Biosynthetic Products for Cancer Chemotherapy

Volume 2

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To Julius A. Rippel,
A pioneering advocate
of biosynthetic products
for cancer treatment and cure

Preface

An overall view of the cancer problem and development of cancer chemotherapeutic biosynthetic products to February 1976 was presented in Volume 1.[231] In the short time that has elapsed since the preparation of Volume 1, several very stimulating advances in application of biosynthetic cancer chemotherapeutic drugs in cancer treatment have been reported. At the May 1976 meeting (in Toronto) of the American Association for Cancer Research, a Sloan-Kettering research group summarized an improved treatment of human neuroblastoma using a combination of vincristine, cytoxan, trifluorothymidine, and papaverine. In the same period other clinical groups described significant advances in the cancer chemotherapeutic treatment of human breast cancer and oat cell carcinoma of the lung. Each of these newer advances in cancer treatment was based on combinations of biosynthetic and synthetic cancer chemotherapeutic drugs. Certainly, further examination of the antineoplastic biosynthetic agents summarized in this volume and the vast number yet to be discovered will eventually provide the means for controlling and/or curing the various types of human cancer.

The main purpose of the present volume is to provide a summary of all the better known naturally occurring anticancer and cytotoxic substances that have appeared in the literature to April 1976. Volume 3 now in preparation will bring the summary to November 1977. The survey of plant and animal antineoplastic constituents was conceived as a means of providing ready access to this field by both chemists and biologists. The biosynthetic anticancer and cytotoxic agents have been summarized in broad groups based on chemical classification and biological origins. In each such group the substances have been arranged according to increasing carbon atom content. Wherever known a summary of the antineoplastic and/or cytotoxic activity, principal physical measurements, and the botanical or zoological source has been included. It is hoped this arrangement will prove exceptionally useful to a cross section of scientists interested in antineoplastic natural products and especially to those bioorganic chemists and biologists actively engaged in discovery and development of cancer chemotherapeutic drugs.

Doubtlessly, some important compounds were inadvertently overlooked and

some errors have not been eliminated from the pages that follow. In both cases we extend our apologies to those affected by such omissions and oversights.

In the final preparation of this volume grateful acknowledgment is extended to Mrs. Christine H. Duplissa for very valuable and expert assistance, to Mrs. Marie D. Baughman for very helpful contributions, and to Mss. Sally J. Keehl, Melinda A. Duplissa, and Robin K. Pettit for their assistance.

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Contents

Introduction

From substantial (and indisputable) evidence already outlined in the previous volume, at least 2–4% of plant species and 8–10% of animal species synthesize antineoplastic and/or cytotoxic substances. The potential of these figures for treatment of human cancer truly staggers the imagination and offers great promise of many curative approaches to the cancer problem. For some perspective one need only to consider that the world's flora may number up to 800,000 and the more conspicuous members of our terrestrial vegetation, the angiosperms, may number from 300,000 to some 500,000[131,231] Further, enormous numbers of microorganism species appear to be available. In the animal segment of life the marine invertebrates alone number over 1,000,000 species, and with marine vertebrates the fishes comprise over 25,000 species. In the arthropod area the class insecta alone includes over 1,000,000 species. Since only a few percent of the known plants and less than 0.5% of the known animals have been evaluated for anticancer or cytotoxic constituents, it is apparent that we have just about reached the end of the beginning in our search for biosynthetic cancer chemotherapeutic drugs.

Most of the better known biosynthetic anticancer and cytotoxic substances mentioned in literature available to April 1976 have been collected, organized, and summarized in the survey of this volume. So far, the higher and lower (microorganisms) plants have been most extensively studied and this biological source accounts for a majority of the biosynthetic products covered in the survey. More specifically, 265 of such agents from plants, 103 from microorganisms, and 35 from animals have been listed. These represent some 145 plant species and 45 animal species. Obviously a great number of new cancer chemotherapeutic drugs of biosynthetic origin await discovery.

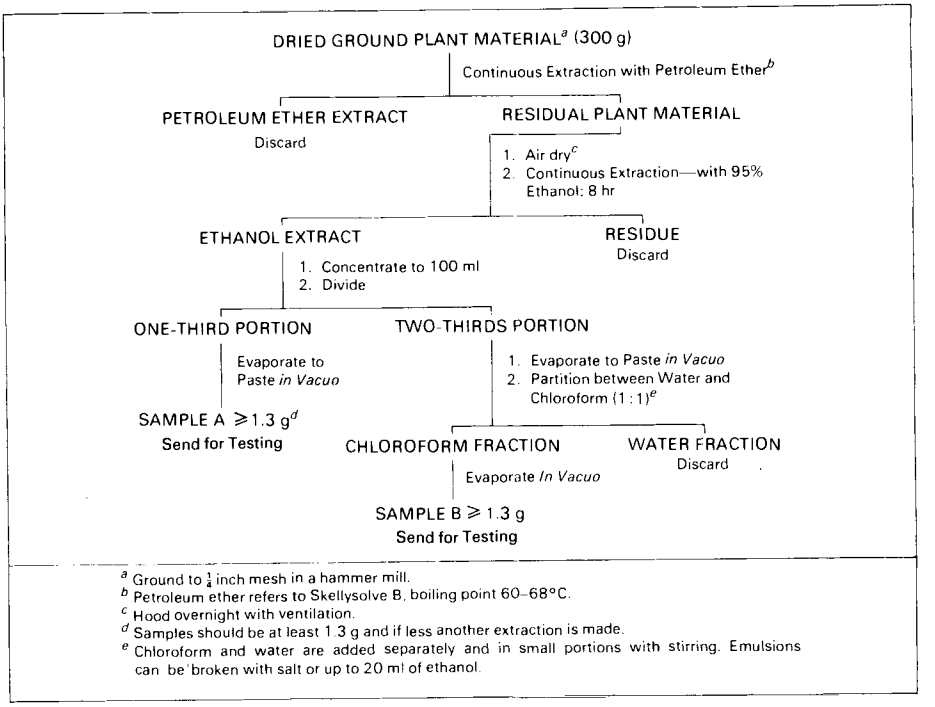
The plant and animal antineoplastic and/or cytotoxic agents have been grouped according to natural products chemistry classification and biosynthetic origin. For example, in Chapter 1, all of the higher plant terpenoids have been grouped together by empirical formula based on increasing carbon content. Similarly, the fungi and other lower plant biosynthetic products appear in Chapter 6 while higher animal biosynthetic products are grouped together in Chapter 8. The surveys include, where known, a structure, a common name, the system and

results of antineoplastic screening and/or cytotoxicity evaluations, a melting point and optical rotation value, whether certain spectral data have been reported, and finally the organism of origin and reference. The listings were prepared to expedite characterization of a known anticancer or cytotoxic compound and to provide an overall assessment of the current chemistry and biology for these important natural products. Unfortunately for some of the newer and/or lesser known anticancer and cytotoxic biosynthetic products, few or no biological screening data have been recorded in the technical literature. Hence, the brief notations under the heading "bioactivity" should be considered only preliminary results and not usually the net result of a comprehensive study involving at least several tumor systems. Generally the most significant biological data have been provided by the U.S. National Cancer Institute, and the key systems used in this program have been emphasized whenever possible.

As was noted in Chapter 1 of Volume 1, the National Cancer Institute's lymphoid leukemia L1210 (LE), lymphocytic leukemia P388 (PS or P388), Walker carcinosarcoma 256 (WA subcutaneous, WM intramuscular), B-16 melanoma (B1), and Lewis lung carcinoma (LL) have been selected as especially valuable tumor systems for selecting compounds potentially effective against human cancer.[322] About five years ago the Walker carcinosarcoma 256 was deemphasized and more recently discontinued in favor of the PS, B1, and LL systems. The KB cell line has been used for many years and has been augmented recently by the P388 cell line.[238] Over 260 experimental tumor systems in animals have been employed in various parts of the world to assess naturally occurring compounds. Many laboratories have a specific preference among these systems and employ them for routine screening. Some of the more widely used tumor systems have been summarized in the Appendix with the National Cancer Institute's abbreviation. A summary of the National Cancer Institute's key systems has also been presented in the Appendix.

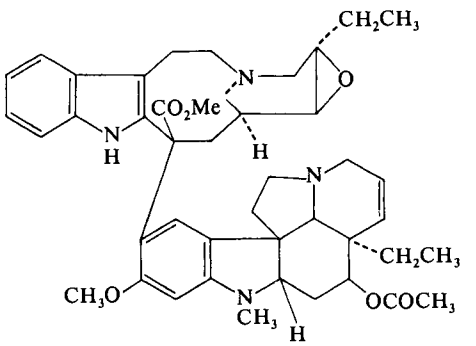
The actual selection of a plant or animal for detailed chemical investigation is usually based on initial screening of a solvent extract or series of solvent extracts. If one or more such mixtures displays a confirmed level of antineoplastic or cytotoxic activity then the extensive chemical and physical manipulations (guided by bioassay) needed for isolation of the active constituent(s) are undertaken. In laboratories collaborating with the U.S. National Cancer Institute, the initial testing involves the P388 and KB systems. A confirmed level of activity (see Appendix) in either one or both systems justifies further investigation. All of the separation techniques common to bioorganic chemistry and biochemistry are then applied to isolating the antineoplastic constituents. Generally these techniques begin with solvent fractionation of the crude extracts followed by application of various chromatographic procedures. By way of illustration, the preliminary fractionation procedure employed in the National Cancer Institute's programs for initial screening of plant products has been outlined in Scheme I. For this procedure at least 1 kg (dried weight) of plant material should be collected to cover initial biological evaluation and where appropriate subsequent confirmatory screening.

SCHEME I



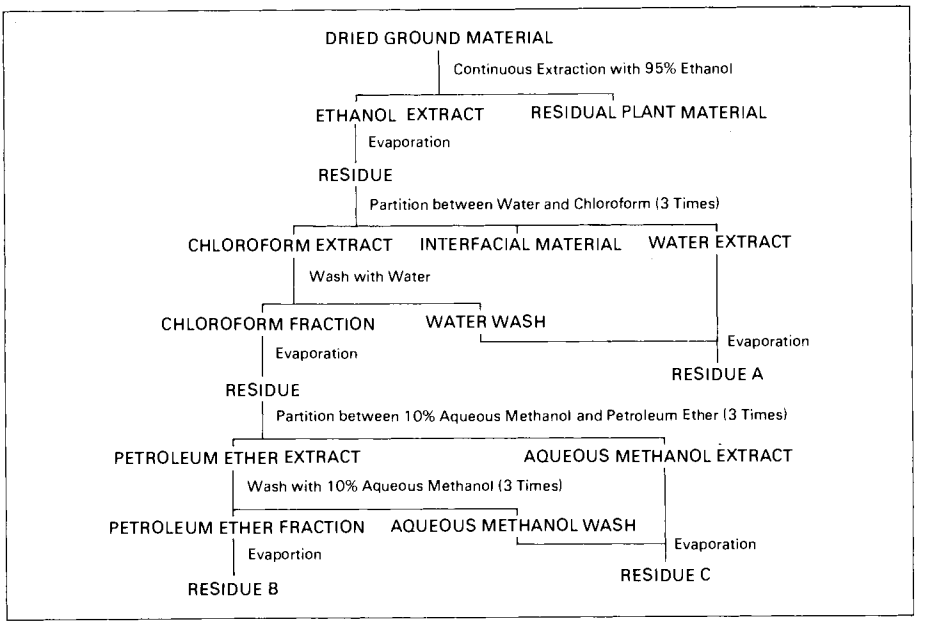
[a] Ground to $\frac{1}{4}$ inch mesh in a hammer mill.
[b] Petroleum ether refers to Skellysolve B, boiling point 60–68°C.
[c] Hood overnight with ventilation.
[d] Samples should be at least 1.3 g and if less another extraction is made.
[e] Chloroform and water are added separately and in small portions with stirring. Emulsions can be broken with salt or up to 20 ml of ethanol.

Once a confirmed active extract has been selected for separation the initial solvent fractionation is guided by bioassay using either the P388 or KB systems. Here it should be emphasized that many unknown events can intervene to complicate the problem when using biological evaluation as a guide to fractionation. Frequently activity is lost during fractionation and this can be due to one or a combination of events including synergistic effects, chemical changes, and the canceling of activity by certain concentrations of substances. For example, in the isolation of leurosine (**1**) the crude alkaloid fraction showed no activity against the P1534 *in vitro* screening system but the pure alkaloid showed marked P1534 cytotoxicity.[56] Also, crude fractions may contain substances with



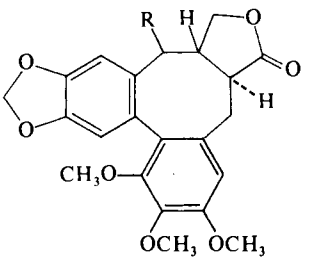
1

SCHEME II

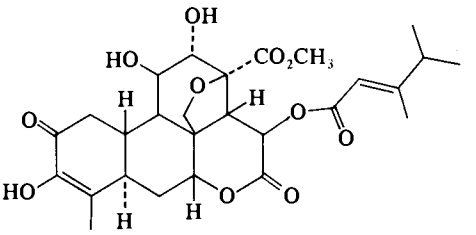


delayed toxicity causing the test animal to die at about the same time as the control animals.[56]

Several solvent fractionation procedures have been developed and some examples follow in Schemes II–VI. Scheme II has been applied to the isolation of alkaloids,[135] cardenolides,[48] and sesquiterpene lactones.[161] Once the active solvent fraction has been located further solvent partitioning can be very useful. For example, in Scheme II further partitioning of the 10% aqueous methanol fraction designated residue C between 20% aqueous methanol and carbon tetrachloride led to isolation of the lignan lactones, steganacin (**2a**), and steganangin (**2b**) from *Steganotaenia araliacea*.[137] For isolation of the simaroubolide, bruceantin (**3**) from *Brucea antidysenterica* the aqueous methanolic fraction was further partitioned between 40% aqueous methanol and chloroform.[138]



2a, R = $OCOCH_3$
b, R = $OCOC(CH_3)=CHCH_3$(Trans)

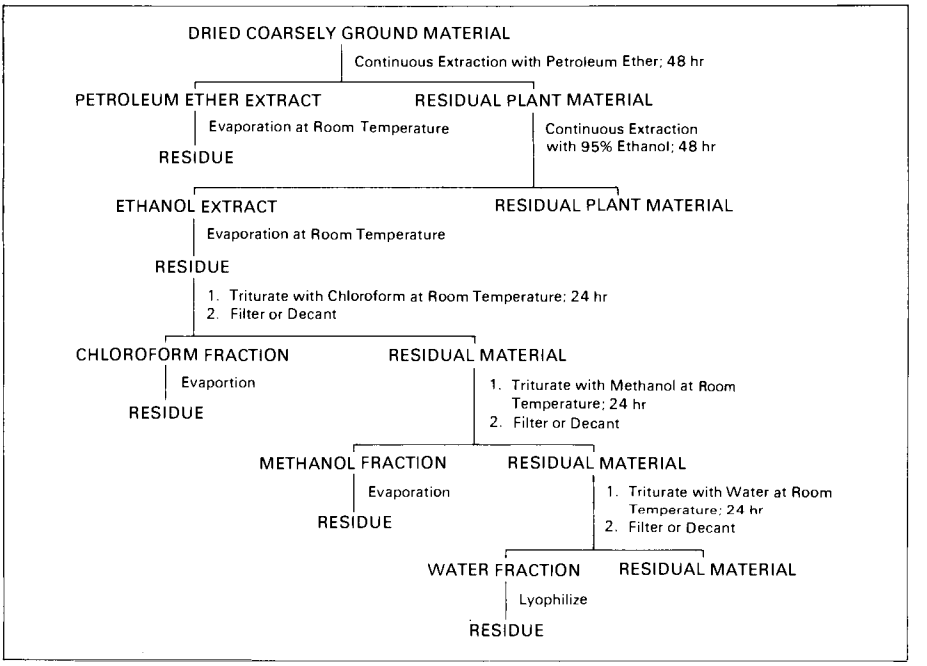


3

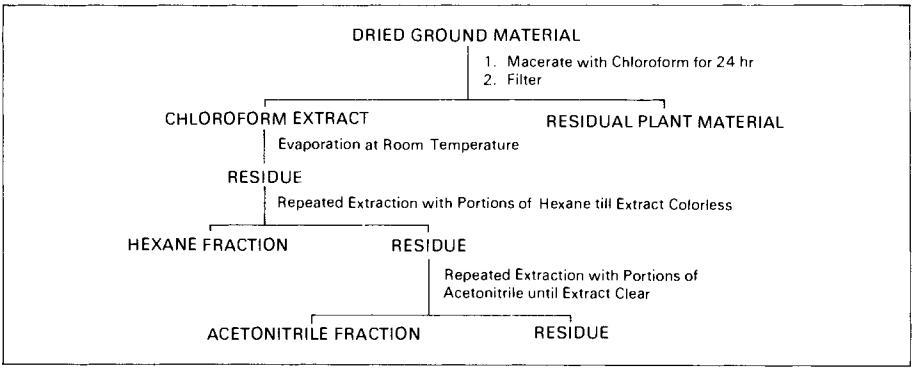
Our group has employed similar fractionation procedures and one of these is illustrated in Scheme III. The above procedure has been applied to isolation of sesquiterpene lactones[233] as well as to the fractionation of insect[240] and marine animal extracts.[249] A very useful alternative to this general solvent fractionation procedure is to dissolve the ethanol extract in 9:1 methanol–water. Next the methanol–water solution is successively extracted with ligroin, carbon tetrachloride, and chloroform while diluting the original solution to 4:1 methanol–water and then to 3:2 methanol–water.[138] The ligroin, carbon tetrachloride, chloroform, and 3:2 water–methanol fractions are sent for biological evaluation.

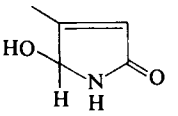
A solvent fractionation procedure frequently used by Cole and co-workers involves initial extraction of the plant with chloroform and is illustrated by Scheme IV. By this means jatropham (**4**) was isolated from *Jatropha*

SCHEME III



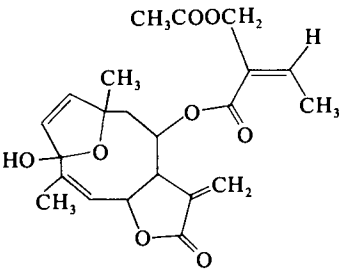
SCHEME IV





4

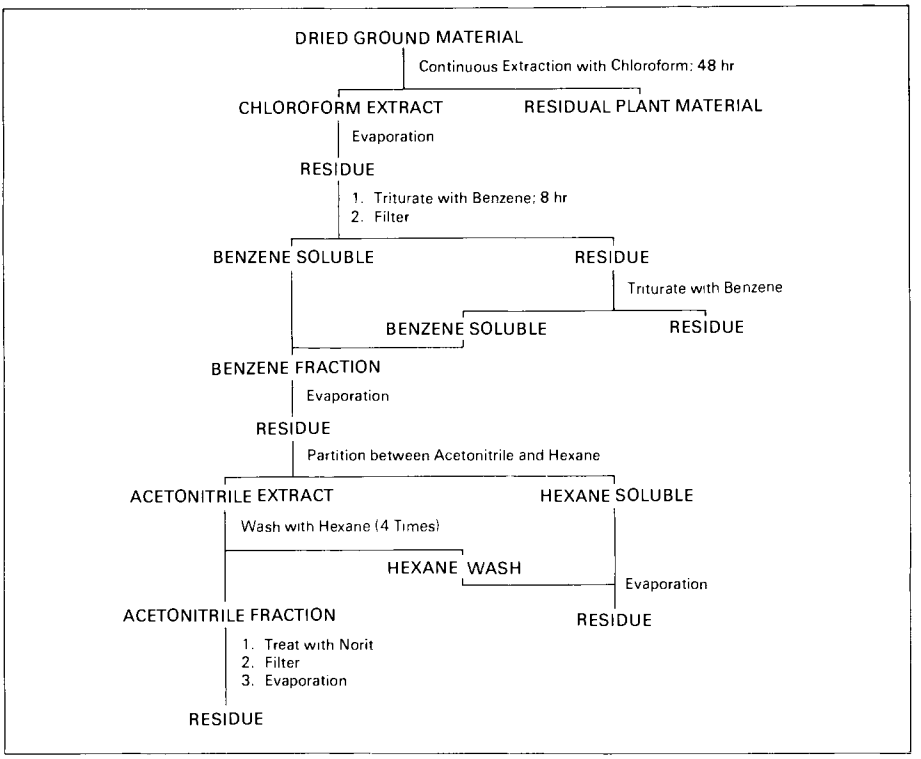
macrorhize.[334] Lactam (**4**) was obtained in crystalline form upon evaporation of the acetonitrile fraction. Application of a similar procedure to the sesquiterpene lactones of *Liatris chapmanii* by Kupchan and colleagues has been used to isolate Liatrin (**5**), Scheme V.[142]



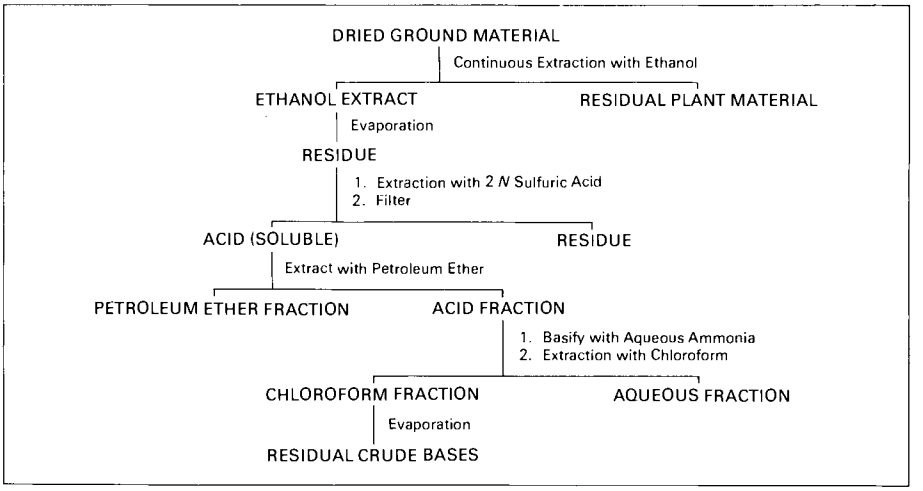
5

As already noted, Scheme II has been applied to the isolation of alkaloids but usually such substances are obtained by employing extraction with dilute aqueous acid as the key step. Two such procedures have been outlined in Schemes VI and VII. As an illustration, Scheme VI has been applied to the isolation of bisbenzylisoquinoline alkaloids from *Pycnarrhena ozantha*.[185] The procedure presented in Scheme VII has been applied to the isolation of related alkaloids from *Cyclea peltata*.[160,174] By means of Scheme VII fractional basification of citric acid fractions A and B with aqueous ammonia, followed by chloroform extraction, ion exchange chromatography, column chromatography (on basic and neutral alumina), and thin-layer chromatography (on alumina and silica gel plates) led to five bisbenzyltetrahydroisoquinoline alkaloids and three artifacts.[160,174]

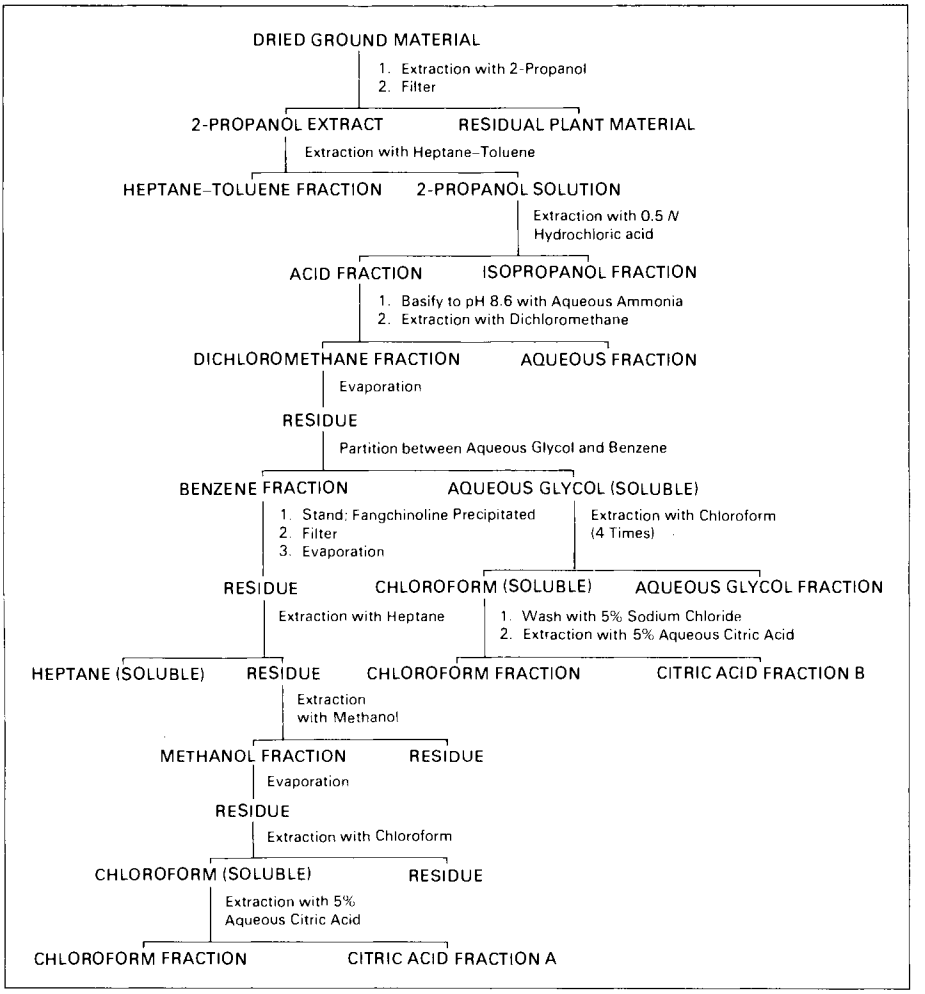
SCHEME V



SCHEME VI



SCHEME VII



When the practical limits of solvent partitioning have been reached, the next step generally involves selection and extensive application of one or more column, preparative-layer, and thin-layer chromatographic procedures. Such techniques range from proper orchestration of alumina and silica gel chromatographic adsorption techniques to gel permeation chromatography on Sephadex LH-20, the Sephadex G-10 to G-200 series, and the Sepharose series to 2B. Also, the various ion exchange resins ranging from the well-known cation and anion exchanges to the newer macroreticular resins of the XAD series may need to be utilized. In our group's isolation of antineoplastic agents from marine animals, arthropods, and plants, we have had to rely on many of the chromatographic procedures common in organic chemistry and biochemistry laboratories and devise improvements.[113,222,230,233,238,246,247,250]

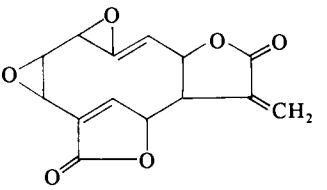
The actual isolation of a naturally occurring antineoplastic agent is nearly

always fraught with difficulties and every step requires expert judgment, improvision, and discovery. On the happy occasion when the isolated antineoplastic agent is a new substance the organic chemical problems begin in earnest. At this point purity must be assessed with great care as nature has a marvelous facility for producing very closely related substances in a particular species. Unless great care is exercised a mixture of two or more compounds may seem to be a pure substance. Here, various thin-layer chromatographic and physical measurements (such as infrared, proton magnetic resonance, and mass spectral) must be carefully interpreted. Establishment of the purity is followed by detailed antineoplastic evaluation and structural determination. The latter usually presents a new and challenging problem requiring all the best resources of instrumental (particularly x-ray crystallographic) and chemical methods of structural elucidation. This stage and subsequent research directed at total synthesis is one of great intellectual excitement and challenge for the chemist and is the starting point for further advances in biology and medicine. Both observations are splendidly illustrated in the following chapters and this is only the beginning.

Chapter 1

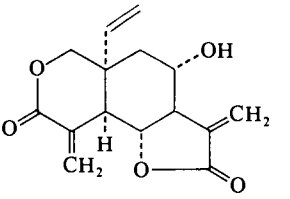
Higher Plant Terpenoids

$C_{15}H_{14}O_6$ Mikanolide



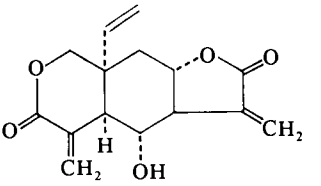
MOL. WT.: 290
BIOACTIVITY: KB: ED_{50}, <1 μg/ml
MELTING POINT: 230–233°C
$[\alpha]_D$: 53.4 SOLVENT: Di
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Mikania scandens* (Compositae)
REFERENCE: 93, 80

$C_{15}H_{16}O_5$ Vernolepin



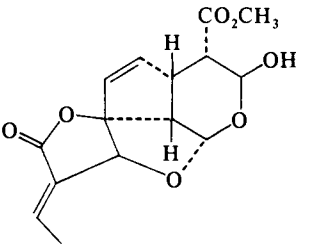
MOL. WT.: 276
BIOACTIVITY: KB: ED_{50}, 2.0 μg/ml
WA: T/C, 32
MELTING POINT: 179–180°C
$[\alpha]_D$: +72 SOLVENT: An
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Vernonia hymenolepis* A. Rich. (Compositae)
LOCATION: Ethiopia
REFERENCE: 153

$C_{15}H_{16}O_5$ Vernomenin



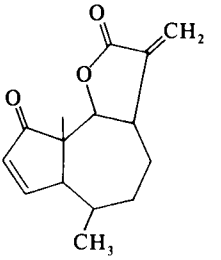
MOL. WT.: 276
BIOACTIVITY: KB: ED_{50}, 20 μg/ml
WA: T/C, 63 (5–8 mg/kg)
$[\alpha]_D$: −62 SOLVENT: An
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Vernonia hymenolepis* A. Rich. (Compositae)
LOCATION: Ethiopia
REFERENCE: 153

$C_{15}H_{16}O_7$ Allamandin



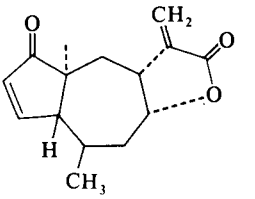
MOL. WT.: 308
BIOACTIVITY: KB: ED_{50}, 2.1 μg/ml
P388: Sign. act.
MELTING POINT: 212–215°C
$[\alpha]_D$: +15 SOLVENT: Me
SPECTRAL DATA: UV, IR, Mass Spec
ORGANISM: *Allamanda cathartica* (Apocynaceae)
LOCATION: Hawaii
REFERENCE: 143

$C_{15}H_{18}O_3$ Ambrosin



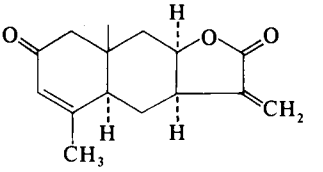
MOL. WT.: 246
BIOACTIVITY: KB: ED_{50}, 0.04 μg/ml
PS: T/C, 180 (35 mg/kg)
MELTING POINT: 146°C
$[\alpha]_D$: −154.5 SOLVENT: Chf
ORGANISM: *Ambrosia maritima* (Compositae) and *Hymenoclea salsola* (Asteraceae)
REFERENCE: 265, 80, 307

$C_{15}H_{18}O_3$ Aromaticin



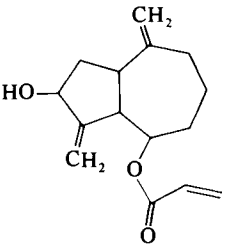
MOL. WT.: 246
BIOACTIVITY: KB: ED_{50}, 0.34 μg/ml
MELTING POINT: 232–234°C
$[\alpha]_D$: +18 SOLVENT: Chf
ORGANISM: *Helenium aromaticum* (Compositae)
REFERENCE: 265

$C_{15}H_{18}O_3$ Pinnatifidin



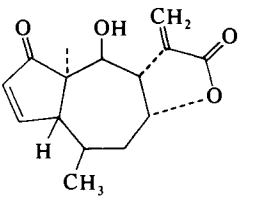
MOL. WT.: 246
BIOACTIVITY: KB: ED_{50}, 1.7 μg/ml
MELTING POINT: 161–164°C
$[\alpha]_D$: +302 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Helenium pinnatifidum* (Compositae)
REFERENCE: 89, 80

$C_{15}H_{18}O_3$ Zaluzanin C



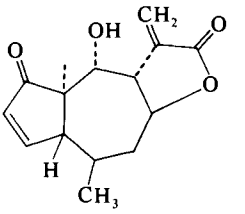
MOL. WT.: 246
BIOACTIVITY: P388: Sign. act.
MELTING POINT: 94–95°C
$[\alpha]_D$: +38 SOLVENT: Chf
ORGANISM: *Zaluzania robinsonii* (Compositae)
LOCATION: Mexico
REFERENCE: 109

$C_{15}H_{18}O_4$ Helenalin



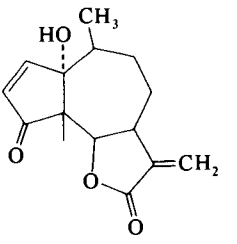
MOL. WT.: 262
BIOACTIVITY: KB: ED_{50}, 0.19 μg/ml
P388: T/C, 220
MELTING POINT: 170.5–174.5°C
$[\alpha]_D$: −102.4
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Helenium autumnale* (Compositae)
LOCATION: Oregon
REFERENCE: 233

$C_{15}H_{18}O_4$ Mexicanin I



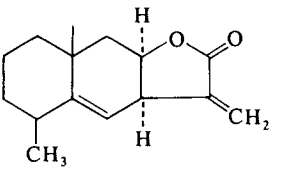
MOL. WT.: 262
BIOACTIVITY: KB: ED_{50}, 0.33 μg/ml
MELTING POINT: 257–260°C
$[\alpha]_D$: +42.5 SOLVENT: Chf
ORGANISM: *Helenium mexicanum* (Compositae)
REFERENCE: 265

$C_{15}H_{18}O_4$ Parthenin



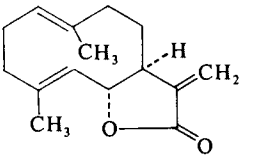
MOL. WT.: 262
BIOACTIVITY: KB: ED_{50}, 0.025 μg/ml
MELTING POINT: 163–166°C
$[\alpha]_D$: +7.02 SOLVENT: Chf
ORGANISM: *Parthenium hysterophorus* L (Compositae)
REFERENCE: 265, 80

$C_{15}H_{20}O_2$ Alantolactone



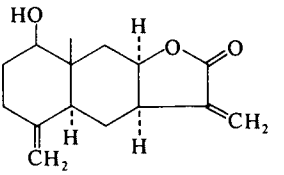
MOL. WT.: 232
BIOACTIVITY: KB: ED_{50}, 1.4 μg/ml
MELTING POINT: 78.5–80°C
SPECTRAL DATA: PMR
REFERENCE: 199, 80

$C_{15}H_{20}O_2$ Costunolide



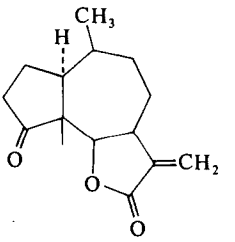
MOL. WT.: 232
BIOACTIVITY: KB: ED_{50}, 0.26 μg/ml
MELTING POINT: 106–107°C
$[\alpha]_D$: +128 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Saussurea lappa* (Compositae)
REFERENCE: 263, 80

$C_{15}H_{20}O_3$ Asperilin



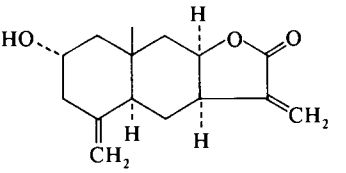
MOL. WT.: 248
BIOACTIVITY: KB: ED_{50}, 1.0 μg/ml
MELTING POINT: 151–152°C
$[\alpha]_D$: +149.6 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Iva asperifolia* (Compositae)
LOCATION: Mexico
REFERENCE: 94, 80

$C_{15}H_{20}O_3$ Damsin



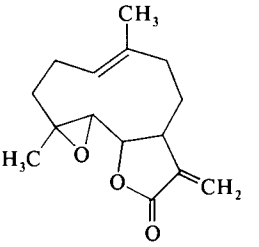
MOL. WT.: 248
BIOACTIVITY: KB: ED_{50}, 0.58 μg/ml
MELTING POINT: 111°C
$[\alpha]_D$ −72
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Ambrosia maritima* and *A. ambrosioides* (Compositae)
REFERENCE: 45,80

$C_{15}H_{20}O_3$ Ivalin



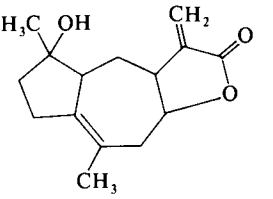
MOL. WT.: 248
BIOACTIVITY: KB: ED_{50}, 0.72 μg/ml
MELTING POINT: 130–132°C
$[\alpha]_D$: +142 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Iva microcephala* (Compositae)
REFERENCE: 88, 80

