

How to build an Internet-accessible interactive key using 3I

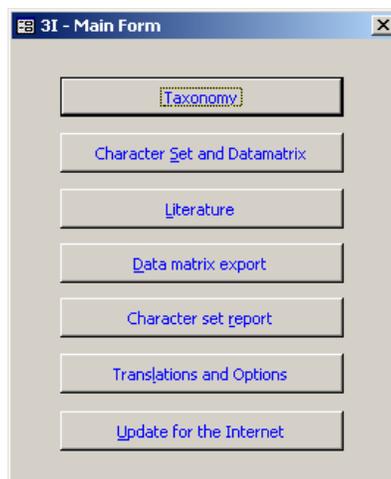
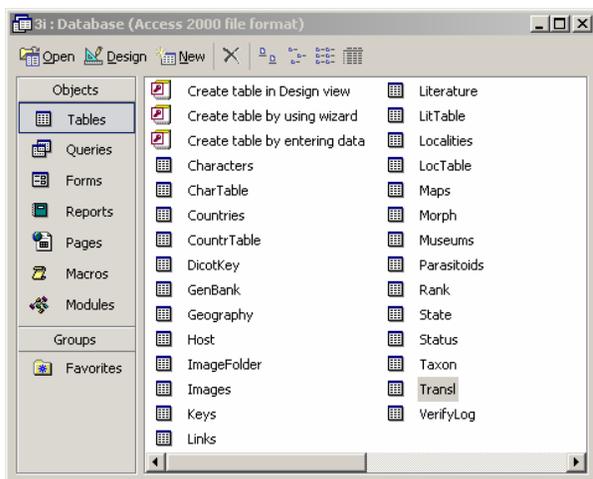
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The **3i.mdb** file is a relational database template created using Microsoft Access. The template includes linked tables designed to store all the information required to produce comprehensive Internet-accessible identification keys, taxonomic databases, and virtual taxonomic revisions. Thus, the first step in creating a 3I project is entering your data into the appropriate tables and fields of the database. A detailed description of the 3I database is provided as a separate file. This section provides step by step instructions on how to build a simple interactive key using 3I and add some functionality to it.

Preparation

- Read the **Introduction** section of the **3I description**.
- If you do not have experience working with MS Access databases, read **Working with the 3I database** section of the description. It provides a brief description of the database structure and navigation.
- Because 3I is an Internet application with all web interfaces provided through Active Server Pages, it requires installation of a Windows Web server. In order to test your interactive key during development, it is recommended to set up your local computer so that it enables you to preview all the interfaces before you provide live access through the Web server. The 3I package provides instructions on how to set up the Internet Information Services on the Windows XP Professional or Windows Vista Home Premium, Business, or Ultimate operating system. The information provided below describes how to work with the database after installation is complete.
- The instructions below are based on the copy of the database stored in the folder **3I_Example** of the installation package. The folder **3I_InternetDB** provides a blank copy of the same database. Copy the **3i.mdb** file into two different folders, one of which is **C:\wwwDB** (the server database folder created during installation). The other folder may be a Desktop or any other folder on your computer (the local database folder). Any editing of the database should be done on the version stored in the local folder; editing the server version of the database is not recommended.
- Open **3i.mdb** from the **local folder**. If you do not have MS Access installed on your computer, a free MS Access 2000 Runtime version is available from the 3I website. The program first displays the **Database window** and the **Main form**.



Setting up an interactive key

- Click **Translations and Options** on the Main form; it will open the table **Transl** containing settings for the interactive keys.
- Select the first record (first line) of the table, which has the title “An Interactive Key to Auchenorrhyncha superfamilies”. To select the record click the left margin (selected record turns black).

