Arthropod Pesticide Resistance Database

Michigan State University

What is the APRD?

Resistance is a widespread phenomenon where arthropod populations develop the ability to avoid the lethal effects of normally fatal concentrations of pesticides and biopesticides. Resistance frequently leads to the increased use, overuse, and even misuse of pesticides, which poses a risk to the environment, phytosanitation, market access, global trade, and public health. There is a worldwide need for accurate and easily accessible pest resistance information – information to be used by numerous stakeholders in agriculture, human health, animal protection, and other pest management arenas.

The Arthropod Pesticide Resistance Database (APRD) is a web-based resistance case entry system that serves as a tool to access arthropod resistance information, and provides a forum for real-time and scale appropriate reporting of the current status of arthropod resistance across the globe. The APRD is a gateway search engine (found on-line at **www.pesticideresistance.com**) that is the only comprehensive arthropod resistance resource worldwide. The Database details thousands of resistance cases since 1914 and is recognized as the world's largest repository of resistance information. Currently, the database receives over 540,000 visits annually that last ten minutes or longer.

The APRD also allows for on-line submission of resistance cases by registered users. Anyone can register and submit cases, but only cases approved by a peer review panel of resistance experts will be accepted into the database. A person does not have to be registered to search the database for resistance cases; however, searching without registration will only reveal basic information such as the insect, pesticide, year of report, location, and reference. Registered users can view the entire case summary, including resistance ratios, bioassay information, and other critical information when available.

How to Contact the Database

The Arthropod Pesticide Resistance Database (APRD) can be found at **www.pesticideresistance.com**, and the following contact information can be found under the "Contact Us" link at the top of the page.

- Mark E. Whalon, Project Director, whalon@msu.edu
- David Mota-Sanchez, Resistance Specialist, motasanc@msu.edu
- Robert M. Hollingworth, Project Co-Director, rmholl@msu.edu
- Lee Duynslager, Webmaster, duynslag@msu.edu

Please feel free to contact any of these people with questions about the Database, or about a submission to the Database.

For questions regarding case submissions, the best contact method is email, but you can also call the Whalon Lab at 1-517-355-1768. (Reaching us by phone may be difficult, so please email if possible.) Also, you can track your case submission online at www.pesticideresistance.com. For online tracking, see "How to Submit a Case to the Database."

If your submission is accepted, it will be published in the Resistant Pest Management (RPM) Newsletter. The RPM Newsletter was developed to spread knowledge of resistance around the world. The goal of the RPM Newsletter is to inform researchers, industry workers, pesticide policy bureaucrats and field personnel of ongoing changes and advances in pesticide resistance management, provide an archival resource to national and international policy leaders, and enhance communication of ideas among resistance managers worldwide. The bi-annual publication has over 1000 electronic subscribers (mostly in government, industry and academia), and hard copies are now part of 61 libraries serial listings worldwide. Example countries with serial listings include the United States, Germany, Italy, the United Kingdom, India, Japan, Taiwan, Egypt, Kenya, Costa Rica, Australia, Malaysia, and New Zealand.

To contact the Resistance Pesticide Newsletter please email RPMNews@msu.edu or call 1-517-355-1768. We will respond to your email as soon as possible.

How to Submit a Case to the Database

The submission process is completely electronic. It is a simple, peer-reviewed procedure that usually takes less than two weeks. However, only registered members can submit a new case for publication to the database. Therefore, the first step in submitting a resistance case is to become a registered member.

To become a registered member:
Go to **www.pesticideresistance.com** and click on the "Sign Up" link near the top of the page. This will take you to an electronic form, which must be filled out. (Anything with a red asterisk is required.) Once the form is submitted, a verification email will be sent to the email address that you provided. Click on the link in the email to verify the registration request. In approximately 24 hours, a confirmation email will be sent to your account stating that you are now registered with the database. If you ever lose your password, you can email David Mota-Sanchez to receive a new one. His email is motasanc@msu.edu, and can be found on the "Login" page.

To submit a resistance case:
Once you are registered, go to **www.pesticideresistance.com** and log on. Once you are logged on, click on the "Submit" link and fill out the necessary information. (Anything with a red asterisk is required.) A Chief Editor will contact you with a password that you will need for submitting your resistance case to the Editorial Board.