$C_{15}H_{20}O_3$ Parthenolide



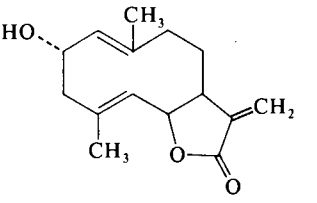
MOL. WT.: 248
BIOACTIVITY: KB: ED_{50}, 2.3 μg/ml
MELTING POINT: 115°C
$[\alpha]_D$: −78 SOLVENT: Dcm
ORGANISM: *Magnolia grandiflora* (Magnoliaceae)
LOCATION: Arizona
REFERENCE: 335

$C_{15}H_{20}O_3$ Pseudoivalin



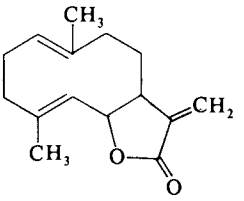
MOL. WT.: 248
BIOACTIVITY: KB: ED_{50}, 1.8 μg/ml
MELTING POINT: 122–123°C
$[\alpha]_D$: −145 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Iva microcephala* (Compositae)
REFERENCE: 91, 80

$C_{15}H_{20}O_3$ Tamaulipin A



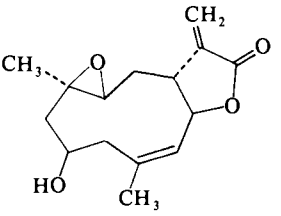
MOL. WT.: 248
BIOACTIVITY: KB: ED_{50}, 1.26 μg/ml
MELTING POINT: 159–160°C
$[\alpha]_D$: +171 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Ambrosia confertiflora* (Compositae)
REFERENCE: 145

$C_{15}H_{20}O_3$ Tamaulipin B



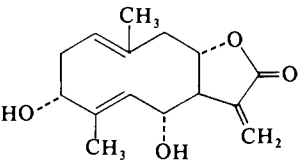
MOL. WT.: 248
BIOACTIVITY: KB: ED_{50}, 2.60 μg/ml
MELTING POINT: 140–142°C
$[\alpha]_D$: +99 SOLVENT: Me
ORGANISM: *Ambrosia confertiflora* (Compositae)
REFERENCE: 145

$C_{15}H_{20}O_4$ Baileyin



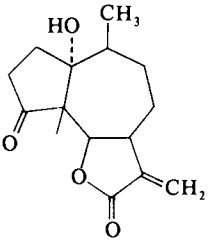
MOL. WT.: 264
BIOACTIVITY: P388 (*in vitro*): ED_{50}, 0.47 μg/ml
MELTING POINT: 189°C
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Baileya multiradiata* (Compositae)
LOCATION: Arizona
REFERENCE: 238

$C_{15}H_{20}O_4$ Chammissonin



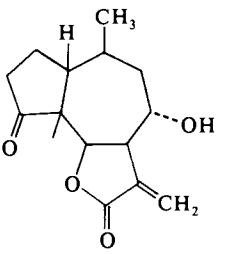
MOL. WT.: 264
BIOACTIVITY: KB: ED_{50}, 2.13 μg/ml
MELTING POINT: 124–125°C
$[\alpha]_D$: −19.8 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Ambrosia chamissonis* (Compositae)
REFERENCE: 145

$C_{15}H_{20}O_4$ Coronopilin



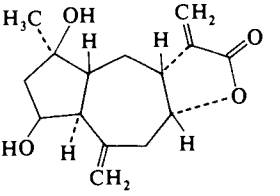
MOL. WT.: 264
BIOACTIVITY: KB: ED_{50}, 1.4 μg/ml
MELTING POINT: 177–178°C
$[\alpha]_D$: −30.2 SOLVENT: Alc
ORGANISM: *Ambrosia psilostachya* DC var. *coronopifolia* (Compositae)
REFERENCE: 265, 80

$C_{15}H_{20}O_4$ Desacetylconfertiflorin



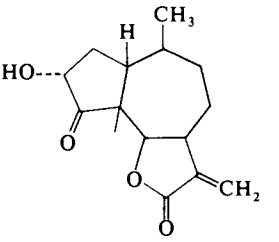
MOL. WT.: 264
BIOACTIVITY: KB: ED_{50}, 2.30 μg/ml
MELTING POINT: 202–204°C
$[\alpha]_D$: +17.3 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Ambrosia confertiflora* (Compositae)
REFERENCE: 145

$C_{15}H_{20}O_4$ Florilenalin



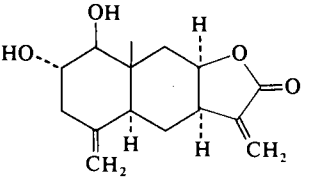
MOL. WT.: 264
BIOACTIVITY: H.Ep.-2: ED_{50}, 1 μg/ml
MELTING POINT: Oil; diacetate derivative, 128–129°C
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Helenium autumnale* (Compositae)
LOCATION: Florida
REFERENCE: 177

$C_{15}H_{20}O_4$ 3-Hydroxydamsin



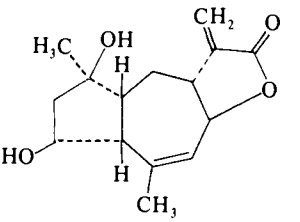
MOL. WT.: 264
BIOACTIVITY: KB: ED_{50}, 2.65 μg/ml
MELTING POINT: 142–145°C
$[\alpha]_D$: +2.7 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Ambrosia psilostachya* (Compositae)
REFERENCE: 145

$C_{15}H_{20}O_4$ Ivasperin



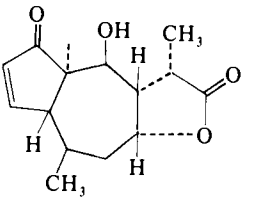
MOL. WT.: 264
BIOACTIVITY: KB: ED_{50}, 1.6 μg/ml
MELTING POINT: 150–151°C
$[\alpha]_D$: +140.5 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Iva asperifolia* (Compositae)
LOCATION: Mexico
REFERENCE: 94, 80

$C_{15}H_{20}O_4$ Pleniradin



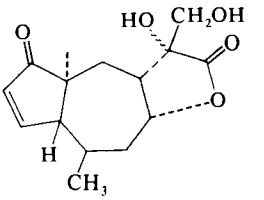
MOL. WT.: 264
BIOACTIVITY: P388 (*in vitro*): ED_{50}, 5.7 μg/ml
MELTING POINT: 94–97°C
$[\alpha]_D$: −35.4 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Baileya multiradiata* (Compositae)
LOCATION: Arizona
REFERENCE: 238

$C_{15}H_{20}O_4$ Plenolin



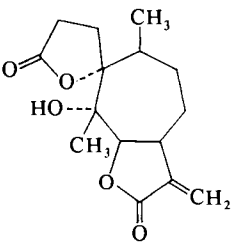
MOL. WT.: 264
BIOACTIVITY: H.Ep.-2: ED_{50}, 0.814 μg/ml
MELTING POINT: 223–226°C
SPECTRAL DATA: IR, PMR
ORGANISM: *Helenium autumnale* (Compositae)
LOCATION: Florida
REFERENCE: 178

$C_{15}H_{20}O_5$ Hymenoflorin



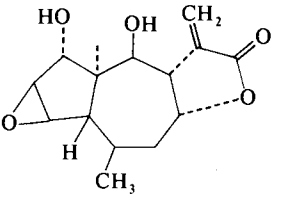
MOL. WT.: 280
BIOACTIVITY: L1210: Sign. act.
MELTING POINT: 197–199°C
$[\alpha]_D$: −54.3 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Hymenoxys grandiflora* (Compositae)
LOCATION: Colorado
REFERENCE: 87

$C_{15}H_{20}O_5$ Psilostachyin A



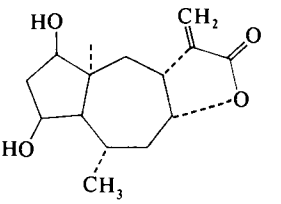
MOL. WT.: 280
BIOACTIVITY: KB: ED_{50}, 5.4 μg/ml
MELTING POINT: 215°C
$[\alpha]_D$: −125 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Ambrosia artemissifolia* (Compositae)
LOCATION: Queensland, Australia
REFERENCE: 14

$C_{15}H_{20}O_5$ Autumnolide



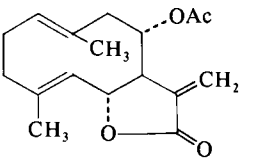
MOL. WT.: 280
BIOACTIVITY: KB: ED_{50}, 3.1 μg/ml
PS: Inactive
MELTING POINT: 199–201°C
SPECTRAL DATA: PMR
ORGANISM: *Helenium autumnale* L. var. *montanum* (Nutt.) Fern. (Compositae)
LOCATION: Oregon
REFERENCE: 324

$C_{15}H_{22}O_4$ Pulchellin



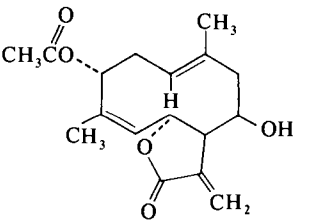
MOL. WT.: 266
BIOACTIVITY: KB: ED_{50}, 1.8 μg/ml
MELTING POINT: 165–168°C
$[\alpha]_D$: −36.2 SOLVENT: Chf
ORGANISM: *Gaillardia pulchella* (Compositae)
REFERENCE: 265, 80

$C_{17}H_{22}O_4$ Tulipinolide



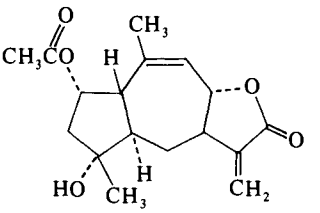
MOL. WT.: 290
BIOACTIVITY: KB: ED_{50}, 0.46 μg/ml
MELTING POINT: 181°C
$[\alpha]_D$: +260 SOLVENT: Be
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Liriodendron tulipifera* L. (Magnoliaceae)
REFERENCE: 44, 80

$C_{17}H_{22}O_5$ Eupaformonin



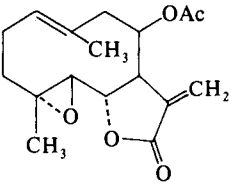
MOL. WT.: 306
BIOACTIVITY: H.Ep.-2: Sign. act.
MELTING POINT: 216–218°C
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Eupatorium formosanum* (Compositae)
LOCATION: Taiwan
REFERENCE: 194

$C_{17}H_{22}O_5$ Gaillardin



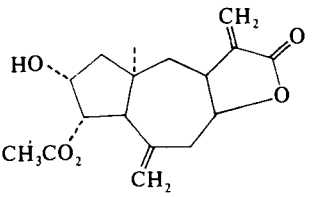
MOL. WT.: 306
BIOACTIVITY: KB: ED_{50}, 0.80 μg/ml
MELTING POINT: 198–199°C
$[\alpha]_D$: −15 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Gaillardia pulchella* Fong. (Compositae)
REFERENCE: 139, 50, 80

$C_{17}H_{22}O_5$ Lipiferolide



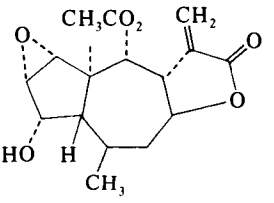
MOL. WT.: 306
BIOACTIVITY: KB: Active
MELTING POINT: 118–119°C
$[\alpha]_D$: −125 SOLVENT: Me
SPECTRAL DATA: PMR
ORGANISM: *Liriodendron tulipifera* L. (Magnoliaceae)
REFERENCE: 46

$C_{17}H_{22}O_5$ Pulchellin E



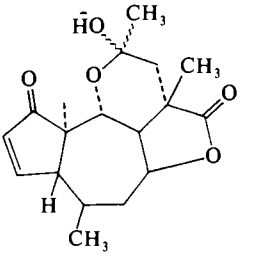
MOL. WT.: 306
BIOACTIVITY: KB: ED_{50}, 1.0 μg/ml
MELTING POINT: 181–183°C
$[\alpha]_D$: +43.8 SOLVENT: Alc
ORGANISM: *Gaillardia pulchella* (Compositae)
REFERENCE: 92, 80

$C_{17}H_{22}O_6$ Gaillardilin



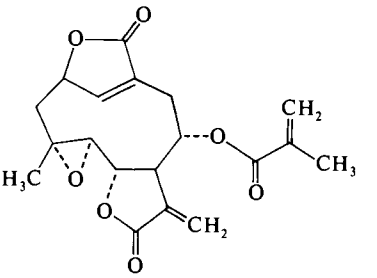
MOL. WT.: 322
BIOACTIVITY: KB: ED_{50}, 2.2 μg/ml
MELTING POINT: 197–199°C
$[\alpha]_D$: −2.03 SOLVENT: Chf
ORGANISM: *Gaillardia pinnatifida* (Compositae)
REFERENCE: 265, 80

$C_{17}H_{24}O_5$ Tenulin



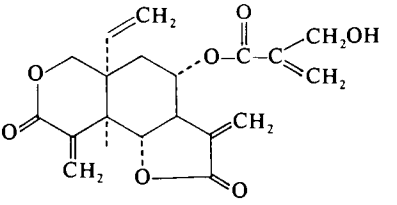
MOL. WT.: 308
BIOACTIVITY: Toxic
ORGANISM: *Helenium amarum* (Rafin.) H. Rock (Compositae)
LOCATION: Texas
REFERENCE: 104

$C_{19}H_{20}O_7$ Elephantopin



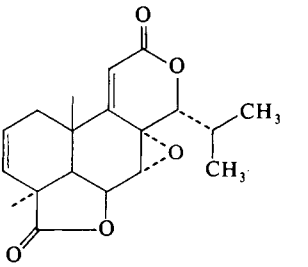
MOL. WT.: 360
BIOACTIVITY: KB: ED_{50}, 0.32 μg/ml
WA: T/C, 22 (100 mg/kg)
PS: T/C, 140 (40, 20 mg/kg)
MELTING POINT: 262–264°C
$[\alpha]_D$: −398 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Elephantopus elatus* Bertol. (Compositae)
LOCATION: Florida
REFERENCE: 130

$C_{19}H_{20}O_7$ Vernodalin



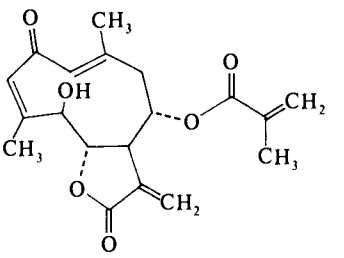
MOL. WT.: 360
BIOACTIVITY: KB: ED_{50}, 1.8 μg/ml
MELTING POINT: Colorless oil
$[\alpha]_D$: +125 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Vernonia amygdalina* Del. (Compositae)
LOCATION: Ethiopia
REFERENCE: 150

$C_{19}H_{22}O_5$ Podolide



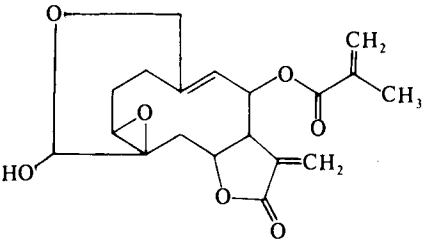
MOL. WT.: 330
BIOACTIVITY: PS (*in vivo* and *in vitro*)
KB
MELTING POINT: 296–298°C
$[\alpha]_D$: −12 SOLVENT: Py
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Podocarpus gracilior* Pilg. (Taxaceae)
REFERENCE: 133

$C_{19}H_{22}O_6$ Molephantin



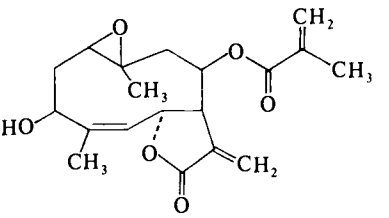
MOL. WT.: 346
BIOACTIVITY: H.Ep.-2: ED_{50}, 0.333 μg/ml
MELTING POINT: 214–216°C
ORGANISM: *Elephantopus mollis* (Compositae)
LOCATION: Taiwan
REFERENCE: 175

$C_{19}H_{22}O_7$ Vernolide



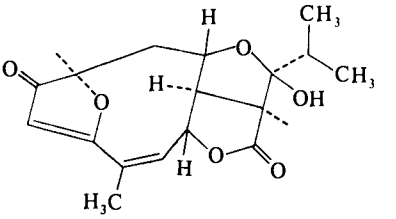
MOL. WT.: 362
BIOACTIVITY: KB: ED_{50}, 2.0 μg/ml
MELTING POINT: 180–183°C
$[\alpha]_D$: +230 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Vernonia colorata* (Compositae)
REFERENCE: 308

$C_{19}H_{24}O_6$ Erioflorin



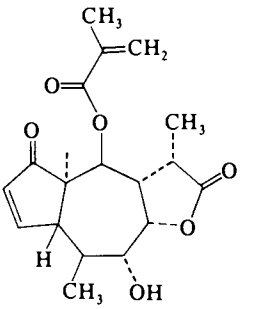
MOL. WT.: 348
BIOACTIVITY: P388: Sign. act.
MELTING POINT: 198–202°C
$[\alpha]_D$: +104 SOLVENT: Chf
ORGANISM: *Eriophyllum lanatum* (Compositae)
REFERENCE: 132

$C_{19}H_{24}O_6$ Eremantholide A



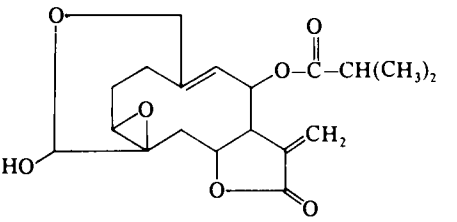
MOL. WT.: 348
BIOACTIVITY: KB: ED_{50}, 2 μg/ml
MELTING POINT: 181–183°C
$[\alpha]_D$: +65 SOLVENT: Alc
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eremanthus elaeagnus* Schultz-Bip. (Compositae)
LOCATION: Brazil
REFERENCE: 258

$C_{19}H_{24}O_6$ Radiatin



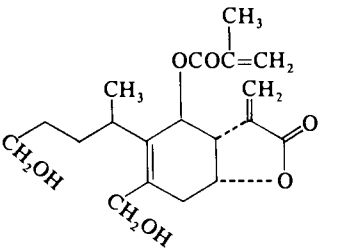
MOL. WT.: 348
BIOACTIVITY: P388 (*in vitro*): ED_{50}, 0.39 μg/ml
MELTING POINT: 202–204°C
$[\alpha]_D$: −84 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Baileya multiradiata* (Compositae)
LOCATION: Arizona
REFERENCE: 238

$C_{19}H_{24}O_7$ Vernomygdin



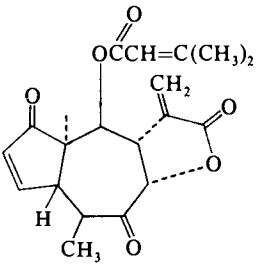
MOL. WT.: 364
BIOACTIVITY: KB: ED_{50}, 1.5 μg/ml
MELTING POINT: 208–210°C
$[\alpha]_D$: +65 SOLVENT: An
SPECTRAL DATA: UV, IR, PMR. Mass Spec
ORGANISM: *Vernonia amygdalina* Del. (Compositae)
LOCATION: Ethiopia
REFERENCE: 150

$C_{19}H_{26}O_6$ Eriolanin



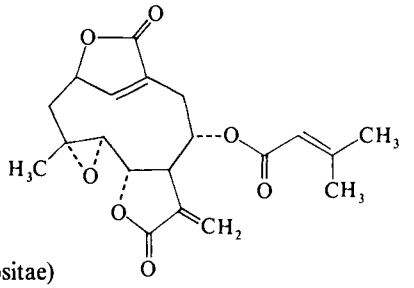
MOL. WT.: 350
BIOACTIVITY: P388: Sign. act.
MELTING POINT: 126.5–128°C
$[\alpha]_D$: −93 SOLVENT: Chf
SPECTRAL DATA: PMR, Mass Spec
ORGANISM: *Eriophyllum lanatum* (Compositae)
REFERENCE: 132

$C_{20}H_{22}O_6$ Multiradiatin



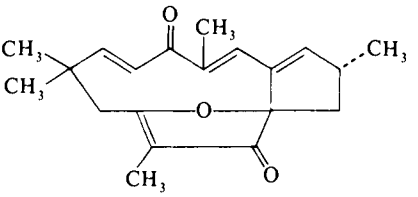
MOL. WT.: 358
BIOACTIVITY: P388 (*in vitro*): ED_{50}, 0.02 μg/ml
LE (*in vitro*): ED_{50}, 0.02 μg/ml
KB: ED_{50}, 0.12 μg/ml
MELTING POINT: 226–230°C
ORGANISM: *Baileya multiradiata* (Compositae)
LOCATION: Arizona, 1966
REFERENCE: 238

$C_{20}H_{22}O_7$ Elephantin



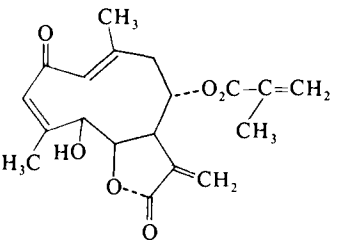
MOL. WT.: 374
BIOACTIVITY: KB: ED_{50}, 0.28 μg/ml
WA: T/C, 12 (100 mg/kg)
MELTING POINT: 242–244°C
$[\alpha]_D$: −380 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Elephantopus elatus* Bertol. (Compositae)
REFERENCE: 130, 145

$C_{20}H_{24}O_3$ Jatrophone



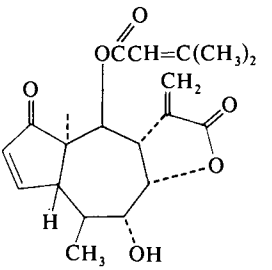
MOL. WT.: 312
BIOACTIVITY: KB: ED_{50}, 0.17 μg/ml
Sign. act. against Sarcoma 180, LL, PS, WM
MELTING POINT: 152–153°C
$[\alpha]_D$: +292 SOLVENT: Alc
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Jatropha gossypiifolia* L. (Compositae)
LOCATION: Costa Rica
REFERENCE: 166, 62

$C_{20}H_{24}O_6$ Molephantinin



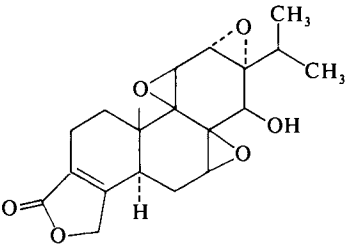
MOL. WT.: 360
BIOACTIVITY: WA 256: T/C, 397 (2.5 mg/kg)
MELTING POINT: 223–225°C
Acetate 131°C
Ketone 136°C
SPECTRAL DATA: IR, PMR
IR, PMR, Mass Spec
ORGANISM: *Elephantopus mollis* H.S.K. (Compositae)
REFERENCE: 176

$C_{20}H_{24}O_6$ Fastigilin C



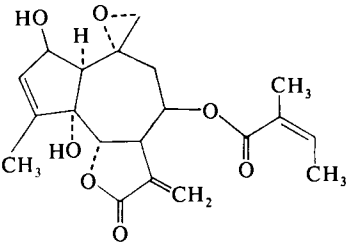
MOL. WT.: 360
BIOACTIVITY: KB: ED_{50}, 0.34 μg/ml
P388 (*in vitro*): 0.004 μg/ml
P388: T/C, 153 (3.12 mg/kg)
MELTING POINT: 197–199°C
$[\alpha]_D$: −85.8 SOLVENT: Chf
ORGANISM: *Gaillardia fastigiata* and *Baileya multiradiata* (Compositae)
LOCATION: Arizona
REFERENCE: 265, 80, 238

$C_{20}H_{24}O_6$ Triptolide



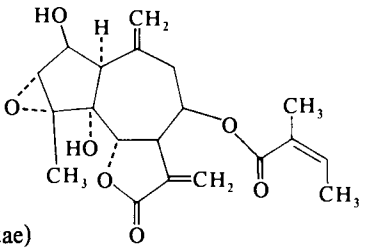
MOL. WT.: 360
BIOACTIVITY: KB: ED_{50}, 0.001 μg/ml
Sign. act. in LE and PS
MELTING POINT: 226–227°C
$[\alpha]_D$: −154 SOLVENT: Dcm
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Trypterygium wilfordii* (Celastraceae)
LOCATION: Taiwan
REFERENCE: 140

$C_{20}H_{24}O_7$ Euparotin



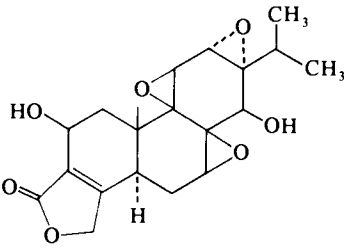
MOL. WT.: 376
BIOACTIVITY: KB: ED_{50}, 0.21 μg/ml
MELTING POINT: 199–200°C
$[\alpha]_D$: −124 SOLVENT: Alc
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium rotundifolium* L. (Compositae)
LOCATION: Florida
REFERENCE: 155

$C_{20}H_{24}O_7$ Eupatundin



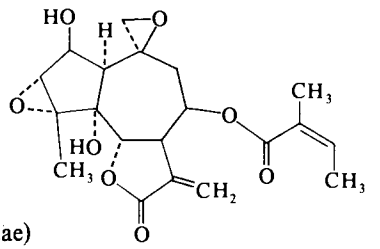
MOL. WT.: 376
BIOACTIVITY: KB: ED_{50}, 0.39 μg/ml
MELTING POINT: 188–189°C
$[\alpha]_D$: −80 SOLVENT: Alc
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Eupatorium rotundifolium* L. (Compositae)
LOCATION: Florida
REFERENCE: 155

$C_{20}H_{24}O_7$ Tripdiolide



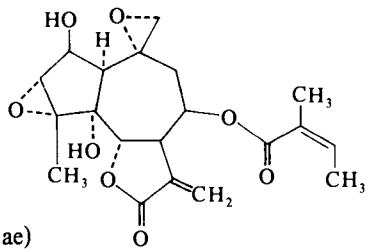
MOL. WT.: 376
BIOACTIVITY: KB: ED_{50}, 0.001 μg/ml
Sign. act. in LE and PS
MELTING POINT: 210–211°C
$[\alpha]_D$: −138 SOLVENT: Dcm
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Trypterygium wilfordii* (Celastraceae)
LOCATION: Taiwan
REFERENCE: 140

$C_{20}H_{24}O_8$ 10-Epieupatoroxin

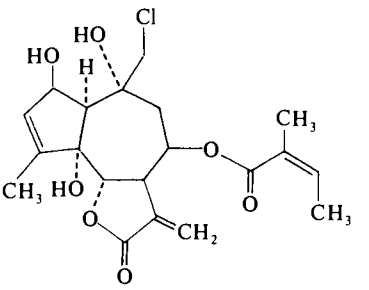


MOL. WT.: 392
BIOACTIVITY: KB: ED_{50}, 2.6 μg/ml
MELTING POINT: 230–232°C
$[\alpha]_D$: −109 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Eupatorium rotundifolium* L. (Compositae)
LOCATION: Florida
REFERENCE: 155

$C_{20}H_{24}O_8$ Eupatoroxin

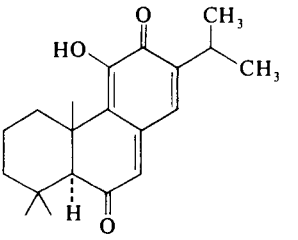


MOL. WT.: 392
BIOACTIVITY: KB: ED_{50}, 2.8 μg/ml
MELTING POINT: 197–200°C
$[\alpha]_D$: −98 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Eupatorium rotundifolium* L. (Compositae)
LOCATION: Florida
REFERENCE: 155



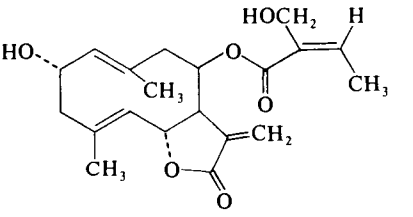
$C_{20}H_{25}ClO_7$ Eupachlorin

MOL. WT.: 412
BIOACTIVITY: KB: ED_{50}, 0.21 μg/ml
MELTING POINT: 219–221°C (dec)
$[\alpha]_D$: −110 SOLVENT: Alc
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Eupatorium rotundifolium* L. (Compositae)
LOCATION: Florida
REFERENCE: 155



$C_{20}H_{26}O_3$ Taxodione

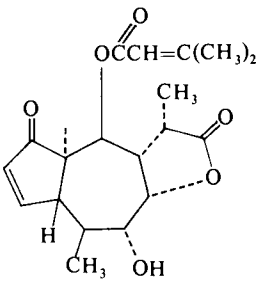
MOL. WT.: 314
BIOACTIVITY: KB: ED_{50}, 3.0 μg/ml
WA: T/C, 7 (50 mg/kg)
MELTING POINT: 115–116°C
$[\alpha]_D$: +56 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Taxodium distichum* Rich. (Taxodiaceae)
LOCATION: Maryland
REFERENCE: 154



$C_{20}H_{26}O_6$ Deacetyleupaserrin

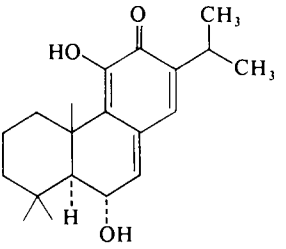
MOL. WT.: 362
BIOACTIVITY: KB: ED_{50}, 0.29 μg/ml
PS: Sign. act.
MELTING POINT: Amorphous foam
$[\alpha]_D$: +75 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium semiserratum* (Compositae)
LOCATION: Florida
REFERENCE: 146

$C_{20}H_{26}O_6$ Fastigilin B



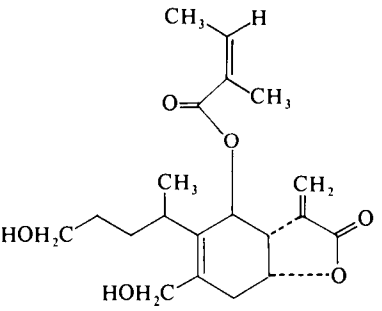
MOL. WT.: 362
BIOACTIVITY: P388 (*in vitro*): ED_{50}, 0.078
KB: ED_{50}, 20 μg/ml
PS: T/C, 141 (100 mg/kg)
MELTING POINT: 259–261°C
ORGANISM: *Baileya multiradiata* (Compositae)
LOCATION: Arizona
REFERENCE: 238

$C_{20}H_{28}O_3$ Taxodone



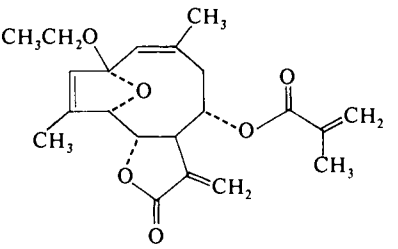
MOL. WT.: 316
BIOACTIVITY: KB: ED_{50}, 1.8 μg/ml
WA: T/C, 9 (25 mg/kg)
MELTING POINT: 164–165°C
$[\alpha]_D$: +50 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Taxodium distichum* Rich. (Taxodiaceae)
LOCATION: Maryland
REFERENCE: 154

$C_{20}H_{28}O_6$ Eriolangin



MOL. WT.: 364
BIOACTIVITY: Sign. act. in KB and PS
MELTING POINT: 94–96°C
$[\alpha]_D$: −91 SOLVENT: Chf
ORGANISM: *Eriophyllum lanatum* (Compositae)
REFERENCE: 132

$C_{21}H_{26}O_6$ Phantomolin

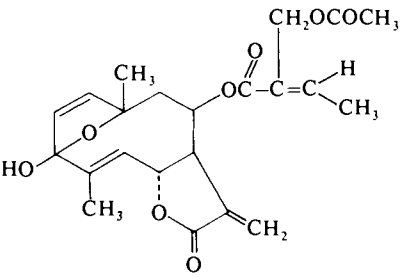


MOL. WT.: 374
BIOACTIVITY: H.Ep.-2: ED_{50}, 0.66 μg/ml
MELTING POINT: An oil
SPECTRAL DATA: IR, PMR
ORGANISM: *Elephantopus mollis* (Compositae)
LOCATION: Taiwan
REFERENCE: 195

$C_{22}H_{17}O_5$ Isogaillardin

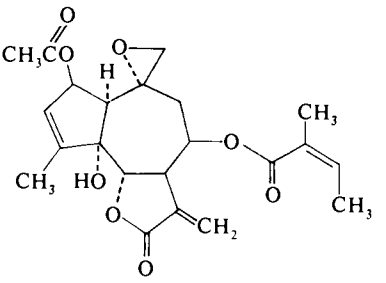
MOL. WT.: 360
BIOACTIVITY: KB: ED_{50}, 1.6 μg/ml
REFERENCE: 80

$C_{22}H_{26}O_8$ Liatrin



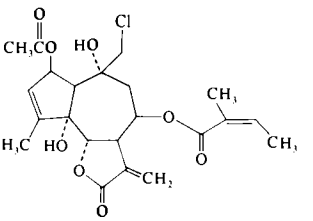
MOL. WT.: 418
BIOACTIVITY: KB: ED_{50}, 1.5 μg/ml
PS: T/C, 157 (5 mg/kg)
MELTING POINT: 130–132°C
$[\alpha]_D$: −142 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Liatris chapmanii* (Compositae)
LOCATION: Florida
REFERENCE: 142, 145

$C_{22}H_{26}O_8$ Euparotin acetate



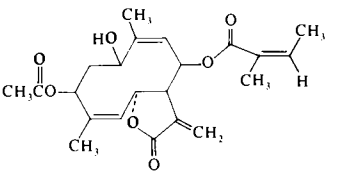
MOL. WT.: 418
BIOACTIVITY: KB: ED_{50}, 0.21 μg/ml
WA: T/C, 23 (75 mg/kg)
MELTING POINT: 156–157°C
$[\alpha]_D$: −191 SOLVENT: Alc
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium rotundifolium* L. (Compositae)
LOCATION: Florida
REFERENCE: 155, 145

$C_{22}H_{27}ClO_8$ 2-Acetoxy derivative of Eupachlorin



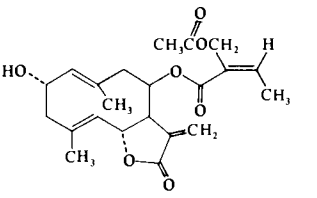
MOL. WT.: 454
BIOACTIVITY: KB: ED_{50}, 0.18 μg/ml
WA: T/C, 38 (300 mg/kg)
MELTING POINT: 161–164°C
$[\alpha]_D$: −192 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Eupatorium rotundifolium* L. (Compositae)
LOCATION: Florida
REFERENCE: 155, 145

$C_{22}H_{28}O_7$ Eupacunin



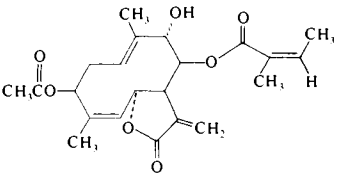
MOL. WT.: 404
BIOACTIVITY: KB: ED_{50}, 2.1 μg/ml
Sign. act. in PS and W256
MELTING POINT: 166–167°C
$[\alpha]_D$: +55 SOLVENT: An
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium cuneifolium* (Compositae)
LOCATION: Florida
REFERENCE: 161

$C_{22}H_{28}O_7$ Eupaserrin



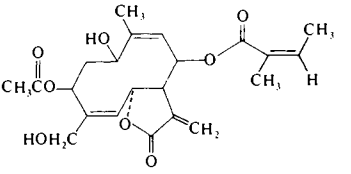
MOL. WT.: 404
BIOACTIVITY: KB: ED_{50}, 0.23 μg/ml
Sign. act. in PS
MELTING POINT: 153–154°C
$[\alpha]_D$: +71.2 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium semiserratum* (Compositae)
REFERENCE: 146

$C_{22}H_{28}O_7$ Eupatocunin



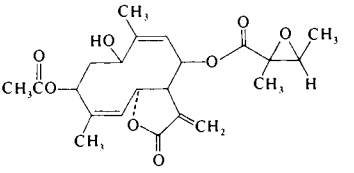
MOL. WT.: 404
BIOACTIVITY: KB: ED_{50}, 0.11 μg/ml
PS: T/C, 135 (60 mg/kg)
MELTING POINT: 163–164°C
$[\alpha]_D$: −129 SOLVENT: An
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium cuneifolium* (Compositae)
LOCATION: Florida
REFERENCE: 161, 145

$C_{22}H_{28}O_8$ Eupacunolin



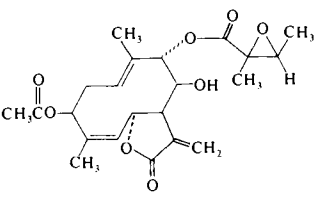
MOL. WT.: 420
BIOACTIVITY: KB: ED_{50}, 3.7 μg/ml
MELTING POINT: 164–165°C
$[\alpha]_D$: +46 SOLVENT: An
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium cuneifolium* (Compositae)
LOCATION: Florida
REFERENCE: 161

