

ACD/Structure Elucidator

*Over a Decade of Development in
Computer Assisted Structure Elucidation*



Visionary Software



Advancing Research

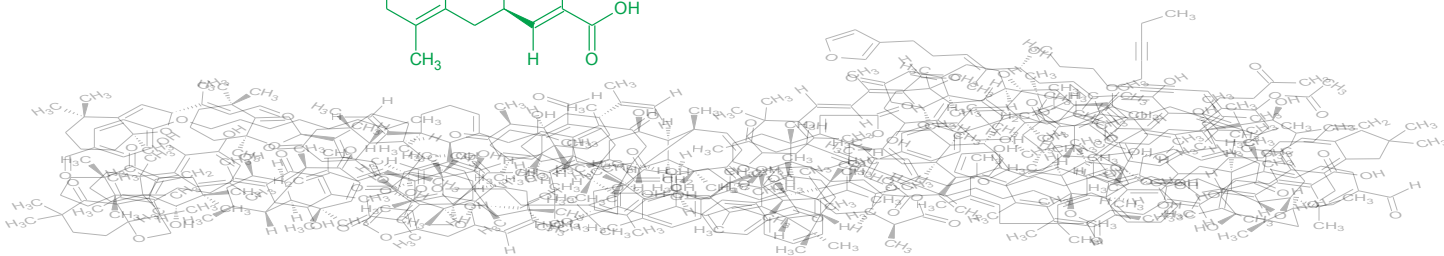
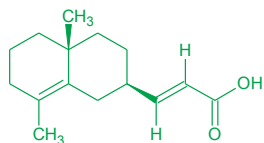
A Case for CASE

Computer-Assisted Structure Elucidation (CASE) is an area of scientific investigation on the frontier between organic chemistry, molecular spectroscopy, and computer science. The general wisdom for structure elucidation is that any proposed structure should always be considered a hypothesis, and while these hypotheses can be proven to be incorrect, it can be very difficult to confirm a structure's identity with 100% confidence. One of the legacies of the late David John Faulkner, a highly respected Professor at the Scripps Institution of Oceanography in the area of natural products chemistry, was advice on how to avoid elucidation mistakes. One of Faulkner's biggest philosophical contributions to the field of structure elucidation was the proposition of the following structure elucidation rules:

- 1 Never propose a structure before you have accumulated ALL possible spectral data
- 2 If the structure is incompatible with any measurement, however minor, then the structure is wrong
- 3 Always find alternative structures, and evaluate ALL alternative structures in a systematic manner

$C_{15}H_{22}O_2$ has >138,000,000,000 possible isomers.

Employing a CASE strategy is the only way to generate all alternative structures and evaluate them in a systematic manner.



"The molecule under analysis acts like a specific coding machine (cipher machine) which codes structural information into each kind of spectrum using it's own code.

The goal of a researcher is to crack the codes [of spectral information] and extract the maximum structural information possible. Obviously, the human expert is frequently unable to derive and check all possible structures. Therefore, it is not surprising that sometimes incorrect structures are elucidated by chemists.

The advantages of the systematic approach are obvious: all plausible structures are exhaustively enumerated, ranked, and automatically displayed."

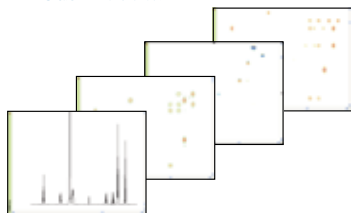
- Mikhail Elyashberg, *Journal of Cheminformatics*, 2008.

ACD/Structure Elucidator: How it Works

Structure Elucidator is a complete software package that helps in the elucidation of unknown structures. It extracts information from various analytical techniques (NMR, MS, and IR) in all instrument formats to generate potential structures that are consistent with the data provided.

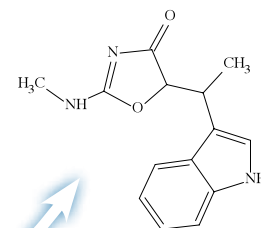
How it Works

Submit data

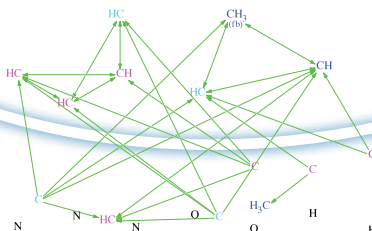


ACD/Structure Elucidator uses molecular formula and 1D and 2D NMR data to generate a Molecular Connectivity Diagram (MCD). The information in this diagram is used to generate potential structures.

