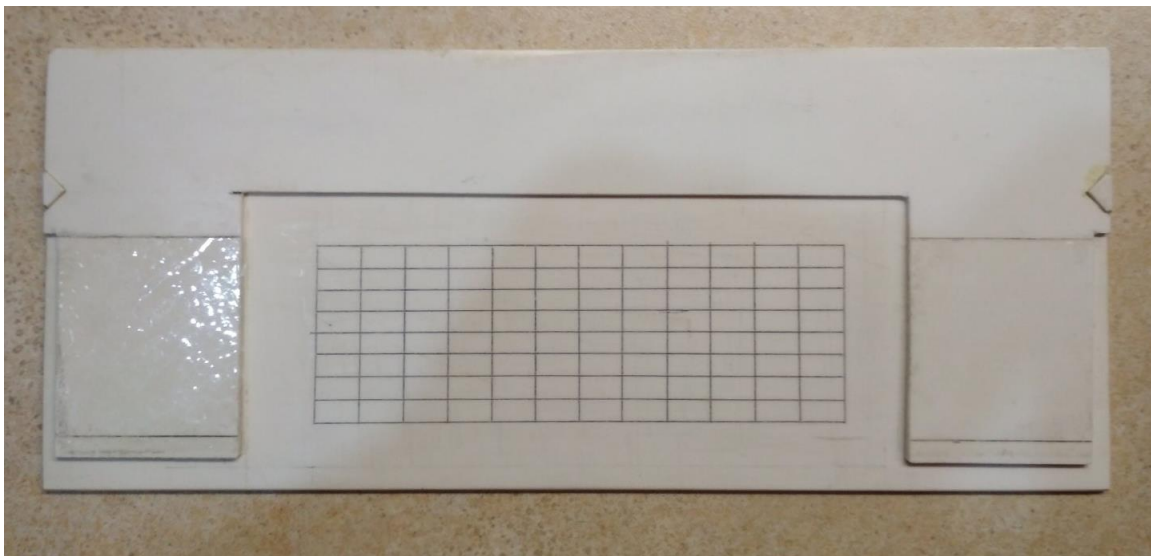
2. Selection and preparation of the researched sample ↑

Sampling for morphometric research is recommended to be carried out during the active season, during the period when the family is raising bee or drone brood, according to the subject of the study. In order to ensure the reliability of future research results, the following is recommended:

- a large queen-insulator is placed on the brood area at the exit in such a way that a small fragment of the food part of the honeycomb gets under the cap. After five to six days, when the wings of the young bees are strong enough to be examined, all the extra bees are swept away, and the frame with the sample under the lid is placed in the freezer for 20 minutes to destroy the bee sample. In this way, the possibility of accidental introduction of extraneous material into the experimental sample, which may occur as a result of interfamily wandering of bees, is excluded.
- either only left or only right forewings of bees/drones are used for sample preparation. The wing is torn off (cut with scissors) and carefully laid out on a single-sided adhesive tape, with the upper side of the wing to the tape, the front edge of the wing to itself (Fig. 1), after which it is pressed against it with several smoothing movements of a toothpick, from the base of the wing.




- after completing the formation of the sample, we cover the laid wings with another strip of adhesive tape, the adhesive side from below. In the place free from the wings, we make the necessary inscriptions with the help of a spirit marker.
- when forming a sample using this method, it is worth preparing auxiliary equipment that will help significantly increase the speed and quality of this work. An example of a device template is given below and it consists of two plastic plates that are superimposed on each other with the help of triangular guide elements. The upper U-shaped plate serves for gluing the adhesive tape, and the lower one has a calibrating grid applied, for convenient and orderly gluing of wings.



– in the opinion of the author, this method provides the optimal ratio of time/some, although there are other methods that will allow obtaining significantly better images of the wings and you can familiarize yourself with them in the additional literature.

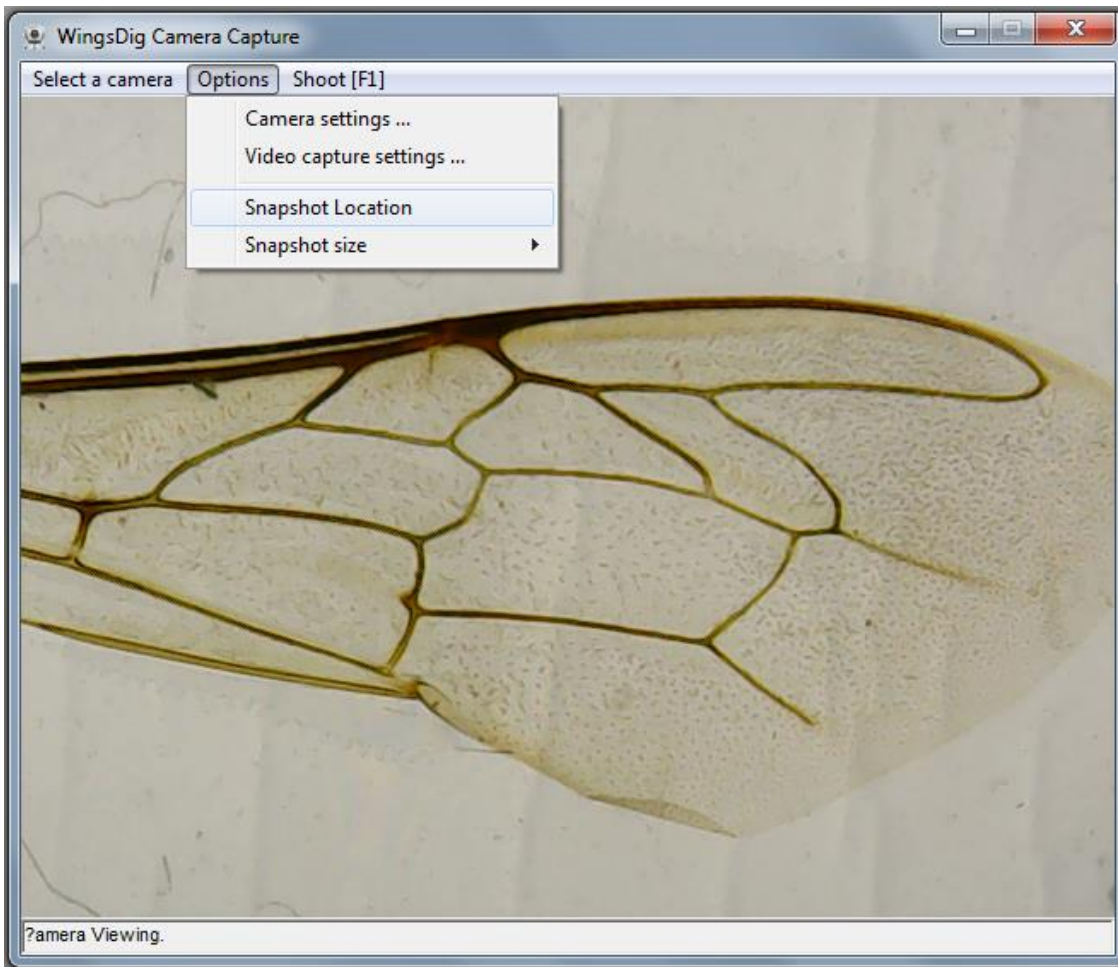
3. Obtaining images of wings with the USB microscope

As already mentioned, the WingsDig program has its own module for working with a USB microscope, so it does not require third-party software. The window of this module is called by the button  on the toolbar of the WingsDig program , or by the corresponding command in the "File" menu.