$C_{22}H_{28}O_8$ Eupacunoxin



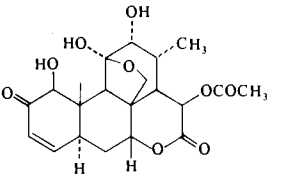
MOL. WT.: 420
BIOACTIVITY: KB: ED_{50}, 2.1 μg/ml
MELTING POINT: 171–172°C
$[\alpha]_D$: +27 SOLVENT: An
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium cuneifolium* (Compositae)
LOCATION: Florida
REFERENCE: 161

$C_{22}H_{28}O_8$ Eupatocunoxin



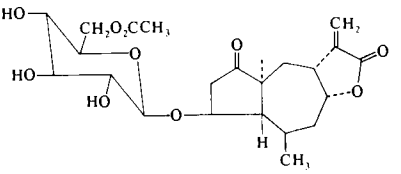
MOL. WT.: 420
BIOACTIVITY: KB: ED_{50}, 1.7 μg/ml
MELTING POINT: 200–201°C
$[\alpha]_D$: −209 SOLVENT: An
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Eupatorium cuneifolium* (Compositae)
LOCATION: Florida
REFERENCE: 161

$C_{22}H_{28}O_9$ Holacanthone



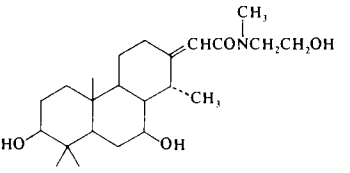
MOL. WT.: 436
BIOACTIVITY: WA256
MELTING POINT: 245–247°C
SPECTRAL DATA: UV, IR, Mass Spec
ORGANISM: *Holacantha emoryi* Gray (Simaroubaceae)
REFERENCE: 325

$C_{22}H_{32}O_{10}$ Paucin



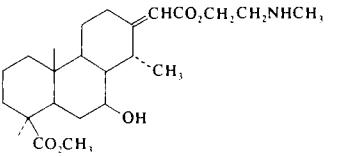
MOL. WT.: 455
BIOACTIVITY: Sign. act. in PS
MELTING POINT: 144–146°C
$[\alpha]_D$: +19.2 SOLVENT: Chf
ORGANISM: *Hymenoxys grandiflora* (Compositae)
LOCATION: Colorado
REFERENCE: 87

$C_{23}H_{39}NO_4$ Norcassaidide



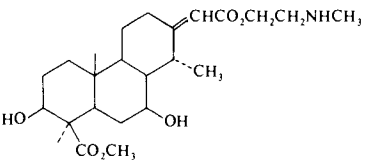
MOL. WT.: 393
BIOACTIVITY: KB: ED_{50}, 18 μg/ml
MELTING POINT: 244°C
$[\alpha]_D$: −61 SOLVENT: Alc
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Erythrophleum chlorostachys* (Fabaceae)
LOCATION: Queensland, Australia
REFERENCE: 183

$C_{24}H_{39}NO_5$ Norcassamidine



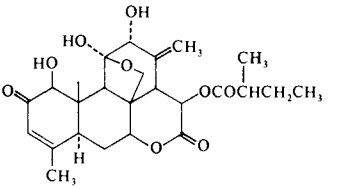
MOL. WT.: 421
BIOACTIVITY: Sign. act. in KB
MELTING POINT: Glass
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Erythrophleum chlorostachys* (Fabaceae)
LOCATION: Queensland, Australia
REFERENCE: 183

$C_{24}H_{39}NO_6$ Norerythrostachamine



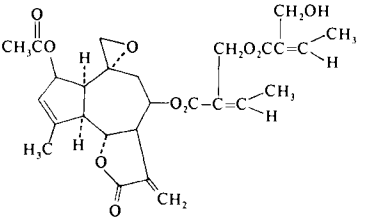
MOL. WT.: 437
BIOACTIVITY: Sign. act. in KB
MELTING POINT: Glass
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Erythrophleum chlorostachys* (Fabaceae)
LOCATION: Queensland, Australia
REFERENCE: 183

$C_{25}H_{32}O_9$ Dehydroailanthinone



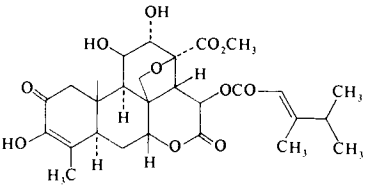
MOL. WT.: 476
BIOACTIVITY: P388 and KB
$[\alpha]_D$: +39.6 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Pierreodendron kerstingii* Little (Simaroubaceae)
REFERENCE: 159

$C_{27}H_{32}O_{10}$ Spicatin



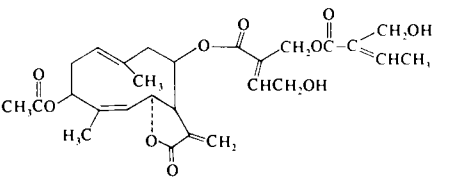
MOL. WT.: 516
BIOACTIVITY: Cytotoxic
MELTING POINT: Glass, hydrobromide, dp 95–98°C
$[\alpha]_{Hg}$: −146 SOLVENT: Chf
SPECTRAL DATA: X-ray crystal structure
ORGANISM: *Liatris spicata* and *Liatris pycnostachya* (Compositae)
REFERENCE: 118, 90

$C_{28}H_{36}O_{11}$ Bruceantin



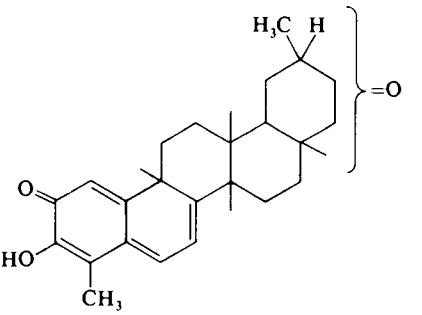
MOL. WT.: 548
BIOACTIVITY: PS: T/C, 197
B1: T/C, 168
LL: T/C, 132
KB: ED_{50}, 0.001 μg/ml
Clinical candidate
$[\alpha]_D$: −27.7 SOLVENT: Py
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Brucea antidysenterica* (Simaroubaceae)
LOCATION: Ethiopia
REFERENCE: 138, 136, 337

$C_{27}H_{34}O_{10}$ Provincialin



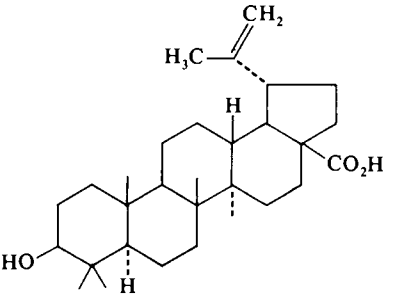
MOL. WT.: 518
BIOACTIVITY: KB: ED_{50}, 3.5 μg/ml
MELTING POINT: Gum
$[\alpha]_D$: −85 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Liatris provincialis* (Compositae)
LOCATION: Florida
REFERENCE: 95

$C_{28}H_{36}O_3$ Maitenin



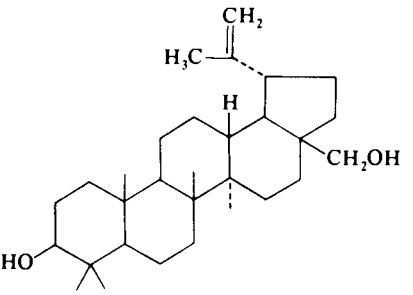
MOL. WT.: 420
BIOACTIVITY: Sign. antitumor act.
MELTING POINT: 228–229°C
SPECTRAL DATA: UV, PMR, Mass Spec
ORGANISM: *Maytenus* sp. (Celastraceae)
LOCATION: Brazil
REFERENCE: 42

$C_{29}H_{46}O_3$ Betulinic acid



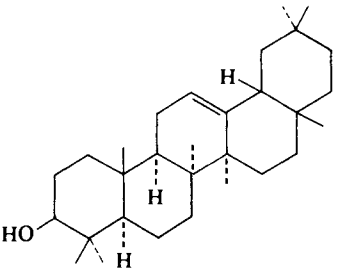
MOL. WT.: 442
BIOACTIVITY: WA256: T/C, 15
MELTING POINT: 291–293°C
$[\alpha]_D$: +6.77 SOLVENT: Py
ORGANISM: *Hyptis emoryi* (Labiatae)
LOCATION: Arizona
REFERENCE: 279

$C_{29}H_{48}O_2$ Betulin



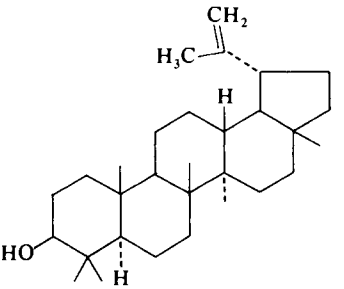
MOL. WT.: 428
BIOACTIVITY: WA: T/C, 13 (600 mg/kg)
MELTING POINT: 253–254°C
$[\alpha]_D$: +18
ORGANISM: *Alnus oregona* (Betulaceae)
LOCATION: California
REFERENCE: 278

$C_{30}H_{50}O$ α-Amyrin



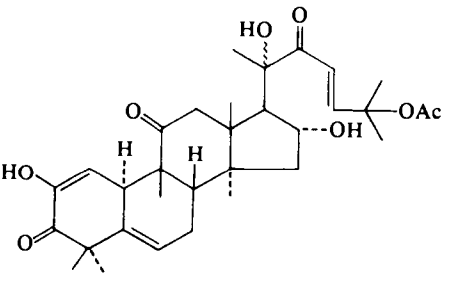
MOL. WT.: 426
BIOACTIVITY: WA: T/C 37 (50–400 mg/kg)
MELTING POINT: 186°C
$[\alpha]_D$: +91.6 SOLVENT: Be
REFERENCE: 80

$C_{30}H_{50}O$ Lupeol



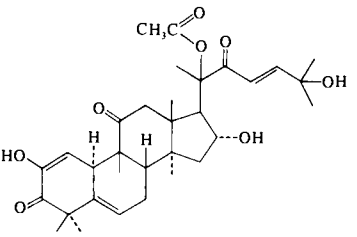
MOL. WT.: 426
BIOACTIVITY: WA: T/C, 39 (50–500 mg/kg)
MELTING POINT: 210–212°C
$[\alpha]_D$: +25
ORGANISM: *Alnus oregona* (Betulaceae)
LOCATION: California
REFERENCE: 278, 80

$C_{32}H_{44}O_8$ Cucurbitacin E



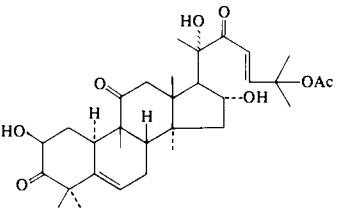
MOL. WT.: 556
BIOACTIVITY: KB: ED_{50}, 4.5×10^{-7} μg/ml
MELTING POINT: 233–235°C
$[\alpha]_D$: −58 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Marah oreganus* Howell and *Bryonia alba* L. (Cucurbitaceae)
REFERENCE: 147, 123

$C_{32}H_{44}O_8$ Datiscacin



MOL. WT.: 556
BIOACTIVITY: KB: Sign. act.
MELTING POINT: 208–212°C
$[\alpha]_D$: −18 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Datisca glomerata* (Cucurbitaceae)
REFERENCE: 171

$C_{32}H_{46}O_8$ Cucurbitacin B



MOL. WT.: 558
BIOACTIVITY: KB: ED_{50}, 2.5×10^{-6} μg/ml
WA: T/C, 30 (1.6 mg/kg)
LL: T/C, 42 (0.8 mg/kg)
MELTING POINT: 181–183°C
$[\alpha]_D$: +87 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Marah oreganus* Howell, *Begonia tuberhybrida* var. *alba*, and *Bryonia alba* L. (Cucurbitaceae)
REFERENCE: 147, 123, 47

Cucurbitacin D

BIOACTIVITY; KB: ED_{50}, 0.005–0.01 μg/ml
ORGANISM: *Bryonia alba* L. (Cucurbitaceae)
REFERENCE: 123

Cucurbitacin I

BIOACTIVITY; KB: ED_{50}, 0.005–0.01 μg/ml
ORGANISM: *Bryonia alba* L. (Cucurbitaceae)
REFERENCE: 123

Cucurbitacin J

BIOACTIVITY; KB: ED_{50}, 0.1–1 μg/ml
ORGANISM: *Bryonia alba* L. (Cucurbitaceae)
REFERENCE: 123

Cucurbitacin K

BIOACTIVITY; KB: ED_{50}, 0.1–1 μg/ml
ORGANISM: *Bryonia alba* L. (Cucurbitaceae)
REFERENCE: 123

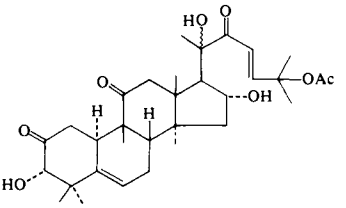
Cucurbitacin L

BIOACTIVITY; KB: ED_{50}, 0.01–0.1 μg/ml
ORGANISM: *Bryonia alba* L. (Cucurbitaceae)
REFERENCE: 123

Cucurbitacin Th I

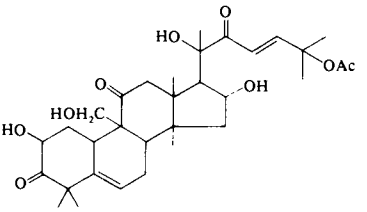
BIOACTIVITY; KB: ED_{50}, 0.1 μg/ml
WA: T/C, 29 (0.7 mg/kg)
ORGANISM: *Bryonia alba* L. (Cucurbitaceae)
REFERENCE: 123

$C_{32}H_{46}O_8$ Isocucurbitacin B



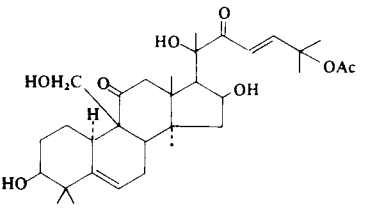
MOL. WT.: 558
BIOACTIVITY: KB: ED_{50}, 0.4 μg/ml
MELTING POINT: 223–223.5°C (dec.)
$[\alpha]_D$: +43 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Marah oreganus* Howell (Cucurbitaceae)
REFERENCE: 147

$C_{32}H_{46}O_9$ Cucurbitacin A



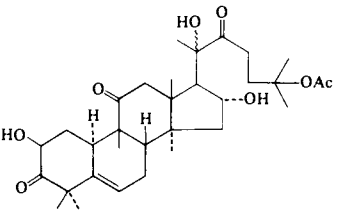
MOL. WT.: 574
BIOACTIVITY: KB: ED_{50}, 0.0014 μg/ml
MELTING POINT: 207–208°C
$[\alpha]_D$: +97 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Cucumis hookeri* (Cucurbitaceae)
REFERENCE: 55, 80

$C_{32}H_{48}O_8$ Cucurbitacin C



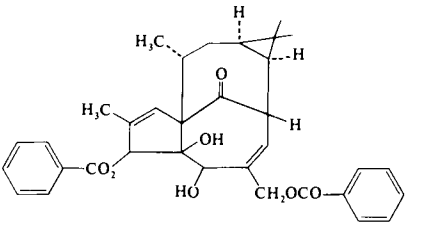
MOL. WT.: 560
BIOACTIVITY: KB: ED_{50}, 0.001 μg/ml
MELTING POINT: 207–207.5°C
$[\alpha]_D$: +95 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Cucumis sativus* (Cucurbitaceae)
REFERENCE: 54, 80

$C_{32}H_{48}O_8$ Dihydrocucurbitacin B



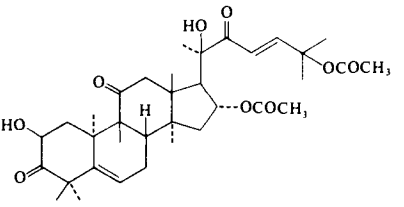
MOL. WT.: 560
BIOACTIVITY: KB: ED_{50}, 0.0017 μg/ml
MELTING POINT: 163.5–164.5°C
$[\alpha]_D$: +53 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Marah oreganus* Howell (Cucurbitaceae)
REFERENCE: 147

$C_{34}H_{36}O_7$ Ingenol Dibenzoate



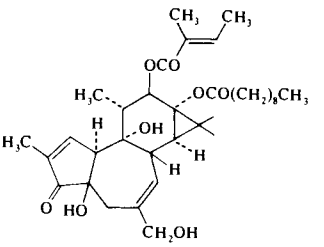
MOL. WT.: 556
BIOACTIVITY: PS, LL, and WA:
Active at very low dose (130–360 μg/kg)
$[\alpha]_D$: +268 SOLVENT: Alc
SPECTRAL DATA: Mass Spec
ORGANISM: *Euphorbia esula* L. (Euphorbiaceae)
REFERENCE: 172

$C_{34}H_{48}O_9$ Fabacein



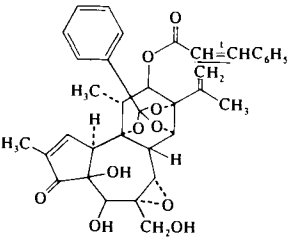
MOL. WT.: 600
BIOACTIVITY: KB: ED_{50}, 1.0 μg/ml
MELTING POINT: 198–201°C
$[\alpha]_D$: +36 SOLVENT: Alc
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Echinocystis fabacea* (Cucurbitaceae)
REFERENCE: 170

$C_{35}H_{44}O$ Phorbol 12-Tiglate 13-decanoate



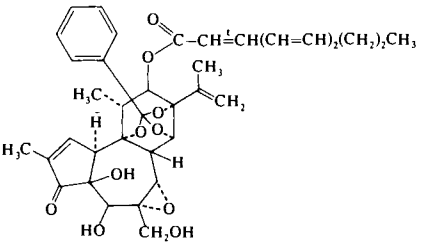
MOL. WT.: 600
BIOACTIVITY: PS: Active at 60–250 μg/kg
$[\alpha]_D$: +39 SOLVENT: Di
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Croton tiglium* L. (Euphorbiaceae)
REFERENCE: 172

$C_{36}H_{36}O_{10}$ Gnidicin



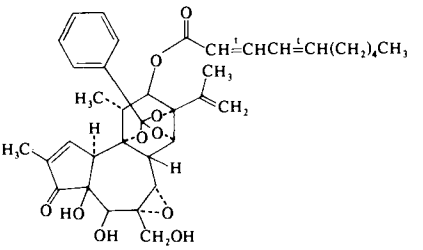
MOL. WT.: 628
BIOACTIVITY: PS: Sign. act.
$[\alpha]_D$: +86.5 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Gnidia lamprantha* (Thymelaeaceae)
REFERENCE: 168

$C_{37}H_{42}O_{10}$ Gniditrin

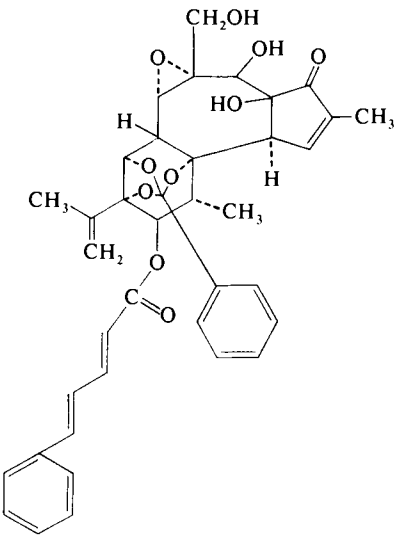


MOL. WT.: 646
BIOACTIVITY: PS: Sign. act.
$[\alpha]_D$: +51 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Gnidia lamprantha* (Thymelaeaceae)
REFERENCE: 168

$C_{37}H_{44}O_{10}$ Gnididin



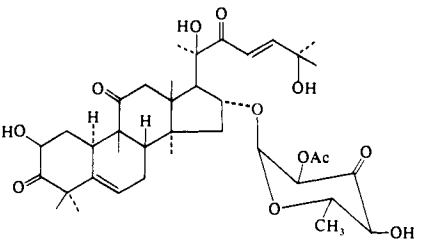
MOL. WT.: 648
BIOACTIVITY: PS: Sign. act.
$[\alpha]_D$: +49 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Gnidia lamprantha* (Thymelaeaceae)
REFERENCE: 168



$C_{38}H_{41}O_{10}$ Mezerein

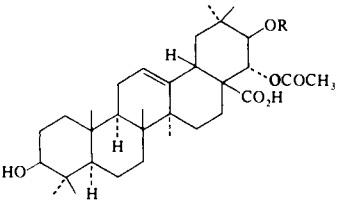
MOL. WT.: 654
BIOACTIVITY: P388: Active
LE: Active
MELTING POINT: 258–262°C
$[\alpha]_D$: +125 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Daphne mezereum* L. (Thymelaeaceae)
REFERENCE: 131

$C_{38}H_{54}O_{12}$ Datiscoside



MOL. WT.: 702
BIOACTIVITY: KB: ED_{50}, 0.16 μg/ml
PS, WM: Sign. act.
MELTING POINT: 174–175°C
$[\alpha]_D$: +26 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Datisca glomerata* Baill. (Cucurbitaceae)
LOCATION: California
REFERENCE: 163

$C_{41}H_{62}O_7$ Saponin P (glucose-arabinose, glycoside of Acerotin and Acerocin)



R = –CO(CH=CH)$_2$CHCH$_2$CH$_3$: Acerotin
CH$_3$

R = –CO(CH=CH)(CH=CH)CHCH$_2$CH$_3$: Acerocin
CH$_3$

MOL. WT.: 666
BIOACTIVITY: Sign. antitumor act., S180, WM
MELTING POINT: Acerotin, 240–243°C;
Acerocin, 205–207°C
$[\alpha]_d$: Acerotin, +67; SOLVENT: Chf; Chf
Acerocin, +104
SPECTRAL DATA: UV, IR, Mass Spec
ORGANISM: *Acer negundo* (Aceraceae)
REFERENCE: 169

Unknown Acer saponin Q

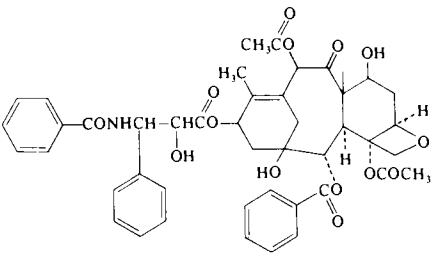
BIOACTIVITY: SA: T/C, 22 (1–6 mg/kg)
REFERENCE: 151, 80

$C_{45}H_{72}O_{16}$ Desglucomusennin

MOL. WT.: 869
BIOACTIVITY: WA: T/C, 42 (1–60 mg/kg)
REFERENCE: 80

$C_{47}H_{51}NO_{14}$ Taxol

MOL. WT.: 853
BIOACTIVITY: KB: ED_{50}, 5.5×10^{-5} µg/ml
Activity in LE: T/C, 131
PS: T/C, 156
P1534
WM
MELTING POINT: 213–216°C
$[\alpha]_D$: −49 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Taxus brevifolia* (Taxaceae)
REFERENCE: 329, 337

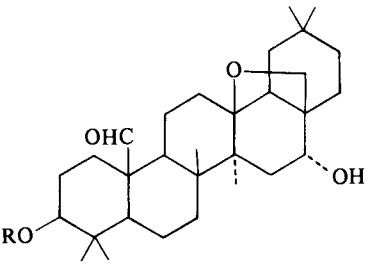


$C_{55}H_{26}O_{24}$ Aescin

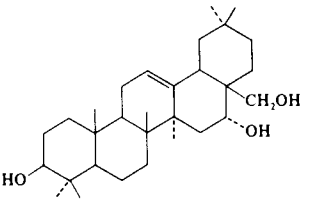
MOL. WT.: 1070
BIOACTIVITY: WA: T/C, 33 (3–60 mg/kg)
REFERENCE: 309, 80

$C_{58}H_{94}O_{27}$ Cyclamin

MOL. WT.: 1222
BIOACTIVITY: WA: T/C, 36 (3–60 mg/kg)
MELTING POINT: 282–283°C
$[\alpha]_D$: −22.6 SOLVENT: Py
ORGANISM: *Cyclamen europaeum* (Primulaceae)
REFERENCE: 310, 80



R = sugar chain
3(D-glucose), D-xylose,
L-arabinose



+ Glucose, rhamnose, galactose,
(1) (2) (1)
glucuronic acid
(1)

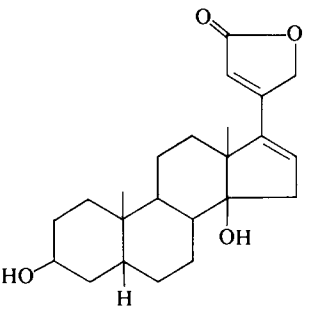
$C_{60}H_{98}O_{27} \cdot 4H_2O$ Myrsine saponin

MOL. WT.: 1268
BIOACTIVITY: WA: T/C, 27 (8 mg/kg)
MELTING POINT: 259–260°C
$[\alpha]_D$: −35 SOLVENT: Me
SPECTRAL DATA: IR
ORGANISM: *Myrsine africana* L. and *Wallenia yunguensis* (Myrsinaceae)
LOCATION: Ethiopia
REFERENCE: 167, 121

Chapter 2

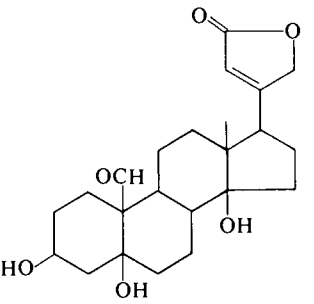
Higher Plant Steroids

$C_{23}H_{32}O_4$ 16-Anhydrogitoxigenin



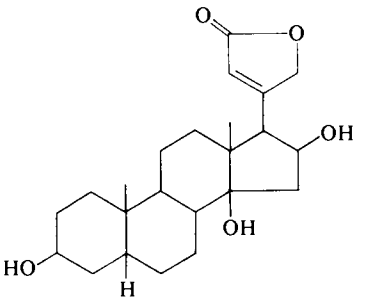
MOL. WT.: 372
BIOACTIVITY: KB: ED_{50}, 4.8 μg/ml
MELTING POINT: 240–244°C
SPECTRAL DATA: UV, IR, Mass Spec
ORGANISM: *Cryptostegia grandiflora* (Asclepiadaceae)
LOCATION: Mexico
REFERENCE: 48

$C_{23}H_{32}O_6$ Strophanthidin



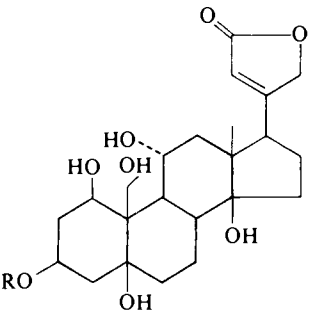
MOL. WT.: 404
BIOACTIVITY: KB: ED_{50}, 0.24 μg/ml
MELTING POINT: 136–138°C
177–178°C
220–230°C (dec.)
$[\alpha]_D$: +43 SOLVENT: Alc
ORGANISM: *Corchorus capsularis* (Tiliaceae)
REFERENCE: 80, 277

$C_{23}H_{34}O_6$ Gitoxigenin



MOL. WT.: 406
BIOACTIVITY: KB: ED_{50}, 2.3 μg/ml
MELTING POINT: 232–235°C
$[\alpha]_D$: +33
ORGANISM: *Cryptostegia grandiflora* (Roxb.) R. Br. (Asclepiadaceae)
LOCATION: Sonora, Mexico
REFERENCE: 48

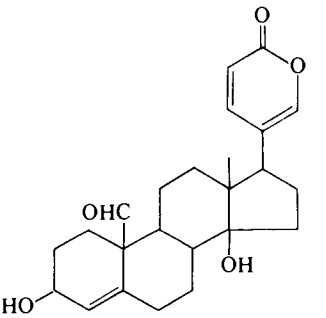
$C_{23}H_{34}O_8$ Ouabagenin



R = Rhamnosyl

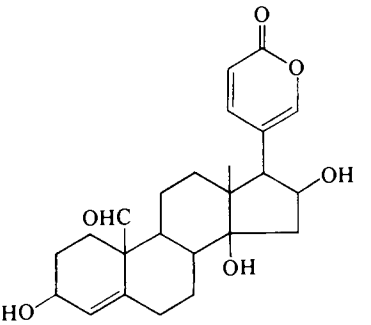
MOL. WT.: 438
BIOACTIVITY: KB: ED_{50}, 2.5 μg/ml
MELTING POINT: 256°C
$[\alpha]_D$: +11 SOLVENT: Aq
ORGANISM: *Strophanthus gratus* (Apocynaceae)
REFERENCE: 80, 197

$C_{24}H_{30}O_5$ Scilliglaucosidin



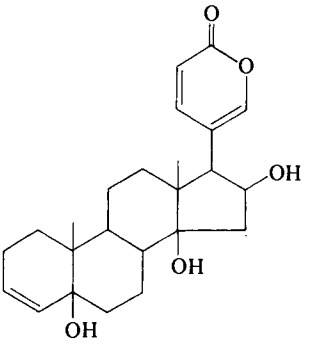
MOL. WT.: 398
BIOACTIVITY: KB: ED_{50}, 0.002 μg/ml
MELTING POINT: 248°C
$[\alpha]_D$: +47 SOLVENT: Alc
SPECTRAL DATA: IR, PMR
ORGANISM: *Bersama abyssinica* Fresen. (Melianthaceae)
LOCATION: Ethiopia
REFERENCE: 162, 289

$C_{24}H_{30}O_6$ Berscillogenin



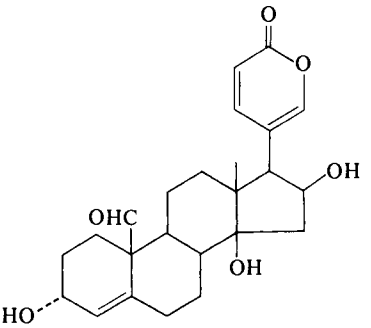
MOL. WT.: 414
BIOACTIVITY: KB: ED_{50}, 0.02 μg/ml
MELTING POINT: 214–216°C (dec.)
$[\alpha]_D$: +42 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bersama abyssinica* Fresen. (Melianthaceae)
LOCATION: Ethiopia
REFERENCE: 162

$C_{24}H_{30}O_6$ Bersenogenin



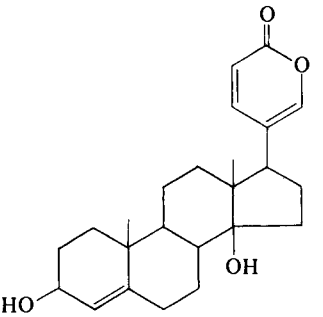
MOL. WT.: 414
BIOACTIVITY: KB: ED_{50}, 0.0046 μg/ml
MELTING POINT: 226–230°C (dec.)
$[\alpha]_D$: +108 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bersama abyssinica* Fresen. (Melianthaceae)
LOCATION: Ethiopia
REFERENCE: 162

$C_{24}H_{30}O_6$ 3-Epiberscillogenin



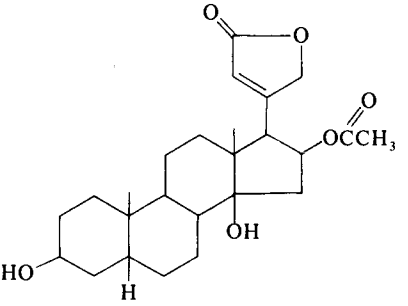
MOL. WT.: 414
BIOACTIVITY: KB: ED_{50}, 0.62 μg/ml
MELTING POINT: 213–215°C (dec.)
$[\alpha]_D$: +84 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bersama abyssinica* (Melianthaceae)
LOCATION: Ethiopia
REFERENCE: 162

$C_{24}H_{32}O_4$ Scillarenin

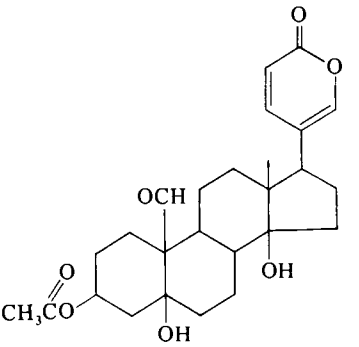


MOL. WT.: 384
BIOACTIVITY: KB: 1×10^{-3} μg/ml
LE: *in vitro*, inactive
MELTING POINT: 230–232°C
SPECTRAL DATA: PMR, Mass Spec
ORGANISM: *Scilla maritima* (Liliaceae)
LOCATION: Egypt
REFERENCE: 111, 241

$C_{25}H_{36}O_6$ Oleandrigenin

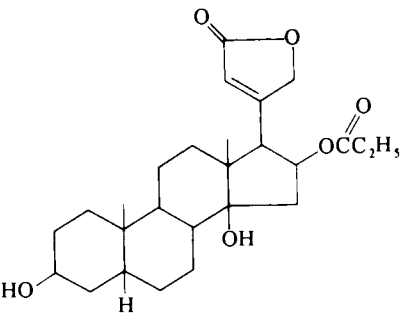


MOL. WT.: 432
BIOACTIVITY: KB: ED_{50}, 0.05 μg/ml
MELTING POINT: 224–225°C
ORGANISM: *Cryptostegia grandiflora* (Roxb.) R. Br. (Asclepiadaceae)
LOCATION: Sonora, Mexico
REFERENCE: 48



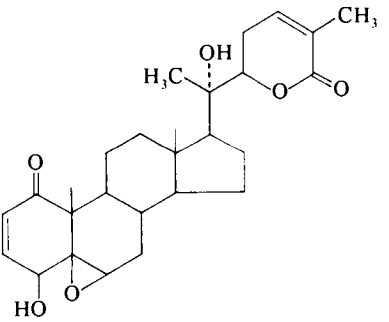
$C_{26}H_{34}O_7$ Hellebrigenin 3-Acetate

MOL. WT.: 458
BIOACTIVITY: KB: ED_{50}, 2.4×10^{-7} μg/ml
WA: T/C, 25
MELTING POINT: 230–232°C
$[\alpha]_D$: +30 SOLVENT: Chf
SPECTRAL DATA: PMR
ORGANISM: *Bersama abyssinica* Fresen. (Melianthaceae)
LOCATION: Ethiopia
REFERENCE: 149, 80



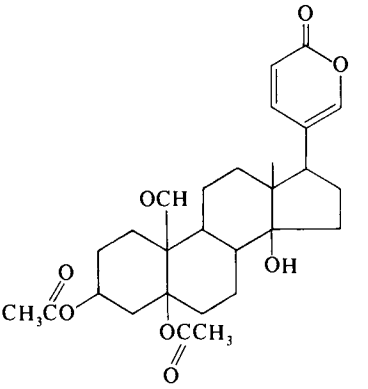
$C_{26}H_{38}O_6$ 16-Propionylgitoxigenin

MOL. WT.: 446
BIOACTIVITY: KB: ED_{50}, 3.7 μg/ml
MELTING POINT: 212–214°C
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Cryptostegia grandiflora* (Roxb.) R. Br. (Asclepiadaceae)
LOCATION: Sonora, Mexico
REFERENCE: 48



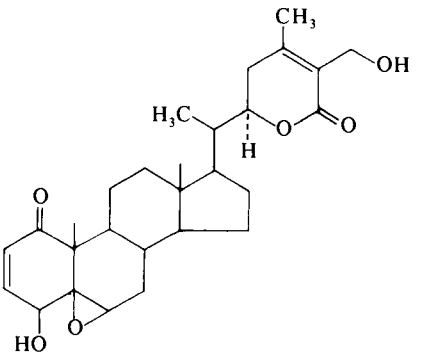
$C_{27}H_{36}O_6$

MOL. WT.: 456
BIOACTIVITY: KB: ED_{50}, 1 μg/ml
MELTING POINT: 251–253°C
$[\alpha]_D$: +80 SOLVENT: Chf
SPECTRAL DATA: IR
ORGANISM: *Withania somnifera* (Solanaceae)
LOCATION: India
REFERENCE: 27



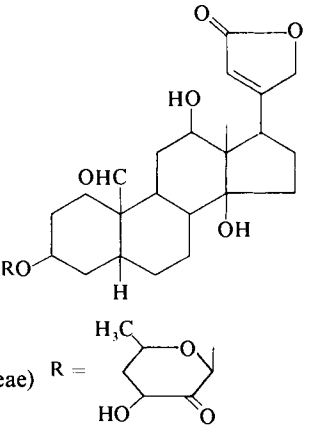
$C_{28}H_{36}O_8$ Hellebrigenin 3,5-diacetate

MOL. WT.: 500
BIOACTIVITY: KB: ED_{50}, 0.0019 μg/ml
MELTING POINT: 217–219°C
$[\alpha]_D$: −23 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Bersama abyssinica* Fresen. (Melianthaceae)
LOCATION: Ethiopia
REFERENCE: 149