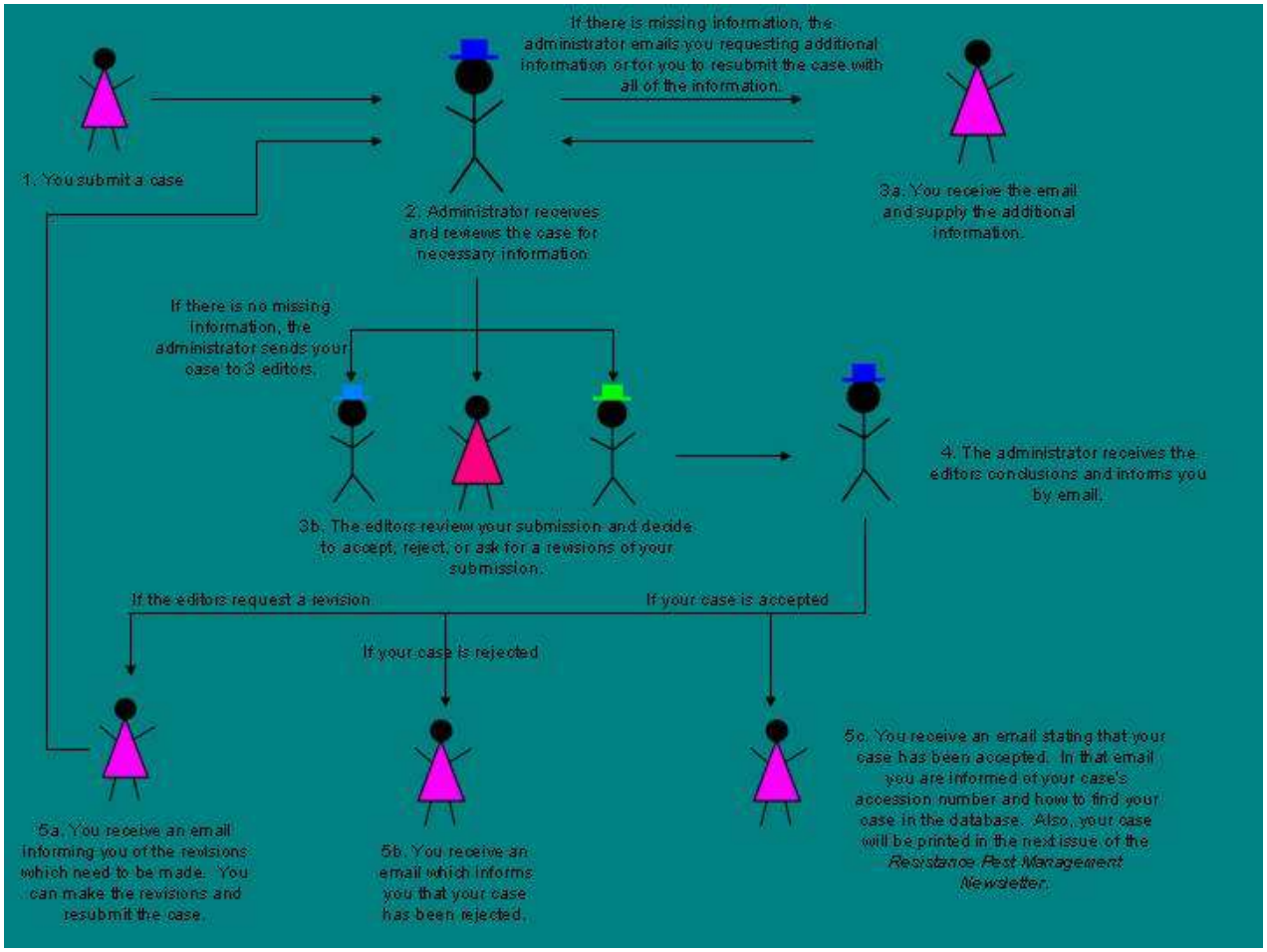
When your case is submitted it will be reviewed for all necessary information. If your case contains the necessary information, it will be assigned to 3 editors. If information is missing, the administrator will email you requesting either the missing information, or a resubmission of your case with the necessary revisions.