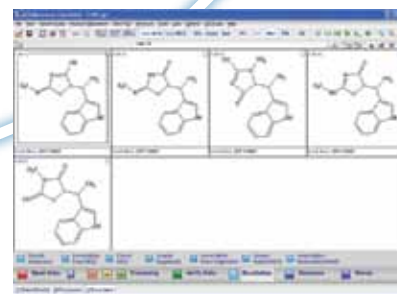
Identify best structure



MCD is automatically created



The MCD is also an interactive tool that a user can easily modify to add or remove information for consideration.



Putting Past Elucidations to Work for the Future of Antibacterial Research

Sequoia Sciences collaborates with commercial and academic laboratories to identify active agents in plant-based samples. Sequoia specializes in the isolation and elucidation of unknown structures from natural sources. To assist in their routine analysis, they apply ACD/Structure Elucidator to enable efficient dereplication of compounds through spectral databasing, and rapid elucidation of unknown compounds via various analytical techniques.

“The choice was obvious for us. The combination of search capabilities, proton and carbon chemical shift predictors as well as the structure elucidation capabilities, meant that there was no hesitation in making this investment. Our previous experience with ACD/Labs products and service made for a seamless transition in adding additional modules.”

Mark O'Neil-Johnson, VP Analytical Chemistry

Real-World
Applications



ACD/Structure Elucidator: A Timeline

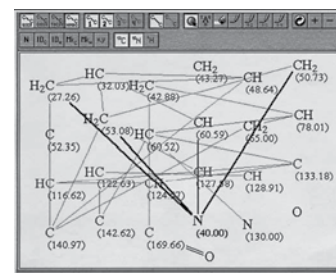
ACD/Labs' mission over the last decade was to take on the daunting challenge of structure elucidation in an unbiased fashion, by leveraging the technological enhancements in computer science as well as the sophisticated algorithms available in ACD/Labs core software offerings to deliver the best CASE system on the market.

With over a decade of product development spanning 10 software versions between 1998–2011 (version 3.5–version 12), Structure Elucidator is the most peer-reviewed system in scientific literature.

This timeline shares our most notable milestones since the initial release of the product in 1998.

First peer-reviewed article describing Structure Elucidator, with the unique ability to build sets of fragments containing no common atoms if structure generation with known methods fails.
[Elyashberg et al., *Autom. Inf. Manage.* 1999, 34, 15-30.](#)

Structure Elucidator development continues with the ability to generate structures from 2D NMR spectra, allowing elucidation of heavier molecules.
[Bilnov et al., *Fresenius J. Anal. Chem.* 2001, 369, 709-714.](#)

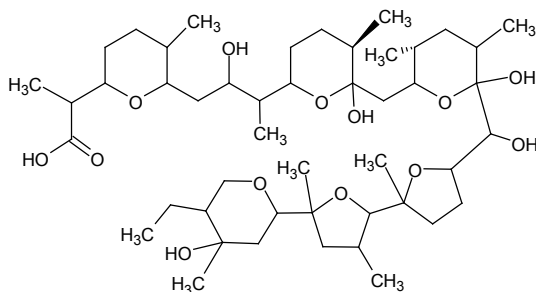


1999

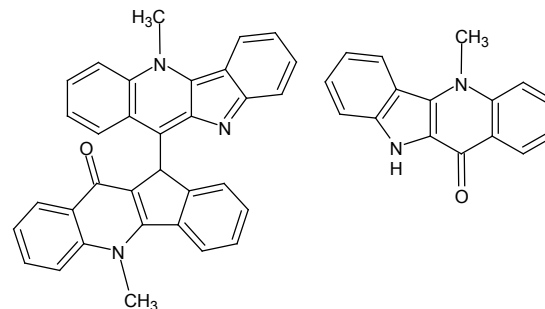
2001

2002

Structures of 60 natural products of up to 65 skeletal atoms are successfully determined by Structure Elucidator.
[Elyashberg et al., *J. Nat. Prod.* 2002, 65, 693-703.](#)



Structure Elucidator is used to determine the structure of degradants of a nonacyclic alkaloid, including an unexpected rearrangement product.
[Martin et al., *J. Heterocyclic Chem.* 2002, 39, 1241-1250.](#)



Real-World Applications

Identifying Mixture Components at Very Low Concentrations

Anna Codina et al. have reported one of the first examples of computer-assisted structure elucidation of volatile impurities isolated by prep-GC. A combination of the proposed in silico methods and instrumentation were successful even in cases where the total amount of material is of the order of 60 nmol.