$C_{28}H_{38}O_6$ Withaferin A

MOL. WT.: 470
BIOACTIVITY: SA: T/C, 38
WA: T/C, 24 (40 mg/kg)
KB: ED_{50}, 0.28 μg/ml
MELTING POINT: 252–253°C
$[\alpha]_D$: +125 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Acnistus arborescens* L. Schlecht. (Solanaceae)
LOCATION: Costa Rica
REFERENCE: 80, 129

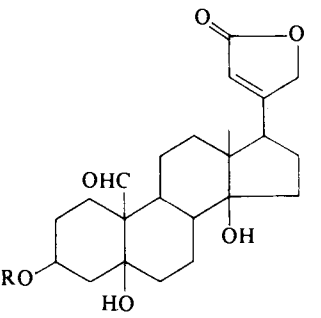


$C_{29}H_{40}O_9$ Calotropin

MOL. WT.: 532
BIOACTIVITY: KB: ED_{50}, 0.025 μg/ml
ORGANISM: *Calotropis procera* and *gigantea* (Asclepiadaceae)
REFERENCE: 80, 82, 128

$C_{29}H_{42}O_{10}$ Convallatoxin

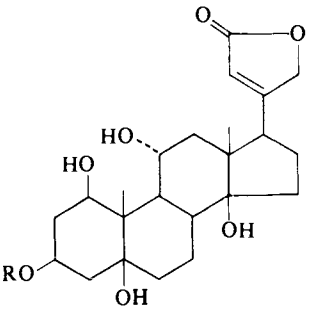
MOL. WT.: 550
BIOACTIVITY: KB: ED_{50}, 34 μg/ml
MELTING POINT: 228–231°C
ORGANISM: *Ornithogallum umbellatum* (Liliaceae)
REFERENCE: 80, 120



R = Rhamnosyl

$C_{29}H_{44}O_{11}$ Opposide

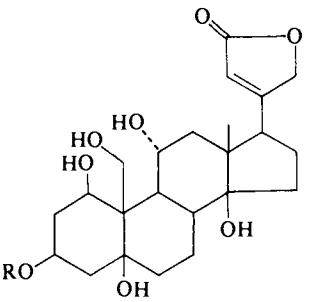
MOL. WT.: 568
BIOACTIVITY: KB: ED_{50}, 0.045 μg/ml
MELTING POINT: 282–287°C
$[\alpha]_D$: −51.4 SOLVENT: Me
ORGANISM: *Acokanthera longiflora* (Apocynaceae)
REFERENCE: 122



R = 6-Desoxy-L-talosyl

$C_{29}H_{44}O_{12}$ Acolongifloriside K

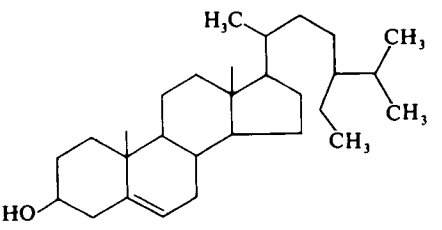
MOL. WT.: 584
BIOACTIVITY: KB: ED_{50}, 0.064 μg/ml
MELTING POINT: 224–232°C
$[\alpha]_D$: −53.2 SOLVENT: Me
ORGANISM: *Acokanthera longiflora* (Apocynaceae)
REFERENCE: 122

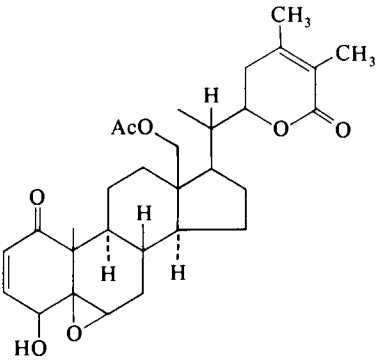


R = 6-Desoxy-L-talosyl

$C_{29}H_{50}O$ β-Sitosterol

MOL. WT.: 414
BIOACTIVITY: WA: T/C, 3 (29–450 mg/kg)
LL: T/C, 32 (18–450 mg/kg)
MELTING POINT: 140°C
$[\alpha]_D$: −37
REFERENCE: 60, 80

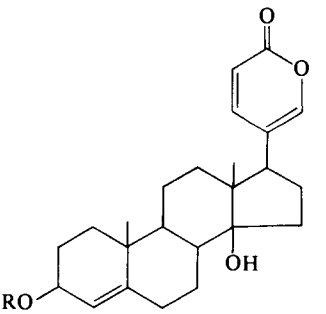




$C_{30}H_{40}O_7$ Withacnistin

MOL. WT.: 512
BIOACTIVITY: KB: ED_{50}, 0.17 μg/ml
MELTING POINT: 130–135°C (amorphous)
$[\alpha]_D$: +123 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Acnistus arborescens* (L.) Schlecht. (Solanaceae)
LOCATION: Costa Rica
REFERENCE: 129

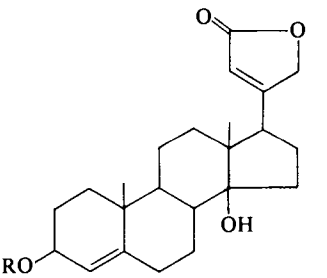
$C_{30}H_{42}O_8$ Proscillaridin A



MOL. WT.: 530
BIOACTIVITY: KB: ED_{50}, 2.6 × 10^{-7} μg/ml
ORGANISM: *Scilla maritima* (Liliaceae)
REFERENCE: 80, 288, 229

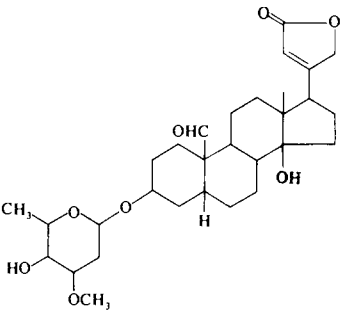
R = L-Rhamnosyl

$C_{30}H_{44}O_8$ Acofrioside L



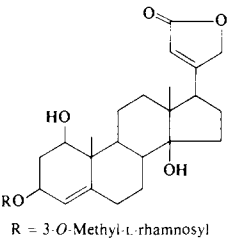
MOL. WT.: 532
BIOACTIVITY: KB: ED_{50}, 0.16 μg/ml
MELTING POINT: 264–268°C
$[\alpha]_D$: −57.3 SOLVENT: Me
SPECTRAL DATA: UV, IR, Mass Spec
ORGANISM: *Acokanthera oppositifolia* (Apocynaceae)
REFERENCE: 122, 86

R = 3-*O*-Methyl-L-rhamnosyl



$C_{30}H_{44}O_8$ Apocannoside

MOL. WT.: 532
BIOACTIVITY: KB: ED_{50}, 0.037 μg/ml
MELTING POINT: 134–137°C
$[\alpha]_D$: −8 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Apocynum cannabinum* L. (Apocynaceae)
LOCATION: Maryland
REFERENCE: 148



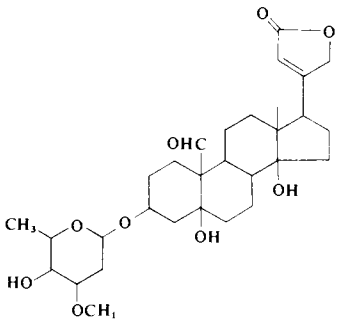
R = 3-*O*-Methyl-L-rhamnosyl

$C_{30}H_{44}O_9$ Acolongifloriside H

MOL. WT.: 548
BIOACTIVITY: KB: ED_{50}, 0.25 μg/ml
MELTING POINT: 249–255°C
$[\alpha]_D$: −42.8 SOLVENT: Me
ORGANISM: *Acokanthera oppositifolia* (Apocynaceae)
REFERENCE: 122

$C_{30}H_{44}O_9$ Acoschimperoside Q

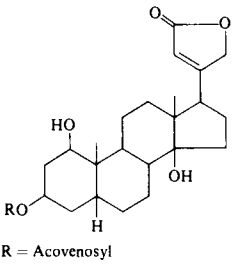
MOL. WT.: 548
BIOACTIVITY: KB: ED_{50}, 0.25 μg/ml
MELTING POINT: 247–248°C
$[\alpha]_D$: −69.2 SOLVENT: Me
SPECTRAL DATA: UV
ORGANISM: *Acokanthera schimperi* (Apocynaceae)
REFERENCE: 122, 303



$C_{30}H_{44}O_9$ Cymarin

MOL. WT.: 548
BIOACTIVITY: KB: ED_{50}, 0.0039 μg/ml
MELTING POINT: 143–144°C
$[\alpha]_D$: +38 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Apocynum cannabinum* L. (Apocynaceae)
LOCATION: Maryland
REFERENCE: 148

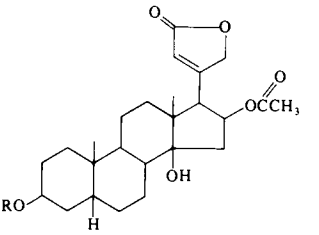
$C_{30}H_{46}O_9$ Acovenoside A



R = Acovenosyl

MOL. WT.: 550
BIOACTIVITY: KB: ED_{50}, 0.031 μg/ml
MELTING POINT: 222°C
$[\alpha]_D$: −64.8 SOLVENT: Di
ORGANISM: *Acokanthera friesiorum* (Apocynaceae)
REFERENCE: 80, 274

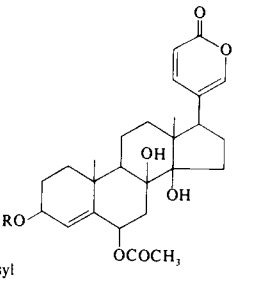
$C_{31}H_{43}O_{12}$ Oleandrigenin 3-rhamnoside



R = Rhamnosyl

MOL. WT.: 607
BIOACTIVITY: KB: ED_{50}, 0.025 μg/ml
MELTING POINT: 273–274°C
ORGANISM: *Cryptostegia grandiflora* (Roxb.) R. Br. (Asclepiadaceae)
LOCATION: Sonora, Mexico
REFERENCE: 48

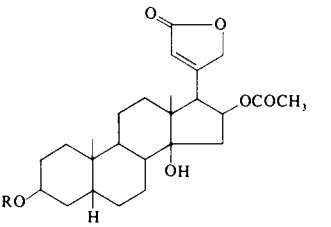
$C_{32}H_{44}O_{12}$ Scilliroside



R = Glucosyl

MOL. WT.: 620
BIOACTIVITY: KB: ED_{50}, 0.023 μg/ml
ORGANISM: *Scilla maritima* (Liliaceae)
REFERENCE: 80, 287

$C_{32}H_{48}O_{10}$ Acoschimperoside P

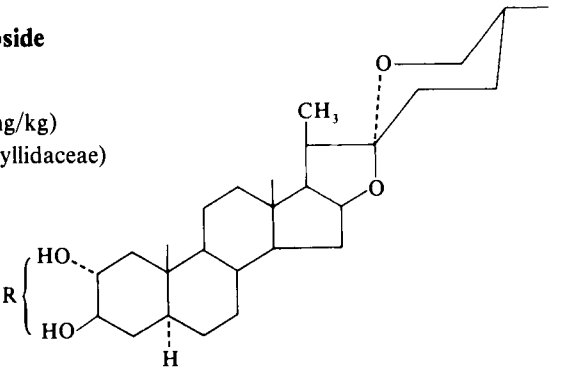


R = L-Glucosyl

MOL. WT.: 592
BIOACTIVITY: KB: ED_{50}, 0.1 μg/ml
MELTING POINT: 275–279°C
$[\alpha]_D$: −35.6 SOLVENT: Me
ORGANISM: *Acokanthera schimperi* (Apocynaceae)
REFERENCE: 122, 303

$C_{34}H_{56}O_8$ Gitogenin galactoside

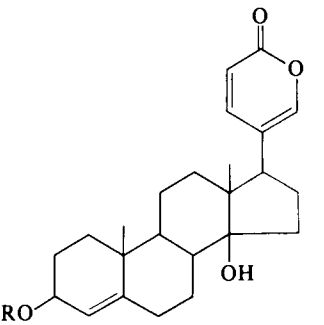
MOL. WT.: 592
BIOACTIVITY: WA: T/C, 17 (65 mg/kg)
ORGANISM: *Agave schottii* (Amaryllidaceae)
REFERENCE: 13



R = Galactosyl

$C_{36}H_{52}O_{13}$ Scillaren A

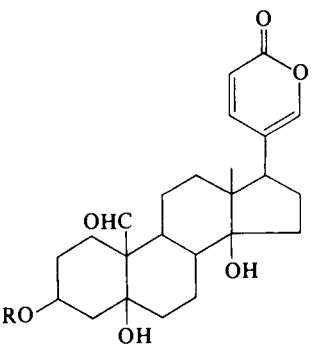
MOL. WT.: 692
BIOACTIVITY: KB: ED_{50}, 0.012 μg/ml
ORGANISM: *Scilla maritima* (Liliaceae)
REFERENCE: 80, 288



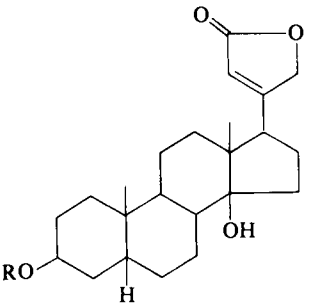
R = Rhamnose-glucose

$C_{36}H_{52}O_{15}$ Hellebrin

MOL. WT.: 724
BIOACTIVITY: KB: ED_{50}, 0.017 μg/ml
MELTING POINT: Aglycone; hellebrigenin, 250°C
ORGANISM: *Helleborus niger* (Ranunculaceae)
REFERENCE: 80, 60



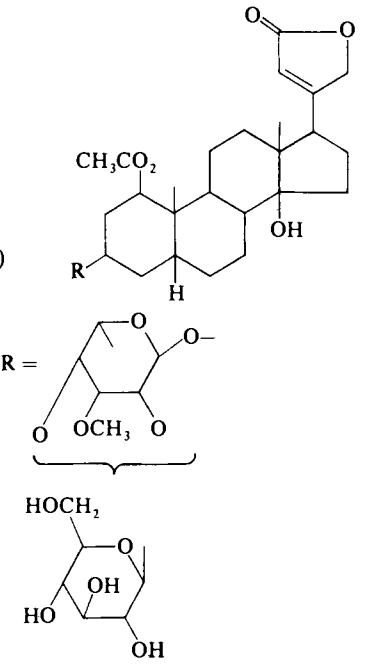
R = Glucosyl-rhamnosyl



R = 3-*O*-Methyl-L-rhamnosyl

$C_{36}H_{56}O_{14}$ Acobioside A

MOL. WT.: 712
BIOACTIVITY: KB: ED_{50}, 0.15 μg/ml
MELTING POINT: 248–258°C
$[\alpha]_D$: −74 SOLVENT: Me
ORGANISM: *Acokanthera oppositifolia* (Apocynaceae)
REFERENCE: 80, 85



$C_{38}H_{58}O_{15}$ Acospectoside A

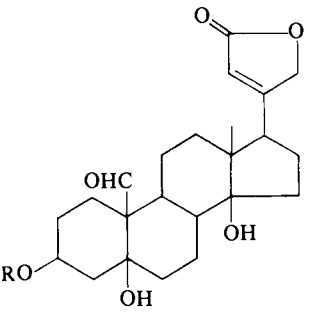
MOL. WT.: 754
BIOACTIVITY: KB: ED_{50}, 0.3 μg/ml
MELTING POINT: 290–298°C
$[\alpha]_D$: −97
ORGANISM: *Acokanthera oblongifolia* (Apocynaceae)
REFERENCE: 80, 117, 116

$C_{42}H_{64}O_{19}$ Diglucoacoschimperoside N

MOL. WT.: 872
BIOACTIVITY: KB: ED_{50}, 3.7 μg/ml
MELTING POINT: 171–174°C
$[\alpha]_D$: −94.5 SOLVENT: Me
ORGANISM: *Acokanthera schimperi* (Apocynaceae)
REFERENCE: 122, 303

$C_{42}H_{64}O_{19}$ K-Strophanthoside

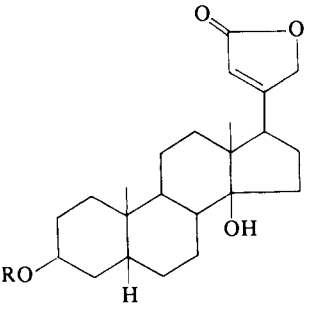
MOL. WT.: 872
BIOACTIVITY: KB: ED_{50}, 0.032 μg/ml
ORGANISM: *Strophanthus kombé* (Apocynaceae)
REFERENCE: 80, 96, 60



R = (β-Glucose)$_2$-cymarosyl

$C_{44}H_{68}O_{22}$ Diglucoacoschimperoside P

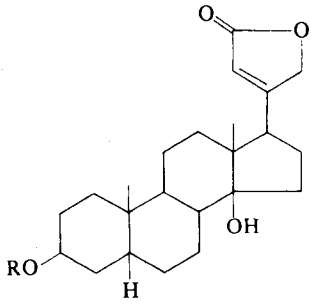
MOL. WT.: 948
BIOACTIVITY: KB: ED_{50}, 1.7 μg/ml
MELTING POINT: 174–179°C
$[\alpha]_D$: −51.5 SOLVENT: Me
ORGANISM: *Acokanthera schimperi* (Apocynaceae)
REFERENCE: 80, 303



R = 4-Glucosylglucosyl

$C_{49}H_{76}O_{19}$ Lanatoside A

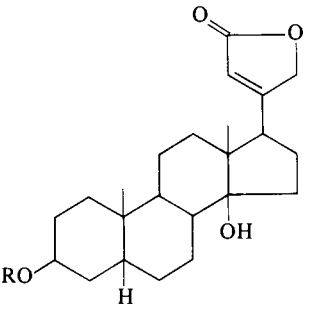
MOL. WT.: 968
BIOACTIVITY: KB: ED_{50}, <1.0 μg/ml
MELTING POINT: 245–248°C
ORGANISM: *Digitalis lanata* (Scrophulariaceae)
REFERENCE: 80, 286



R = Acetylglucose-(digitoxose)$_3$

$C_{49}H_{76}O_{20}$ Lanatoside C

MOL. WT.: 984
BIOACTIVITY: KB: ED_{50}, 0.024 μg/ml
MELTING POINT: 245–248°C
ORGANISM: *Digitalis lanata* (Scrophulariaceae)
REFERENCE: 80, 286



R = $(Digitoxose)_2$-acetyldigitoseglucosyl

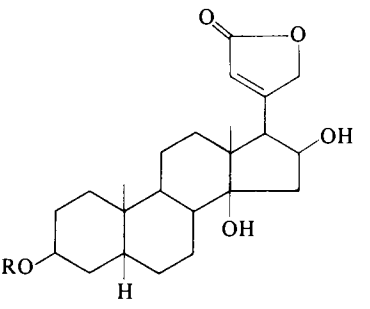
A strophanthidin glycoside

Structure unknown
BIOACTIVITY: KB: ED_{50}, <0.25 μg/ml
MELTING POINT: 163–168°C
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Parquetina nigrescens* (Asclepiadaceae)
LOCATION: Africa
REFERENCE: 198

$C_{49}H_{76}O_{22}$ Lanatoside B

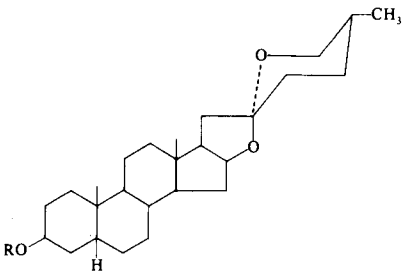
occurs with Lanatosides A and C

MOL. WT.: 1016
BIOACTIVITY: KB: ED_{50}, 0.38 μg/ml
MELTING POINT: 245–248°C
ORGANISM: *Digitalis lanata* (Scrophulariaceae)
REFERENCE: 80, 286



R = Acetylglucose-$(digitoxose)_3$

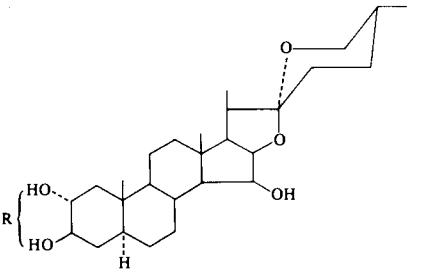
$C_{51}H_{84}O_{22}$ Parillin



R = $(Glucose)_3$(rhamnose)

MOL. WT.: 1048
BIOACTIVITY: WA: Sign. act.
MELTING POINT: 220–223°C
$[\alpha]_D$: −64 SOLVENT: Alc
ORGANISM: *Smilax aristolochiaefolia* Mill. (Liliaceae)
REFERENCE: 311

$C_{56}H_{92}O_{29}$ Digitonin



R = (Xylose)$(Galactose)_2(Glucose)_2$

MOL. WT.: 1228
BIOACTIVITY: CA: Sign. act.
MELTING POINT: 235°C (dec.)
$[\alpha]_D$: −54.3 SOLVENT: Me
ORGANISM: *Digitalis purpurea* (Scrophulariaceae)
REFERENCE: 80, 266

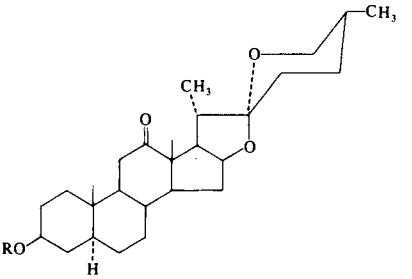
$C_{57}H_{96}O_{30}$ (ca.) Saponaria saponin

MOL. WT.: 1260
BIOACTIVITY: SA: T/C, 30 (0.5–9 mg/kg)
WA: T/C, 14 (0.5–9 mg/kg)
ORGANISM: *Saponaria officinalis* L. (Caryophyllaceae)
REFERENCE: 80

$C_{59}H_{96}O_{26}$ Hederasaponin C

MOL. WT.: 920
BIOACTIVITY: WA: T/C, 38
REFERENCE: 80, 338

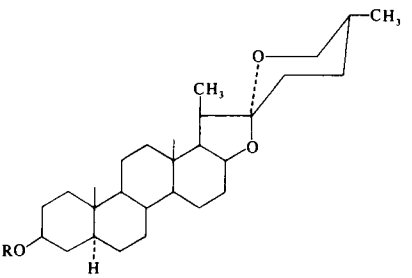
$C_{68}H_{110}O_{36}$ Hecogenin glycoside



R = (L-rhamnose)$_2$(D-xylose)(D-glucose)$_4$

MOL. WT.: 1502
BIOACTIVITY: WA: Sign. act.
ORGANISM: *Agave pacifica* (Amaryllidaceae)
REFERENCE: 105

$C_{68}H_{112}O_{34}$ Tigogenin glycoside



R = (L-rhamnose)$_3$(D-xylose)(D-glucose)$_3$

MOL. WT.: 1472
BIOACTIVITY: WA: Sign. act.
KB: ED_{50}, 0.15 μg/ml
MELTING POINT: 287–293°C
$[\alpha]_D$: −21.5 SOLVENT: Me
ORGANISM: *Agave pacifica* (Amaryllidaceae); *Acokanthera schimperi* (Apocynaceae)
REFERENCE: 105, 122, 303

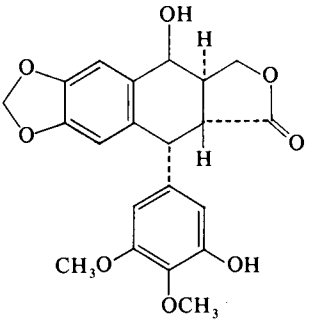
Acolongifloriside G

BIOACTIVITY: KB: ED_{50}, 0.15 μg/ml
MELTING POINT: 287–293°C
$[\alpha]_D$: −21.5 SOLVENT: Me
ORGANISM: *Acokanthera schimperi* (Apocynaceae)
REFERENCE: 122, 303

Chapter 3

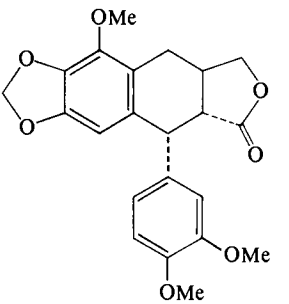
Higher Plant Lignans

$C_{21}H_{20}O_8$ 3′-Demethylpodophyllotoxin

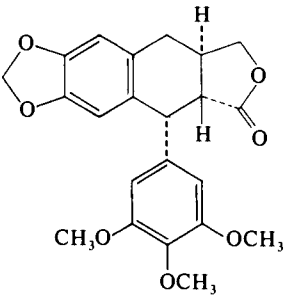


MOL. WT.: 400
BIOACTIVITY: P388: T/C, 130 (1 mg/kg)
KB: ED_{50}, 1 μg/ml
MELTING POINT: Amorphous
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Linum album* (Linaceae)
REFERENCE: 333

$C_{22}H_{22}O_7$ 5′-Desmethoxy-β-peltatin-A-methyl ether

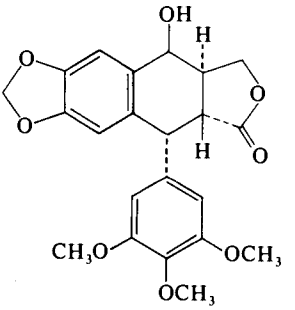


MOL. WT.: 398
BIOACTIVITY: WA: T/C, 20
MELTING POINT: 182–182.5°C
$[\alpha]_D$: −146 SOLVENT:. Chf
SPECTRAL DATA: PMR
ORGANISM: *Bursera fagaroides* (Burseraceae)
REFERENCE: 15



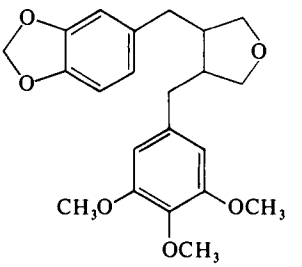
$C_{22}H_{22}O_7$ Desoxypodophyllotoxin

MOL. WT.: 398
BIOACTIVITY: KB: ED_{50}, 0.0026 μg/ml
HeLa: ED_{50}, 0.0036 μg/ml
Sarcoma 37: Sign. act.
P388: T/C, 148
MELTING POINT: 166–169°C
$[\alpha]_D$: −113.9 SOLVENT: Chf
ORGANISM: *Thujopsis dolabrata* (Cupressaceae) and *Bursera microphylla* (Burseraceae)
REFERENCE: 3, 12



$C_{22}H_{22}O_8$ Podophyllotoxin

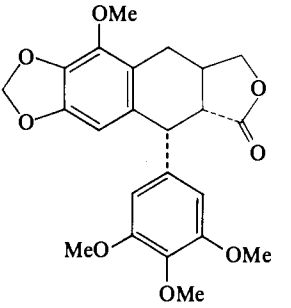
MOL. WT.: 414
BIOACTIVITY: WA: T/C, 27
PS: T/C, 171
KB: ED_{50}, <0.01 μg/ml
MELTING POINT: 114–116°C
SPECTRAL DATA: UV, IR, Mass Spec
ORGANISM: *Podophyllum peltatum* (Berberidaceae) and *Linum album* (Linaceae)
REFERENCE: 81, 333



$C_{22}H_{26}O_6$ Burseran

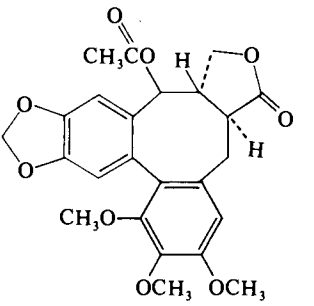
MOL. WT.: 386
BIOACTIVITY: KB: ED_{50}, 0.026 μg/ml
MELTING POINT: Oil
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Bursera microphylla* (Burseraceae)
REFERENCE: 29

$C_{23}H_{24}O_8$ β-Peltatin A-Methylether



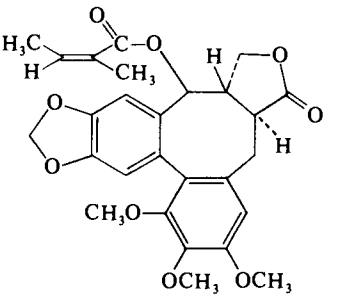
MOL. WT.: 428
BIOACTIVITY: WA: T/C, 10
MELTING POINT: 124–127°C
$[\alpha]_D$: −118 SOLVENT: Chf
SPECTRAL DATA: PMR
ORGANISM: *Bursera fagaroides* (Burseraceae)
REFERENCE: 15

$C_{24}H_{24}O_9$ Steganacin



MOL. WT.: 456
BIOACTIVITY: KB: ED_{50}, 0.1–0.001 μg/ml
P388: Sign. act.
$[\alpha]_D$: −114 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec.
ORGANISM: *Steganotaenia araliacea* (Apiaceae)
LOCATION: Ethiopia
REFERENCE: 137

$C_{27}H_{28}O_9$ Steganangin



MOL. WT.: 496
BIOACTIVITY: KB: ED_{50}, 0.1–0.001 μg/ml
P388: Sign. act.
MELTING POINT: 142.5–143°C
$[\alpha]_D$: −113 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Steganotaenia araliacea* (Apiaceae)
LOCATION: Ethiopia
REFERENCE: 137

Tannin-tri-*O*-galloyl-D-glucose

BIOACTIVITY: W256: T/C, 32
ORGANISM: *Calycogonium squamulosum* (Melastomataceae)
LOCATION: Puerto Rico
REFERENCE: 187

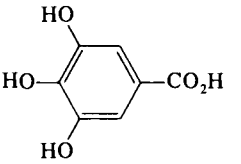
Tannin

BIOACTIVITY: Responsible for activity shown by many crude extracts especially in WM, SA, and LL (not KB)
REFERENCE: 80

Chapter 4

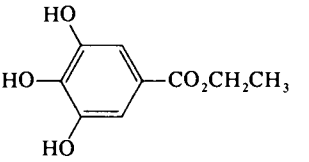
Quinones, Flavans, and Other Nonnitrogenous Higher Plant Products

$C_7H_6O_5$ Gallic acid



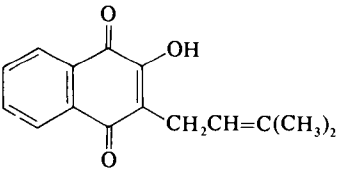
MOL. WT.: 170
BIOACTIVITY: KB: ED_{50}, 3.1 μg/ml
MELTING POINT: 158–160°C
SPECTRAL DATA: Mass Spec
ORGANISM: *Rhus trilobata* (Anacardiaceae) and *Oenothera caespitosa* (Onagraceae)
LOCATION: Utah
REFERENCE: 250, 251, 313

$C_9H_{10}O_5$ Ethyl gallate



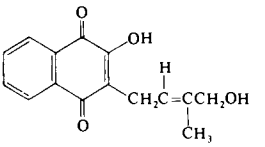
MOL. WT.: 198
BIOACTIVITY: KB: ED_{50}, 18 μg/ml
MELTING POINT: 158–160°C
SPECTRAL DATA: Mass Spec
ORGANISM: *Rhus trilobata* (Anacardiaceae)
LOCATION: Utah
REFERENCE: 250

$C_{15}H_{14}O_3$ Lapachol



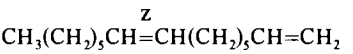
MOL. WT.: 242
BIOACTIVITY: WA: T/C, 27 (100–400 mg/kg)
MELTING POINT: 139–140°C
ORGANISM: *Stereospermum suaveoleis* (Bignoniaceae)
REFERENCE: 239, 80, 269

$C_{15}H_{14}O_4$ Lomatiol



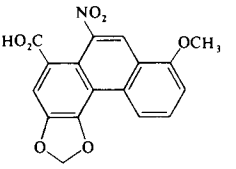
MOL. WT.: 258
BIOACTIVITY: WA: T/C, 42 (32–250 mg/kg)
MELTING POINT: 128–129°C
ORGANISM: *Lomatia* sp. (Proteaceae)
LOCATION: Australia
REFERENCE: 80, 65

$C_{15}H_{28}$ (Z)-1,-8-Pentadecadiene



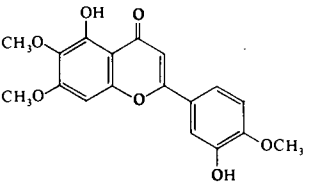
MOL. WT.: 208
BIOACTIVITY: PS: T/C, 127 (100 mg/kg)
WA: T/C, 14 (400 mg/kg)
MELTING POINT: Liquid
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Echinacea angustifolia* DC. and *E. pallida* (Nutt.) Britt. (Compositae)
LOCATION: Central and west central USA and Canada
REFERENCE: 323

$C_{17}H_{11}O_7$ Aristolochic acid



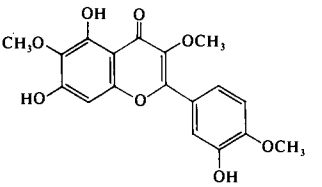
MOL. WT.: 327
BIOACTIVITY: Adenocarcinoma
755: T/C, 23 (4 mg/kg)
MELTING POINT: 281–286°C
ORGANISM: *Aristolochia indica* (Aristolochiaceae)
LOCATION: India
REFERENCE: 144

$C_{18}H_{16}O_7$ Eupatorin



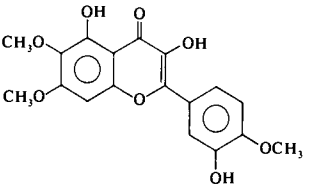
MOL. WT.: 344
BIOACTIVITY: KB: ED_{50}, 4.6 μg/ml
MELTING POINT: 196–198°C
SPECTRAL DATA: UV, PMR
ORGANISM: *Eupatorium semiserratum* DC. (Asteraceae)
LOCATION: Florida
REFERENCE: 164

$C_{18}H_{16}O_8$ Centaureidin



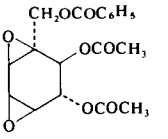
MOL. WT.: 360
BIOACTIVITY: KB: ED_{50}, 2.7 μg/ml
MELTING POINT: 200–201°C
SPECTRAL DATA: UV, PMR
ORGANISM: *Olearia muelleri* (Compositae)
LOCATION: Australia
REFERENCE: 106

$C_{18}H_{16}O_8$ Eupatin



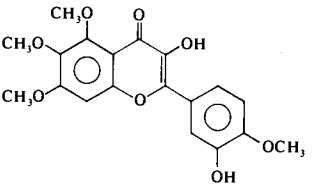
MOL. WT.: 360
BIOACTIVITY: KB: Sign. act.
MELTING POINT: 243–245°C
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Eupatorium semiserratum* (Asteraceae)
LOCATION: Florida
REFERENCE: 165

$C_{18}H_{18}O_8$ Crotepoxide



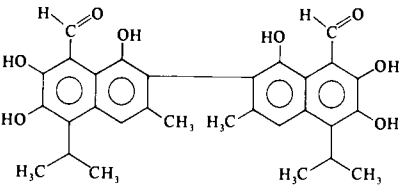
MOL. WT.: 362
BIOACTIVITY: WA: T/C, 22 (450 mg/kg)
LL: Marginally active
MELTING POINT: 150–151°C
$[\alpha]_D$: +74 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Croton macrostachys* Hochst. (Euphorbiaceae)
LOCATION: Ethiopia
REFERENCE: 152

$C_{19}H_{18}O_8$ Eupatoretin



MOL. WT.: 374
BIOACTIVITY: KB: Sign. act.
MELTING POINT: 146–148°C
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Eupatorium semiserratum* (Asteraceae)
LOCATION: Florida
REFERENCE: 165

$C_{30}H_{30}O_8$ Gossypol



MOL. WT.: 518
BIOACTIVITY: P388: T/C, 150 (10 mg/kg)
MELTING POINT: 178–180°C
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Montezuma speciosissima* (Malvaceae)
LOCATION: Puerto Rico
REFERENCE: 108

$C_{40}H_{72}O_{21}$ Ipolearoside

Glycoside of 3,11-dihydroxy-hexadecanoic acid and glucose, rhamnose and fucose

MOL. WT.: 888
BIOACTIVITY: WA256: Sign. act.
MELTING POINT: 184–187°C
$[\alpha]_D$: −50 SOLVENT: Me
ORGANISM: *Ipomoea leari* (Convolvulaceae)
LOCATION: India
REFERENCE: 270

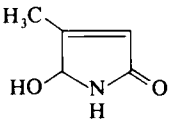
Polysaccharide fractions

BIOACTIVITY: SA: Active
ORGANISM: *Lasallia pensylvanica* and other lichens (Compositae)
REFERENCE: 217

Chapter 5

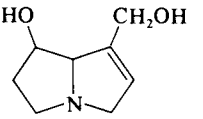
Higher Plant Alkaloids, Amides, and Ansa Macrolides