31 - Translations						
Flag	KeyN:	Nur	Abr.	LanguageName	Title:	Copy:
<input checked="" type="checkbox"/>	1	1	En	English	An Interactive Key to Auchenorrhyncha superfamilies	Author
<input type="checkbox"/>		2	Ru	Russian	Интерактивная Определительная Таблица	Автор

- Copy this record (the same way you copy phrases in MS Word, e.g., using the Edit menu).
- Select the last record (last line) of this table (marked with asterisk, which means a new record; the last record in each table and most forms is reserved for a new record) and Paste the copied record.
- Modify this new record as follows:
 - In the field **KeyN** enter the number **2** (different interactive keys created from the same database must have different numbers).
 - Select a title for your key by changing the text in the **Title** field, to, e.g., “My first Interactive key”.
 - In the field **Copy**, enter your name and year, e.g. “© D. Dmitriev, 2008”.
- Close the table by clicking the “X” at the top right corner of the table. Ignore any “Do you want to save...” warnings, they refer to changes in database structure, and not in the data; all the data are saved in the database automatically when moving from one record to another, or when the table is closed.

Modifying the list of taxa

The list of taxa is stored in the table **Taxon** and may be edited either in table view, or in form view. The form **Taxonomy** is accessible from the **Main** form. Work with the table is described here; but work with the form is similar. The table **Taxon** contains a record for each taxon in the database, including all hierarchic levels and invalid names (synonyms, etc.). The field **Parent** provides hierarchical structure to the record relations in the table. Each name (except the one with the highest rank) should have a parent taxon designated. For species the parent taxon is the name of a genus or subgenus, for genus it is the name of a tribe, subfamily, or family, and so on. For invalid taxon (synonym, homonym, misspelling, etc.) it is the name of a valid taxon.

- In the **Database window**, check that the tab **Tables** is selected in the Objects menu. Open the **Taxon** table by double clicking on its name.
- The table provides a list of taxa included in the key “Superfamilies of Auchenorrhyncha” with the order Homoptera as the highest rank taxon included in the database. If the taxon of interest to you is not in this order, you should first enter the name of the taxon of higher rank that includes both Homoptera and your group (e.g., class Insecta). Go to the last line of the table (reserved for a new record) and enter the following: in the **Name** field enter “Insecta”; in the **Rank** field select “Class”

from the dropdown box; in the field **Status** leave “Valid” (the default value). You have created a new record for the parent taxon “Insecta”.

- Because 3I does not allow more than one taxon without a parent designated, the newly entered record “Insecta” should be selected as a parent for “Homoptera”. Find the taxon record for Homoptera and place the cursor in its **Parent** field. Because the newly entered taxon “Insecta” is not yet present in the dropdown list of available parent names, you must update this list by pressing {F9} and then entering “Insecta” as the parent for “Homoptera”.
- Go to the end of the table again and enter a new record with a taxon of your group by typing the name and then selecting the appropriate Rank, Status, and Parent.
- The remaining instructions assume that you are going to enter data to create an interactive key for species of one genus in the database, but the instructions are applicable to keys for taxa at any rank. Enter a new record with the name of the genus. Select “Genus” as the rank, “Valid” as the status. Select the name of your group as the parent (press {F9} to update the field Parent before entering the appropriate name). The Author of the genus may be entered as well.
- Create additional records for some species of this genus. Each of them should be marked as “Species” in the Rank field and “Valid” in the Status field. Enter the genus name as the Parent (as above press {F9} to update the dropdown menu for this field). Enter the author and year of description in appropriate field. Each species record may also include the name of the original genus, but those names (if different from the Parent name) should be entered to the database as separate taxon records first. Finally, to include a species in the interactive key, enter the number “2” in the **KeyN** field in the species record. This number was given to the key in the **Transl** table.
- After creating records for the species in a genus, the type species may be selected by entering the species name in the **Type** field of the genus record (press {F9} to update the dropdown menu for this field).