When the editors review the case, they can approve, reject, or request revision of the case. If the case is rejected, you will receive an email informing you of your case's rejection. If the editors ask for a revision of the case, then you will receive an email regarding the editors' decision, including necessary revisions for acceptance. You can revise the case submission and resubmit it. If the case is accepted, then you are emailed with their decision of acceptance. Once accepted, the case is submitted into the Database, where it receives an accession number (for citation purposes) and information about where to find the case in the Database. The case is also included in the next issue of the Resistance Pest Management (RPM) Newsletter, a biyearly publication.

To track your resistance case:
During the submission process, you can track your submission to see its submission status. On your "My Account" page, you can see a list of your submissions by genus. This page will tell you the status of your submission, and whether it has been accepted, rejected, or needs revision.

To use the cloning function:
The cloning function is used when you have more than one resistance case of the same type, and most of the information for each case remains the same. If the resistance case that you are submitting is already published, you can submit your case as a clone. To do this, log on to your account and go to the "My Account" page. You will see a record of the resistance cases that you have submitted and where they are in the submission process. Next to each submission, there is a "Clone" tab that you can click on to clone your case. The cloned case will appear at the end of the submitted cases on your "My Account" page.

An example of the cloning feature: You have found resistance in the German cockroach from several populations in Georgia, USA, to fipronil. Each population was tested using the same bioassay method but each population has a different resistance ratio. For this example, after you submit the first case of resistance you can "clone" it. Go to "My Account," where you will find the case you submitted and an exact replica of that case - the clone - which will be listed last. You can click on the cloned case and you only have to change the resistance ratio, since insect, pesticide, location, collection dates, bioassay type, and reference are already entered from the previous case.



How the Database Works

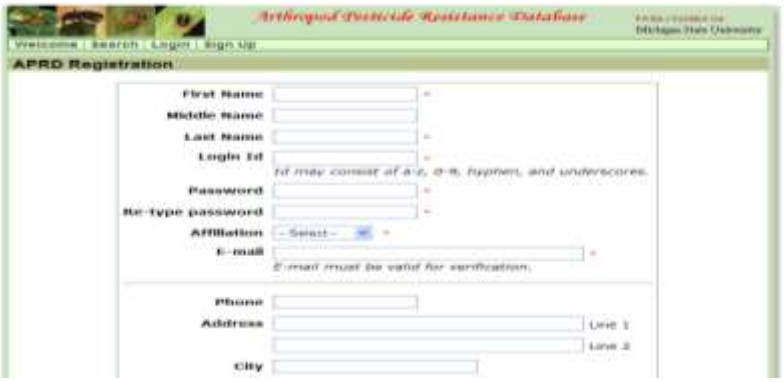
Welcome

The home page of the database, found at www.pesticideresistance.com, gives a brief introduction and has tabs to other parts of the database.

Login

By clicking on the "Login" tab, you are taken to this page where you can either sign into your account (by entering your username and password into the correct fields), or register with the database by clicking "Sign Up."

Sign Up



If you click "Sign Up," you are taken to this page. Please see the subsection "To become a registered user" under "How to Submit a Case to the Database" for further information.

My Account

Once you sign into your account, click on the "My Account" tab, which will take you to a page similar to the one shown above. This page lists all of the cases which you have submitted to the database, and their submission status. Please see "How to Submit a Case to the Database" for further information.

You can change your password by clicking on the "Change Password" tab.

By clicking on the "Update Profile" tab, you can change the information that you submitted when you created your account.

FAQs

By clicking on "FAQs" at the top right-hand corner of the webpage, you will be directed to this page. The FAQs page is designed to answer common questions about the Database. If you have a question, please check this page first. If your question is not answered here, please contact us.

Contact Us

By clicking "Contact Us" at the top right-hand corner of the webpage, you will be directed to this page. If you have a question or problem that is not addressed on the FAQs page, please email anyone listed on this page. For more contact information, please see "How to Contact the Database."

Searching the Database

Searching by Species

Search

By clicking the "Search" tab, you are taken to this search page. From here you can search for any resistance case in the Database. You can search based on species, active ingredient, location, reference (author, title or publication year), or mode of action.