$C_5H_7NO_2$ Jatropham



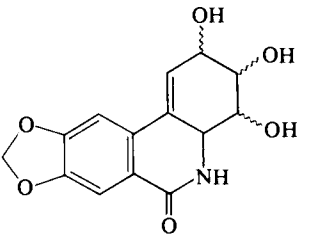
MOL. WT.: 113
BIOACTIVITY: PS: T/C, 125
MELTING POINT: 131–132°C
$[\alpha]_D$: −62 SOLVENT: Aq
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Jatropha macrorhiza* (Euphorbiaceae)
LOCATION: Arizona
REFERENCE: 334

$C_8H_{13}NO_2$ Loline



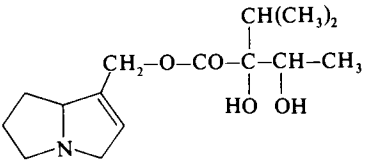
MOL. WT.: 155
BIOACTIVITY: Ehrlich carcinoma: Active
REFERENCE: 30

$C_{14}H_{13}NO_6$ Narciclasine



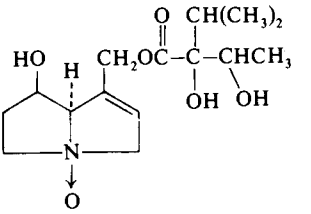
MOL. WT.: 291
ORGANISM: *Narcissus bulbus* (Amaryllidaceae)
REFERENCE: 79

$C_{15}H_{25}NO_4$ Supinine



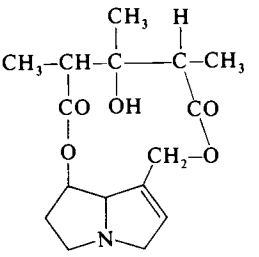
MOL. WT.: 283
BIOACTIVITY: CA: T/C, 51
MELTING POINT: 146–147.5°C
$[\alpha]_D$: −23.8 SOLVENT: Alc
REFERENCE: 33

$C_{15}H_{25}NO_6$ Indicine N-oxide



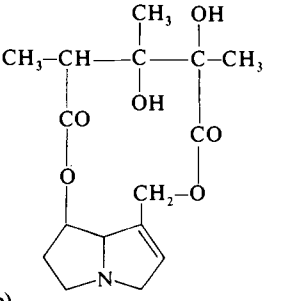
MOL. WT.: 315
BIOACTIVITY: LE: T/C, 140
PS: T/C, 200
Bl: T/C, 153
ORGANISM: *Heliotropium indicum* (Boraginaceae)
REFERENCE: 205, 337

$C_{16}H_{23}NO_5$ Fulvine



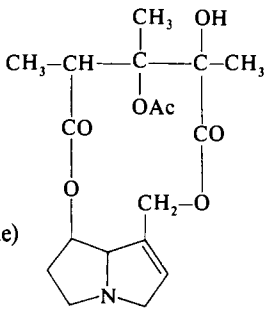
MOL. WT.: 309
BIOACTIVITY: CA: T/C, 36
WA: T/C, 26
WA: T/C, 49
MELTING POINT: 213–214°C
$[\alpha]_D$: −1.5 SOLVENT: Alc
ORGANISM: *Crotalaria spectabilis* and *C. retusa* (Leguminosae)
LOCATION: Australia, USA
REFERENCE: 33

$C_{16}H_{23}NO_6$ Monocrotaline



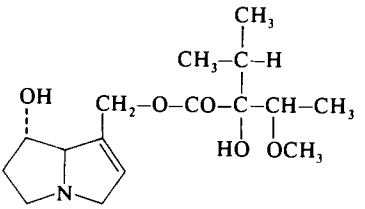
MOL. WT.: 325
BIOACTIVITY: CA: T/C, 7
LE: T/C, 136
SA: T/C, 33
WA: T/C, 0
MELTING POINT: 202–203°C
$[\alpha]_D$: −55 SOLVENT: Alc
ORGANISM: *Crotalaria spectabilis* and *C. retusa* (Leguminosae)
LOCATION: Australia, USA
REFERENCE: 33

$C_{16}H_{25}NO_7$ Spectabiline



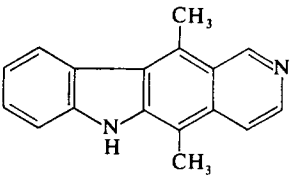
MOL. WT.: 343
BIOACTIVITY: CA: T/C, 18
WA: T/C, 4
MELTING POINT: 185.5–186°C
$[\alpha]_D$: +121 SOLVENT: Chf
ORGANISM: *Crotalaria spectabilis* and *C. retusa* (Leguminosae)
LOCATION: Australia, USA
REFERENCE: 33

$C_{16}H_{27}NO_5$ Heliotrine



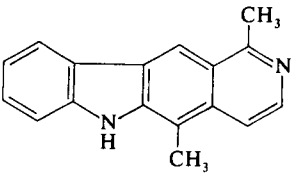
MOL. WT.: 313
BIOACTIVITY: CA: T/C, 45
WA: T/C, 0
MELTING POINT: 128°C
$[\alpha]_D$: +54.2 SOLVENT: Chf
REFERENCE: 33

$C_{17}H_{14}N_2$ Ellipticine



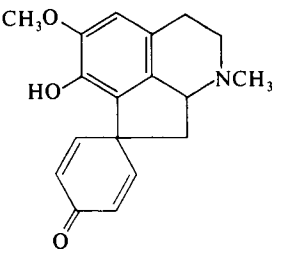
MOL. WT.: 246
BIOACTIVITY: LE: T/C, 172
PS: T/C, 204
B1: T/C, 142
LL: T/C, 129
MELTING POINT: 315–317°C
SPECTRAL DATA: UV, PMR
ORGANISM: *Ochrosia moorei* and *Excavatia coccinea* (Apocynaceae)
LOCATION: Australia
REFERENCE: 38, 337

$C_{17}H_{14}N_2$ Olivacine



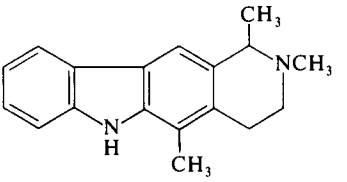
MOL. WT.: 246
BIOACTIVITY: SA: T/C, 42 (25–300 mg/kg)
LE: T/C, 151 (25–250 mg/kg)
MELTING POINT: 312–324°C
ORGANISM: *Aspidosperma* sp. (Apocynaceae)
REFERENCE: 71, 80

$C_{18}H_{19}NO_3$ Glaziovine



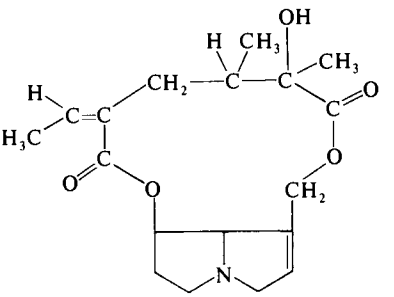
MOL. WT.: 297
BIOACTIVITY: KB: ED_{50}, 2.6 μg/ml
MELTING POINT: 235–237°C
SPECTRAL DATA: UV
ORGANISM: *Annona purpurea* L. (Annonaceae)
LOCATION: Puerto Rico
REFERENCE: 282

$C_{18}H_{20}N_2$ *d*-Guatambuine



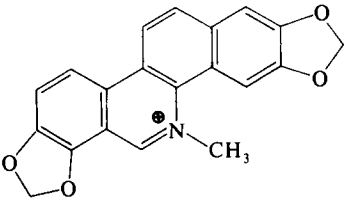
MOL. WT.: 264
BIOACTIVITY: LE: T/C, 145
MELTING POINT: 249–252°C
$[\alpha]_D$: +112 SOLVENT: Chf
ORGANISM: *Aspidosperma* sp. (Apocynaceae)
REFERENCE: 80, 71

$C_{18}H_{25}NO_5$ Senecionine



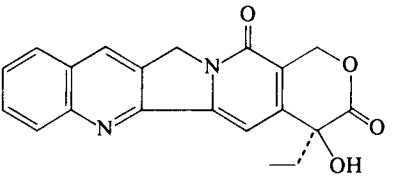
MOL. WT.: 335
BIOACTIVITY: WA: T/C, 40
MELTING POINT: 249°C
$[\alpha]_D$: −51 SOLVENT: Chf
ORGANISM: *Senecio magnificus* (Compositae)
REFERENCE: 80, 32

$C_{20}H_{14}NO_4$ Sanguinarine



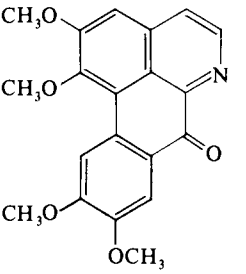
MOL. WT.: 332
BIOACTIVITY: Antitumor act.
ORGANISM: *Chelidonium majus* (Papaveraceae)
REFERENCE: 80, 30

$C_{20}H_{16}N_2O_4$ Camptothecin



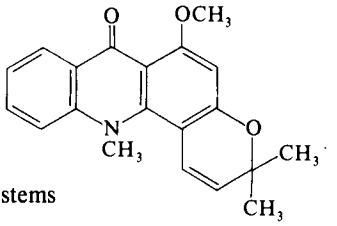
MOL. WT.: 348
BIOACTIVITY: LE: T/C, 200 (0.25–1 mg/kg)
KB: ED_{50}, 0.07 μg/ml
WA: T/C, 0
MELTING POINT: 264–267°C (dec)
$[\alpha]_D$: +31.3 SOLVENT: Chf–Me, 8–2
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Camptotheca acuminata* (Nyssaceae)
LOCATION: China
REFERENCE: 326

$C_{20}H_{17}NO_4$ *O*-Methyl-atheroline



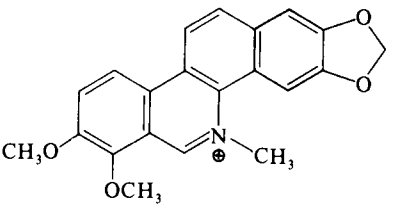
MOL. WT.: 335
BIOACTIVITY: KB: ED_{50}, 5.1 μg/ml
MELTING POINT: 225–227°C
SPECTRAL DATA: UV
ORGANISM: *Annona purpurea* L. (Annonaceae)
LOCATION: Puerto Rico
REFERENCE: 282

$C_{20}H_{19}NO_3$ Acronycine



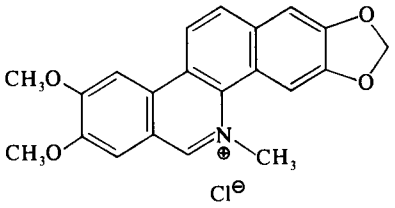
MOL. WT.: 321
BIOACTIVITY: Sign. act. against 12 experimental tumor systems
MELTING POINT: 176–178°C
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Acronychia bauert* Schott. (Rutaceae)
LOCATION: Australia
REFERENCE: 295, 189, 10

$C_{21}H_{18}ClNO_4$ Chelerythrine



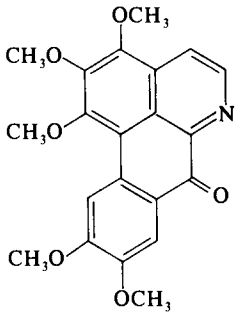
MOL. WT.: 383
BIOACTIVITY: Cytotoxic
ORGANISM: *Chelidonium majus* (Papaveraceae)
REFERENCE: 30

$C_{21}H_{18}ClNO_4$ Nitidine chloride



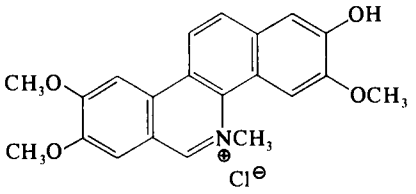
MOL. WT.: 383
BIOACTIVITY: LE: T/C, 134
PS: T/C, 197
MELTING POINT: 277–278°C
ORGANISM: *Zanthoxylum nitidum* (Rutaceae)
LOCATION: India
REFERENCE: 75, 8, 74, 126, 337

$C_{21}H_{19}NO_6$ Oxopurpureine



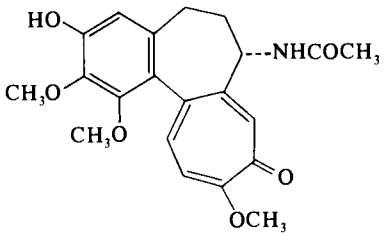
MOL. WT.: 381
BIOACTIVITY: KB: ED_{50}, 5.8 μg/ml
MELTING POINT: 198–202°C (dec)
SPECTRAL DATA: UV, PMR
ORGANISM: *Annona purpurea* L. (Annonaceae)
LOCATION: Puerto Rico
REFERENCE: 282

$C_{21}H_{20}ClNO_4$ Fagaronine



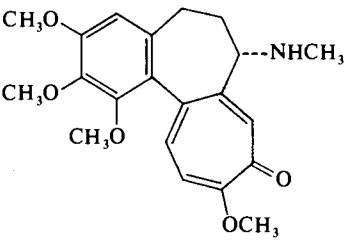
MOL. WT.: 385
BIOACTIVITY: PS: T/C, 265 (100 mg/kg)
MELTING POINT: 202°C and 255°C
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Fagara zanthoxyloides* (Rutaceae)
LOCATION: Ghana
REFERENCE: 208, 304

$C_{21}H_{23}NO_6$ 3-Desmethylcolchicine



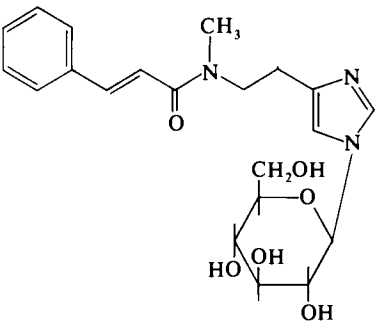
MOL. WT.: 385
BIOACTIVITY: KB: ED_{50}, 0.024 μg/ml
LE: Sign. act.
MELTING POINT: 178–180°C
$[\alpha]_D$: −130 SOLVENT: Chf
SPECTRAL DATA: PMR, Mass Spec
ORGANISM: *Colchicum speciosum* (Liliaceae)
LOCATION: Holland
REFERENCE: 135

$C_{21}H_{25}NO_5$ Demecolcine



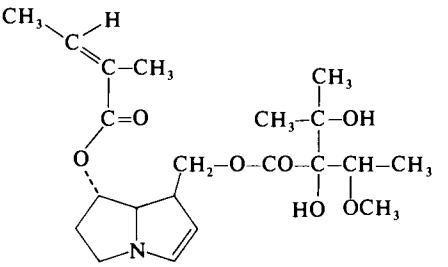
MOL. WT.: 371
BIOACTIVITY: KB, PS: Active
MELTING POINT: 186°C
$[\alpha]_D$: −129 SOLVENT: Chf
ORGANISM: *Colchicum speciosum* (Liliaceae)
LOCATION: Holland
REFERENCE: 135

$C_{21}H_{27}N_3O_6$ Casimiroedine



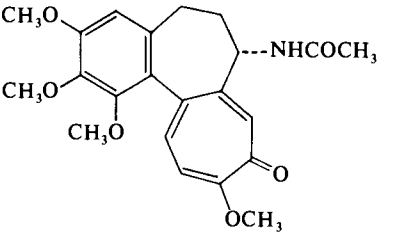
MOL. WT.: 417
BIOACTIVITY: LE: T/C, 138
MELTING POINT: 223–224°C
$[\alpha]_D$: −30.7 SOLVENT: 1% HCl
SPECTRAL DATA: PMR, Mass Spec
ORGANISM: *Casimiroa edulis* (Rutaceae)
LOCATION: Mexico
REFERENCE: 226

$C_{21}H_{33}NO_7$ Lasiocarpine



MOL. WT.: 411
BIOACTIVITY: WM: T/C, 18
WA: T/C, 32
MELTING POINT: 96.5–97°C
$[\alpha]_D$: −3.0 SOLVENT: Alc
REFERENCE: 33

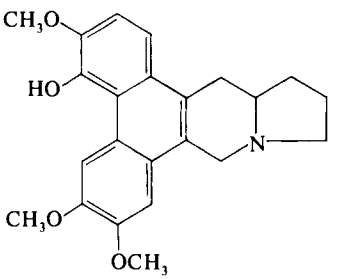
$C_{22}H_{25}NO_6$ Colchicine



MOL. WT.: 399
BIOACTIVITY: PS, KB: Active
MELTING POINT: 152–153°C
$[\alpha]_D$: −121 SOLVENT: Chf
ORGANISM: *Colchicum speciosum* (Liliaceae)
LOCATION: Holland
REFERENCE: 135

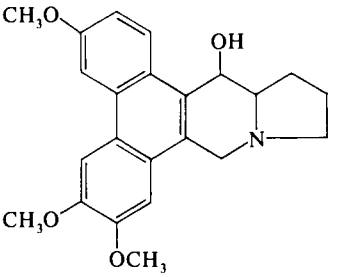
$C_{23}H_{25}NO_4$ Compound B

MOL. WT.: 379
BIOACTIVITY: CA: T/C, 38
WA: T/C, 30
ORGANISM: *Tylophora crebriflora* (Asclepiadaceae)
REFERENCE: 76



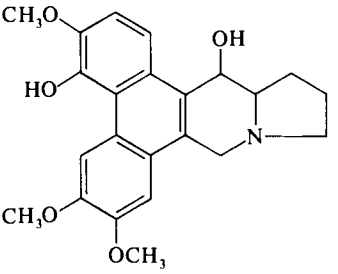
$C_{23}H_{25}NO_4$ Tylophorinine

MOL. WT.: 379
BIOACTIVITY: LE: T/C, 130
MELTING POINT: 248–249°C
$[\alpha]_D$: −14.2 SOLVENT: Chf
SPECTRAL DATA: UV
ORGANISM: *Tylophora asthmatica* (Asclepiadaceae)
REFERENCE: 80, 76



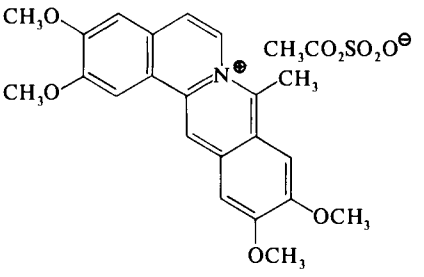
$C_{23}H_{25}NO_5$ Compound C

MOL. WT.: 395
BIOACTIVITY: SA: T/C, 18
CA: T/C, 31
WA: T/C, 40
ORGANISM: *Tylophora crebriflora* (Asclepiadaceae)
REFERENCE: 80, 76

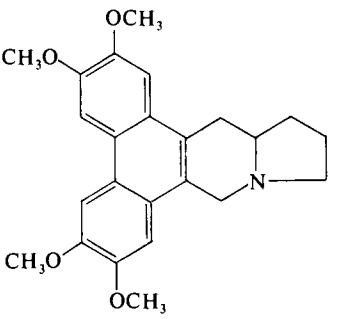


$C_{23}H_{25}NO_9S$ Coralyne sulfoacetate

MOL. WT.: 491
BIOACTIVITY: LE: T/C, 130 (200 mg/kg)
PS: T/C, 195 (400 mg/kg)
MELTING POINT: dp 278–280°C
Chloride, dp 250–252°C
REFERENCE: 343, 337

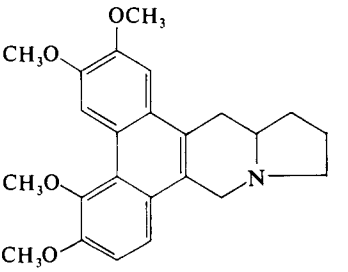


$C_{24}H_{27}NO_4$ Tylophorine



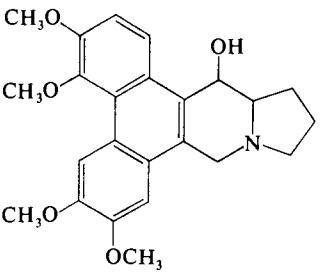
MOL. WT.: 393
BIOACTIVITY: LE: T/C, 150
MELTING POINT: 286–287°C
$[\alpha]_D$: −11.6 SOLVENT: Chf
SPECTRAL DATA: UV
ORGANISM: *Tylophora crebriflora* (Asclepiadaceae)
REFERENCE: 76

$C_{24}H_{27}NO_4$ Tylocrebrine



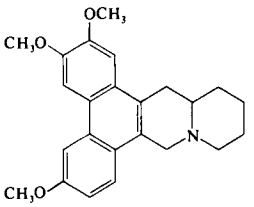
MOL. WT.: 393
BIOACTIVITY: CA: T/C, 21
WA: T/C, 41
PS: T/C, 170
LE: T/C, 168 (10 mg/kg)
MELTING POINT: 218–220°C
$[\alpha]_D$: +20.5 SOLVENT: Chf
SPECTRAL DATA: UV
ORGANISM: *Tylophora crebriflora* (Asclepiadaceae)
REFERENCE: 80, 68

$C_{24}H_{27}NO_5$ Compound A



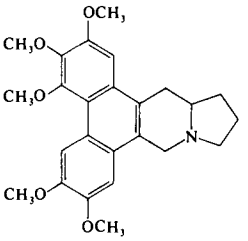
MOL. WT.: 409
BIOACTIVITY: SA: T/C, 10
CA: T/C, 19
WA: T/C, 25
LE: T/C, 140
P4: T/C, 140
MELTING POINT: 213–215°C
ORGANISM: *Tylophora crebriflora* (Asclepiadaceae)
REFERENCE: 80, 76

$C_{24}H_{29}NO_3$ Cryptopleurine



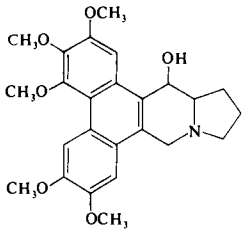
MOL. WT.: 379
BIOACTIVITY: KB: ED_{50}, 0.00078 μg/ml
MELTING POINT: 195–197°C
$[\alpha]_D$: −64 SOLVENT: Chf
ORGANISM: *Boehmeria cylindrica* (Urticaceae)
LOCATION: Australia
REFERENCE: 57

$C_{25}H_{29}NO_5$ Compound E



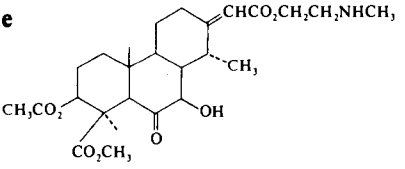
MOL. WT.: 423
BIOACTIVITY: WA: T/C, 35
ORGANISM: *Tylophora crebriflora* (Asclepiadaceae)
REFERENCE: 80, 76

$C_{25}H_{29}NO_6$ Compound D



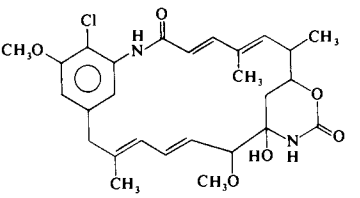
MOL. WT.: 439
BIOACTIVITY: LE: T/C, 145
ORGANISM: *Tylophora crebriflora* (Asclepiadaceae)
REFERENCE: 80, 76

$C_{26}H_{38}NO_8$ 3β-Acetoxynorerythrosuamine



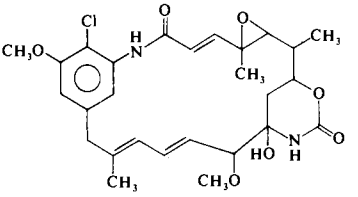
MOL. WT.: 492
BIOACTIVITY: KB: ED_{50}, 0.0003 μg/ml
MELTING POINT: 173–175°C, hydrochloride
SPECTRAL DATA: PMR
ORGANISM: *Erythrophleum chlorostachys* (Leguminosae)
REFERENCE: 184

$C_{27}H_{33}ClN_2O_6$ Maysenine



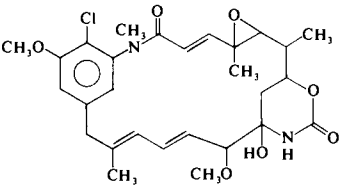
MOL. WT.: 516
BIOACTIVITY: KB: ED_{50}, 10^{-2} μg/ml
PS: Active
MELTING POINT: 184–185°C
$[\alpha]_D$: −57 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Maytenus buchananii* (Celastraceae)
LOCATION: Kenya
REFERENCE: 156

$C_{27}H_{33}ClN_2O_7$ Normaysine



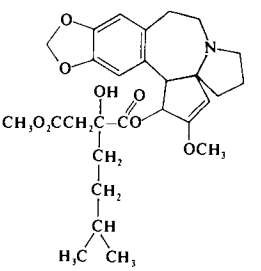
MOL. WT.: 532
BIOACTIVITY: KB: ED_{50}, 0.01 μg/ml
MELTING POINT: 187–188°C
$[\alpha]_D$: −217 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Maytenus buchananii* (Celastraceae)
LOCATION: Kenya
REFERENCE: 156

$C_{28}H_{35}ClN_2O_7$ Maysine



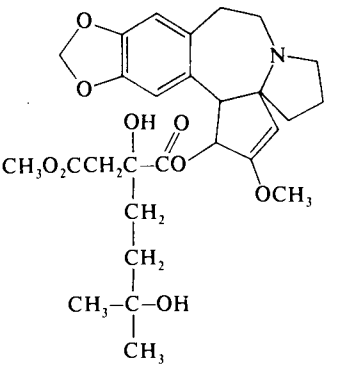
MOL. WT.: 546
BIOACTIVITY: KB: ED_{50}, 0.01 μg/ml
MELTING POINT: 137–141°C
$[\alpha]_D$: −173 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Maytenus buchananii* (Celastraceae)
LOCATION: Kenya
REFERENCE: 156

$C_{28}H_{37}NO_8$ Deoxyharringtonine



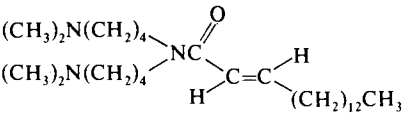
MOL. WT.: 515
BIOACTIVITY: PS, LE: Sign. act.
MELTING POINT: Amorphous
$[\alpha]_D$: −119 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Cephalotaxus harringtonia cv.* (Taxaceae)
REFERENCE: 210, 255

$C_{28}H_{37}NO_9$ Harringtonine



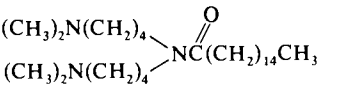
MOL. WT.: 531
BIOACTIVITY: PS: T/C, 294–405 (0.5–1 mg/kg)
LE: T/C, 137 (2 mg/kg)
MELTING POINT: Amorphous solid
$[\alpha]_D$: −106 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Cephalotaxus harringtonia* (Taxaceae)
REFERENCE: 255

$C_{28}H_{57}N_3O$ Solapalmitenine



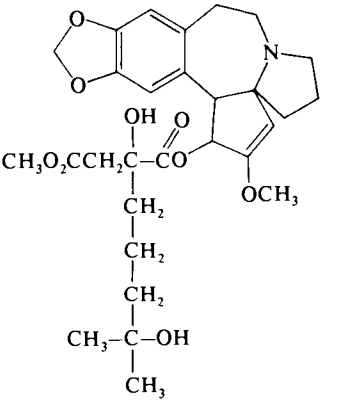
MOL. WT.: 451
BIOACTIVITY: KB: ED_{50}, 0.15 μg/ml
MELTING POINT: bp 153°C (0.08 mm)
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Solanum tripartitum* Dunal. (Solanaceae)
LOCATION: Bolivia
REFERENCE: 141

$C_{28}H_{59}N_3O$ Solapalmitine



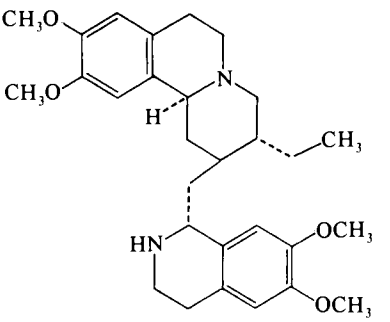
MOL. WT.: 453
BIOACTIVITY: KB: ED_{50}, 0.22 μg/ml
MELTING POINT: bp 150°C (0.05 mm)
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Solanum tripartitum* Dunal. (Solanaceae)
LOCATION: Bolivia
REFERENCE: 141

$C_{29}H_{39}NO_9$ Homoharringtonine



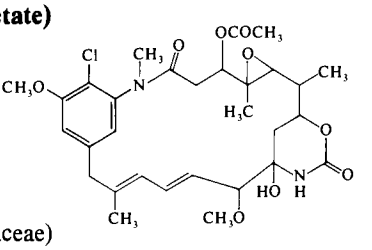
MOL. WT.: 545
BIOACTIVITY: PS: T/C, 244–338 (0.25–1 mg/kg)
LE: T/C, 142 (1 mg/kg)
MELTING POINT: Amorphous solid
$[\alpha]_D$: −119 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Cephalotaxus harringtonia* (Taxaceae)
REFERENCE: 255

$C_{29}H_{40}N_2O_4$ Emetine



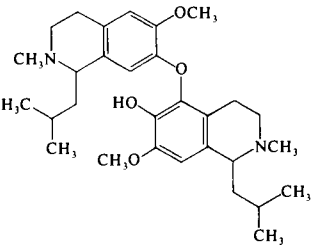
MOL. WT.: 480
BIOACTIVITY: LE: T/C, 140
PS: T/C, 200
MELTING POINT: 243–245°C, hydrobromide
$[\alpha]_D$: −49.2 SOLVENT: Chf
ORGANISM: *Cephaelis ipecacuanha* (Rubiaceae)
REFERENCE: 235, 280, 213

$C_{30}H_{39}ClN_2O_9$ Maytanacine (Maytansine acetate)



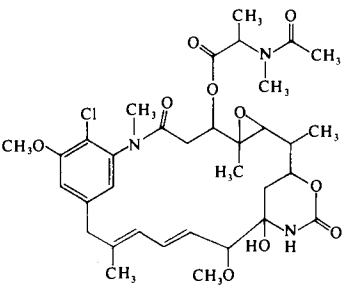
MOL. WT.: 605
BIOACTIVITY: PS: T/C, 230 (100 mg/kg)
MELTING POINT: 234–237°C
$[\alpha]_D$: −119 SOLVENT: Chf
SPECTRAL DATA: UV, IR, Mass Spec
ORGANISM: *Putterlickia verrucosa* Szyszyl. (Celastraceae)
REFERENCE: 134

$C_{30}H_{44}N_2O_4$ Pilocereine



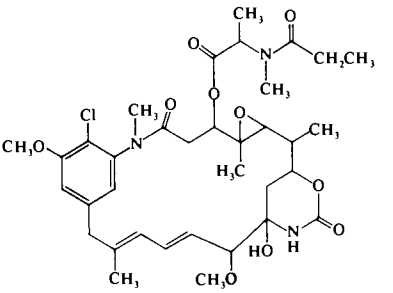
MOL. WT.: 496
BIOACTIVITY: KB: ED_{50}, 0.26 μg/ml
MELTING POINT: 168–170°C
ORGANISM: *Lophocereus schotti* (Cactaceae)
REFERENCE: 80, 49

$C_{34}H_{46}ClN_3O_{10}$ Maytansine



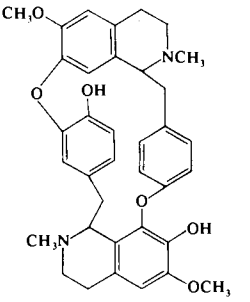
MOL. WT.: 691
BIOACTIVITY: Activity against Sarcoma 180, LL, LE, PS, WA, KB
MELTING POINT: 171–172°C
$[\alpha]_D$: −145 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Maytenus ovatus* Loes. (Celastraceae)
LOCATION: Ethiopia
REFERENCE: 157

$C_{35}H_{48}ClN_3O_{10}$ Maytanprine



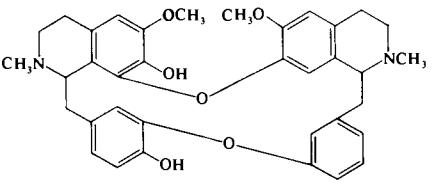
MOL. WT.: 705
BIOACTIVITY: PS: Sign. act. at μg/kg dose levels
MELTING POINT: 169–170°C
$[\alpha]_D$: −125 SOLVENT: Chf
SPECTRAL DATA: PMR, Mass Spec
ORGANISM: *Maytenus buchananii* (Celastraceae)
LOCATION: Ethiopia
REFERENCE: 157a

$C_{36}H_{38}N_2O_6$ L-Curine



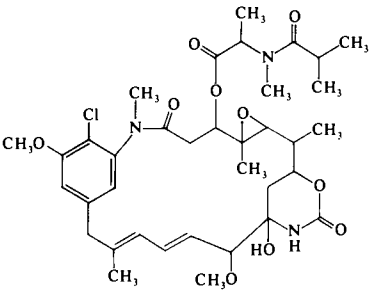
MOL. WT.: 594
BIOACTIVITY: KB: ED_{50}, <0.14 μg/ml
REFERENCE: 80, 34
ORGANISM: *Aristolochia* sp.

$C_{36}H_{38}N_2O_6$ Obamegin



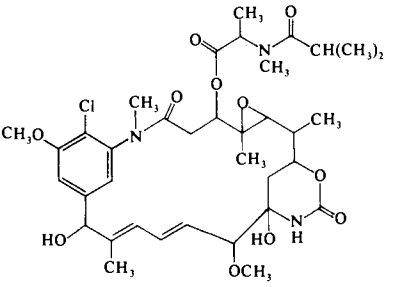
MOL. WT.: 594
BIOACTIVITY: KB: ED_{50}, 4.1 μg/ml
MELTING POINT: 171–173°C
ORGANISM: *Berberis tschonoskyana* (Berberidaceae)
REFERENCE: 80, 34

$C_{36}H_{50}ClN_3O_{10}$ Maytanbutine



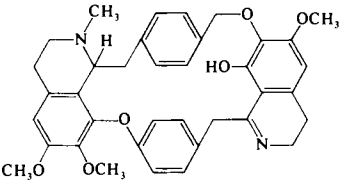
MOL. WT.: 719
BIOACTIVITY: PS: Sign. act. at μg/kg dose levels
MELTING POINT: 170–171°C
$[\alpha]_D$: −122 SOLVENT: Chf
SPECTRAL DATA: PMR, Mass Spec
ORGANISM: *Maytenus buchananii* (Celastraceae)
LOCATION: Ethiopia
REFERENCE: 157a

$C_{36}H_{50}ClN_3O_{11}$ Colubrinol



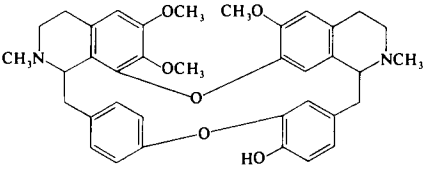
MOL. WT.: 735
BIOACTIVITY: KB: ED_{50}, 10^{-5} μg/ml
PS: Sign. act.
MELTING POINT: 194–196°C
$[\alpha]_D$: −94 SOLVENT: Chf
ORGANISM: *Colubrina texensis* (Rhamnaceae)
REFERENCE: 328

$C_{37}H_{38}N_2O_6$ Cissampareine



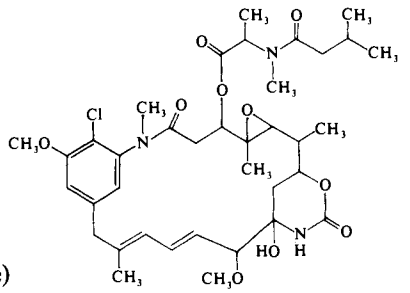
MOL. WT.: 606
BIOACTIVITY: KB: ED_{50}, 2.0 μg/ml
MELTING POINT: 239–240°C
$[\alpha]_D$: −111 SOLVENT: Chf
ORGANISM: *Cissampelos pareira* L. (Menispermaceae)
REFERENCE: 158

$C_{37}H_{40}N_2O_6$ Oxyacanthine



MOL. WT.: 608
BIOACTIVITY: KB: ED_{50}, 0.76 μg/ml
MELTING POINT: 206–208°C
ORGANISM: *Berberis tschonoskyana* (Berberidaceae)
REFERENCE: 80, 34

$C_{37}H_{52}ClN_3O_{10}$ Maytanvaline

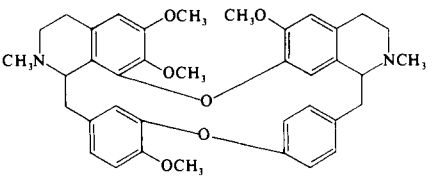


MOL. WT.: 733
BIOACTIVITY: KB: ED_{50}, 10^{-5} μg/ml
PS: Sign. act.
MELTING POINT: 175–176.5°C
$[\alpha]_D$: −135 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Maytenus buchananii* (Celastraceae)
LOCATION: Kenya
REFERENCE: 156

$C_{38}H_{42}N_2O_6$ Isotetrandine

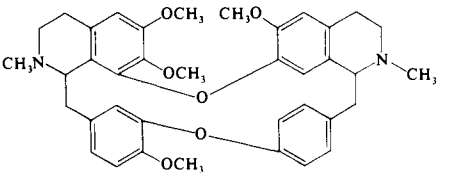
MOL. WT.: 622
BIOACTIVITY: KB: ED_{50}, 1.5 μg/ml
MELTING POINT: 179–181°C
ORGANISM: *Berberis morrisonensis* (Berberidaceae)
REFERENCE: 80, 16

$C_{38}H_{42}N_2O_6$ L-Tetrandrine (Pheanthine)



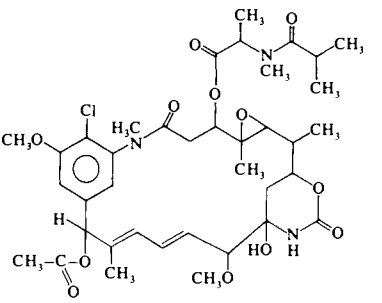
MOL. WT.: 622
BIOACTIVITY: WA: T/C, 25 (25–400 mg/kg)
REFERENCE: 80, 34
ORGANISM: *Menispermaceae* sp.