Taxon : Table																
	Key	Hie	KeyN	Edit	Output	AutoDes	Name	Author	Year	YearRet	Rank	Status	Parent	OrigGen	OrigSubGen	Type
+	1	001			<input type="checkbox"/>	<input type="checkbox"/>	Auchenorrhyncha				Suborde	Valid	Homoptera (Order)			
+	3	001			<input type="checkbox"/>	<input checked="" type="checkbox"/>	Cicadomorpha				Infraorde	Valid	Auchenorrhyncha (Suborde)			
+	4	001			<input type="checkbox"/>	<input checked="" type="checkbox"/>	Fulgoromorpha				Infraorde	Valid	Auchenorrhyncha (Suborde)			
+	5	001	1		<input type="checkbox"/>	<input checked="" type="checkbox"/>	Cercopoidea				Superfa	Valid	Cicadomorpha (Infraorder)			
+	6	001	1		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Cicadoidea				Superfa	Valid	Cicadomorpha (Infraorder)			
+	7	001	1		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Membracoidea				Superfa	Valid	Cicadomorpha (Infraorder)			
+	8	001	1		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Fulgoroidea				Superfa	Valid	Fulgoromorpha (Infraorder)			
+	9	001			<input type="checkbox"/>	<input checked="" type="checkbox"/>	cicadas				Synony	Common	Cicadoidea (Superfamily)			
+	10	001			<input type="checkbox"/>	<input checked="" type="checkbox"/>	spittlebugs and frog				Synony	Common	Cercopoidea (Superfamily)			
+	11	001			<input type="checkbox"/>	<input checked="" type="checkbox"/>	leafhoppers and tree				Synony	Common	Membracoidea (Superfamily)			
+	12	001			<input type="checkbox"/>	<input checked="" type="checkbox"/>	planthoppers				Synony	Common	Fulgoroidea (Superfamily)			
+	13				<input type="checkbox"/>	<input type="checkbox"/>	Homoptera				Order	Valid				
+	14				<input type="checkbox"/>	<input checked="" type="checkbox"/>	Cicadellidae				Family	Valid	Membracoidea (Superfamil)			
+	15				<input type="checkbox"/>	<input checked="" type="checkbox"/>	Erythroneura	Fitch	1851		Genus	Valid	Cicadellidae (Family)			tricincta Fitch 1851
▶	16	2			<input type="checkbox"/>	<input checked="" type="checkbox"/>	octonotata	Walsh	1862	a:149	Species	Valid	Erythroneura Fitch 1851 (Gei)	Erythroneura Fitch		
+	17	2			<input type="checkbox"/>	<input checked="" type="checkbox"/>	kanwakae	Robinson	1924	c:292	Species	Valid	Erythroneura Fitch 1851 (Gei)	Erythroneura Fitch		
+	18	2			<input type="checkbox"/>	<input checked="" type="checkbox"/>	tricincta	Fitch	1851	a:63	Species	Valid	Erythroneura Fitch 1851 (Gei)	Erythroneura Fitch		
+	19	2			<input type="checkbox"/>	<input checked="" type="checkbox"/>	fraxa	Robinson	1924	c:292	Species	Valid	Erythroneura Fitch 1851 (Gei)	Erythroneura Fitch		
*	nber)				<input type="checkbox"/>	<input checked="" type="checkbox"/>						Valid				

Record: 15 of 18

- Close the Taxon table.

Associating the interactive key with a higher ranking taxon

- Open the **Keys** table.
- Enter a new record, where **KeyN** is “2” (the number given to your current interactive key) and **Description** is a short name of your interactive key. In the **Key** field–, select the name of the genus for your key from the dropdown box. Leave the DistanceMatrix field blank.

KeyN	Description	Key	DistanceMatrix
1	Auchenorrhyncha	Auchenorrhyncha (Suborder)	
2	Erythroneura species	Erythroneura Fitch 1851 (Genus)	

- Close the table.

Modifying the list of characters and their states

The list of characters is stored in the **Characters** table; the list of character states is stored in the **State** table. Both can be modified in table view, or a special form accessible by clicking “Characters” on the main form can be used. Work with tables is described here. In order for the interactive key to work, you should include enough characters and states to uniquely define each taxon morphologically, i.e., each taxon should have a unique combination of character states.

- Open the **Characters** table. It includes the list of characters used in the key for superfamilies of Auchenorrhyncha.
- You can use one of the characters, “Body size”, present in the first key, in your interactive key as well. Modify the **KeyN** field for this character to “1,2” (no spaces). This means that this character is shared between the keys 1 and 2.
- Enter some new characters by creating a new record for each. For each new character you should enter the name of the character in the **CharEn** field; unique number of character in the **Char** field (this field is used to order the list of characters; this order can be changed at any time); and the number of your key in the **KeyN** field, which is 2 in this example. The checkbox **Numeric** should be checked for numeric characters (characters which have exact numeric values instead of discrete states). Three optional fields may also be edited: **Weight** for character importance; **Morph**, to specify a broader category of morphological characters (e.g., body region); **Type** to specify the sex or stage of development for which this character is applicable (“m” = male characters, “f” = female characters, “mf” = applicable to both males and females).