To illustrate how to use each search function, an example of German cockroach (*Blattella germanica*) resistance to fipronil reported in 2003 in North Carolina, USA will be used. (This is the same example that was used to explain cloning in "How to Submit a Case to the Database.")

The species search page displays drop down boxes for Order, Family, Genus, and Year. If you are looking for a specific species you can go directly to the Genus drop down menu and make your selection. This action will automatically fill in the Order and Family boxes for you. If you are interested in finding broader resistance within an Order or Family, begin by making your selection within one of those categories and click search. This action will display all of the insects within that Order or Family that have been reported as resistant.

In our example, we begin my selecting *Blattella* from the Genus drop down menu (shown above) and clicking search. The year was left at "Select All" although 2003 could have been entered for it. When APRD administration submits cases, the year is usually the year in which the resistance was discovered, which is not necessarily the same year it was published. Keep in mind that if you are looking for a specific case and you select the year it was published, you may not find the case you are looking for.

Search by Species

Clicking Search displays a list of all the species within the Order, Family, or Genus you selected. In our example there is only one species within the Genus *Blattella*. For each species in the list, the common name, number of cases, and importance group are shown. The importance groups are medical, agricultural, parasite, pollinator, and other.

List of Active Ingredients

Clicking on the name of the species you are interested in shows all of the active ingredients (pesticides) to which the species is resistant. To find the case that you are looking for simply scroll down the list of active ingredients and click on the one you want. If you do not see the active ingredient you are looking for, no resistance case has been submitted for it. For our search, we will click on "fipronil" to see the resistance cases associated with it. (Note: the page has been cropped and does not show all active ingredients to which *B. germanica* is resistant.)