Setting up the microscope module is similar to what is done in its native program (amcap program or similar). Remember that our USB microscope is perceived by the computer as another USB camera. That is, if a USB camera is

already connected to the computer or permanently mounted , then it is necessary to choose between them the microscope (menu command "Select a camera"), as well as choose a new folder for the next batch of wingimages (menu command "Options" > "Frame Location" as shown in the following illustration.



Upon execution of this command, a dialog box will open with the option of selecting an existing folder or creating a new one in the file system of the computer . The latter is very important at the beginning of processing each new sample, because otherwise all images will be saved in the folder with which the user worked in the previous session, and the path of the last selected folder is always saved in the program settings.

By default, the program already selects the optimal wing image size of 1600x1200 pixels, which is optimal for the morphometric study of bee wings. If necessary, it can be changed with the command "Options" > "Frame size".


To save the image from the microscope in the above folder, execute the menu command "Remove" or press the "F1" key on the keyboard. Simultaneously with saving in the specified location, the newly created image will be added to the "TPS object " image collection and displayed in the WingsDig window as a floating image of the wing.

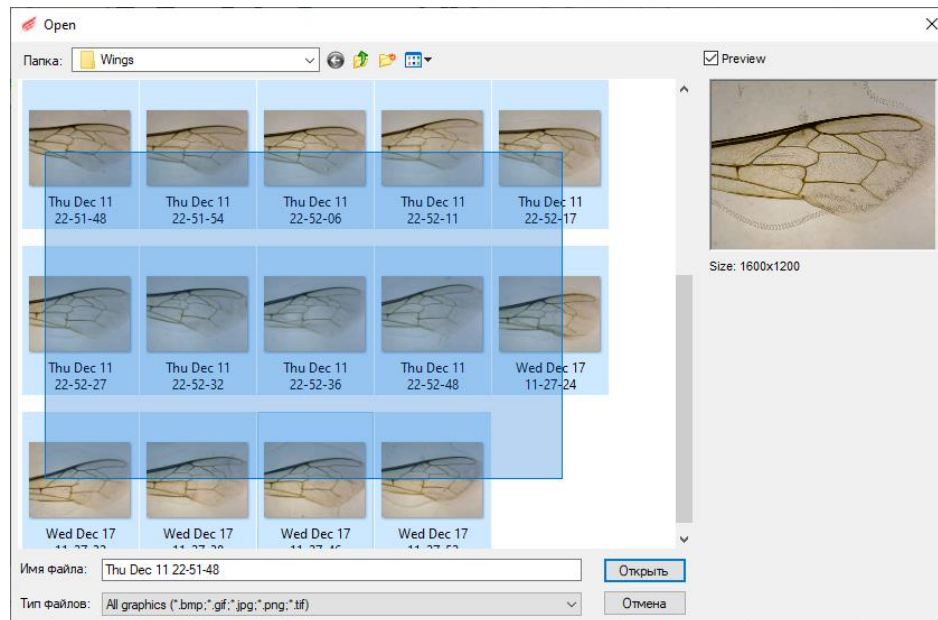
Important warning! After receiving all images of the sample from the microscope, do not forget to save the virtual "TPS object" in the same folder where the images were placed ("File" > "Save TPS document as..." menu command). The fact is that the WingsDig program records in a file TPS is a short path to the images used, or rather just their names. Therefore, if the user saves the TPS file in another location, the program will not be able to load the necessary wing images during repeated editing (**TPS file is an ordinary text file and does not contain images!**). If, for any reason, the user needs to save the TPS file and its image in separate places, then in the WingsDig settings, you need to set the appropriate option - menu command "Settings" > "Full path to images (TPS)".

4. Obtaining images of wings using a scanner

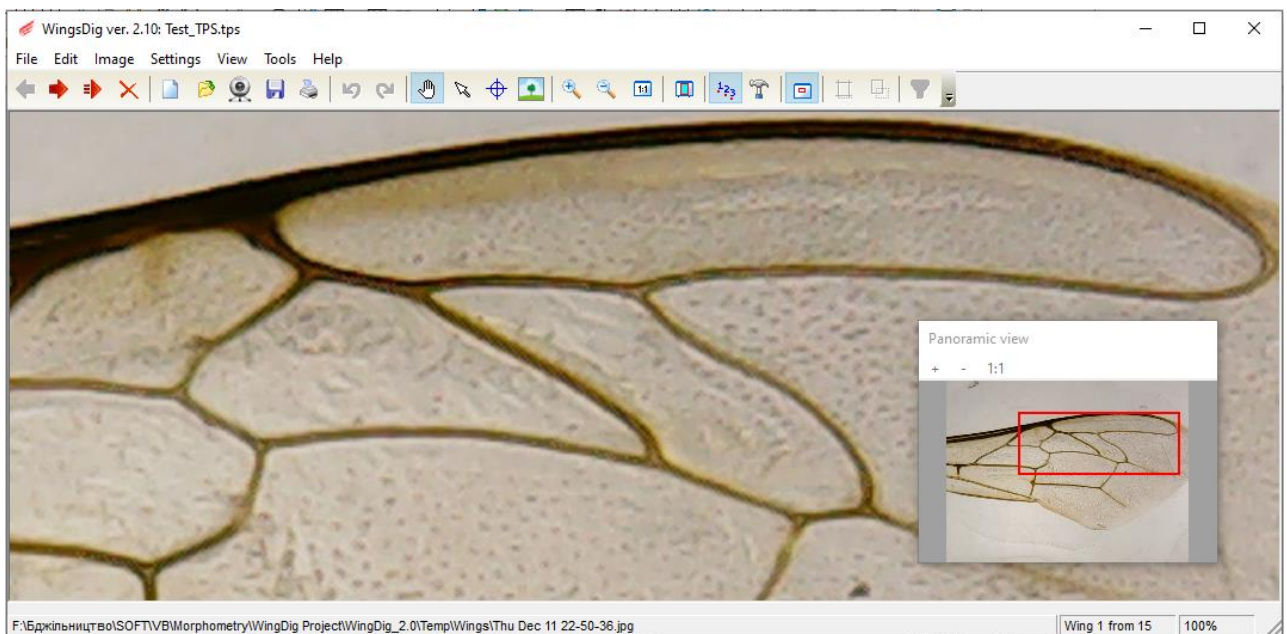
In this case, the test sample is prepared in a similar way, or any other of the recommended ones, but all the wings will end up in one and rather voluminous file . To ensure sufficient quality of the scanned image, the resolution of the future image must be specified in the scanner at least 4800 dpi. Program WingsDig allows you to successfully process similar group images of wings, however, a number of conveniences offered by WingsDig when working with a USB microscope, such as "wing navigation", "wing search by number", etc., will not be available.

5. Adding new images


Add a new image or a group of images to an existing TPS using the menu command "File" > "Open..." > "Wing image file(s)", or using the button  on the toolbar. Each new opened image is added to the wing collection of the current "TPS object". Also, image files can be dragged into the program window with the left mouse button from "Explorer" or another file manager, having previously selected them.