	Key1	KeyN	Char	Type	Weight	Numeric	Morph	CharRu	CharEn	CharDt
+	1	1,2	1	mf		<input checked="" type="checkbox"/>			Body size	
+	2	1	2	mf		<input type="checkbox"/>			Number of ocelli	
+	3	1	3	mf		<input type="checkbox"/>			Presence of tegulae	
+	5	1	4	mf		<input type="checkbox"/>			{Lateral spines on }hind tibiae	
+	4	1	5	n		<input type="checkbox"/>			Nymph habitat	
+	6	2	10	mf		<input type="checkbox"/>	Coloration		Presence of transverse bands.	
+	7	2	11	m		<input type="checkbox"/>	Male Genitalia		Shape of pygofer dorsal apendage	
+	8	2	12	m		<input type="checkbox"/>	Male Genitalia		Length of third point of style apex	
▶	+	9	13	m		<input type="checkbox"/>	Male Genitalia		Bifurcation of ventral processes of aedeagus	
*		nber)		mf		<input type="checkbox"/>				

- The **State** table is linked to the Characters table and may be accessed by clicking the small plus sign at the left of each record. This will open the subset of states associated with a particular character. In this example, the subset of states is blank. Two or more states for each character should be entered to the table. Only two fields should be modified for each state: **State** – the state number (which should always start with zero, and the sequence should not contain gaps, e.g., 0, 1, 2, 3, etc.); **StateEn** – the state name. Numeric characters have only one state, where the State field is “0” and the StateEn field contains the measurement units (e.g., “mm”). **Important Note:** Because 3I uses the same data for interactive keys and autogenerated species descriptions, the verbal descriptions of characters and states should be structured so that, when combined, they form a grammatical phrase or sentence in telegraphic style. Thus, for a character referring to the shape of the dorsal apendage of the pygofer,

the character name might be “Dorsal appendage of pygofer in lateral view” and the states might be “curved dorsad”, “straight”, and “curved ventrad”. Combining the character name with one of these states yields “Dorsal appendage of pygofer in lateral view curved dorsad” in the taxon description generated by 3I. See also 3I description for more details on the Logic of automatically generated descriptions.

Key1	KeyN	Char	Type	Weight	Numeric	Morph	CharRu	CharEn	CharDt
1	1,2	1	mf		<input checked="" type="checkbox"/>		Body size		
	Key2	State	Key1	StateRu	StateEn				
+	1	0	Body size	mm					
*	umber)		Body size						
+	2	1	2	mf	<input type="checkbox"/>		Number of ocelli		
+	3	1	3	mf	<input type="checkbox"/>		Presence of tegulae		
+	5	1	4	mf	<input type="checkbox"/>		{Lateral spines on }hind tibiae		
+	4	1	5	n	<input type="checkbox"/>		Nymph habitat		
+	6	2	10	mf	<input type="checkbox"/>	Coloration	Presence of transverse bands.		
+	7	2	11	m	<input type="checkbox"/>	Male Genitalia	Shape of pygofer dorsal appendage		
+	8	2	12	m	<input type="checkbox"/>	Male Genitalia	Length of third point of style apex		
	Key2	State	Key1	StateRu	StateEn				
+	17	0	Length of third point o	less than half distance between other two points					
+	18	1	Length of third point o	more than half distance between other two points					
+	19	2	Length of third point o	more than distance between other two points					
*	umber)		Length of third point o						
+	9	2	13	m	<input type="checkbox"/>	Male Genitalia	Bifurcation of ventral processes of aedeagus		
*	umber)		mf		<input type="checkbox"/>				

- Close the Characters table.