$C_{38}H_{42}N_2O_6$ D-Tetrandrine



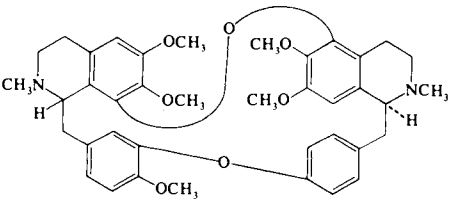
MOL. WT.: 622
BIOACTIVITY: WA: T/C, 40
KB: ED_{50}, 0.17 μg/ml
MELTING POINT: 245–246°C
ORGANISM: *Cyclea peltata* (Menispermaceae)
REFERENCE: 80, 174

$C_{38}H_{52}ClN_3O_{12}$ Colubrinol acetate



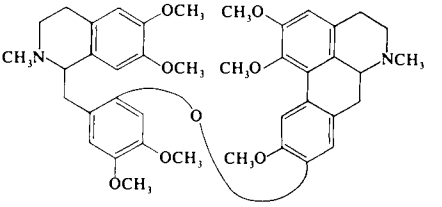
MOL. WT.: 777
BIOACTIVITY: KB: ED_{50}, 10^{-5} μg/ml
P388: Sign. act.
MELTING POINT: 179–182°C
$[\alpha]_D$: −127 SOLVENT: Chf
ORGANISM: *Colubrina texensis* (Rhamnaceae)
REFERENCE: 328

$C_{39}H_{44}N_2O_7$ Thalidasine

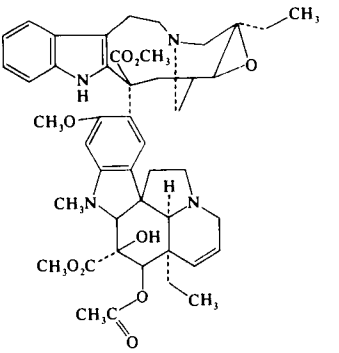


MOL. WT.: 652
BIOACTIVITY: WA: T/C, 20
KB: ED_{50}, 12 μg/ml
MELTING POINT: 105–107°C
$[\alpha]_D$: −70 SOLVENT: Me
SPECTRAL DATA: UV, PMR, Mass Spec
ORGANISM: *Thalictrum dasycarpum* Fisch. and Lall. (Ranunculaceae)
REFERENCE: 80, 173

$C_{41}H_{48}N_2O_8$ Thalicarpine

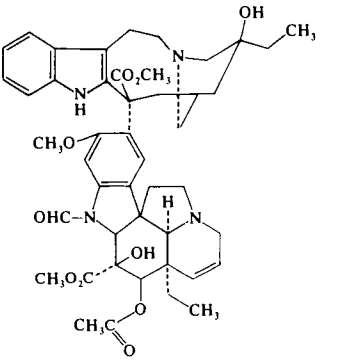


MOL. WT.: 696
BIOACTIVITY: WA: T/C, 10 (40–320 mg/kg)
KB: ED_{50}, 2.1 μg/ml
MELTING POINT: 160–161°C
ORGANISM: *Thalictrum dasycarpum* (Ranunculaceae)
REFERENCE: 80, 34



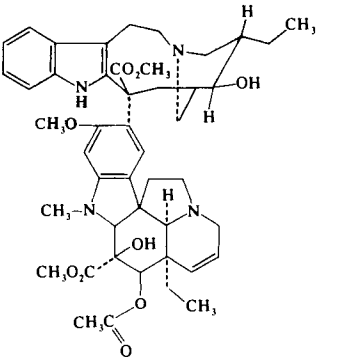
$C_{46}H_{56}N_4O_9$ Vinleurosine (Leurosine)

MOL. WT.: 810
BIOACTIVITY: Active in Erlich ascites carcinoma and Freund ascites
MELTING POINT: 202–205°C
$[\alpha]_D$: +72 SOLVENT: Chf
ORGANISM: *Vinca rosea* L. (*Catharanthus roseus*) (Apocynaceae)
LOCATION: Western hemisphere, Madagascar
REFERENCE: 56, 294, 107



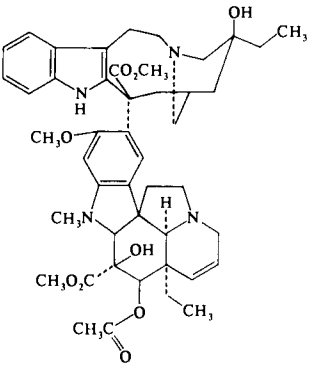
$C_{46}H_{56}N_4O_{10}$ Vincristine (Leurocristine)

MOL. WT.: 824
BIOACTIVITY: LE: T/C, 147
PS: T/C, 242
Bl: T/C, 189
Active against P1534 leukemia, Ridgeway osteogenic sarcoma, SA
In clinical use
ORGANISM: *Vinca rosea* L. (*Catharanthus roseus*) (Apocynaceae)
LOCATION: Western hemisphere area, Madagascar
REFERENCE: 337, 293, 216, 294



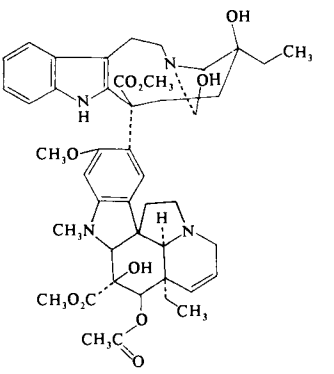
$C_{46}H_{58}N_4O_9$ Vinrosidine (Leurosidine)

MOL. WT.: 810
BIOACTIVITY: Active against P1534 leukemia, Ridgeway osteogenic sarcoma
ORGANISM: *Vinca rosea* L. (*Catharanthus roseus*) (Apocynaceae)
LOCATION: Western hemisphere area, Madagascar
REFERENCE: 294, 216, 107



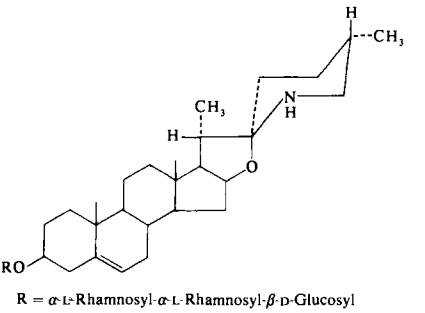
$C_{46}H_{58}N_4O_9$ Vinblastine (Vincaleukoblastine)

MOL. WT.: 810
BIOACTIVITY: LE: T/C, 140
PS: T/C, 212
Bl: T/C, 220
Active in P1534 leukemia, Erlich ascites carcinoma, Freund ascites, SA
In clinical use
MELTING POINT: 211–216°C
$[\alpha]_D$: +42 SOLVENT: Chf
ORGANISM: *Vinca rosea* L. (*Catharanthus roseus*) (Apocynaceae)
LOCATION: Western hemisphere, Madagascar
REFERENCE: 37, 36, 35, 216, 219, 294



$C_{46}H_{58}N_4O_{10}$ Leurocolombine

MOL. WT.: 826
BIOACTIVITY: RO: Active
SPECTRAL DATA: UV, Mass Spec
ORGANISM: *Vinca rosea* L. (Apocynaceae)
REFERENCE: 296



R = α-L-Rhamnosyl-α-L-Rhamnosyl-β-D-Glucosyl

$C_{47}H_{78}NO_{15}$ β-Solamarine

MOL. WT.: 896
BIOACTIVITY: SA: Active
ORGANISM: *Solanum dulcamara* L. (Solanaceae)
REFERENCE: 19, 128

Proteinaceous substances

BIOACTIVITY: 5WM: T/C, 3 (33 mg/kg); T/C, 28 (100 mg/kg)
ORGANISM: *Caesalpinia gilleisii* (Caesalpinioideae)
LOCATION: Arizona
REFERENCE: 315

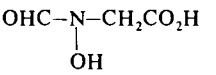
Proteinaceous material: Compound A

BIOACTIVITY: SA: T/C, 11 (10 mg/kg)
WA: T/C, 39 (45 mg/kg)
3LL: T/C, 22 (12 mg/kg)
ORGANISM: *Mirabilis multiflora* (Nyctaginaceae)
LOCATION: Arizona
REFERENCE: 314

Chapter 6

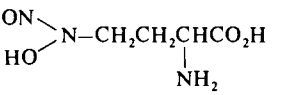
Fungi and Other Lower Plant Biosynthetic Products

$C_3H_5NO_4$ **Hadacidin**



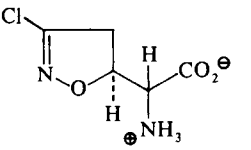
MOL. WT.: 119
BIOACTIVITY: Anticancer
ORGANISM: *Penicillium* sp. (Moniliaceae)
REFERENCE: 110, 283

$C_3H_7N_3O_4$ **L(−)-Alanosine**



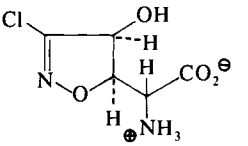
MOL. WT.: 149
BIOACTIVITY: LE: T/C, 182
PS: T/C, 181
MELTING POINT: 190°C
$[\alpha]_D$: −37.8 SOLVENT: Aq
SPECTRAL DATA: UV
ORGANISM: *Streptomyces alanosinicus* (Streptomycetaceae)
REFERENCE: 181, 22, 337

$C_5H_7ClN_2O_3$ **(αS,5S)-α-Amino-3-chloro-4,5-dihydro-5-isoxazoleacetic acid**



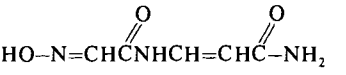
MOL. WT.: 178
BIOACTIVITY: L1210: Sign. act.
Clinical candidate
ORGANISM: *Streptomyces sviceus* (Streptomycetaceae)
REFERENCE: 201, 200

$C_5H_7ClN_2O_4$ **(αS,4S,5R)-α-Amino-3-chloro-4-hydroxy-4,5-dihydro-5-isoxazoleacetic acid**



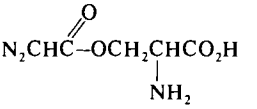
MOL. WT.: 194
BIOACTIVITY: L1210: Sign. act.
MELTING POINT: 165°C (dec)
ORGANISM: *Streptomyces sviceus* (Streptomycetaceae)
REFERENCE: 202, 200

$C_5H_7N_3O_3$



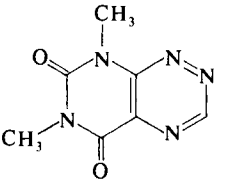
MOL. WT.: 157
BIOACTIVITY: Anticancer
MELTING POINT: dp 210°C
SPECTRAL DATA: UV, PMR
ORGANISM: *Streptomyces achromogenes* (Streptomycetaceae)
REFERENCE: 336

$C_5H_7N_3O_4$ **Azaserine**



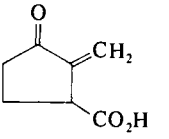
MOL. WT.: 173
BIOACTIVITY: LE: T/C, 142 (54 mg/kg)
SA: Active
REFERENCE: 285, 73

$C_7H_7N_5O_2$ **Fervenulin**



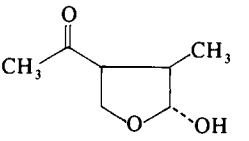
MOL. WT.: 193
BIOACTIVITY: Antitumor act.
MELTING POINT: 178–179°C (dec)
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces fervens* (Streptomycetaceae)
REFERENCE: 53, 41

$C_7H_8O_3$ **Sarkomycin**



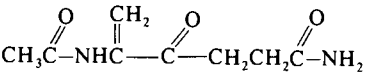
MOL. WT.: 140
BIOACTIVITY: EA: Active
$[\alpha]_D$: −32.5 SOLVENT: Me
REFERENCE: 320, 339

$C_7H_{13}O_3$ Botryodiplodin



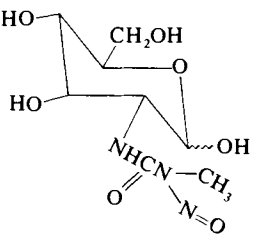
MOL. WT.: 145
BIOACTIVITY: Anti-leukemic
MELTING POINT: bp111–113°C (4 mm)
REFERENCE: 192

$C_8H_{12}N_2O_3$ Primocarcin



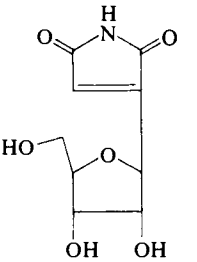
MOL. WT.: 184
BIOACTIVITY: Anticancer
MELTING POINT: Dihydro. 137–141°C
SPECTRAL DATA: UV, IR
REFERENCE: 103, 292

$C_8H_{15}N_3O_7$ Streptozotocin



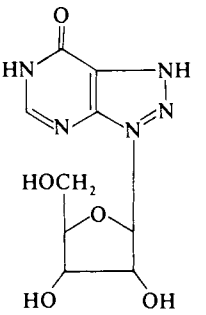
MOL. WT.: 265
BIOACTIVITY: LE: T/C, 160
PS: T/C, 154
In clinical use
MELTING POINT: 115–115.5°C
ORGANISM: *Streptomyces achromogenes* (Streptomycetaceae)
REFERENCE: 97, 337

$C_9H_{11}NO_6$ Showdomycin



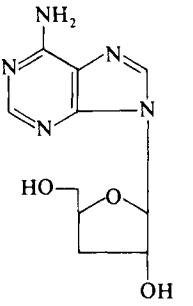
MOL. WT.: 229
BIOACTIVITY: EA: Active
MELTING POINT: 153–154°C
$[\alpha]_D$: +49.9 SOLVENT: Aq
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Streptomyces showdoensis* (Streptomycetaceae)
REFERENCE: 218, 40, 316

$C_{10}H_{12}N_4O_5$ Formycin B



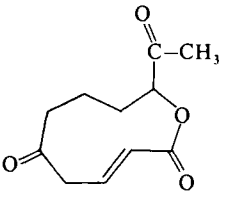
MOL. WT.: 268
BIOACTIVITY: Antitumor act.
MELTING POINT: 245–249°C
SPECTRAL DATA: UV
REFERENCE: 1

$C_{10}H_{12}N_5O_3$ Cordycepin



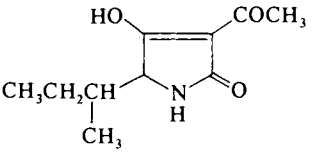
MOL. WT.: 250
BIOACTIVITY: Antitumor
ORGANISM: *Cordyceps militaris* (Linn.) Link (Hypocreaceae)
REFERENCE: 125, 316

$C_{10}H_{12}O_4$ Vermiculine



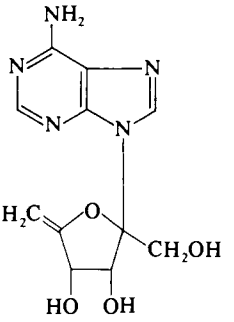
MOL. WT.: 196
BIOACTIVITY: HeLa: ED_{50}, 1.8 μg/ml
EA, Sarcoma 37: Sign. act.
ORGANISM: *Penicillium vermiculatum* (Moniliaceae)
REFERENCE: 63

$C_{10}H_{15}NO_3$ Tenuazonic acid



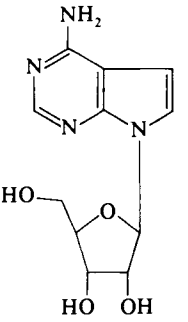
MOL. WT.: 197
BIOACTIVITY: Human adenocarcinoma: Sign. act.
MELTING POINT: bp ~117°C
$[\alpha]_D$: −136 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Alternaria tenuis* Auct.
REFERENCE: 52

$C_{11}H_{13}N_5O_4$ Angustmycin A (decoyinine)



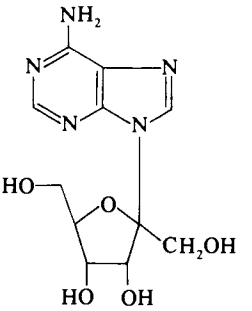
MOL. WT.: 279
BIOACTIVITY: Sign. antitumor act.
MELTING POINT: 130–133°C
$[\alpha]_D$: +43.5 SOLVENT: Aq
SPECTRAL DATA: UV
REFERENCE: 191

$C_{11}H_{14}N_4O_4$ Tubercidin



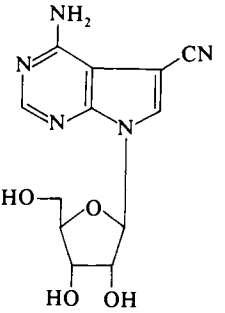
MOL. WT.: 266
BIOACTIVITY: Sign. anticancer act.
MELTING POINT: 247–248°C (dec)
REFERENCE: 225

$C_{11}H_{15}N_5O_5$ Psicofuranine

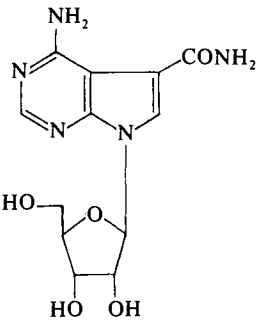


MOL. WT.: 297
BIOACTIVITY: W256: T/C, 40
MELTING POINT: 212–214°C (dec)
$[\alpha]_D$: −53.7 SOLVENT: DMSO
ORGANISM: *Streptomyces hygroscopicus* (Streptomycetaceae)
REFERENCE: 276

$C_{12}H_{13}N_5O_4$ Toyocamycin



MOL. WT.: 291
BIOACTIVITY: Antitumor act.
MELTING POINT: 243°C
$[\alpha]_D$: −55.6 SOLVENT: 0.1 N HCl
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces toyocaensis* (Streptomycetaceae)
REFERENCE: 306



$C_{12}H_{15}N_5O_5$ Sangivamycin

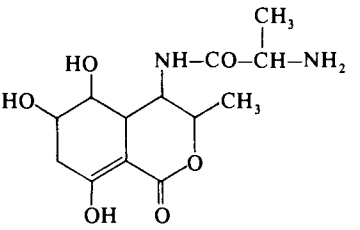
MOL. WT.: 309
BIOACTIVITY: LE: T/C, 167
PS: T/C, 190
MELTING POINT: 260°C
$[\alpha]_D$: −45.7 SOLVENT: 0.1 N HCl
SPECTRAL DATA: UV, IR, PMR
ORGANISM: Unidentified species of *Streptomyces* (Streptomycetaceae)
REFERENCE: 259

$C_{13}H_{14}N_2O_4$ Neothramycin A

MOL. WT.: 262
BIOACTIVITY: LE: Active
EA: T/C, >200
Cytotoxic to Yoshida sarcoma and C3H cells
MELTING POINT: dp 132–147°C
$[\alpha]_D$: +272 SOLVENT: Di
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Streptomyces* No. MC916-C4 (Streptomycetaceae)
REFERENCE: 298

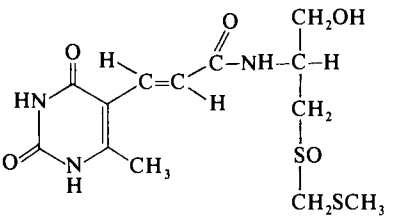
$C_{13}H_{14}N_2O_4$ Neothramycin B

MOL. WT.: 262
BIOACTIVITY: LE: Active
EA: T/C, >200
Cytotoxic to Yoshida sarcoma and C3H cells
MELTING POINT: dp 144–151°C
$[\alpha]_D$: +314 SOLVENT: Di
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Streptomyces* No. MC916-C4 (Streptomycetaceae)
REFERENCE: 298



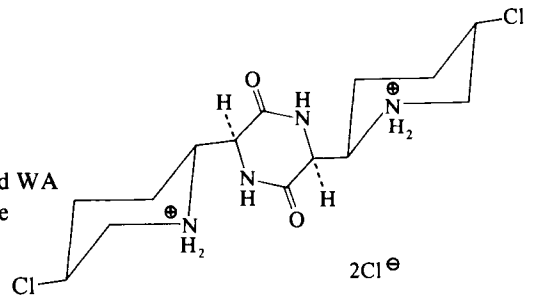
$C_{13}H_{20}N_2O_6$ Actinobolin

MOL. WT.: 300
BIOACTIVITY: Antitumor act.
MELTING POINT: Amorphous
ORGANISM: *Streptomyces griseoviridus* var. *atrofaciens* (Streptomycetaceae)
REFERENCE: 4



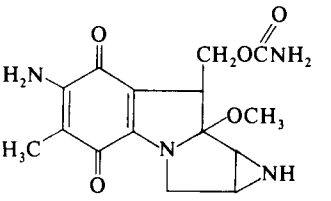
$C_{13}H_{21}N_3O_6S_2$ Sparsomycin

MOL. WT.: 379
BIOACTIVITY: Antitumor act.
ORGANISM: *Streptomyces sparsogenes* (Streptomycetaceae)
REFERENCE: 21, 254, 316, 336a



$C_{14}H_{22}Cl_2N_4O_2 2HCl$

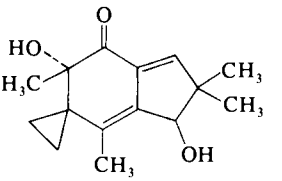
MOL. WT.: 421
BIOACTIVITY: LE: T/C, >200, RO and WA
Active clinical candidate
MELTING POINT: >330°C
$[\alpha]_D$: +11 SOLVENT: Aq
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Streptomyces griseoluteus* (Streptomycetaceae)
REFERENCE: 7, 253, 61, 302



$C_{15}H_{18}N_4O_5$ Mitomycin C

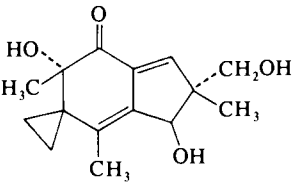
MOL. WT.: 334
BIOACTIVITY: Antitumor act.
In clinical trial
LE: T/C, 170
PS: T/C, 250
Bl: T/C, 167
MELTING POINT: >300°C
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces caesipitosus* (Streptomycetaceae)
REFERENCE: 284, 330

$C_{15}H_{20}O_3$ Illudin-M



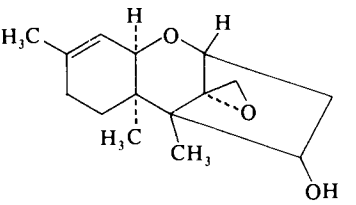
MOL. WT.: 248
BIOACTIVITY: Reported to have antitumor act.
MELTING POINT: 128–130°C
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Clitocybe illudens* (Tricholomataceae)
REFERENCE: 193

$C_{15}H_{20}O_4$ Lampterol (Illudin-S)



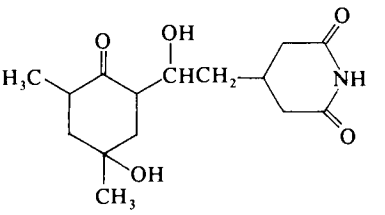
MOL. WT.: 264
BIOACTIVITY: Activity 120 γ/kg as measured in Ehrlich mouse ascitic tumors
MELTING POINT: 127–129°C
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Lampteromyces japonicus*
REFERENCE: 204, 214

$C_{15}H_{22}O_3$ Roridin C (trichodermol)



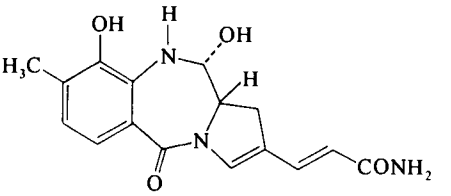
MOL. WT.: 250
BIOACTIVITY: Cytotoxic
MELTING POINT: 117–119°C
$[\alpha]_D$: −33 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Myrothecium verrucaria* and *M. roridum*
REFERENCE: 78, 300

$C_{15}H_{23}NO_5$ Streptovitacin A



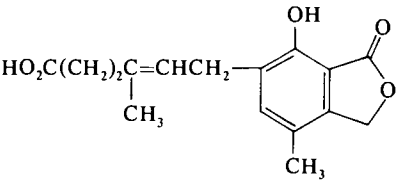
MOL. WT.: 297
BIOACTIVITY: LE: T/C, 155
PS: T/C, 181
MELTING POINT: Acetate, 141–142°C
$[\alpha]_D$: Acetate, −8.8 SOLVENT: Me
ORGANISM: *Actinomyces* sp.
REFERENCE: 337, 261

$C_{16}H_{17}N_3O_4$ Anthramycin



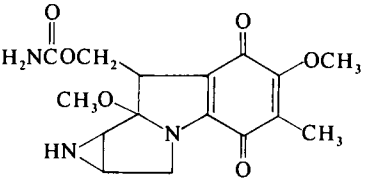
MOL. WT.: 315
BIOACTIVITY: Antitumor act.
Has been in clinical trial
MELTING POINT: 188–194°C (dec)
$[\alpha]_D$: +930 SOLVENT: DMF
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces refuineus* var. *thermotolerans* and *S. caesipitosus* (Streptomycetaceae)
REFERENCE: 179, 180, 100

$C_{16}H_{18}O_5$



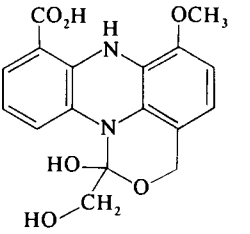
MOL. WT.: 290
BIOACTIVITY: Antitumor act.
MELTING POINT: 141°C
ORGANISM: *Penicillium brevi-compactum* (Moniliaceae)
REFERENCE: 18

$C_{16}H_{19}N_3O_6$ Mitomycin A



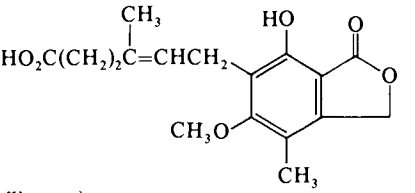
MOL. WT.: 349
BIOACTIVITY: Antitumor act.
MELTING POINT: 159–161°C (dec)
SPECTRAL DATA: UV
ORGANISM: *Streptomyces caesipitosus* and *S. verticillatus* (Streptomycetaceae)
REFERENCE: 330

$C_{17}H_{16}N_2O_5$ Griseolutein B



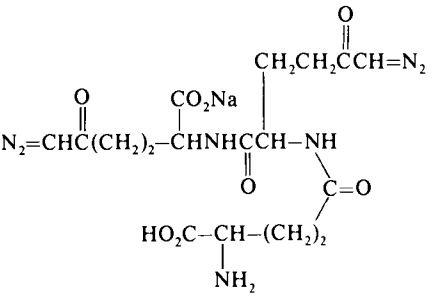
MOL. WT.: 328
BIOACTIVITY: Antitumor act.
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Streptomyces griseoluteus* (Streptomycetaceae)
REFERENCE: 213a

$C_{17}H_{20}O_6$ Mycophenolic acid



MOL. WT.: 320
BIOACTIVITY: Antitumor act.
MELTING POINT: Methyl ester, 104–105°C
SPECTRAL DATA: PMR
ORGANISM: *Penicillium stoloniferum* Thom. (Moniliaceae)
REFERENCE: 25, 17

$C_{17}H_{22}N_7O_8Na$ Azotomycin

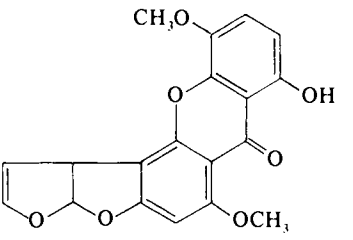


MOL. WT.: 475
BIOACTIVITY: LE: T/C, 168
PS: T/C, 220
WA, SA: Active in clinical trial
SPECTRAL DATA: IR
ORGANISM: *Streptomyces ambofaciens* (Streptomycetaceae)
REFERENCE: 332

$C_{19}H_{14}O_6$ SS228 (a quinone)

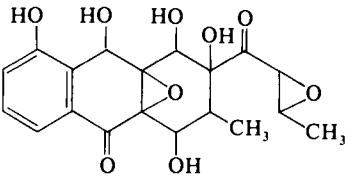
MOL. WT.: 338
BIOACTIVITY: EA: Active
MELTING POINT: dp 256–266°C
SPECTRAL DATA: UV, PMR
ORGANISM: *Chainia* sp.
LOCATION: Sagami Bay mud
REFERENCE: 223

$C_{19}H_{14}O_7$ 5-Methoxy-sterigmatocystin



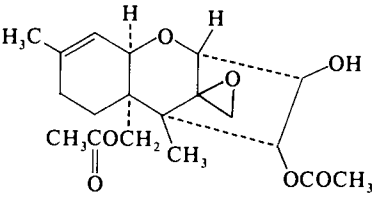
MOL. WT.: 354
BIOACTIVITY: LE: T/C, 160
PS: T/C, 24[c]
Bl: T/C, 134
LL: T/C, 139
MELTING POINT: dp 223°C
$[\alpha]_D$: −360 SOLVENT: Chf
SPECTRAL DATA: PMR
ORGANISM: *Aspergillus versicolor* (Perisporiaceae) and *Sterigmatocystis* sp.
REFERENCE: 99, 84, 83, 337

$C_{19}H_{20}O_9$ Cervicarcin



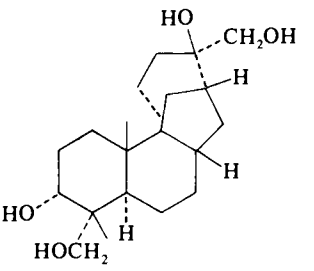
MOL. WT.: 392
MELTING POINT: 205°C
$[\alpha]_D$: −59.7 SOLVENT: Alc
SPECTRAL DATA: UV, PMR
ORGANISM: *Streptomyces ogaensis* (Streptomycetaceae)
REFERENCE: 203

$C_{19}H_{26}O_7$ Anguidin



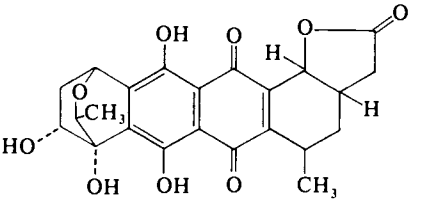
MOL. WT.: 366
BIOACTIVITY: LE: T/C, 144
PS: T/C, 207
MELTING POINT: 162–164°C
$[\alpha]_D$: −27 SOLVENT: Chf
ORGANISM: *Fusarium anguioides* (Tuberculariaceae)
REFERENCE: 186

$C_{20}H_{34}O_4$ Aphidicolin



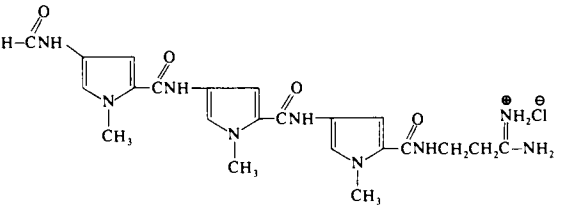
MOL. WT.: 338
BIOACTIVITY: Antitumor act.
MELTING POINT: 227–233°C
$[\alpha]_D$: +12 SOLVENT: Me
SPECTRAL DATA: IR, PMR
ORGANISM: *Cephalosporium aphidicola* (Mucedinaceae)
REFERENCE: 39

$C_{22}H_{20}O_{10}$ Granaticin A (litmomycin)



MOL. WT.: 444
BIOACTIVITY: PS: T/C, 166 (1.5 mg/kg)
KB: ED_{50}, 1.6 μg/ml
MELTING POINT: 223–225°C
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Streptomyces litmogenes* (Streptomycetaceae)
REFERENCE: 28

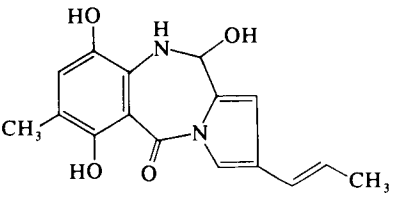
$C_{22}H_{28}C1N_9O_4$ Distamycin A



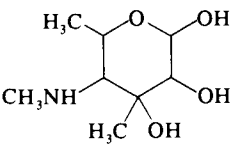
MOL. WT.: 517
BIOACTIVITY: WA, EA, SA: Active
MELTING POINT: Hydrochloride, 184–187°C
ORGANISM: *Streptomyces distallicus* (Streptomycetaceae)
REFERENCE: 77

$C_{24}H_{31}N_2O_7$ As a glycoside of Sibirosamine

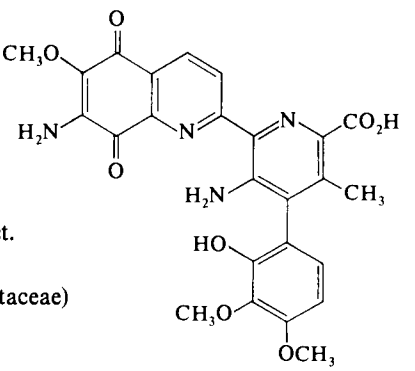
MOL. WT.: 458
BIOACTIVITY: Active in 6 murine tumor systems
ORGANISM: *Streptosporangium sibiricum* (Actinomycetaceae)
REFERENCE: 66



The complete antitumor antibiotic is Sibiromycin

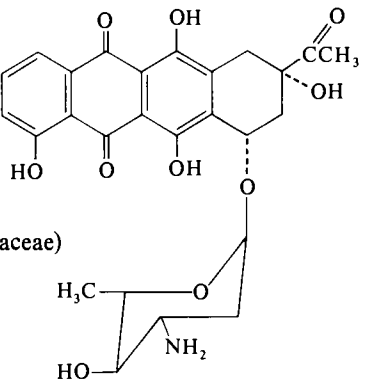


$C_{25}H_{22}N_4O_8$ Streptonigrin



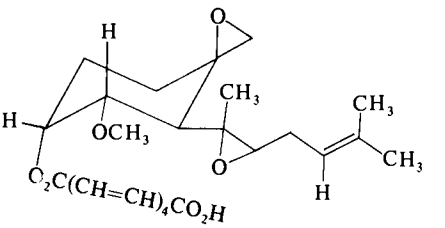
MOL. WT.: 506
BIOACTIVITY: HeLa: ED_{50}, 2.8×10^{-2} μg/ml
SA, Adenocarcinoma 755: Sign. act.
MELTING POINT: 275°C (dec)
ORGANISM: *Streptomyces flocculus* (Streptomycetaceae)
REFERENCE: 260

$C_{26}H_{27}NO_{10}$ Carminomycin I



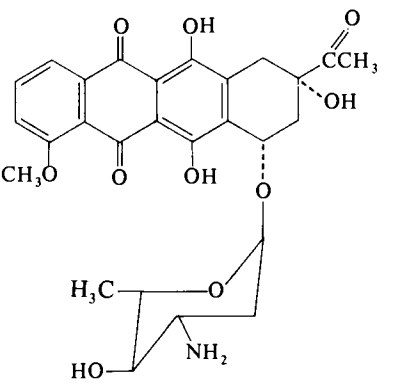
MOL. WT.: 513
BIOACTIVITY: LE: Some cures in clinical trial
Useful in human sarcoma
$[\alpha]_D$: +289
SPECTRAL DATA: UV, IR
ORGANISM: *Actinomadura carminata* (Actinomycetaceae) and *Actinomyces cremeospinus* sp. Nov.
REFERENCE: 67, 20, 234

$C_{26}H_{34}O_7$ Fumagillin



MOL. WT.: 458
BIOACTIVITY: SA: T/C, 20
CA: T/C, 37
MELTING POINT: 191–193°C (dec)
$[\alpha]_D$: +24 SOLVENT: Chf
ORGANISM: *Aspergillus fumigatus* (Perisporiaceae)
REFERENCE: 31, 301

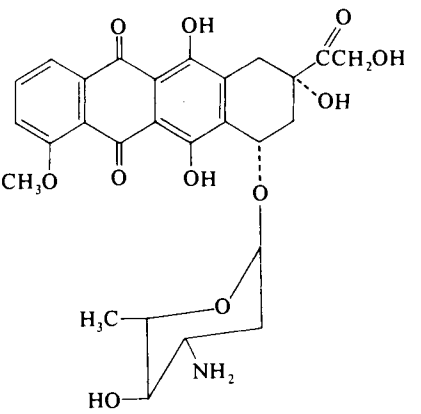
$C_{27}H_{29}NO_{10}$ Daunomycin



MOL. WT.: 527
BIOACTIVITY: LE: T/C, 158
PS: T/C, 227
Bl: T/C, 260
In clinical use
MELTING POINT: Hydrochloride, 188–190°C
$[\alpha]_D$: Hydrochloride, +253 SOLVENT: Me
ORGANISM: *Streptomyces peucetius* (Streptomycetaceae)
REFERENCE: 268, 234