All of them will immediately become elements of the wings collection of the internal "TPS object", while the first added image will become active.

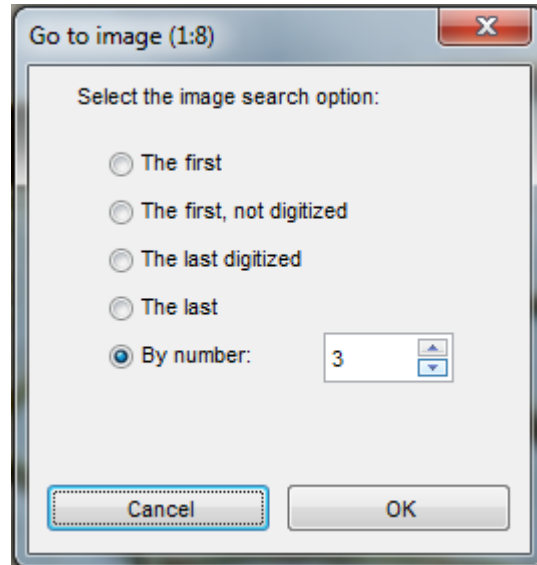



Such "dragging" makes it possible to completely abandon the stitching of individual wings into a single image. Although, unlike tpsDig2, the speed of the program does not depend at all on the size of the image or on the number of digitized points, that is, it is instantaneous.

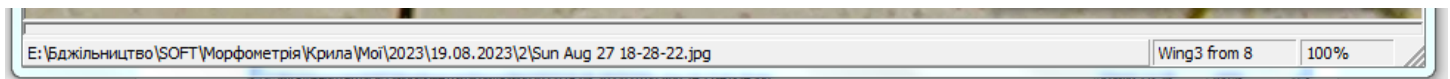
Attention once again! The newly created "TPS object" named "Untitled" is only in the memory of the program, but not on the computer disk. If it contains useful information, then before closing the program, it should be saved to disk using the menu command "File" > "Save data as ...". After that, all subsequent changes should be saved with the command "File" > "Save data" or the button  on the panel tools

6. Navigation through the wing collection

On the toolbar there are buttons   for navigating through the wing collection, as well as a switch to any wing button , which brings up a dialog box for choosing a transition method.







Also, next to the toolbar, there is a button  to remove from the collection, if something does not suit this image. In the status line (at the bottom of the main program window) there is information about the location of the current image on your computer, its serial number in the collection, the total number of images in the collection, as well as the current scale of the image.



By saving a TPS - file with undigitized wings to disk, you will actually save only a list of images. You can digitize it later, **but BE CAREFUL** - you should not upload such an incomplete file to MorphoXL. This will cause an error, because the number of landmarks (points) in each image should be a multiple of 8, 12 or 19, and they are not there at all. A similar error will be created by a file in which not all "reserved" wings are digitized. Basically, the TPS file is a normal text file, in which for each wing there is information about the image used, the number of points placed on it, as well as the coordinates of these points. **The TPS file does not contain any images!** Therefore, when it is necessary to send the results of the digitization to another person for the purpose of checking or editing, the TPS file must be sent together with the used wing images.

7. Main window of the program, digitization and editing

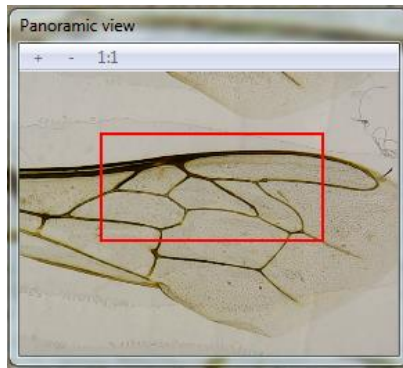
Work in the WingsDig program is performed in four modes:


1. **Move mode** (button  on the toolbar) – move the current image in the program window;
2. **Point editing mode** (button  on the toolbar) – point editing (changing the location, adding missed points, changing the current number);
3. **Digitization mode** (button  on the toolbar) – mode of placing points.
4. **The image editing mode** (button  on the toolbar) is used when correction or copying of an existing image is needed.

8. Image navigation

There are certain peculiarities in the way of navigating through the image in the main window of the program. Images can be moved with the mouse only in "Move Modes". In the rest of the modes, we navigate through the image either by moving **the red rectangle** in the "Panoramic View" window, or with the mouse wheel, or with the movement arrows (left, right, up, down) on the keyboard. The red rectangle of the "Panoramic View" window shows us the part of the image that

the program currently displays in the main working window.




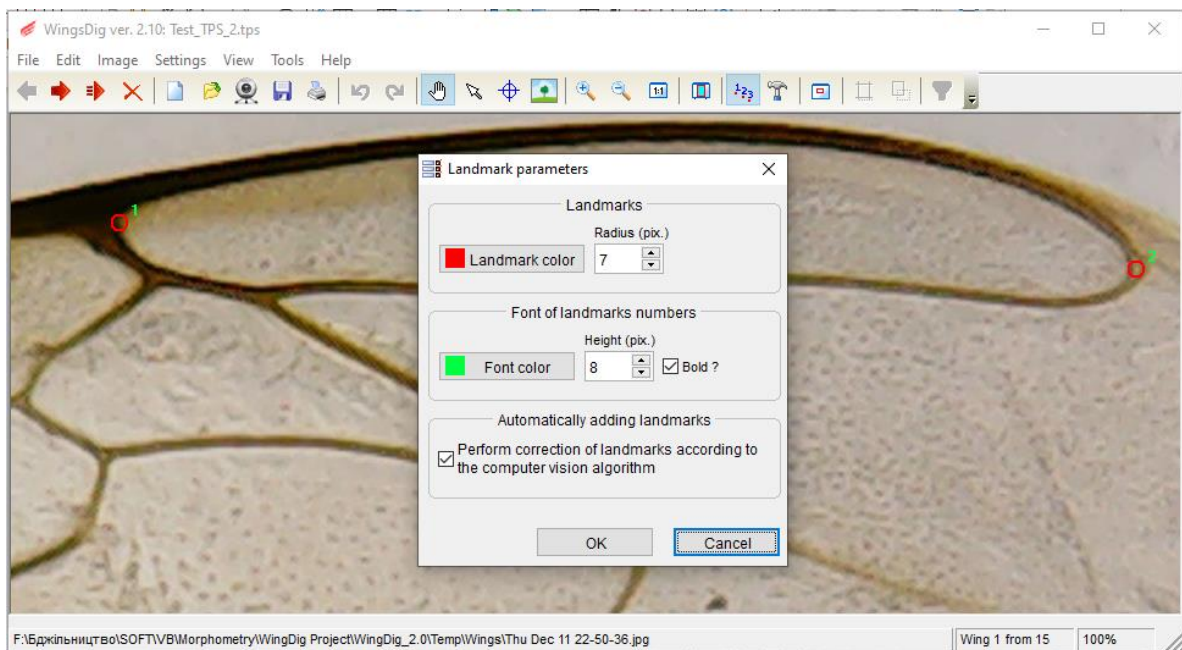
The "Panoramic view" window is called/hidden by a button  on the toolbar, or by the corresponding command in the "View" menu.