Scoring the taxa

- Open the form **Characters** by clicking the button “Character Set and Datamatrix” on the Main form. This form is divided into 3 main frames. The top frame provides the list of valid taxa from the Taxon table; the middle frame provides the list of characters from the Characters table; the lower frame allows you to select appropriate states, or enter values for numeric characters, for each taxon-character combination. On the right of the frame with the list of taxa, there is a dropdown box with the list of interactive keys. Selecting the Key to your species will filter the taxon and character records, and leave only those used in this key.

The screenshot shows the '3I - Characters' form with the following components:

- Taxon names:** A list of species names with checkboxes:
 - fraxa Robinson 1924c Erythroneura (Species)
 - kanwakaie Robinson 1924c Erythroneura (Species)
 - octonotata Walsh 1862a Erythroneura (Species)
 - tricincta Fitch 1851a Erythroneura (Species)
- Language:** Radio buttons for Russian, English (selected), German, French, and Spanish.
- Remarks:** A list of options: Description, Distribution 1, Distribution 2, Host, Images.
- Character set dropdown:** A dropdown menu currently showing 'Erythroneur' with a list of options: Show all, Auchenorrhyncha, Erythroneura species, and Character set.
- Characters:** A list of characters:
 - Body size
 - Presence of transverse bands.
- Record:** A navigation bar showing 'Record: 1 of 4 (Filtered)'.

- Each character should be scored for each taxon using the fields in the lower frame. To do this, select a taxon in the top frame, select a character at the middle frame, and select the appropriate state from the dropdown box in the lower frame or, for numeric characters, enter the range of values (MIN and MAX) exhibited by the taxon. Multiple states may be selected for a character if the taxon is

polymorphic. If you do not score a particular character for a taxon, the key assumes that all possible states are present in the taxon for that character.

- To the left of each taxon name, there are two small fields: enter any character to the first field (e.g., “+”), to mark that the taxon is scored and check the check box to indicate that the taxon is ready to be included in the interactive key (only scored taxa should be checked). Two different fields are required, because some taxa could be scored, but not included in the key (e.g., undescribed taxa). Different symbols in the first field can be used to distinguish between completely and incompletely scored taxa.
- When the datamatrix is scored, close the form.

Update for the Internet

- In the Main form, press the button **Update for the Internet** (the same option is available from the taxonomic form). This will generate hierarchic code in the Taxon table. This code is used for faster sorting of the records and generating taxonomic pages on the Web. **This operation should be performed before copying the database to the server every time any changes were made to the Taxon table.**
- Copy the database (3i.mdb file) from your local folder to the server folder (c:\wwwDB\). Use commands of Windows to copy and paste the file from one folder to another.
- The installation documentation provides instructions on how to access and preview a sample interactive key from your computer. For easier access to the new interactive key the **index.asp** file (the start page of your web site) should be customized. Using **NotePad** or another simple text editor, open the **index.asp** file from the folder **C:\inetpub\wwwroot\key**. Duplicate the hyperlink for the interactive key. In the address, change “KeyN=1” to “KeyN=2” (which will refer to the new interactive key added to the database. Also change the text of the hyperlink (e.g., “My first interactive key”).

```

<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=windows-1252">
<link rel="stylesheet" href="style.css">
<title>3I links</title>
</head>
<body>
<h1>3I links</h1>
<p>
<a href="http://Hecalus/key/key.asp?key=Erythroneura&lng=En&i=1&keyN=1">
Interactive key</a></p>
<p>
<a href="http://Hecalus/key/key.asp?key=Erythroneura&lng=En&i=1&keyN=2">
My first interactive key</a></p>
<p>
<a href="http://Hecalus/key/search.asp?key=Erythroneura&lng=En">
Search the database</a></p>

```

- To see your interactive key, open an Internet Explorer (or other browser) window. In the address line type: **http://Computer_Name/key/**. Where the “Computer_Name” is the real name of your computer. Follow the hyperlink.