The authors state, "We are of the opinion that for relatively small organic molecules, the combined computational approach can nowadays be faster and more thorough than the expert spectroscopist. Thus, despite there being many instances in the literature describing CASE as an expert system to assist in solving difficult problems, we prefer to use it for the relatively routine investigations so that the expert can focus on complex elucidations involving mixtures, weak data, and/or with several peaks overlapping."

Anna Codina et al., *Anal. Chem.*, 2010, 82, 9127–9133



Impurity

Structure Elucidator's efficient processing of 2D NMR is found to be necessary to elucidate complex natural compounds, and significantly faster than other systems.

Elyashberg et al., *J. Chem. Inf. Comp. Sci.* 2004, 44, 771-792.

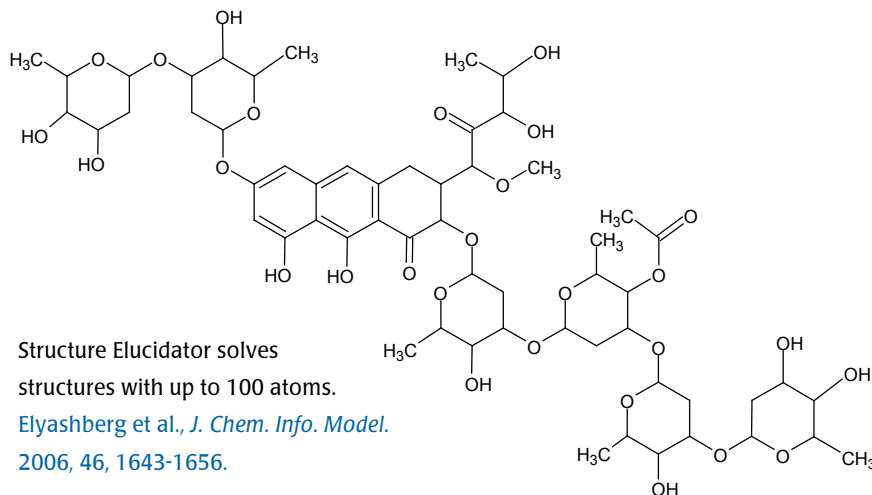
A CASE review article is published citing ACD/Structure Elucidator as the most promising achievement in terms of practical applicability of all CASE systems available.

Steinbeck, *Nat. Prod. Rep.* 2004, 21, 512-518.