9. Placement and editing of landmarks

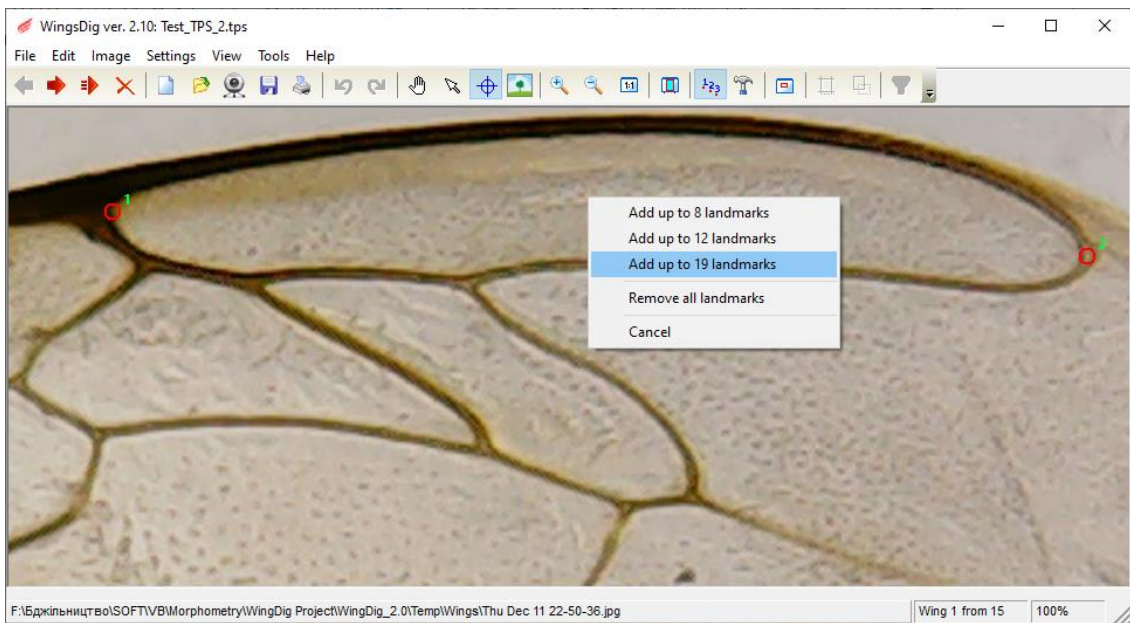
On each image of the wing, the user must put a strictly defined number of landmarks, according to the type of TPS file - 8, 12, or 19 landmarks per wing. The landmarks are placed in a clear sequence, in the center of the knots formed at the intersection of the wing veins. When placing the landmarks, it is very important that the center of the point is clearly in the center of the nodule, at the intersection of the axes of the adjacent veins. For this, it is necessary that the diameter of the point coincides with the size of the nodule. That is, the landmark must be inscribed in the nodule in such a way that it touches its outer borders in at least three points



The diameter of a landmark, like its other parameters, can be changed in the dialog box "Points parameters" by calling it with the button  on the toolbar



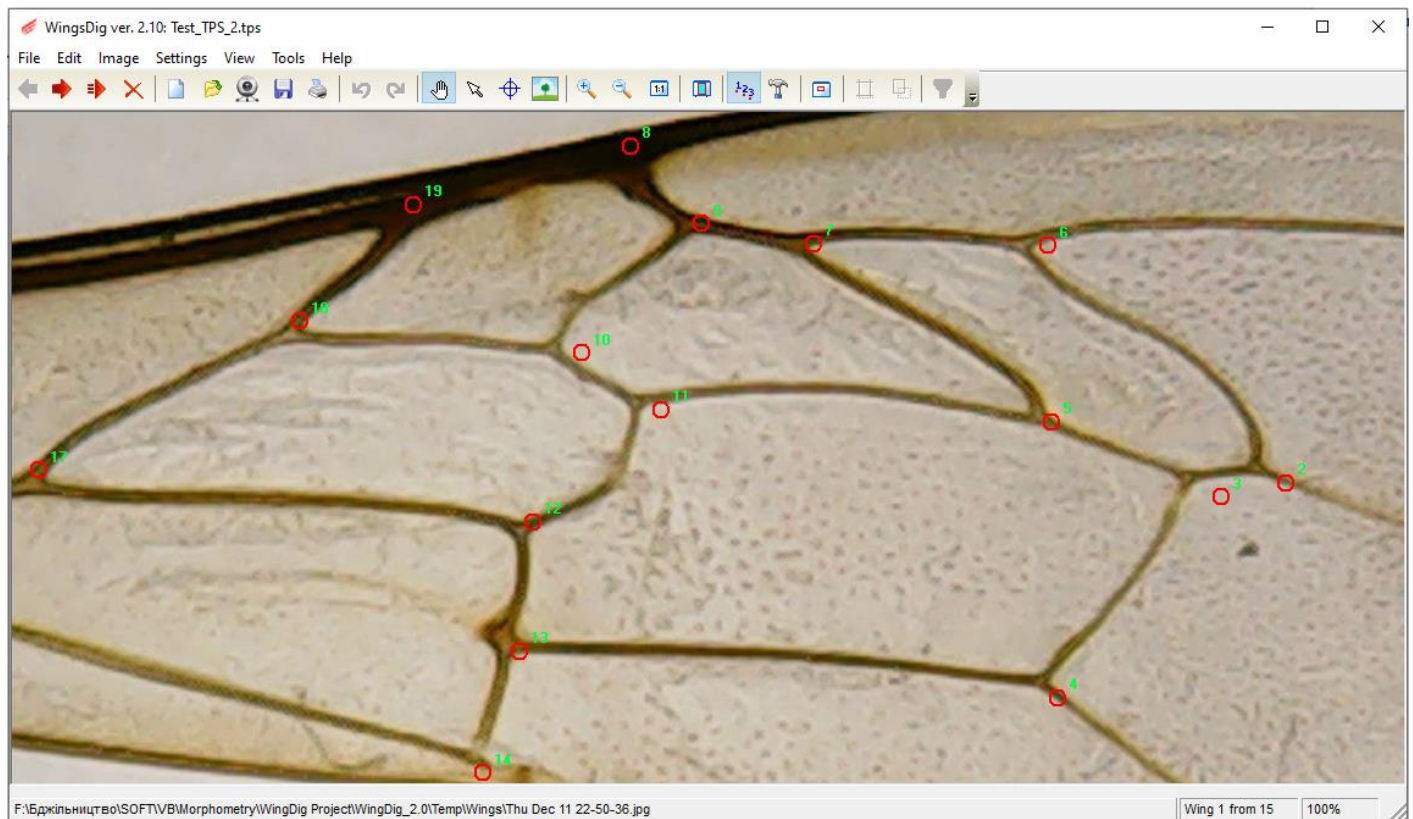
To digitize the wing, it is recommended to use the special WingsDig service function. To do this, we transfer the program to the appropriate mode of operation with the help of the button  on the toolbar. Next, we insert landmarks 1 and 2, as shown in the following illustration, and right-click on the free part of the image to call up the context menu for automatically adding the remaining landmarks, in accordance with the type of TPS.