Further modifications of the interactive key

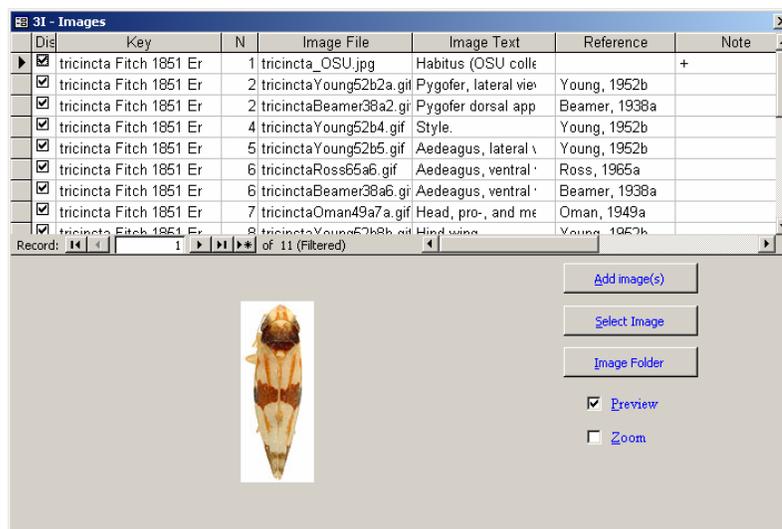
New taxa, characters, and their states may be entered into the database, taxa and characters may be illustrated, and information about synonyms, distribution, host plants, literature, etc. may be added at any time. All those changes may be previewed instantly by simply copying the database file from the local folder to the server folder. All functionality of 3I is not described here; please refer to the 3I description document for more details. We will focus only on few important features: illustrations for taxa and character states, and adding dots to the distribution maps (i.e., specimen-level data).

Illustrating character states

- Prepare images illustrating each state of a particular character. Illustrations should be formatted as follows. Any Internet-compatible image format is acceptable (JPG, GIF, or PNG are recommended). We strongly recommended using short file names, without gaps or punctuation marks, for images. Images will appear on the Internet as they are, without resizing, so the recommended size for images is 180x180 pixels; this will ensure that all images are visible in a popup window without the need for scrollbars. The images should be stored in the server folder **C:\inetpub\wwwroot\key\images**.
- To link images to the database, open the **Characters** form (the same form was used to score the datamatrix). Select the character to which you intend to add illustrations. Click the button **State Set**, which will open a form with the list of character states associated with this character. Each state has a **File** button; clicking on this will open a dialogue window and allow you to select the appropriate image file. Click OK to link this file to the database. Files are not physically embedded into the database, only the names of files are stored in the State table. Repeat these steps to select images for all states.
- Close the States form. You may copy your database to the server folder and preview the changes.

Illustrating taxa

- To illustrate a taxon, prepare the images in the same way you did for character states. Recommended size for images is between 150x150 and 300x300 pixels. The images should be stored in the server folder **C:\inetpub\wwwroot\key\images1** (different from character images).
- To link images to the database, open the **Characters** form. Select a taxon, for which you intend to add some illustrations. Click the **Images** button, which will open the **Images** form.
- Click the button **Add Image(s)**; it will open a dialogue window which allows you to select appropriate image files. Click OK to link the selected image files to new records.
- For each new image enter the **Image Text** (This will appear as a popup message that is displayed when the mouse cursor is moved over the image on the Web page. Do not add the name of the taxon, it will be added automatically). In the field **N** enter the number of the image which will refer to the order in which the images will be displayed on the Web page (use the same numbers for homologous structures).
- The **Images** form allows previewing the images inside the database. To see your images, check the check box **Preview**, then select an image you want to preview. The images are loaded from the folder **C:\inetpub\wwwroot\key\images1**. A different folder may be specified by clicking the **Image Folder** button.



- After the images have been selected and described, close the form. You may now copy your database to the server folder and preview the changes.

Adding specimen information

- Specimen information is stored in the **Localities** table. It can be opened from database window, or through the **Characters** form. If you do the latter, the records associated with a particular taxon will be filtered.
- To add a dot on the distribution map, enter the taxon name to the **Key** field. Fill in as many fields in the record for each specimen as possible. If exact geographical coordinates are entered, the exact locality will be plotted on the map generated on the Web. If the exact coordinates are not available, but the information about the Country, State, and County is provided, the map will plot the locality as the county centroid. If the county is left blank, the state centroid will be plotted, etc.
- After entering the locality data, close the table. You may copy your database to the server folder and preview the results.