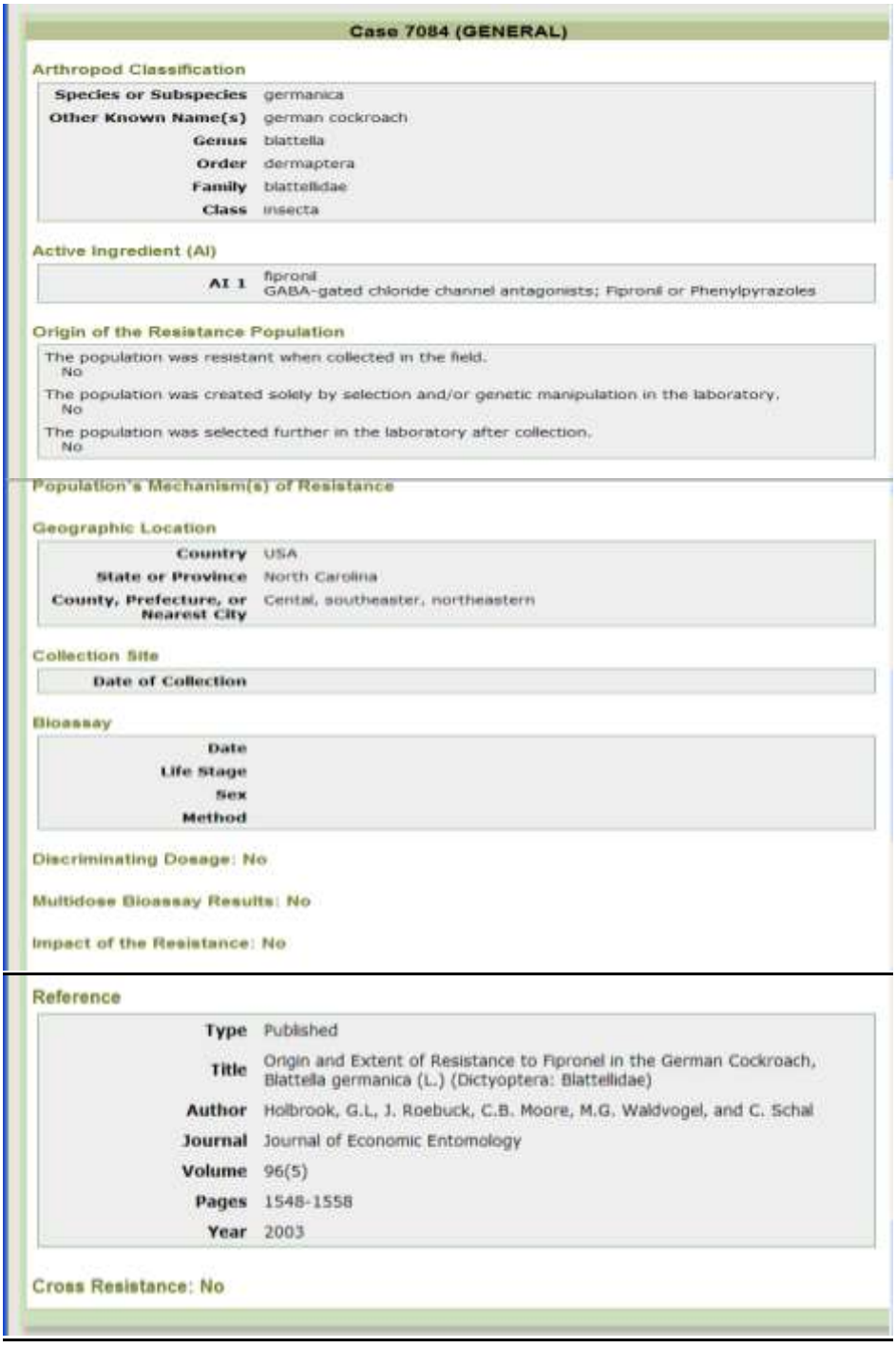
Resistance Cases

This page lists all of the resistance cases of the German cockroach to fipronil. There are two cases of resistance in *B. germanica* to fipronil listed under the heading "Resistance Case(s)." You can also click on the word fipronil, which will take you to a list of all resistance cases reported to fipronil. This page can be reached alternatively by an active ingredient search (covered in the next section). Clicking on "blatella germanica" will take you back to the page listing all the active ingredients.

The case we are searching for is from North Carolina, and we can access that by clicking on the case id "7084." This opens a pop-up window which gives all of the information about this resistance case, including the reference.

Since this case was added prior to updating the database, some categories in the summary are blank. Newer cases will have information entered for these categories including field or lab selected, bioassay method, and resistance ratios. We are slowly working to update these older cases to include all available information, but this will undoubtedly take several years.

Pop-Up Window: Case Information



Case 7084 (GENERAL)

Arthropod Classification

Species or Subspecies	germanica
Other Known Name(s)	german cockroach
Genus	blattella
Order	dermaptera
Family	blattellidae
Class	insecta

Active Ingredient (AI)

AI 1	fipronil GABA-gated chloride channel antagonists; Fipronil or Phenylpyrazoles

Origin of the Resistance Population

The population was resistant when collected in the field.
No

The population was created solely by selection and/or genetic manipulation in the laboratory.
No

The population was selected further in the laboratory after collection.
No

Population's Mechanism(s) of Resistance

Geographic Location

Country	USA
State or Province	North Carolina
County, Prefecture, or Nearest City	Cental, southeaster, northeastern

Collection Site

Date of Collection	

Bioassay

Date	
Life Stage	
Sex	
Method	

Discriminating Dosage: No

Multidose Bioassay Results: No

Impact of the Resistance: No

Reference

Type	Published
Title	Origin and Extent of Resistance to Fipronel in the German Cockroach, Blattella germanica (L.) (Dictyoptera: Blattellidae)
Author	Holbrook, G.L, J. Roebuck, C.B. Moore, M.G. Waldvogel, and C. Schal
Journal	Journal of Economic Entomology
Volume	96(5)
Pages	1548-1558
Year	2003

Cross Resistance: No

Searching by Active Ingredient

Search by Active Ingredient

The active ingredient search page is accessed by clicking the "Active Ingredient" tab. This takes you to a page in which the active ingredients are listed in alphabetical order. To scroll to the next page click the word "next." Keep clicking the "next" button until you see the active ingredient you are looking for. Once you see the active ingredient you want, access that page by clicking on the ingredient (in this case, fipronil).

List of Species

This page will list every species with a reported resistance to the active ingredient that you are searching for. Click on the species that you want (in this case, *Blattella germanica*). Doing so opens the webpage which lists every reported resistance case of the German cockroach to fipronil.