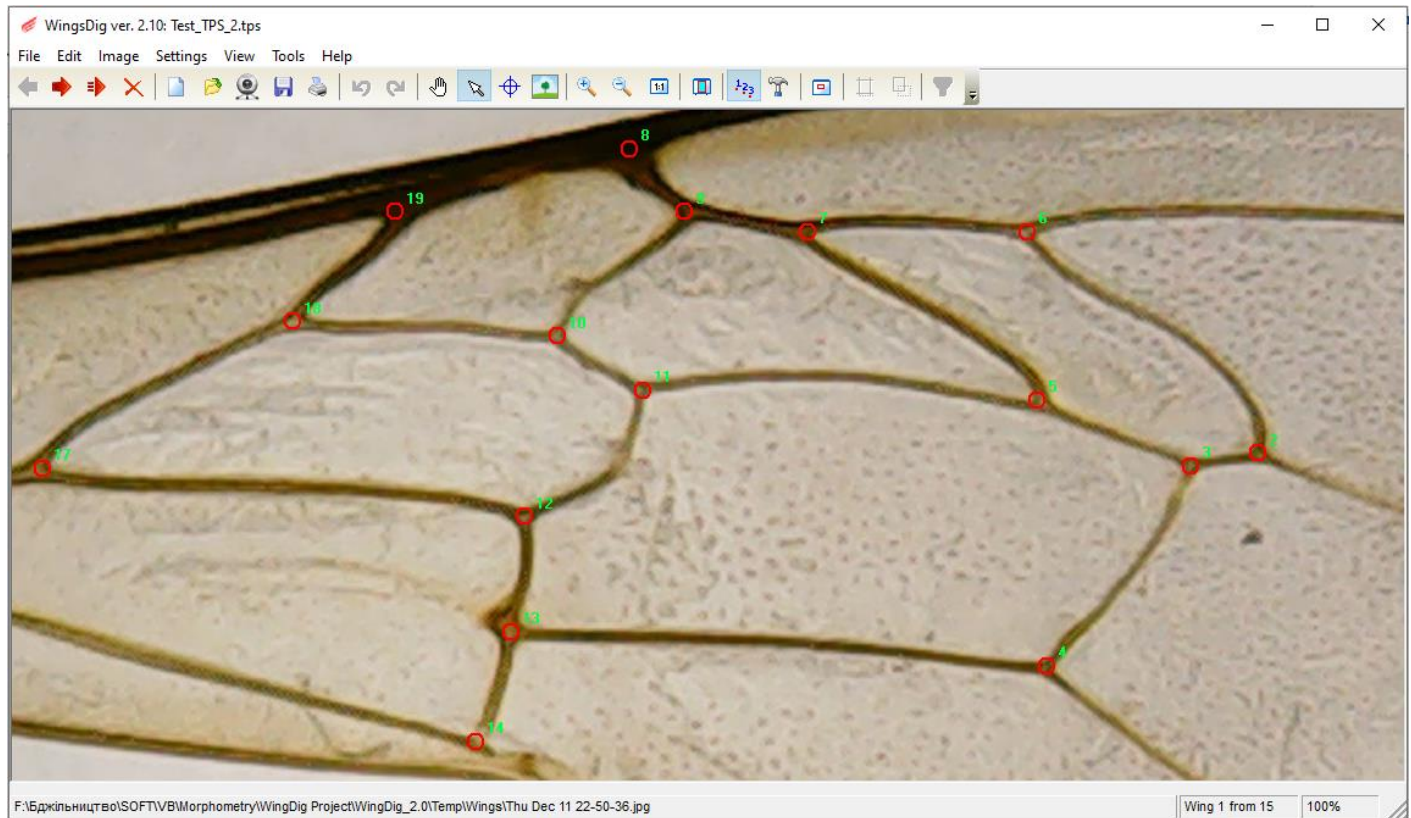
New landmarks are placed in the application according to the internal template. This template is superimposed on the image of the wing, taking into account the scale of the image of the wing and its angle of inclination relative to the horizontal. The application receives these parameters from the previously set reference landmarks "1" and "2", which must be set according to the rules of 8-point morphometry (figure above). Since the wing pattern of different subspecies of bees differs significantly, the internal template can place new landmarks only quite approximately and they will need to be corrected. In this case, the numbering of landmarks and their location will already correspond to the selected standard (8, 12, or 19). The work of the internal template can be significantly improved if the option "Perform correction of landmarks using a computer vision algorithm" is selected in the "Landmark parameters" dialog box.

Note: When receiving images from the scanner, all landmarks will have to be placed manually, since this service function will not make sense (there are many wings in one image ...).

Below are examples of the service function **without optimization**, when adding up to 19 points in the DAWINO style:




as well as examples of her work **with optimization**, using a computer vision algorithm:

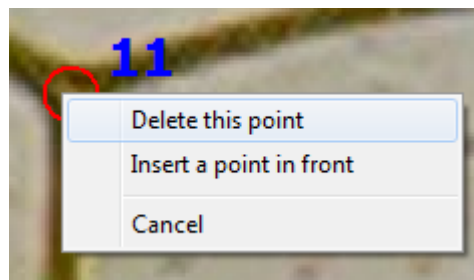


Note: This optimization gives excellent results only for high-quality images of individual wings measuring 1200x1600 pixels. An image with a different resolution can be converted to this format in the "Image Editing Mode", using the menu command "Image" > "Dimensions...".

It should be noted that the results of any graphic correction only apply to the downloaded copy of the image and to save them to a file, you must use the "Save" button on the toolbar or the corresponding command (the "File" menu). Otherwise, they will all be lost when moving to the next wing.

Landmarks numbering can be shown/removed using the command  on the toolbar .