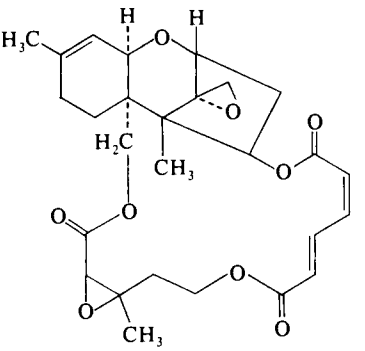
$C_{27}H_{29}NO_{11}$ Adriamycin

MOL. WT.: 543
BIOACTIVITY: LE: T/C, 164
PS: T/C, >300
Bl: T/C, 300
MELTING POINT: Hydrochloride, 204–205°C
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces peucetius* var. *caesius* (Streptomycetaceae)
REFERENCE: 268, 43, 70, 5, 234



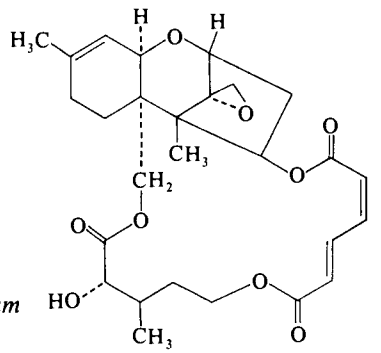
$C_{27}H_{32}O_9$ Verrucarin B

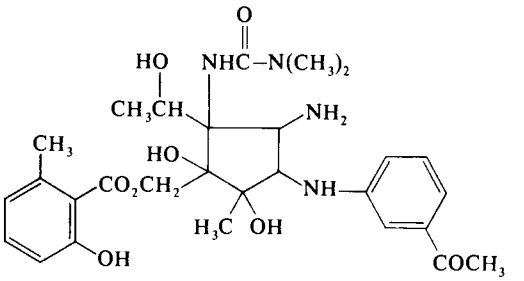
MOL. WT.: 500
BIOACTIVITY: WA: Active
S37: Active
P815: ED_{50}, 0.003 μg/ml
MELTING POINT: dp >330°C
$[\alpha]_D$: +94 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Myrothecium verrucaria* and *M. roridum*
REFERENCE: 78, 300



$C_{27}H_{34}O_9$ Verrucarin A

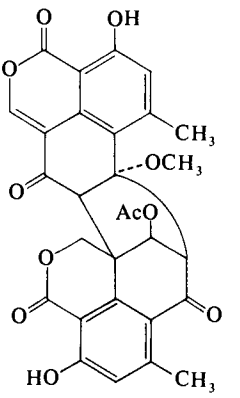
MOL. WT.: 502
BIOACTIVITY: WA Active
S37: Active
F815: ED_{50}, 6×10^{-4} μg/ml
MELTING POINT: dp > 330°C
$[\alpha]_D$: +207 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Myrothecium verrucaria* and *M. roridum*
REFERENCE: 78, 300





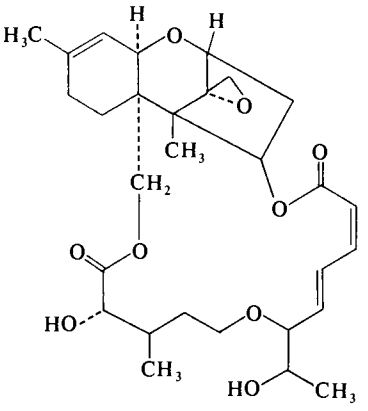
$C_{28}H_{38}N_4O_8$ Pactamycin

MOL. WT.: 558
BIOACTIVITY: LE: T/C, 122
PS: T/C, 145
KB: Active
$[\alpha]_D$: +22 SOLVENT: Alc
SPECTRAL DATA: UV, PMR
ORGANISM: *Streptomyces pactum* (Streptomycetaceae)
REFERENCE: 11, 316, 73, 72, 336b



$C_{29}H_{22}O_{11}$ Duclauxin

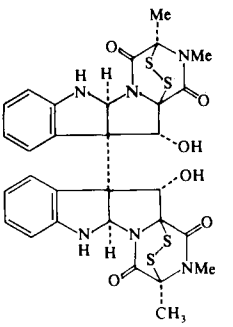
MOL. WT.: 546
BIOACTIVITY: EA: Active
MELTING POINT: 235–236°C
$[\alpha]_D$: +323 SOLVENT: $CHCl_3$
SPECTRAL DATA: UV, PMR, Mass Spec
ORGANISM: *Penicillium stipitatum* (Moniliaceae)
REFERENCE: 127



$C_{29}H_{40}O_9$ Roridin A

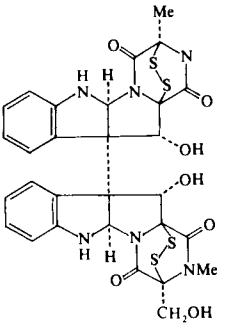
MOL. WT.: 532
BIOACTIVITY: WA: Active
S37: Active
P815: ED_{50}, 0.001 μg/ml
MELTING POINT: 198–204°C
$[\alpha]_D$: +130 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Myrothecium verrucaria* and *M. roridum*
REFERENCE: 300, 78

$C_{30}H_{28}N_6O_6S_4$ Verticillin A



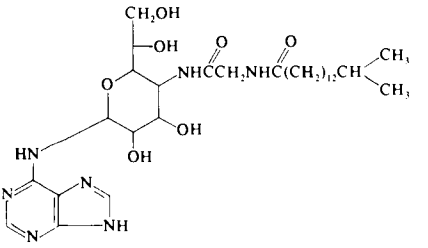
MOL. WT.: 696
BIOACTIVITY: HeLa: ED_{50}, 0.2 γ/ml
MELTING POINT: 199–213 °C (dec)
$[\alpha]_D$ +703.7 SOLVENT: Di
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Vesticillium* sp.
REFERENCE: 211

$C_{30}H_{28}N_6O_7S_4$ Verticillin B

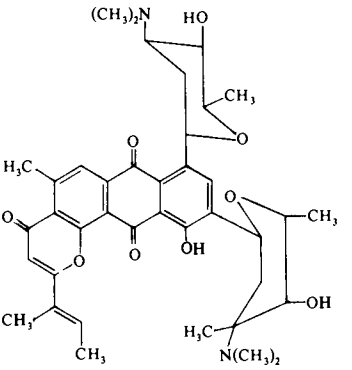


MOL. WT.: 712
BIOACTIVITY: HeLa: ED_{50}, 0.2 γ/ml
MELTING POINT: 230–233°C (dec)
$[\alpha]_D$: +704.7 SOLVENT: Di
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Vesticillium* sp.
REFERENCE: 211

$C_{30}H_{51}N_7O_7$ Septacidin

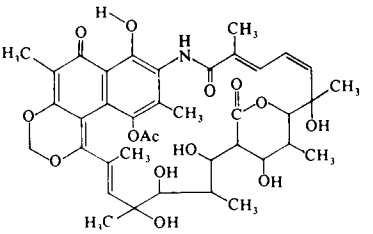


MOL. WT.: 621
BIOACTIVITY: CA755: T/C, 25
SA: Sign. act.
MELTING POINT: 215–220°C
$[\alpha]_D$: +6.6 SOLVENT: DMF
SPECTRAL DATA: UV
ORGANISM: *Streptomyces fimbriatus* (Streptomycetaceae)
REFERENCE: 2, 51



$C_{39}H_{48}N_2O_9$ Kidamycin

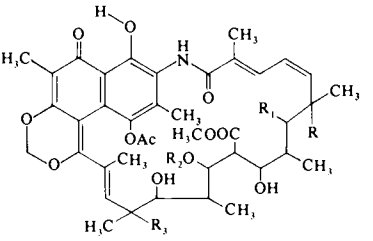
MOL. WT.: 688
BIOACTIVITY: EA: T/C, 277
L1210: T/C, 130
SA: Sign. act.
MELTING POINT: dp 212–214°C
$[\alpha]_D$: +476 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Streptomyces phaeoverticillatus* (Streptomycetaceae)
REFERENCE: 62, 115, 318



$C_{40}H_{51}NO_{14}$ Streptovaricin F

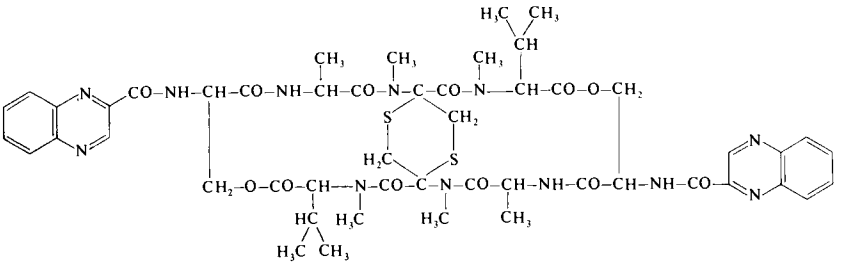
MOL. WT.: 769
BIOACTIVITY: Antitumor act.
REFERENCE: 264, 327

Streptovaricins A–G (C most abundant)



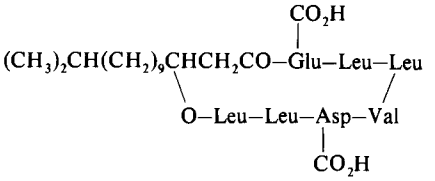
A, R = OH; R_1 = H, OH; R_2 = Ac; R_3 = OH
B, R = H; R_1 = H, OH; R_2 = Ac; R_3 = OH
C, R = H; R_1 = H, OH; R_2 = H; R_3 = OH
D, R = H; R_1 = H, OH; R_2 = H; R_3 = H
E, R = H; R_1 = =O; R_2 = H; R_3 = OH
G, R = OH; R_1 = H, OH; R_2 = H; R_3 = OH

$C_{50}H_{60}O_{12}N_{12}S_2$ Echinomycin



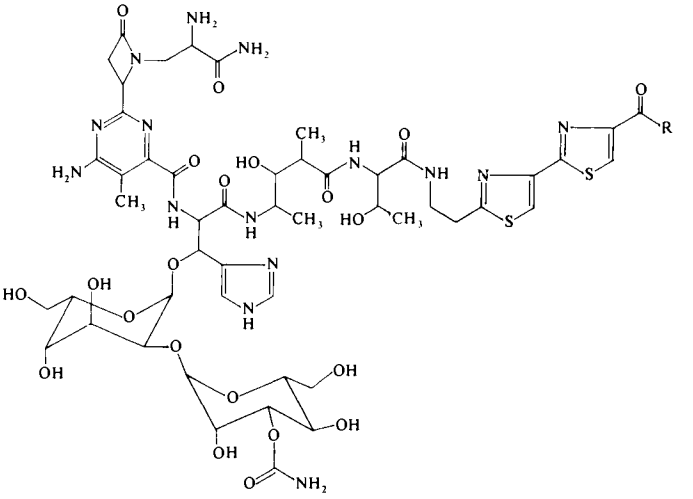
MOL. WT.: 1084
ORGANISM: *Streptomyces* sp. (Streptomycetaceae)
REFERENCE: 119, 6, 316

$C_{53}H_{93}N_7O_{13}$ Surfactin



MOL. WT.: 1035
BIOACTIVITY: EA: Sign. act.
MELTING POINT: 247–249°C
$[\alpha]_D$: +39 SOLVENT: Chf
ORGANISM: *Bacillus natto* KMD 2311 (Schizomycetes)
REFERENCE: 114

$C_{55}H_{79}ClN_{16}O_{21}S_3$ Bleomycin A_2



R = $NH(CH_2)_3\overset{\oplus}{S}(CH_3)_2Cl^{\ominus}$

MOL. WT.: 1430

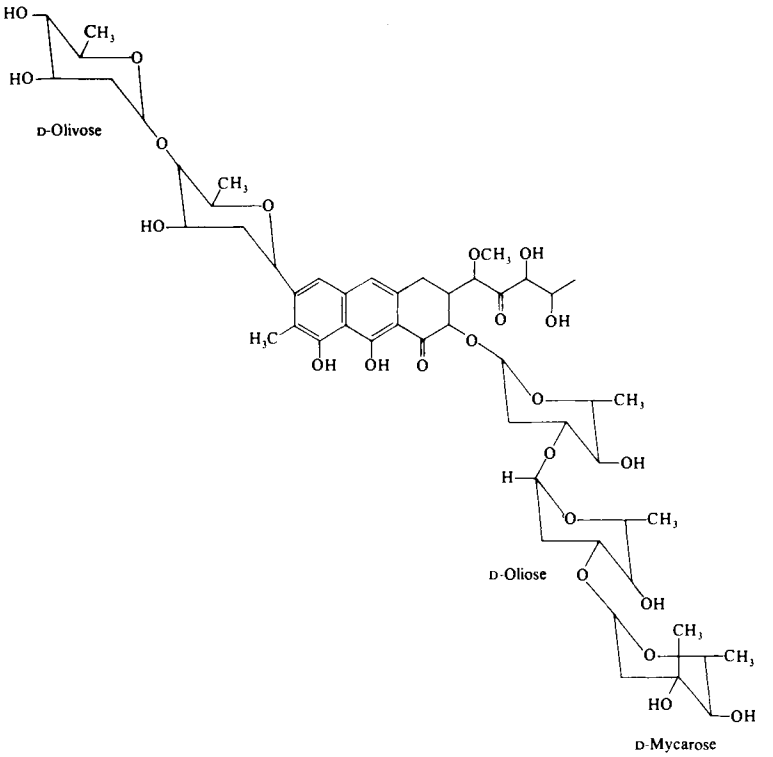
BIOACTIVITY: Antitumor act. in clinical use
PS: T/C, 150
Bl: T/C, 168
LL: T/C, 158

SPECTRAL DATA: UV, IR

ORGANISM: *Streptomyces verticillus* (Streptomycetaceae)

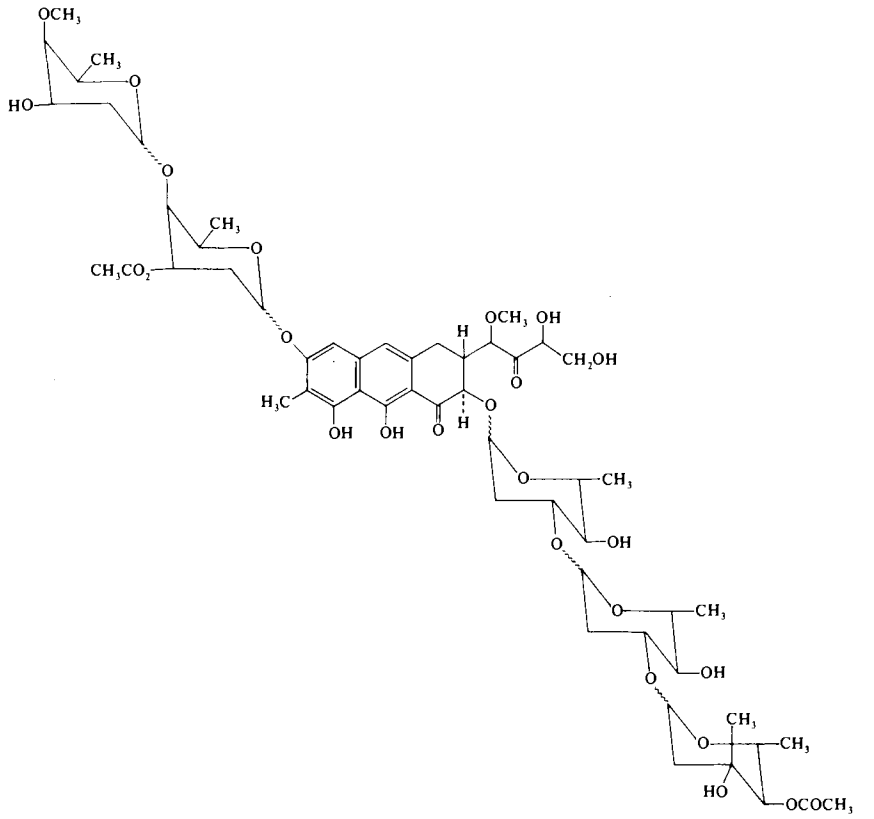
REFERENCE: 299, 317, 215, 319

$C_{57}H_{76}O_{24}$ Aureolic acid (Mithramycin)



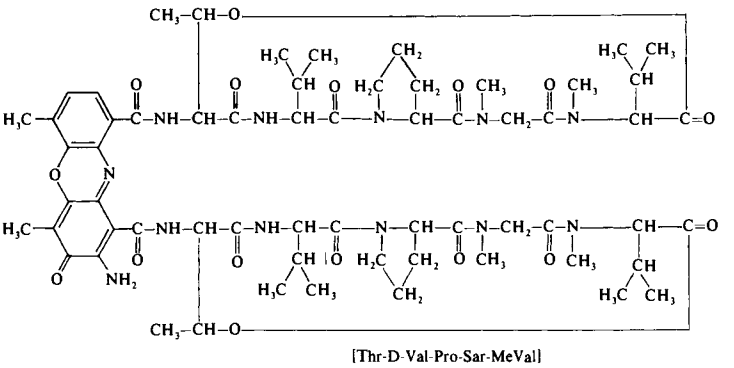
MOL. WT.: 1144
BIOACTIVITY: HeLa: ED_{50}, 0.05 μg/ml
MELTING POINT: 180–183°C
$[\alpha]_D$: −51 SOLVENT: Alc
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces* sp. (Streptomycetaceae)
REFERENCE: 9, 262

$C_{57}H_{82}O_{26}$ Chromomycin A_3



MOL. WT.: 1182
BIOACTIVITY: PS: T/C, 150
MELTING POINT: Heptaacetate, 223°C
$[\alpha]_D$: −57; −43.9 SOLVENT: Alc; Chf
SPECTRAL DATA: UV, IR, PMR
ORGANISM: *Streptomyces griseus* (Streptomycetaceae)
REFERENCE: 212

$C_{62}H_{86}N_{12}O_{16}$ Actinomycin D



[Thr-D-Val-Pro-Sar-MeVal]

MOL. WT.: 1255
BIOACTIVITY: LE: T/C, 145
PS: T/C, >275
Bl: T/C, 203
MELTING POINT: 241–243°C
$[\alpha]_D$: −323 SOLVENT: Me
REFERENCE: 206

Dactinomycin

BIOACTIVITY: Antitumor act. (clinical trial)
REFERENCE: 305

Settacidin

A nucleopeptide
BIOACTIVITY: CA755, S180: Active Earle's L cells
MELTING POINT: dp 215–220°C
$[\alpha]_D$: +6.6 SOLVENT: DMF
SPECTRAL DATA: UV
ORGANISM: *Streptomyces fimbriatus* (Streptomycetaceae)
REFERENCE: 51

Alazopeptin

An L-Alanyl-(6-diazo-5-oxo)-L-Norleucyl-(6-diazo-5-oxo)-L-norleucine
BIOACTIVITY: Sign. antitumor act.
ORGANISM: *Streptomyces griseoplanus* (Streptomycetaceae)
ORGANISM: 228

OS-3256-B

An aza amino acid derivative related to Alazopeptin
BIOACTIVITY: L1210: T/C, 192 (9 mg/kg)
SA: Active Cytotoxic (HeLa cells)
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces candidus* var. *azaticus* (Streptomycetaceae)
REFERENCE: 273

Mitomalcin

BIOACTIVITY: Antitumor act.
ORGANISM: *Streptomyces malayensis* (Streptomycetaceae)
REFERENCE: 190

PSX-1

BIOACTIVITY: EA HeLa: ED_{50}, 2.0 μg/ml
Sarcoma 37: ED_{50}, 1.5 μg/ml
MELTING POINT: 33–34°C
$[\alpha]_D$: +182 SOLVENT: Chf
SPECTRAL DATA: UV, IR
ORGANISM: *Penicillium stipitatum* (Moniliaceae)
REFERENCE: 64

Roche 5-9000

BIOACTIVITY: Sign. antitumor act.
ORGANISM: *Streptomycete*
REFERENCE: 342

Neocarzinostatin

BIOACTIVITY: LE: T/C, 163
PS: T/C, >200
SA: Active
ORGANISM: *Streptomyces carzinostaticus* (Streptomycetaceae)
REFERENCE: 207, 196

Ala-Ala-Pro-Thr-Ala-Thr-Val-Thr-Pro-Ser-
Ser-Gly-Leu-Ser-Asp-Gly-Thr-Val-Val-Lys-
30
Val-Ala-Gly-Ala-Gly-Leu-Gln-Ala-Gly-Thr-
Ala-Tyr-Asp-Val-Gly-Gln-Cys-Ala-Ser-Val-
Asn-Thr-Gly-Val-Leu-Trp-Asn-Ser-Val-Thr-
60
Ala-Ala-Gly-Ser-Ala-Cys-Asx-Pro-Ala-Asn-
Phe-Ser-Leu-Thr-Val-Arg-Arg-Ser-Phe-Glu-
Gly-Phe-Leu-Phe-Asp-Gly-Thr-Arg-Trp-Gly-
90
Thr-Val-Asx-Cys-Thr-Thr-Ala-Ala-Cys-Gln-
100
Val-Gly-Leu-Ser-Asp-Ala-Ala-Gly-Asp-Gly-
109
Glu-Pro-Gly-Val-Ala-Ile-Ser-Phe-Asn-

Renastacarcin

A polypeptide
BIOACTIVITY: EA, SA: Active
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces* sp. (Streptomycetaceae)
REFERENCE: 272

Macracidmycin

High molecular weight structure unknown. Other such antitumor agents include: Actinocarcin, A216, Carzinocidin, Enomycin, Lymphomycin, Melanomycin, Peptimycin, Phenomycin, Sanitamycin
BIOACTIVITY: EA
SPECTRAL DATA: UV, IR
ORGANISM: *Streptomyces atrofaciens* (Streptomycetaceae)
REFERENCE: 224

Carboxypeptidase G_1

BIOACTIVITY: L1210: T/C, 127
L1210: ED_{50}, 0.0025 γ/ml
W256: ED_{50}, 0.0025 γ/ml
SA: Sign. act.
ORGANISM: *Pseudomonas stutzeri* (Urticaceae)
REFERENCE: 26

Glutaminase-asparaginases

BIOACTIVITY: Ascites tumor: Sign. act.
ORGANISM: *Acinetobacter glutaminasificans* and *Pseudomonas aureofaciens* (Urticaceae)
REFERENCE: 275

Glycoprotein Phallolysin
>30,000

BIOACTIVITY: Cytolytic
ORGANISM: *Amanita phalloides*
REFERENCE: 59, 58

Yeast mannan

BIOACTIVITY: SA: T/C, 10–15
ORGANISM: *Saccharomyces cerevisiae* (Saccharomycetes)
REFERENCE: 98

Polysaccharides

BIOACTIVITY: SA: Active
$[\alpha]_D$: −15.6 SOLVENT: Aq
ORGANISM: *Flammulina velutipes*
REFERENCE: 341, 101

Polysaccharides A_3 and A_5

BIOACTIVITY: SA: Active
ORGANISM: *Pleurotus ostreatus*
LOCATION: Japan
REFERENCE: 340

Polysaccharide preparation G-Z

BIOACTIVITY: SA: Active
$[\alpha]_D$: −23 SOLVENT: 0.1 N NaOH
ORGANISM: *Ganoderma applanatum* (Polyporaceae)
REFERENCE: 271

Polysaccharide preparation P2

BIOACTIVITY: SA: Active
ORGANISM: *Phellinus linteus* (Polyporaceae)
LOCATION: Japan
REFERENCE: 271

Scleroglucan polysaccharide

BIOACTIVITY: Antitumor act.
ORGANISM: *Sclerotium glucanicum*
REFERENCE: 281

Concanavalin A

A Jackbean lectin
BIOACTIVITY: KHT fibrosarcoma and AKR lymphoma *in vitro*
ORGANISM: *Canavalia ensiformis* (Fabaceae)
REFERENCE: 182

Supplement to Chapter 6

Fungi and Other Lower Plant Antibiotics Under Study by the U.S. National Cancer Institute Include the Following:

Actinomycin C2
Actinomycin C3
Actinogan
Actinorubin
Amicetin
Anisomycin
Antibiotic 1037
Antibiotic B17498X
Antibiotic E73
Antibiotic M5-18903
Ascomycin
5-Azacytidine
Azastreptonigrin
Azotomycin
Blasticidin-S
Bleomycin Al
Bluensomycin sulfate
Candicidin
Carbomycin
Chartreusin-2 hydrate
Chloramphenicol
Chromomycin A2
Cinerubin B
Cinnamycin
Copiamycin, acetyl
Coumermycin Al
Cyanein
Cycloheximide
Duazomycin A
Duramycin
Enteromycin
Flammulin
Formycin A
Fusarubin
Fusidic acid
Gelbecidine
Gliotoxin
Gougerotin
Griseofulvin
Hedamycin
Iyomycin B_1
Iyomycin complex
Kanchanomycin
Kasugamycin
Kundrymycin
Lasgosin
Macromomycin
Mikamycin
Mitocromin
Mitogillin
Mitosper
Mycorhodin
Narangomycin
Nebularin
Nisin
Nonactin
Oligomycin
Olivomycin
Oosporein
PA147
Phleomycin
Porfiromycin
Prodigiosin
Puromycin
Pyrazomycin
Restrictocin
Rifamycin SV
Rubradirin
Rufochromomycin
Ryanodine
Sancyclin
Saramycetin
Sarkomycin, sodium salt
Sistomycosin
Statolon
Stendomycin salicylate
Streptolydigin
Streptorubin
Thiosangivamycin
Viridogrisein
Zorbamycin
Noformycin
Viundrymycin
Threomycin

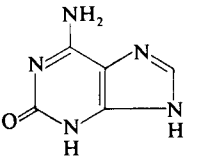
Chapter 7

Marine Invertebrate and Other Lower Animal Biosynthetic Products

$C_2H_7NO_3S$ Taurine $H_2NCH_2CH_2SO_3H$

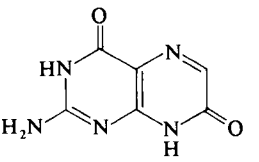
MOL. WT.: 125
BIOACTIVITY: PS: T/C, 131
MELTING POINT: 320°C (dec)
ORGANISM: *Macrocallista nimbosa* (Mollusca) and *Turbo stenogyrus* (Mollusca)
LOCATION: Florida and Taiwan, respectively
REFERENCE: 248

$C_5H_5N_5$ Isoguanine



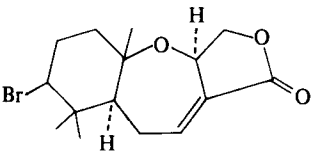
MOL. WT.: 135
BIOACTIVITY: CA: Active
ORGANISM: *Prioneris thestylis* Dbldy. (Pieridae) (Arthropoda/Insecta)
LOCATION: Taiwan
REFERENCE: 247

$C_6H_5N_5O_2$ Isoxanthopterin



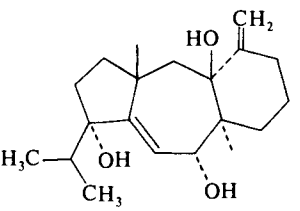
MOL. WT.: 179
BIOACTIVITY: WA256: T/C, 29
ORGANISM: *Catopsilia crocale* (Arthropoda/Insecta)
LOCATION: Taiwan
REFERENCE: 240

$C_{15}H_{21}BrO_3$ Aplysistatin



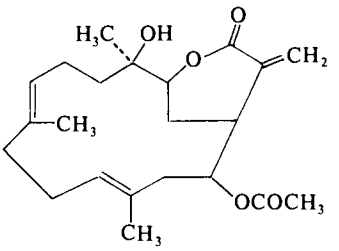
MOL. WT.: 328
BIOACTIVITY: P388: ED_{50}, 2.7 μg/ml
MELTING POINT: 173–175°C
SPECTRAL DATA: IR, PMR, Mass Spec
ORGANISM: *Aplysia angasi* (Aplysiidae) (Mollusca)
LOCATION: Australia
REFERENCE: 236

$C_{20}H_{32}O_3$ Dolatriol



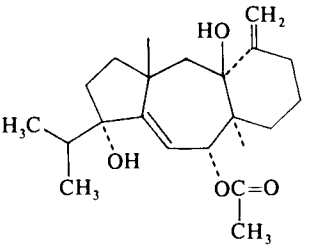
MOL. WT.: 320
BIOACTIVITY: P388: ED_{50}, 13 μg/ml
MELTING POINT: 235–236°C
SPECTRAL DATA: IR, PMR
ORGANISM: *Dolabella* sp. (Mollusca) (Aplysiidae)
LOCATION: Indian Ocean
REFERENCE: 249

$C_{22}H_{32}O_5$ Crassin acetate



MOL. WT.: 376
BIOACTIVITY: PS: T/C, 130 (50 mg/kg)
KB: ED_{50}, 2 μg/ml
ORGANISM: *Pseudoplexaura porosa* (Coelenterata), *P. flagellosa*, *P. wagenapri*, and *P. crucis*
LOCATION: Caribbean
REFERENCE: 331

$C_{22}H_{34}O_4$ Dolatriol 6-acetate



MOL. WT.: 362
BIOACTIVITY: P388: ED_{50}, 10 μg/ml
MELTING POINT: 210–212°C
SPECTRAL DATA: IR, PMR
ORGANISM: *Dolabella* sp. (Aplysiidae) (Mollusca)
LOCATION: Indian Ocean
REFERENCE: 249

Thelenostatin 1

BIOACTIVITY: P388: ED_{50}, 1.5 μg/ml
MELTING POINT: 213–217°C
ORGANISM: *Thelenota ananas* (Echinodermata)
LOCATION: Taiwan and Marshall Islands
REFERENCE: 237

Actinostatin 1

BIOACTIVITY: KB: ED_{50}, 2.6 μg/ml
L1210: ED_{50}, 2.1 μg/ml
MELTING POINT: 218–220°C
ORGANISM: *Actinopyga mauritiana* (Echinodermata)
LOCATION: Hawaii

Stichostatin 1

BIOACTIVITY: P388: ED_{50}, 2.9 μg/ml
ORGANISM: *Stichopus chloronotus* (Echinodermata)
LOCATION: Australia

$C_{145}H_{204}N_4O_{78}$ Palytoxin

MOL. WT.: 3247
BIOACTIVITY: P388: T/C, 132
EA: Sign. act.
MELTING POINT: Chars at 300°C
$[\alpha]_D$: +26 SOLVENT: Aq
ORGANISM: *Palythoa sp.* (Coelenterata)
LOCATION: Hawaii
REFERENCE: 256

Dichostatin (polypeptide)

BIOACTIVITY: WA: T/C, 36 (3 mg/kg)
PS: T/C, 130 (6 mg/kg)
ORGANISM: *Allomyrina dichotomus* (Arthropoda/Insecta)
LOCATION: Taiwan
REFERENCE: 246

Stoichactin

BIOACTIVITY: EA: 100% inhibition
ORGANISM: *Stoichactis kenti* (Echinodermata) (sea cucumber)
LOCATION: Tahiti
REFERENCE: 220

Active fractions

BIOACTIVITY: P388: Active
ORGANISM: *Luidia clathrata* (Echinodermata) (a starfish)
LOCATION: Gulf of Mexico
REFERENCE: 252

Active fraction

BIOACTIVITY: EA: Sign. act.
ORGANISM: *Reteterebella queenslandia* (an Annelid) (Annelida)
LOCATION: Australia
REFERENCE: 221

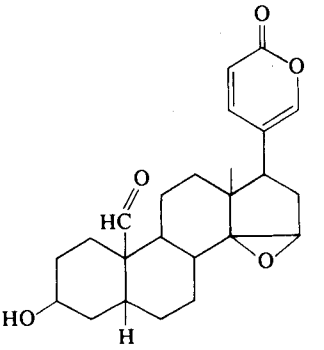
Active fractions

BIOACTIVITY: PS, EA: Active
ORGANISM: *Anthopleura elegantissima* Brandt (Coelenterata) (a sea anemone)
REFERENCE: 257

Chapter 8

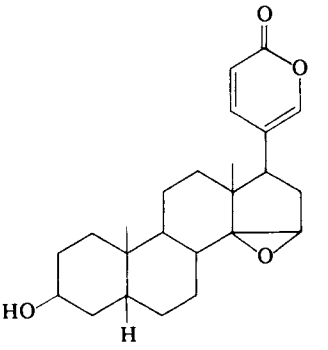
Marine Vertebrate and Other Higher Animal Biosynthetic Products

$C_{24}H_{30}O_5$ Resibufagin



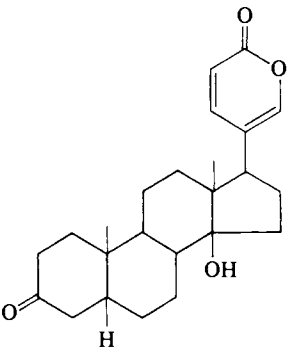
MOL. WT.: 398
BIOACTIVITY: KB: 0.63 μg/ml
MELTING POINT: 210–212°C
ORGANISM: *Bufo Bufo gargarizans* (Chordata/Amphibia)
LOCATION: China
REFERENCE: 241, 124

$C_{24}H_{32}O_4$ Resibufogenin



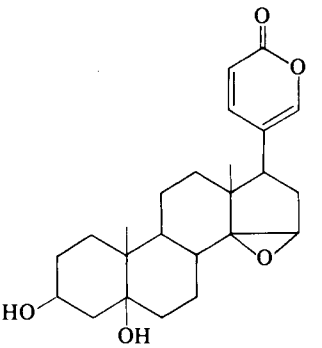
MOL. WT.: 384
BIOACTIVITY: KB: ED_{50}, 0.34 μg/ml
MELTING POINT: 115–130/164–172°C
108–120/162–166°C
117–122/157–166°C
$[\alpha]_D$: −5 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo Bufo gargarizans* (Chordata/Amphibia) and *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: China and Japan, respectively
REFERENCE: 80, 209, 245, 102, 124

$C_{24}H_{32}O_4$ Bufolone



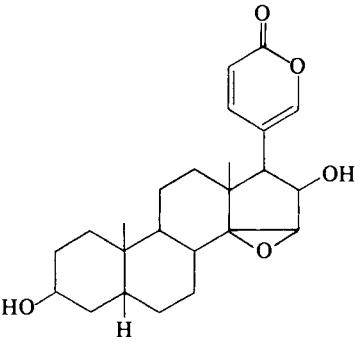
MOL. WT.: 384
BIOACTIVITY: Cytotoxic
MELTING POINT: 242–245°C
219–234°C
$[\alpha]_D$: +2.9 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: Japan
REFERENCE: 241, 102, 111

$C_{24}H_{32}O_5$ Marinobufagin

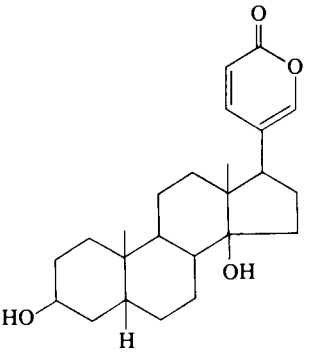


MOL. WT.: 400
BIOACTIVITY: KB: 2.5–0.086 μg/ml
EA: T/C, 155 (1.25 mg/kg) and some cures
LE, PS: Inactive at 1.25–10 mg/kg
PS (*in vitro*): 29 μg/ml
LE (*in vitro*): 43 μg/ml
MELTING POINT: 223–225°C
215–217°C
$[\alpha]_D$: +8.6 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo marinus* (Chordata/Amphibia) and *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: South America and Japan, respectively
REFERENCE: 242, 102

$C_{24}H_{32}O_5$ Desacetyl-cinobufagin

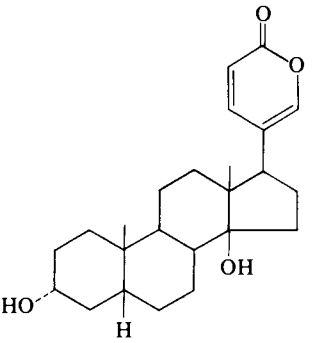


MOL. WT.: 400
BIOACTIVITY: KB: 0.1 μg/ml
PS (*in vitro*): 22 μg/ml
LE (*in vitro*): 24 μg/ml
MELTING POINT: 153–160°C
179–181°C
$[\alpha]_D$: +19.5 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo Bufo gargarizans* (Chordata/Amphibia) and *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: China and Japan, respectively
REFERENCE: 244, 241, 124, 102