2006

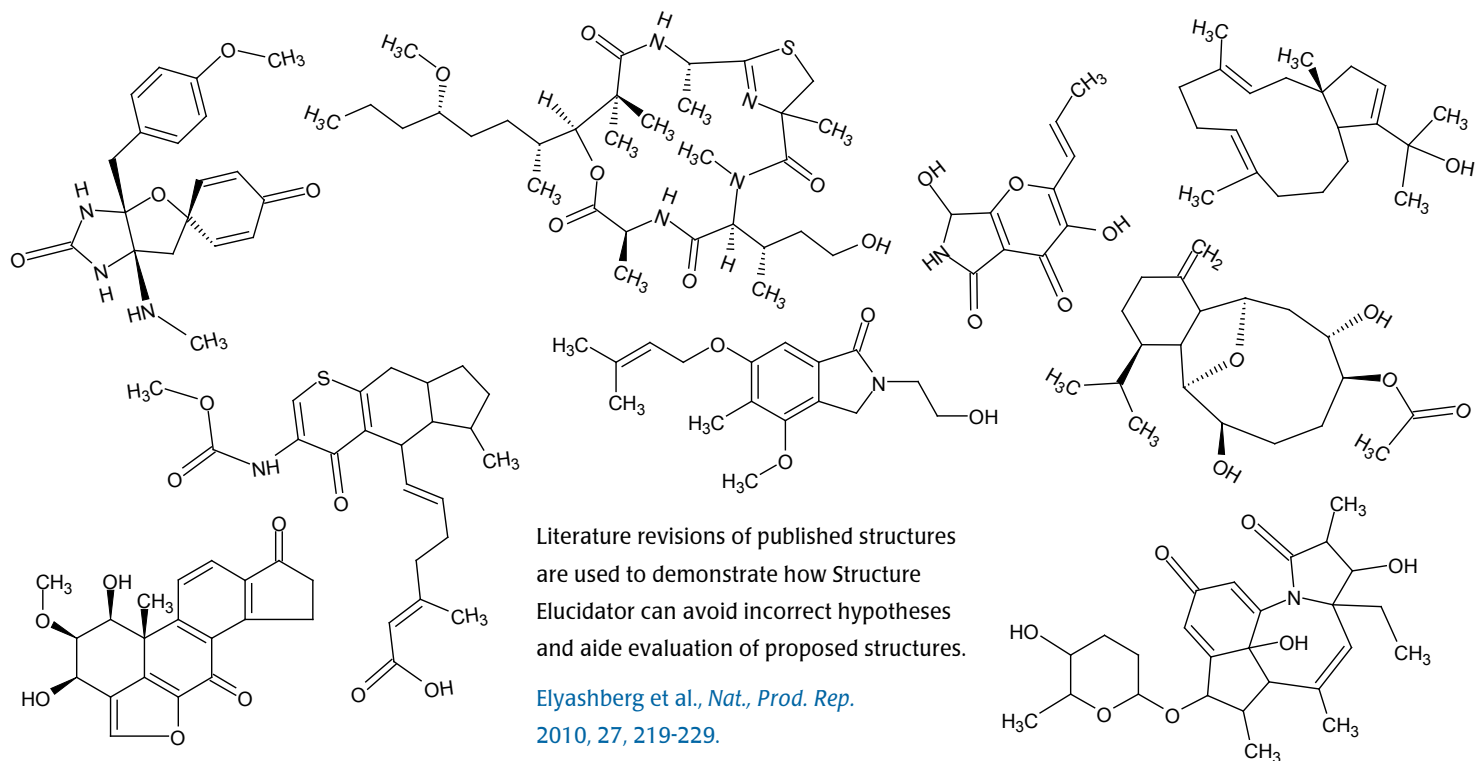
2007

2004



Fuzzy Structure Generation is introduced, capable of delivering a correct solution in the presence of an unknown number of non-standard correlations with unknown lengths in 2D NMR data.

Elyashberg et al., *J. Chem. Info. Model.* 2007, 47, 1053-1066.



2008

Structure Elucidator found to be the most advanced commercial expert tool, encompassing all features of other products but with even more advanced functionality.

Elyashberg et al.,
Prog. Nucl. Magn. Reson. Spectrosc.
2008, 53, 1-104

2010

M. Elyashberg's 2009 CASE review paper featuring Structure Elucidator is still the most accessed paper from the Journal of Cheminformatics.

Elyashberg et al., *J. Cheminf.*, 2009, 1-3.

Contemporary Computer-Assisted Approaches to Molecular Structure Elucidation, a book featuring Structure Elucidator and describing the state-of-the-art in CASE systems is accepted for publication.

M. Elyashberg, A. Williams, K. Blinov, *Royal Soc. Chem.*

2011

Coming Soon

The next generation of Structure Elucidator, an integral part of the ACD/Spectrus family of products.