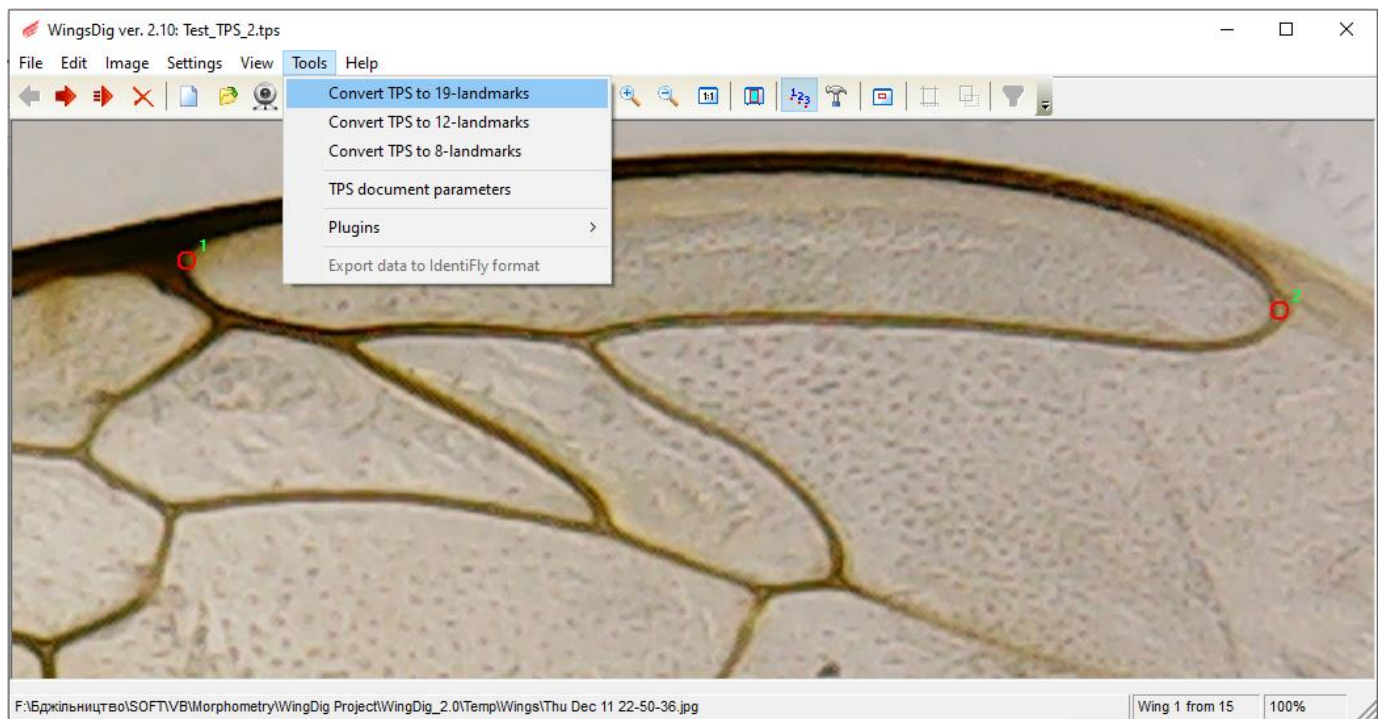
With manual digitization, sometimes a situation arises when the user misses a dot, or puts an extra one. To correct this situation, switch the program to landmarks editing mode using the button  on the toolbar. For the first case, we find the landmark that is next to the missed one and call up the context menu on it with the right mouse button, where we execute the "Insert point" command. The newly created landmark will receive the number of the edited one, and the numbers for the rest, including the edited one, will be increased by one.





For the opposite situation, call the context menu on the extra landmarks and execute the "Remove point" command.

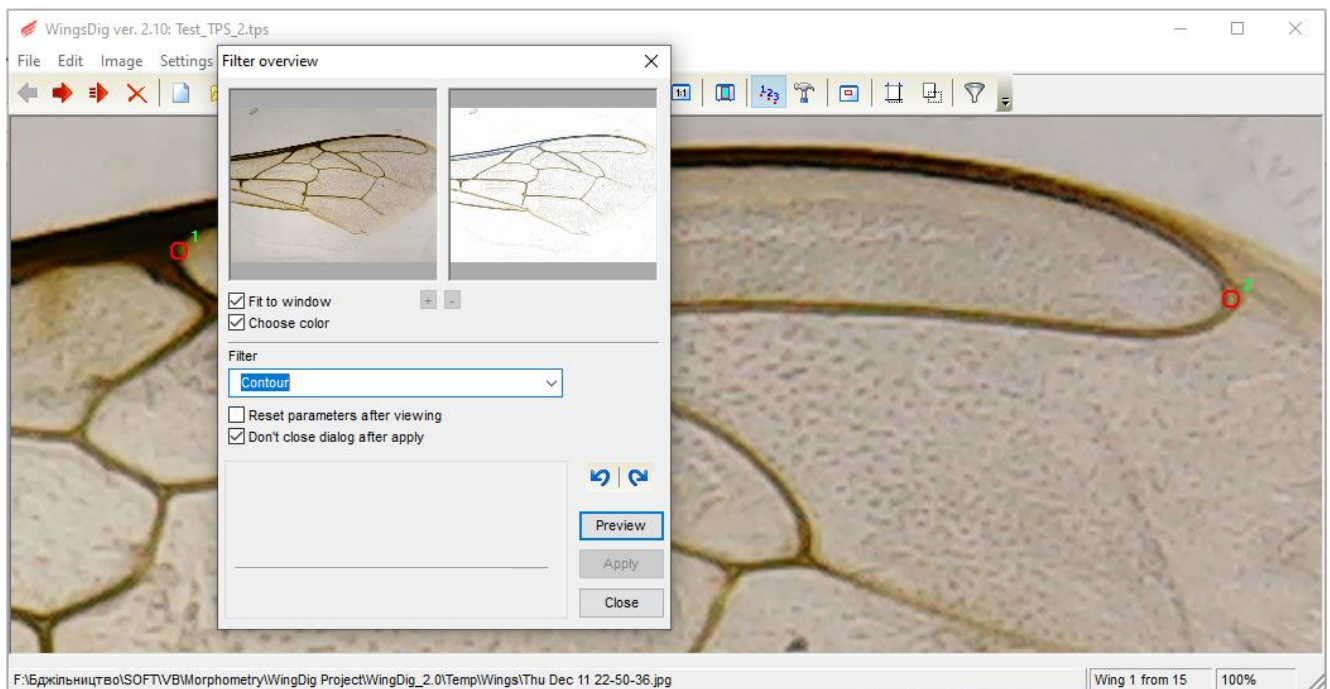
10. Converting an existing TPS file

If there is a saved or newly created TPS that contains at least 2 landmarks per wing, the program can automatically expand it to 8, 12, or 19 landmarks per wing. Of course, some new landmarks will have to be slightly adjusted even if the option to use the computer vision algorithm to adjust the added landmarks is selected (the "Landmark Parameters" window). The corresponding TPS conversion commands are in the «Tools» menu.