Searching by Location

Search by Location

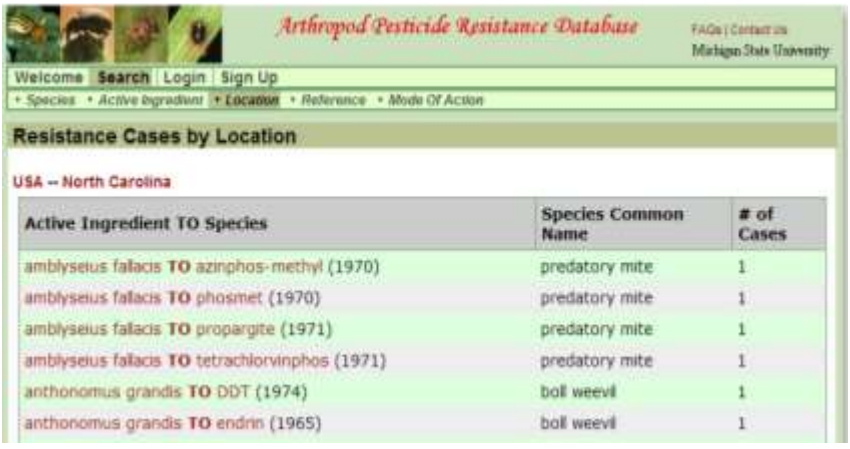
You can search by location by clicking the "Location" tab. This brings up a page with a drop down box to search by country. Select the country for which you are searching and click "Search."

List of Regions

Clicking "Search" displays a page listing regions of the country where resistance has been reported.

Scroll down the page to find the region that you wish to search for, and click on the name of the region (in this case, North Carolina). This displays a page listing every case of resistance in that region, listed alphabetically by genus, species and then active ingredient. Scroll down the list to the species and active ingredient for which you are searching. If the species or active ingredient is missing, then no case of resistance has yet been reported.

Resistance Cases

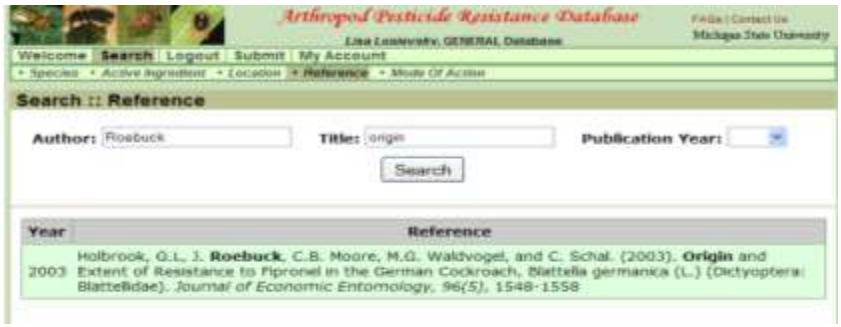


Clicking on the genus, species, and active ingredient for which you are searching will again take you to the page listing all cases of resistance, which was shown before.

Scroll down the list to the desired species and active ingredient. If the species or active ingredient is missing, then no case of resistance has yet been reported.

Searching by Reference

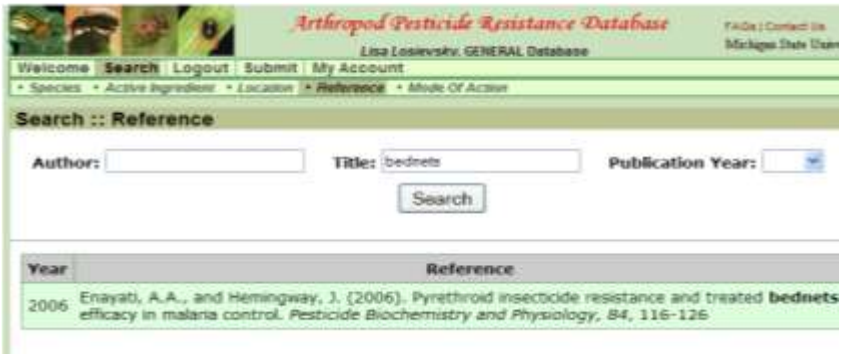
Searching by Reference



You can search by reference by clicking the "Reference" tab. This brings up a page in which you can type author or title information, or select a year from the drop-down box. Entering any of the above information will give you the citation information for any resistance case meeting your criteria. When using searching by author, you do not have to use the primary author (the first author listed in the reference); you can use any author cited in the reference.