Solving a Structure Computationally After 10 Years of Human Effort

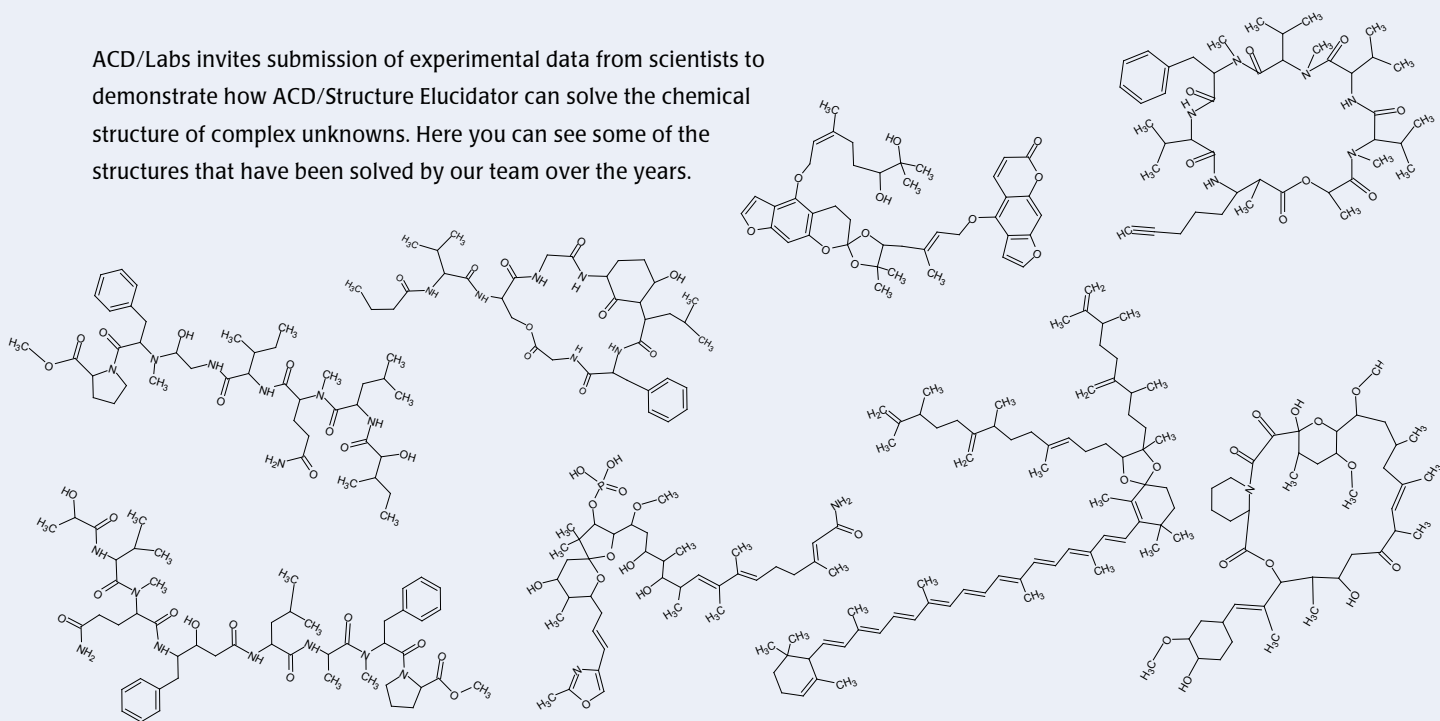
A novel indoloquinoline dimeric alkaloid, quindolincryptotackiene, was characterized through extensive utilization of CASE methods. A decade earlier, the NMR data for this unknown was collected but manual elucidations were deemed unsuccessful due to the complexity of the problem and a lack of consistency between the NMR data and all proposed chemical structures. When ACD/Structure Elucidator was employed, a new set of compounds were proposed and, upon further structure verification, the chemical structure for quindolincryptotackiene was identified 10 years after the initial data collection.

K. Blinov et al., *Magn. Reson. Chem.* 2003, 41, 577-584



ACD/Labs Structure Elucidator Challenge

ACD/Labs invites submission of experimental data from scientists to demonstrate how ACD/Structure Elucidator can solve the chemical structure of complex unknowns. Here you can see some of the structures that have been solved by our team over the years.



ACD/Structure Elucidator

Resolving Unknown Chemical Structures from Experimental Data

ACD/Structure Elucidator can improve your elucidation workflow in a variety of ways: by generating a complete set of all structures that fit the experimental data; by offering viable alternatives to a proposed structure; and by supporting the use of other analytical information to narrow down the structural possibilities—all helping to resolve structures faster and more efficiently.

Features:

- Vendor neutral analytical data processing for NMR, MS, UV-IR, and Chromatography data
- Dereplication of known compounds—search the internal library of 2 million structural fragments, and 425,000 chemical structures
- Proposed chemical structure generation using molecular formula, NMR, MS, and IR data
- Rank proposed structures based on consistencies between experimental and predicted chemical shifts
- Determine relative stereochemistry—optimize structures in 3D and determine stereochemistry with NOESY and ROESY data
- Database all knowledge obtained from the elucidation such as assigned experimental spectra, chemical structures, analysis results, along with user data and notes

Learn more about ACD/Structure Elucidator:

www.acdlabs.com/se/