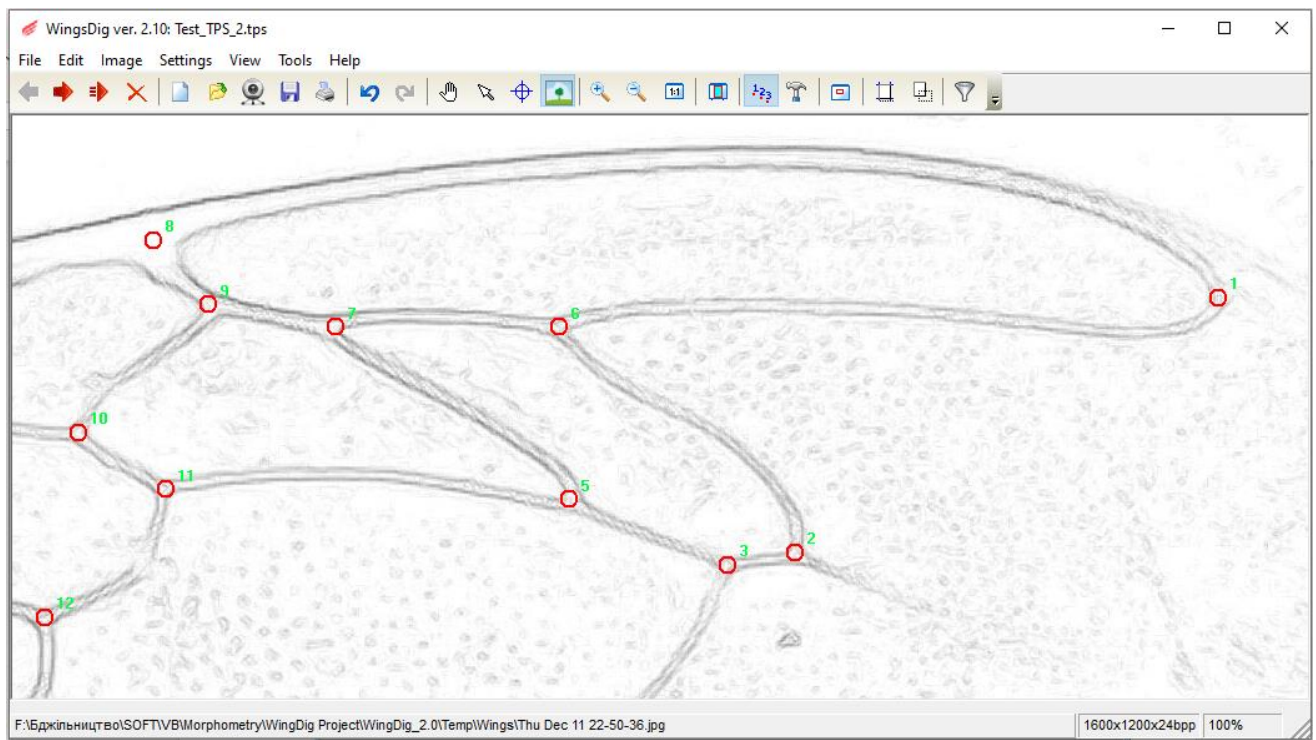
11. Image quality editing

To improve the quality of images and some other operations on graphic files, the program implements a corresponding mode of operation, which is called by a button  on the toolbar or by the corresponding "Edit" menu command. In addition to a set of standard selection, cropping, copy-paste functions, the ability to process images with the help of graphic filters has been implemented. A dialog box with a list of implemented filters is called by a button  on the toolbar, and some of the most used filters can be executed using the menu command "Image" > "Filter ...".



The use of filters can significantly improve the quality of wing images, which will provide better positioning of points. Also, they can be useful for other applied purposes - illustrating publications and so on.

Below is an example of alternately applying the Contour, Contrast, and Grayscale filters. The appearance of the image before applying the filter can be seen in the picture above, which is in the background, under the "Filters Overview" window.



12. Editing metadata in a TPS file

In the WingsDig program it is possible to store in the TPS file additional information about the test sample, without violating the specification of TPS files. MorphoXL uses this information to automatically populate the appropriate fields on the main page of the morphometric report. Also, thanks to this additional information, the MorphoXL program automatically switches between drone and bee studies, notifying the user. Editing of such metadata in the WingsDig program is carried out by the menu command «Tools»> "TPS document parameters".

TPS document parameters

Points Per Wing: 19 Get from INI

*Association: UA-3 *Beekeeper Code: 70

*Queen Number: 405 *Queen Year: 2022

Copulation: Artificial insemination

Insemination Place: UA-3-70

Country: Україна

Region: Львів

Apiary Number:

Beekeeper: Ігор довгунік

Colony Number: 2

Race/Line: A.m.carnica var. carpatica

Image Resolution: DPI

* - fields are required to automatically generate the TPS file name

Subject of study

☒ Bees ☐ Drones

☐ Save the name and beekeeper code for future documents

☐ When saving a new document, suggest a name according to its parameters

Save Cancel

If the fields with an asterisk are filled in correctly in the dialog box and the option "When saving a new document, suggest a name based on its parameters" is enabled, then in the dialog box of saving, the WingsDig program will offer an automatically generated name of the TPS file in the BeeBreed codification style. That is, in this case, the program will offer the name "UA-3-70-405-2022.tps".

13. Analysis of digitization results

To analyze the digitization results, as the final stage of the morphometric study of the wings of the selected sample of bees, a program called MorphoXL is used, which is located in the WingsDig program plug-ins folder. The most extensive analysis is performed by the MorphoXL program for 19-point studies, where, based on geometric morphometry data, the breed belonging to the experimental colony is analyzed, and the breeding suitability of the founding mother of this colony is evaluated based on a number of indices of classical morphometry. At the same time, 19-point studies can be performed both in the style of the DAWINO protocol (files "*.txt", "*.csv", "*.tps"), and in the style of the IdentiFly program - graphic files of the format "*.png", which contain data about digitization results.

In addition, WingsDig has the option to send the digitization results to MorphoXL directly, bypassing the step of saving these results to a file. This can be useful when working on a sample, as only the digitized portion of the sample is automatically sent to MorphoXL for analysis in this mode. In this way, we can assess the expediency of continuing work on the sample, especially if this sample is sufficiently voluminous. To do this, use the menu command «Tools» > "Add-ons" > "Open in MorphoXL". If at this point the user has already filled in the metadata (previous section), then it will also be included in the MorphoXL report. Below is the MorphoXL program window with the results of data analysis dynamically sent from the WingsDig program.

MorphoXL.xls - [UA-3-70-405-2022] - Excel

Файл Главная Вставка Разметка страницы Формулы Данные Рецензирование Вид Разработчик ? Помощь Вход Общий доступ

beecolony x ✓ fx UA-3-70-405-2022

To call the program menu, press the logo, or "Ctrl+F"

MORPHOXL - a morphometric analysis program for bee wings.

10.01.2024
(study date)

Results of the morphometric analysis of workerbees

UA-3-70-405-2022
(breeding number / colony)

The results of research the morphometric indices

Parameter name	Variability	Average value	Cv
Cubital index	2,192 ... 4,139	2,974 ± 0,062	12,9%
Hantel (Dumbbell) index	0,885 ... 1,221	1,033 ± 0,014	8,3%
Discoidal shift angle	-0,718 ... 7,264	3,295 ± 0,300	-
Precubital index	2,502 ... 2,982	2,718 ± 0,019	4,3%
Meier's index	-9,281 ... -5,216	-7,268 ± 0,148	-
Izmailov index	-9,019 ... 0,080	-5,411 ± 0,338	-

Colony General Information

Country	Україна
Region	Львів
Beekeeper	Ігор довгунік
Apiary number	
Colony number	2
Queen number	405
Race/lineage	A.m.carnica var. carpatica
Copulation	штучне осіменіння
Place of insemination	UA-3-70

Analysis of breed compatibility based on morphometric indices

Breed	Number of positions	Experiment. test of bees	Forecast for the entire colony (95%)	Applied breed ranges of the studied indices		
				Cubital index	Discoidal shift angle	Hantel (Dumbbell) index
A.m.Mellifera	0	0,00%	0,00%	0,76 ... 2,00	-13,36 ... 0,00	0,616 ... 0,923
A.m.Caucasica	0	0,00%	3,00%	1,61 ... 2,75	-5,68 ... 1,89	0,685 ... 0,948
A.m.Sossimai	16	42,10%	32,00%	1,86 ... 3,00	-1,89 ... 5,68	0,829 ... 1,113
A.m.Ligustica	30	78,90%	71,00%	2,00 ... 3,29	-0,95 ... 8,54	0,829 ... 1,206
A.m.Carnica	37	97,40%	83,00%	2,00 ... 5,00	-0,95 ... 12,39	0,923 ... 1,420

Options Report Appendix 1 Appendix 2 Appendix 3 Append ...

Готово 100%

Detailed instructions for working with the MorphoXL program can be found in the folder of this program.