When searching by title, you do not have to use the complete title, but if you do it must be spelled correctly and be exactly the same as it was entered into the system. It is easy to make a mistake when searching for whole titles. If you use a whole title and cannot find what you are looking for, try using a partial title or key word.

Title Search



When you are searching for a specific topic, it is helpful to search using a key word in the title search. For example, if you are looking for resistance cases involving bednets, you can type "bednets" into the title box and it will list any reference that used that word in the title.

Searching by Mode of Action

To access the mode of action search, click the "Mode of Action" tab. Select the mode of action you are interested in from the drop down list and click search.

Searching by Mode of Action

Clicking search displays a table listing all of the active ingredients which act by this mode of action. Click on the active ingredient (in this case, fipronil) for which you are searching. This will bring up the page listing all of the species with known resistance to the ingredient. From here, it is exactly like an active ingredient search, so please see that section for more information.

Editor List

We would like to acknowledge and thank our editors of the APRD.

Reviewer	Class of Pesticide
Tom Anderson	Flonicamid
Nigel Armes	Phenylpyrazoles (Fiproles)
	Organotin miticides
	Uncouplers of oxidative phosphorylation via disruption of proton gradient
	Inhibitors of chitin biosynthesis, type 0, Lepidopteran
	Hydramethylnon
	Mitochondiral complex electron transport inhibitors
	Metaflumizone
Andrea Bassi	Indoxacarb
Carlos A. Granadino	Pyriproxyfen
	Etoxazole
	Und Pyridalyl
Alasdair Haley	Propargite Tetradifon
	Neuronal inhibitors (unknown mode of action)
Graham Head	Microbial disruptors of insect midgut membranes (includes transgenic crops expressing Bacillus thuringiensis toxins)
Alan McCaffery	Nicotine
	Chloride channel activators
	Fenoxycarb
	Pyrnetrozine
	Inhibitors of chitin biosynthesis, type 0, Lepidopteran
	Moulting disruptor, Dipteran
Ralf Nauen	Neonicotinoids
	Nicotine
	Inhibitors of lipid synthesis
Venkat Pedibhotla	Phenylpyrazoles (Fiproles)
	Uncouplers of oxidative phosphorylation via disruption of proton gradient
	Mitochondrial complex electron transport inhibitors
	Metaflumizone
Suresh Prabhakaran	Sulfuryl fluoride
Phil Robinson	Cryolite
	Organotin miticides
David Rogers	Neonicotinoids
	Inhibitors of lipid synthesis
Caydee Savinelli	Chloride channel activators
	Pyrnetrozine
Robin Slatter	Und Pyridalyl
Tom Sparks	Organophosphates
	Nicotinic Acetylcholine receptor agonists (allosteric)(not group 4)
	Juvenile hormone analogues
	Fenoxycarb
	Pyriproxyfen
	Diacylhydrazines
	Octopaminergic agonists
Bruce Stanley	Carbamates Triazemate
	Indoxacarb
Nick Storer	Microbial disruptors of insect midgut membranes (includes transgenic crops expressing Bacillus thuringiensis toxins)
Gary Thompson	Nicotinic Acetylcholine receptor agonists (allosteric)(not group 4)
Bob Hollingworth	
David Mota-Sanchez	
Mark Whalon	

Acknowledgements

We would like to acknowledge all of the people who have a part in updating and maintaining the Arthropod Pesticide Resistance Database and the *Resistance Pest Management Newsletter*.

Mark E. Whalon	Project Director,
David Mota-Sanchez	Resistance Specialist
Robert M. Hollingworth	Project Co-Director
Lee Duynslager	Webmaster
Lisa Losievsky	System Administrator
Saunté Sutton	System Administrator
Jeanette Wilson	RPM Newsletter Coordinator
Abbra Puvalowski	RPM Newsletter Coordinator

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