14. Localization of the WingsDig program

The WingsDig program supports multilingual interface. The user can localize the application to the local language by creating the appropriate language file and placing it in the application folder. Changing the interface language is performed using the "Settings" > "Interface language" menu command. To localize the program, the user can call the corresponding help window by executing the menu command "Help" > "About the language file ' *.lng' ".

Your language file

At startup, the program reads the regional settings of your operating system. According to this data, the program searches for a language file, which for your country should be called

UKR.lng

To create this file, you can translate any existing language file, but be sure to include the following in the title of your file:

Language: Ukrainian (українська)
WingsDig version: 2.0.0
Author:
Email:
LocaleID: 1058
Encoding: 204
Comment: The default language for Ukraine
/XXXXXXXXXXXXXXXXXXXXX

Copy this text and paste it instead of the title in your language file

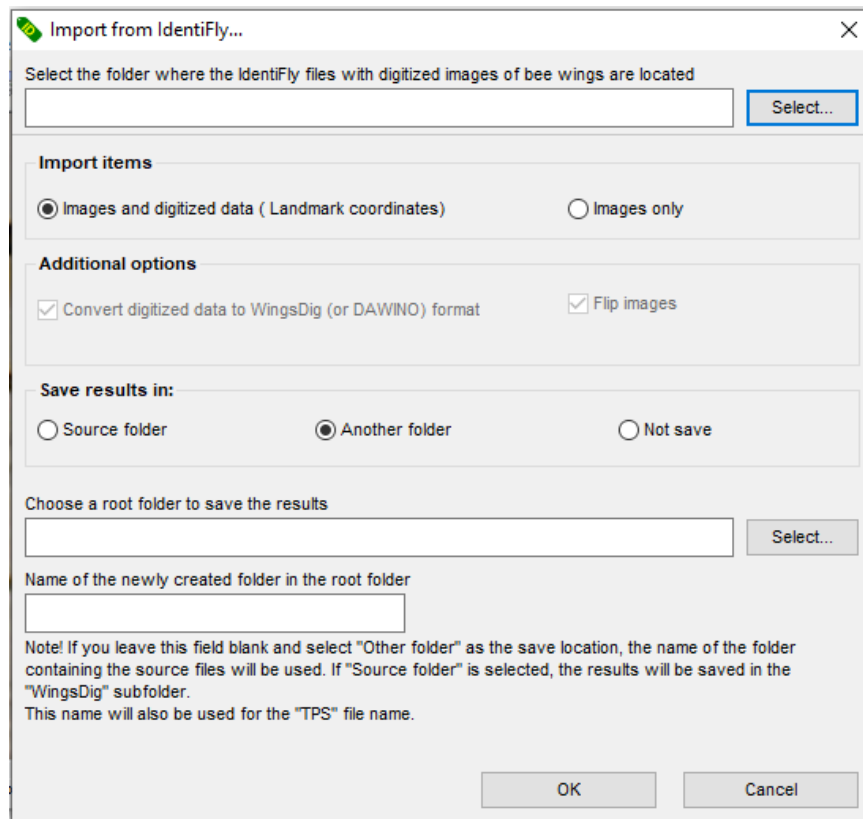
Note! Your language file already exists in the application folder.

OK

15 . Data exchange with the IdentiFly application

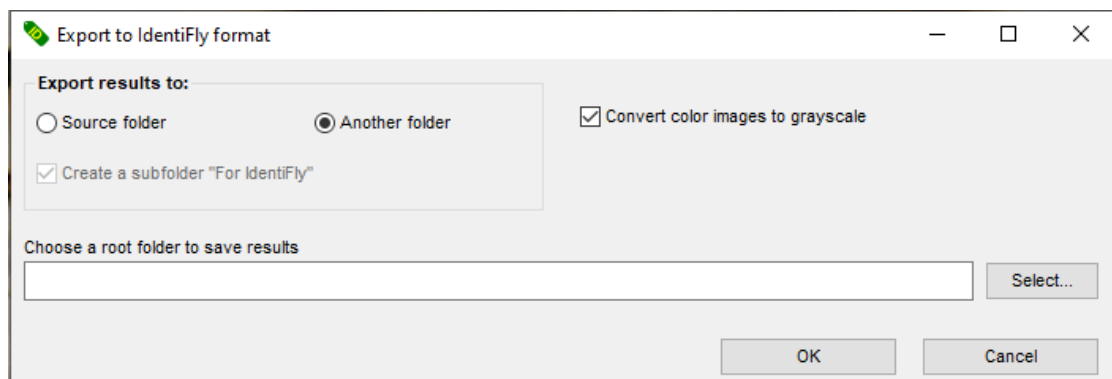
The WingsDig application implements the ability to convert and exchange digitization data (import/export) with the IdentiFly application.

Data is obtained using the menu command "File" > "Import from IdentiFly (*.dw.png files)". The import dialog box specifies the location of the source data, as well as other acquisition and conversion parameters.



As a result of the import, all wing images are rotated horizontally by 180 degrees and saved in the specified location in the "JPG" graphic format. And the digitization data is converted to the standard WingsDig format DAWINO and saved in the newly created TPS file.

Data export is performed using the menu command «Tools»> "Export data to IdentiFly format". The necessary data conversion parameters are specified in the exporter dialog box.



According to the export results, all wing images will be rotated horizontally by 180 degrees and saved in the specified location in the "PNG" graphic format. These graphic files will also contain the digitization results converted to the IdentiFly format.

16 . History changes

21/12/2024 – When automatically placing landmarks according to an internal template, landmark correction is implemented using a computer vision algorithm.

The ability to import/export digitization data with the IdentiFly application has been created.

Now, if the program is in "Image Editing Mode", the "Save" button on the toolbar saves the changes to the current graphic file (wing image). In all other program modes, the "Save" button is responsible for saving the changes to the "TPS" file.

The "Recent TPS Files..." command has been created in the "File" menu, which expands the list of up to ten previously opened files.

Completely updated algorithms for converting TPS files in the «Tools» menu. You can convert not only a saved TPS, but also a newly created TPS, provided that all its wings are digitized to 2, 8, or 12 landmarks on the wing. That is, having only two landmarks per wing, such a TPS can be converted to 8, 12, or 19-point with one command, including the correction of landmarks using a computer vision algorithm.

Fixed one non-critical bug in the MorphoXL plugin.

30/12/2023 – The MorphoXL plugin implements a geometric morphometry module

03/13/2023 – Implemented possibility preservation in TPS files of additional metadata about the parameters of the test sample, without violating the specification TPS files .

12/28/2022 – A dynamic communication mode with the MorphoXL program has been created. Converting the MorphoXL program into a WingsDig plugin.

06/12/2021 – Summary of several successive versions that have not been publicly distributed. This is a graphics editing mode, multilingual interface support, direct interaction with USB microscope and without third-party tools, a number of new service functions for more convenient creation and conversion of a TPS file , etc. Bug fixes and improvements to several internal algorithms.

03/07/2019 – Implemented the ability to select multiple image files in the standard dialog ("File" > "Open" menu). Increased speed of scrolling images with the help of the mouse wheel and navigation arrows on the keyboard.

Any comments, suggestions, or information about program errors to the following e-mail address:

dovgunykigor@gmail.com

Igor Dovgunyk, Lviv, 2019 – 2024

UNION OF UKRAINIAN QUEEN BEE BREEDERS