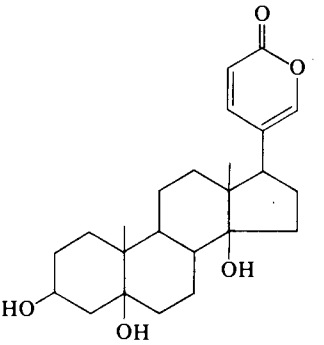
$C_{24}H_{34}O_4$ Bufalin

MOL. WT.: 386
BIOACTIVITY: KB: ED_{50}, <0.1 μg/ml
MELTING POINT: 242–243°C
232–241°C
$[\alpha]_D$: −9.4 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo vulgaris* (Chordata/Amphibia), *Bufo Bufo gargarizans* (Chordata/Amphibia), and *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: Europe, China, and Japan, respectively
REFERENCE: 80, 321, 112, 102, 124



$C_{24}H_{34}O_4$ 3-Epi-bufalin

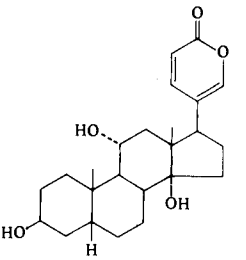
MOL. WT.: 386
BIOACTIVITY: Cytotoxic
MELTING POINT: 279–283°C
268–273°C
259–269°C
$[\alpha]_D$: −1.5 SOLVENT: Chf
ORGANISM: *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: Japan
REFERENCE: 241, 102



$C_{24}H_{34}O_5$ Telocinobufagin

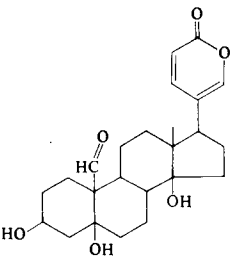
MOL. WT.: 402
BIOACTIVITY: KB: ED_{50}, 0.033 μg/ml
MELTING POINT: 163–177/210–211°C
158–170/205–209°C
$[\alpha]_D$: +5.9 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo vulgaris* (Chordata/Amphibia), *Bufo formosus* Boulenger (Chordata/Amphibia), and *Bufo Bufo gargarizans* (Chordata/Amphibia)
LOCATION: Europe, Japan, and China, respectively
REFERENCE: 80, 321, 243, 102

$C_{24}H_{34}O_5$ Gamabufotalin



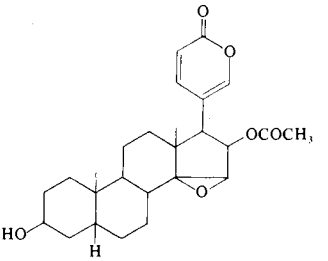
MOL. WT.: 402
BIOACTIVITY: KB: ED_{50}, 0.022 μg/ml
MELTING POINT: 260–269°C
261–263°C
258–266°C
$[\alpha]_D$: −13.7 SOLVENT: Me
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo Bufo gargarizans* (Chordata/Amphibia) and *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: China and Japan, respectively
REFERENCE: 102, 241

$C_{24}H_{32}O_6$ Hellebrigenin

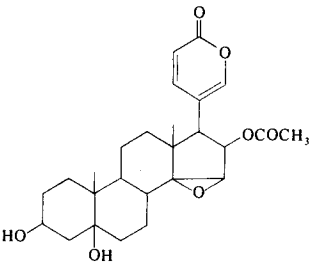


MOL. WT.: 416
BIOACTIVITY: Cytotoxic
MELTING POINT: 153–157/232–235°C
$[\alpha]_D$: +19.5 SOLVENT: Chf
ORGANISM: *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: Japan
REFERENCE: 102

$C_{26}H_{34}O_6$ Cinobufagin

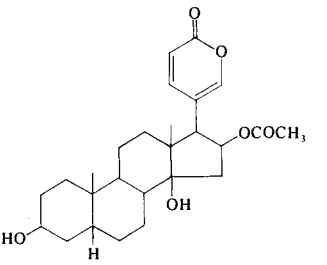


MOL. WT.: 442
BIOACTIVITY: KB: ED_{50}, 0.01 μg/ml
MELTING POINT: 167–170/210–213°C
216–217°C
$[\alpha]_D$: −3.2 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo marinus* (Chordata/Amphibia) and *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: South America and Japan, respectively
REFERENCE: 80, 267, 244, 102



$C_{26}H_{34}O_7$ Cinobufotalin

MOL. WT.: 458
BIOACTIVITY: KB: ED_{50}, 0.24 μg/ml
MELTING POINT: 251–255°C
$[\alpha]_D$: +9.8 SOLVENT: Chf
ORGANISM: *Bufo Bufo gargarizans* Boulenger (Chordata/Amphibia) and *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: China and Japan, respectively
REFERENCE: 80, 102



$C_{26}H_{36}O_6$ Bufotalin

MOL. WT.: 446
BIOACTIVITY: KB: ED_{50}, 0.026 μg/ml
MELTING POINT: 148°C } double
220°C } mp
215–220°C
156–158/227–231°C
$[\alpha]_D$: +5 SOLVENT: Chf
SPECTRAL DATA: UV, IR, PMR, Mass Spec
ORGANISM: *Bufo vulgaris* (Chordata/Amphibia), *Bufo Bufo gargarizans* (Chordata/Amphibia), and *Bufo formosus* Boulenger (Chordata/Amphibia)
LOCATION: Europe, China, and Japan, respectively
REFERENCE: 80, 321, 102, 124, 113

Cytotoxin II

A polypeptide venom constituent
BIOACTIVITY: Cytotoxic
ORGANISM: *Naja Naja* (Chordata/Reptilia) (A cobra)
REFERENCE: 297

Snake venoms

BIOACTIVITY: Cytotoxic
ORGANISM: Various species
REFERENCE: 312

Plasma

Membranes from lymph node cells
BIOACTIVITY: Cytotoxic
ORGANISM: Mouse
REFERENCE: 290

Human spleen fraction

BIOACTIVITY: Cytotoxic
REFERENCE: 188

L-Asparaginase

BIOACTIVITY: Antitumor act. in clinical use
ORGANISM: *Mycobacterium tuberculosis*
REFERENCE: 291

Stellin

BIOACTIVITY: Antitumor act.
ORGANISM: *Sturgeon milt* (Chordata/Pisces)
REFERENCE: 227

Appendix

Cancer Chemotherapeutic Evaluation Systems Employed by the U.S. National Cancer Institute

The first summary of experimental tumor systems used by the National Cancer Institute appeared in 1959[24] and an expanded version (24 systems) was summarized in 1962.[23] By 1972 a third edition was published describing the six key test systems.[69] The four *in vivo* screening systems now employed are the murine lymphoid leukemia L1210 (LE), the lymphocytic leukemia P388 (PS or P388), the melanotic melanoma B16 (B1), and Lewis lung carcinoma (LL). The *in vitro* system most commonly employed by the National Cancer Institute in the past has been a cell line from a human epidermoid carcinoma of the nasopharynx (KB). More recently, cell lines from the P388 and LE screening systems have been introduced into the National Cancer Institute's biological programs. The newest addition to the National Cancer Institute's key tumor systems are the colon ($T/C \geq 140$) and mammary ($T/C \leq 42$) tumors. The P388 and KB procedures are used routinely for evaluating extracts from natural products. When the antineoplastic agent has been isolated, it is then evaluated further in the P388 screen and studies are begun in the LE, BI, LL, colon, and mammary systems. Biosynthetic products selected for preclinical development must show a high level of activity in several of these representative experimental tumor systems.

In Vivo Test Systems

The *animals* used in the test systems are obtained from suppliers accredited by the National Cancer Institute and are handled according to strict standards ordered by the Institute. Particular strains of mice are used in the L1210, P388, B16, and LL systems, while albino rats are used in the WA system. In the case of mice, the animals must be within a 3-g weight range with a minimum weight for males of 18 g and for females of 17 g. In a single experiment only one sex is used

for all the test and control animals. In the WA system the rats used fall within a weight range of 50 to 70 g and only one sex is used in each experiment.

In general, each test group comprises six animals, while the number of animals in a control group varies according to the number of test groups. Treatment of the test animals usually begins 24 hr following implantation of the tumor. The test material is injected intraperitoneally as a solution or suitable suspension in sterile saline (0.85% sodium chloride in distilled water). If this procedure is not satisfactory a limited amount of 95% ethanol is added prior to addition of the saline. The evaluation is started with 400 mg/kg as the highest permissible dose followed by 200 and 100 mg/kg levels. When toxicity of the test material is known, dose levels are determined accordingly (see below).

The survival time of the control animals varies according to the test system used. In the L1210 system an acceptable control survival time is 8 to 11 days, while in the P388 system 9 to 14 days is considered permissible. The animal weights are generally recorded on the 5th day of the experiment. With the L1210 and P388 test systems all surviving animals are sacrificed on the 30th day.

An evaluation of the test results is calculated on the basis of either mean survival time or mean tumor weight. The evaluation based on mean survival time utilizes the factor expressed as a percentage. This factor is computed

$$\frac{T}{C} = \frac{\text{Mean survival time of the test group}}{\text{Mean survival time of the control group}}$$

for all the test groups containing more than 65% survivors on the 5th day. An initial $T/C \geqq 125$ demonstrates activity, and if this level is reproduced using two different samples of the material the activity is considered as confirmed.

The evaluation based on mean tumor weight utilizes the factor

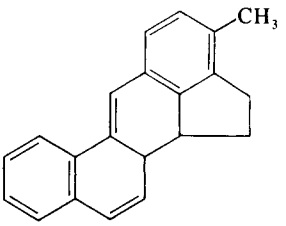
$$\frac{T}{C} = \frac{\text{Mean tumor weight of excised tumors from test group}}{\text{Mean tumor weight of excised tumors from control group}}$$

expressed as a percentage. An initial T/C value less than or equal to 42 demonstrates activity, and reproduction of this value using two different samples confirms activity.

The dose levels of the material to be tested are naturally influenced by its toxicity. In survival time studies, a test is considered toxic if the $T/C < 85$, or if 34% deaths of the test group have occurred by the significant day (day 5 for the L1210 and P388 systems). Another factor indicative of toxicity in the L1210 and P388 systems is a negative average weight change difference (test group minus control group) of 4 g or more on day 5. In tumor inhibition studies, a test is considered toxic if 34% of the animals are dead by the day of sacrifice.

The specific *in vivo* test systems used by the National Cancer Institute are as follows,[69]

Mouse Lymphoid Leukemia L1210, This murine tumor line originated in 1948 and was induced in the spleen and lymph nodes by painting the skin with methylcholanthrene (I). Evaluation of the L1210 system is based on survival time, a reproducible value of $T/C \geq 125$ demonstrating significant activity.



I

Mouse Lymphocytic Leukemia P388 was induced in DBA/2 mice in 1955 by painting with methylcholanthrene (**I**). Evaluation of results is related (T/C $\geqq$ 120%) to that used for the L1210 system.

Mouse Melanotic Melanoma B16. The B1 tumor arose spontaneously in 1954 on skin at the base of the ear of a C57BL/6 mouse. The estimation of activity is based on survival time with application of similar criteria (T/C $\geqq$ 140 for activity) to those used in the L1210 and P388 systems.

Mouse Lewis Lung Carcinoma LL. Arose spontaneously in 1951 as carcinoma of the lung in a C57BL/6 mouse. In this system evaluation may be based either on survival time (similar criteria with T/C $\geqq$ 140 to the above systems) or on tumor weight. In the latter method significant activity is indicated by reproducible values of T/C $\leqq$ 42.

Walker Carcinosarcoma 256. This tumor arose spontaneously in the region of the mammary gland of a pregnant albino rat in 1928. As with the LL system above, evaluation is based either on survival time or tumor weight.

In Vitro Test Systems[69]

In the KB cell culture screen cells derived in 1954 from a human epidermoid carcinoma of the mouth are cultivated on Eagles basal medium. The materials are tested as solutions in distilled water or saline at concentrations of 100, 10 and 1 μg/ml. Evaluation is based on the effective dose which inhibits cell growth to 50% of the control growth (ED_{50}). With natural product extracts, ED_{50} values less than or equal to 30 μg/ml in the first test with an average less than or equal to 20 μg/ml in the first two tests demonstrate activity. For pure compounds $ED_{50} \leqq 10$ is considered satisfactory.

Other Tumor Systems

Some of the experimental tumor systems less frequently used by the National Cancer Institute, but in some instances commonly employed in other laboratories, are now listed alphabetically according to the National Cancer Institute's abbreviation and summary description.

AC – Carcinoma of the adrenal cortex (No. 2)
AD – ADJ-PC-22 plasma cell
AG – L1210/8-azaguanine
AK – AK leukemia (lymphoma)
AM – Amelanotic melanoma (No. 4)
AW – P388/57155 (a terephthalanilide)
A2 – ADJ-PC-20 plasma cell
A3 – Lieberman plasma cell No. 1 (LPC-1)
A5 – ADJ-PC-5 plasma cell
BC – L1210/BCNU, NSC 409962
B1 – B16 melanocarcinoma
CA – Adenocarcinoma 755
CD – CD8F1 Mammary tumor
CH – Chang liver (cell line)
CM – Dunning leukemia/mitomycin C (solid)
CS – Dunning leukemia/1-aminocyclopentane-1 carboxylic acid (solid)
C3 – C3H Mammary tumor
DA – Dunning leukemia (ascites) (see DL)
DH – Dunning leukemia/hexamethylmelamine (solid)
DL – Dunning leukemia (solid)
DM – DMBA induced mammary adenocarcinoma
DN – Dunning leukemia/nitrogen mustard (solid)
DR – Dunning leukemia/29189 (a thiopurine) (ascites)
DX – Dunning leukemia/Cytoxan (ascites)
D1 – Adenocarcinoma of the duodenum (hamster and cell culture)
EA – Ehrlich ascites
EM – Ependymoblastoma
EN – Adenocarcinoma of the endometrium
EI – Lysogenic induction bacteria
FR – P815/Fur (5-fluorouridine) (ascites)
FS – Fibrosarcoma (No. 2)
FU – P815/5-fluorouracil (ascites)
FV – Friend virus leukemia (solid)
GA – Gardner $6C_3HED$ lymphosarcoma
G1 – Glioma 261
G2 – Glioma 26
HE – Hepatoma 129 (mouse)
HE – Cystadenocarcinoma of the liver (No. 1) (hamster)
HE – HeLa human carcinoma (cell culture)
HR – Hep 2/6-mercaptopurine
HX – Hep 2/methotrexate
H1 – HS1 human sarcoma (rat, egg)
H2 – Hep 2 human epidermoid carcinoma
H3 – Hep 3 human epidermoid carcinoma
IC – L1210 intracerebral inoculation (see LE)
IC – Dunning leukemia intracerebral inoculation (see DL)
KB – Human epidermoid carcinoma of the nasopharynx
K4 – AK4 lymphoid leukemia
LB – L1210/B1C, NSC 82196
LC – L1210/cytosine arabinoside, NSC 63878
LD – L1210/D1C, NSC 45388
LE – L1210 lymphoid leukemia
LL – Lewis lung carcinoma
LP – Liposarcoma (No. 1)
LW – L1210/38280 (a terephthalanilide)
LX – L1210/methotrexate
LZ – L1210, subcutaneous (see LE)
L1 – Leiomyosarcoma (No. 1)
L2 – Leiomyosarcoma (No. 2) (hamster)
L2 – Lymphoma 2 (mouse)
L4 – Lymphoma 4
L8 – L5178Y lymphatic leukemia (mouse)
L8 – Lymphoma 8 (rat)
MC – Adenocarcinoma of breast
ME – Mecca lymphosarcoma
ML – L1210/methyl-GAG
MM – Melanotic melanoma
MP – L1210/6-mercaptopurine
MS – Murphy-Sturm lymphosarcoma
M2 – MPC-2 plasma cell
NH – Novikoff hepatoma
NP – Plasmacytoma No. 1/Urea, 1,3-bis (2-chloroethyl)-1-nitroso-
NR – Neurilemmoma No. 1
OG – Osteogenic sarcoma
OS – Osteogenic sarcoma He 10734
PL – P815/vinblastine
PM – Plasmacytoma No. 1/triethylenemelamine
PN – Adenocarcinoma of the pancreas (No. 1)
PR – Adenocarcinoma of prostate
PS – P388 lymphocytic leukemia
PT – Carcinoma of pituitary
PV – P388/vincristine
PW – P388/38280 (a terephthalanilide)
PX – Plasmacytoma No. 1/Cytoxan
P1 – Plasmacytoma No. 1
P2 – Plasmacytoma No. 2B
P4 – P1534 leukemia
P8 – P815 mast cell leukemia (ascites)
P9 – P329 reticulum cell sarcoma
RC – Adenocarcinoma of kidney
RO – Ridgway osteogenic sarcoma

RS – Reticulum cell sarcoma (Kelley) (mouse)
RS – Reticulum cell lymphosarcoma No. 5 (hamster)
SA – Sarcoma 180
SB – Adenocarcinoma of small bowel
TG – Dunning leukemia/thioguanine riboside
WA – Walker carcinosarcoma 256 (subcutaneous)
WC – Walker carcinosarcoma 256/Cytoxan (subcutaneous)
W1 – Walker carcinosarcoma 256 (intraperitoneal) (see WA)
WM*– Walker carcinosarcoma 256 (intramuscular) (see WA)
WP – Walker carcinosarcoma 256 (pulmonary) (see WA)
XE – Eilich ascites tumor enzymes
XL – Mouse L1210
XM – Human leukemia cell enzyme
XW – Human erythrocyte enzyme
XR – Human RBC (whole)
XS – Human RBC (unspecified)
XX – Human RBC (broken)
2X – P288/methotrexate
4A – L4946/azaserine
5P – P335 leukemia
6T – L1210/6-thioguanine
7P – Ca755/6-mercaptopurine (solid)
8C – P1798 cortisone
8P – P1798 lymphosarcoma
25 – Carcinoma 1025
28 – P288 lymphocytic leukemia
49 – L4946 lymphatic leukemia (solid)
81 – P1081 chloroleukemia
91 – S91 Cloudman melanoma
98 – C1498 myeloid leukemia

* WM refers to the intramuscular route and is a discontinued tumor code.

Organism and Compound Index

A. HIGHER PLANTS

B. Higher Plant Components

C. Fungi and Other Lower Plants

D. Fungi and Other Lower Plant Components

E. Animals

F. Animal Components

Bibliography

1. E. M. Acton, K. J. Ryan, D. W. Henry, and L. Goodman. *J. C. S. Chem. Commun.* 986 (1971).
2. H. Agahigian, G. D. Vickers, M. H. von Saltza, Joyce Reid, A. I. Cohen, and H. Gauthier. *J. Org. Chem.* **30**, 1085 (1965).
3. A. Akahori, F. Yasuda, M. Andō, K. Hori, and T. Okanishi. *Chem. Pharm. Bull. (Tokyo)* **20**, 1150 (1972).
4. F. J. Antosz, D. B. Nelson, D. L. Herald, Jr., and M. E. Munk. *J. Amer. Chem. Soc.* **92**, 4933 (1970).
5. F. Arcamone, S. Penco, and A. Vigevani. *Cancer Chemother. Rep.* Pt 3 **6**, 123 (1975).
6. Mrs. A. J. Arif, C. Singh, A. P. Bhaduri, C. M. Gupta, A. W. Khan, and M. M. Dhar. *Indian J. Biochem.* **7**, 193 (1970).
7. B. H. Arison and J. L. Beck. *Tetrahedron* **29**, 2743 (1973).
8. H. R. Arthur, W. H. Hui, and Y. L. Ng. *Chem. Ind. (London)* 1514 (1958).
9. G. P. Bakhaeva, Yu. A. Berlin, E. F. Boldyreva, O. A. Chuprunova, M. N. Kolosov, V. S. Soifer, T. E. Vasiljeva, and I. V. Yartseva. *Tetrahedron Lett.* 3595 (1968).
10. J. R. Beck, R. Kwok, R. N. Booher, A. C. Brown, L. E. Patterson, P. Pranc, B. Rockey, and A. Pohland. *J. Amer. Chem. Soc.* **90**, 4706 (1968).
11. B. K. Bhuyan. *Appl. Microbiol.* **10**, 302 (1962).
12. E. Bianchi, M. E. Caldwell, and J. R. Cole. *J. Pharm. Sci.* **57**, 696 (1968).
13. E. Bianchi and J. R. Cole. *J. Pharm. Sci.* **58**, 589 (1969).
14. E. Bianchi, C. C. J. Culvenor, and J. W. Loder. *Aust. J. Chem.* **21**, 1109 (1968).
15. E. Bianchi, K. Sheth, and J. R. Cole. *Tetrahedron Lett.* 2759 (1969).
16. I. R. C. Bick, P. S. Clezy, and W. D. Crow. *Aust. J. Chem.* **9**, 111 (1956).
17. J. H. Birkinshaw, A. Brachen, E. N. Morgan, and H. Raistrick. *Biochem. J.* **43**, 216 (1948).
18. J. H. Birkinshaw, H. Raistrick, and D. J. Ross. *Biochem. J.* **50**, 630 (1952).
19. M. Boll. *Acta Chem. Scand.* **17**, 1852 (1963).
20. M. G. Brazhnikova, V. B. Zbarsky, V. I. Ponomarenko, and N. P. Potapova. *J. Antibiot. (Tokyo)* **XXVII**, 254 (1974).
21. British 974,541 (Upjohn Co,) Nov. 4, 1964: U.S. Appl. Oct. 26, 1961 [*Chem. Abstr.* **62**, 5855d (1965)].
22. H. Brockmann. *Fortschr. Chem. Org. Naturst.* **18**, 1 (1960).
23. *Cancer Chemother. Rep.* **25**, 1 (1962).
24. *Cancer Chemother. Rep.* **1**, 42 (1959).
25. L. Canonica, B. Rindone, E. Santaniello, and C. Scolastico. *Tetrahedron* **28**, 4395 (1972).
26. B. A. Chabner, P. L. Chello, and J. R. Bertino. *Cancer Res.* **32**, 2114 (1972).
27. S. K. Chakraborti, B. K. De, and T. Bandyopadhyay. *Experientia* **30**, 852 (1974).
28. C-J. Chang, H. G. Floss, P. Soong, and C-T. Chang. *J. Antibiot.* **XXVIII**, 156 (1975).
29. J. R. Cole, E. Bianchi, and E. R. Trumbull. *J. Pharm. Sci.* **58**, 175 (1969).

30. G. A. Cordell and N. R. Farnsworth. *Heterocyles* **4**, 393 (1976).
31. E. J. Corey and B. B. Snider. *J. Amer. Chem. Soc.* **94**, 2549 (1972).
32. C. C. J. Culvenor. *Aust. J. Chem.* **15**, 158 (1962).
33. C. C. J. Culvenor. *J. Pharm. Sci.* **57**, 1112 (1968).
34. M. Curcumelli-Rodostamo and M. Kulka. *The Alkaloids*, Vol. 9, Ed. by R. H. F. Manske, Academic Press, New York, 1967, p. 133.
35. J. H. Cutts. *Proc. Am. Assoc. Cancer Res.* **2**, 289 (1958).
36. J. H. Cutts, C. T. Beer, and R. L. Noble. *Cancer Res.* **20**, 1023 (1960).
37. J. H. Cutts, C. T. Beer, and R. L. Noble. *Rev. Can. Biol.* **16**, 487 (1957).
38. L. K. Dalton, S. Demerac, B. C. Elmes, J. W. Loder, J. M. Swan, and T. Teitei. *Aust. J. Chem.* **20**, 2715 (1967).
39. W. Dalziel, B. Hesp, K. M. Stevenson, and J. A. J. Jarvis. *J. C. S. Perkin Trans.* **I**, 2841 (1973).
40. K. R. Darnall, L. B. Townsend, and R. K. Robins. *Proc. Nat. Acad. Sci. U.S.* **57**, 548 (1967).
41. G. D. Daves, Jr., R. K. Robins, and C. C. Cheng. *J. Org. Chem.* **26**, 5256 (1961).
42. F. Delle Monache, G. Marini-Bettalo, O. Goncalves de Lima, I. D'Albuqerque, and J. Côelho. *Gazz. Chim. Ital.* **102**, 317 (1972).
43. A. DiMarco, M. Gaetani, and B. Scarpinato. *Cancer Chemother. Rep.* **53**, 33 (1969).
44. R. W. Doskotch and F. S. El-Feraly. *J. Pharm. Sci.* **58**, 877 (1969).
45. R. W. Doskotch and C. D. Hufford. *J. Pharm. Sci.* **58**, 186 (1969).
46. R. W. Doskotch, S. L. Keely, Jr., and C. D. Hufford. *J. C. S. Chem. Commun.* 1137 (1972).
47. R. W. Doskotch, M. Y. Malik, and J. L. Beal. *Lloydia* **32**, 115 (1969).
48. R. W. Doskotch, M. Y. Malik, C. D. Hufford, S. N. Malik, J. E. Trent, and W. Kubelka. *J. Pharm. Sci.* **61**, 570 (1972).
48a. J. D. Douros, private communication.
49. C. Djerassi, S. K. Figdor, J. M. Bobbitt, and F. X. Markley. *J. Amer. Chem. Soc.* **79**, 2203 (1957).
50. T. A. Dullforce, G. A. Sim, D. N. J. White, J. E. Kelsey, and S. M. Kupchan. *Tetrahedron Lett.* 973 (1969).
51. J. D. Dutcher, M. H. Von Saltza, and F. E. Pansy. *Antimicrob. Agents Chemother.* 83 (1963).
52. L. R. Duvall. *Cancer Chemother. Rep.* No. 30, 55 (1963).
53. T. E. Eble, E. C. Olsen, C. M. Large, and J. W. Shell. *Antibiot. Ann.* 227 (1959–1960).
54. P. R. Enslin, J. M. Hugo, K. B. Norton, and D. E. A. Rivett. *J. Chem. Soc.* 4787 (1960).
55. P. R. Enslin, J. M. Hugo, K. B. Norton, and D. E. A. Rivett. *J. Chem. Soc.* 4779 (1960).
56. N. R. Farnsworth. *J. Pharm. Sci.* **61**, 1840 (1972).
57. N. R. Farnsworth, N. K. Hart, S. R. Johns, J. A. Lamberton, and W. Messmer. *Aust. J. Chem.* **22**, 1805 (1969).
58. H. Faulstich and M. Weckauf-Bloching. *Hoppe-Seyler's Z. Physiol. Chem.* **355**, 1489 (1974).
59. H. Faulstich, S. Zobeley, and M. Weckauf-Bloching. *Hoppe-Seyler's Z. Physiol. Chem.* **355**, 1495 (1974).
59a. J. Ferluga and A. C. Allison. *Nature* **255**, 708 (1975).
60. L. F. and M. Fieser. *Steroids*. Reinhold Publishing Corporation, New York, 1959.
61. R. M. Folk. A. C. Peters, K. L. Pavkov, and J. A. Swenberg. *Cancer Chemother. Rep.* Pt 3 **5**, 37 (1974).
62. M. Furukawa, I. Hayakawa, and G. Ohta. *Tetrahedron* **31**, 2989 (1975).
63. J. Fuska, L. Ivanitskaya, K. Horakova, and I. Kuhr. *J. Antibiot.* **XXVII**, 141 (1974).
64. J. Fuska, I. Kuhr, P. Nemec, and A. Fuskova. *J. Antibiot.* **XXVII**, 123 (1974).
65. M. Gates. *J. Amer. Chem. Soc.* **70**, 617 (1948).
66. G. F. Gause. "Sibiromycin," in *Antibiotics*, Vol. III, "Mechanism of Action of Antimicrobial and Antitumor Agents," Ed. by J. W. Corcoran and F. E. Hahn. Springer-Verlag, New York, 1975, p. 269.
67. G. F. Gause, M. G. Brazhnikova and V. A. Shorin. *Cancer Chemother. Rep.* Pt 1 **58**, 255 (1974).

68. E. Gellert and R. Rudzats. *J. Med. Chem.* **7**, 361 (1964).
69. R. I. Geran, N. H. Greenberg, M. M. MacDonald, A. M. Schumacher, and B. J. Abbott. *Cancer Chemother. Rep.* Pt 3 **3**, No. 2 (1972).
70. M. Ghione. *Cancer Chemother. Rep.* Pt 3 **6**, 83 (1975).
71. B. Gilbert. *The Alkaloids*, Vol. 8, Ed. by R. H. F. Manske. Academic Press, New York, 1965, p. 335.
72. I. H. Goldberg. "Pactamycin." in *Antibiotics*, Vol. III, "Mechanism of Action of Antimicrobial and Antitumor Agents," Ed. by J. W. Corcoran and F. E. Hahn. Springer-Verlag, New York, 1975, p. 498.
73. A. Goldin and R. K. Johnson. *Cancer Chemother. Rep.* Pt 1 **58**, 63 (1974).
74. K. W. Gopinath, T. R. Govindachari, P. C. Parthasarathy, and N. Viswanathan. *J. Chem. Soc.* 4012 (1959).
75. K. W. Gopinath, J. M. Kohli, M. S. Y. Khan, and A. R. Kidwai. *Indian J. Chem.* **1**, 99 (1968).
76. T. R. Govindachari. "Tylophora Alkaloids," Chapter 13, in *The Alkaloids*, Vol. 9, Ed. by R. H. F. Manske. Academic Press, New York, 1967, p. 517.
77. F. E. Hahn. "Distamycin A and Netropsin," in *Antibiotics*, Vol. III, "Mechanism of Action of Antimicrobial and Antitumor Agents," Ed. by J. W. Corcoran and F. E. Hahn. Springer-Verlag, New York, 1975, p. 79.
78. E. Härri, W. Loeffler, H. P. Sigg, H. Stahelin, C. Stoll, C. Tamm, and D. Wiesinger. *Helv. Chim. Acta* **45**, 839 (1962).
79. J. L. Hartwell. *Lloydia* **30**, 379 (1967).
80. J. L. Hartwell and B. J. Abbott. *Adv. Pharmacol. and Chemother.* **7**, 117 (1969).
81. J. L. Hartwell and W. E. Detty. *J. Amer. Chem. Soc.* **72**, 246 (1950).
82. C. H. Hassall and K. Reyle. *J. Chem. Soc.* 85 (1959).
83. Y. Hatsuda and S. Kuyama. *J. Agr. Chem. Soc. Jap.* **28**, 989 (1954) [*Chem. Abstr.* **50**, 15522d (1956)].
84. Y. Hatsuda, S. Kuyama, and N. Terashima. *J. Agr. Chem. Soc. Jap.* **28**, 992 and 998 (1954) [*Chem. Abstr.* **50**, 15522h (1956)].
85. P. Hauschild-Rogat, J. V. Euw, O. Schindler, E. Weiss, and T. Reichstein. *Helv. Chim. Acta* **45**, 2116 (1962).
86. P. Hauschild-Rogat, E. Weiss, and T. Reichstein. *Helv. Chim. Acta* **50**, 2299 (1967).
87. W. Herz, K. Aota, A. L. Hall, and A. Srinivasan. *J. Org. Chem.* **39**, 2013 (1974).
88. W. Herz and G. Högenauer. *J. Org. Chem.* **27**, 905 (1962).
89. W. Herz, R. B. Mitra, K. Rabindran, and N. Viswanathan. *J. Org. Chem.* **27**, 4041 (1962).
90. W. Herz, J. Poplawski, and R. P. Sharma. *J. Org. Chem.* **40**, 199 (1975).
91. W. Herz, A. Romo de Vivar, and M. V. Lakshmikanthan. *J. Org. Chem.* **30**, 118 (1965).
92. W. Herz and S. K. Roy. *Phytochemistry* **8**, 661 (1969).
93. W. Herz, P. S. Santhanam, P. S. Subramaniam, and J. J. Schmid. *Tetrahedron Lett.* 3111 (1967).
94. W. Herz and N. Viswanathan. *J. Org. Chem.* **29**, 1022 (1964).
95. W. Herz and I. Wahlberg. *J. Org. Chem.* **38**, 2485 (1973).
96. J. C. Hess, A. Hunger, and T. Reichstein. *Helv. Chim. Acta* **35**, 2202 (1952).
97. E. J. Hessler and H. K. Jahnke. *J. Org. Chem.* **35**, 245 (1970).
98. H. Hojo, M. Uchiyama, and S. Suzuki. *J. Pharm. Soc. (Japan)* 947 (1973).
99. J. S. E. Holker and S. A. Kagal. *J. C. S. Chem. Commun.* 1574 (1968).
100. L. H. Hurley and M. Zmijewski. *J. C. S. Chem. Commun.* 337 (1974).
101. T. Ikekawa, M. Sano, M. Okabe, and F. Fukuoka. *Chem. Pharm. Bull. (Tokyo)* **23**, 2148 (1975).
102. E. Iseli, M. Kotake, E. Weiss, and T. Reichstein. *Helv. Chim. Acta* **48**, 1093 (1965).
103. K. Isono. *J. Antibiot. (Tokyo)* Sec. A 14, 160 (1961).
103a. H. J. Issaq, E. W. Barr, T. Wei, C. Meyers, and A. Aszalos, Private communication.
104. G. W. Ivie, D. A. Witzel, and D. D. Rushing. *J. Agr. Food Chem.* **23**, 845 (1975).
105. A. I. Jada. *Diss. Abstr. Int. B* **32**, 194 (1971).

106. P. R. Jefferies, J. R. Knox, K. R. Price, and B. Scaf. *Aust. J. Chem.* **27**, 221 (1974).
107. I. S. Johnson. "Plant Alkaloids," Section XIII, in *Cancer Medicine,* Ed. by J. F. Holland and E. Frei, III. Lea and Febiger, Philadelphia, 1973, p. 840.
108. S. D. Jolad, R. M. Wiedhopf, and J. R. Cole. *J. Pharm. Sci.* **64**, 1889 (1975).
109. S. D. Jolad, R. M. Wiedhopf, and J. R. Cole. *J. Pharm. Sci.* **63**, 1321 (1974).
110. E. A. Kaczka, C. O. Gitterman, E. L. Dulaney, and K. Folkers. *Biochemistry* **1**, 340 (1962).
111. Y. Kamano and G. R. Pettit. *J. Org. Chem.* **39**, 2629 (1974).
112. Y. Kamano and G. R. Pettit. *J. Org. Chem.* **38**, 2202 (1973).
113. Y. Kamano, G. R. Pettit, and M. Inoue. *J. Org. Chem.* **39**, 3007 (1974).
114. Y. Kameda, S. Ouhira, K. Matsui, S. Kanatomo, T. Hase, and T. Atsusaka. *Chem. Pharm. Bull. (Tokyo)* **22**, 938 (1974).
115. N. Kanda, M. Kono, and K. Asano. *J. Antibiot. (Tokyo)* 553 (1972).
116. G. Kapadia. *J. Pharm. Sci.* **58**, 1555 (1969).
117. G. J. Kapadia. *J. Pharm. Sci.* **54**, 1834 (1965).
118. B. Karlsson, A-M. Pilotti, A-C. Wiehager, I. Wahlberg, and W. Herz. *Tetrahedron Lett.* 2245 (1975).
119. W. Keller-Schierlein, M. L. Mihailović, and V. Prelog. *Helv. Chim. Acta* **42**, 305 (1959).
120. R. B. Kelly, E. G. Daniels, and L. B. Spaulding. *J. Med. Chem.* **8**, 547 (1965).
121. H. K. Kim, N. R. Farnsworth, H. H. S. Fong, R. N. Blomster, and G. J. Persinos. *Lloydia* **33**, 30 (1970).
122. D. G. I. Kingston and T. Reichstein. *J. Pharm. Sci.* **63**, 462 (1974).
123. J. Konopa, A. Matuszkiewicz, M. Hrabowska, and K. Onoszka. *Arzneimittelforschung (Drug Res.)* **24**, 1741 (1974).
124. N. Höriger, D. Živanov, H. H. H. Linde, and K. Meyer. *Helv. Chim. Acta* **55**, 2549 (1972).
125. N. M. Kredich and A. J. Guarino. *Biochim. Biophys. Acta* **41**, 363 (1960) [*C. A.* **74**, 83042s (1971)].
126. A. M. Kuck, S. M. Albonico, and V. Deulofeu. *Chem. Ind. (London)* 945 (1966).
127. I. Kuhr, J. Fuska, P. Sedmera, M. Podojil, J. Vokoun, and Z. Vanek. *J. Antibiot. (Tokyo)* **XXVI**, 535 (1973).
128. S. M. Kupchan. *Pure Appl. Chem.* **21**, 227 (1970).
129. S. M. Kupchan, W. K. Anderson, P. Bollinger, R. W. Doskotch, R. M. Smith, J. A. Saenz Renauld, H. K. Schnoes, A. L. Burlingame, and D. H. Smith. *J. Org. Chem.* **34**, 3858 (1969).
130. S. M. Kupchan, Y. Aynehchi, J. M. Cassady, H. K. Schnoes, and A. L. Burlingame. *J. Org. Chem.* **34**, 3867 (1969).
131. S. M. Kupchan and R. L. Baxter. *Science* **187**, 652 (1975).
132. S. M. Kupchan, R. L. Baxter, C-K. Chiang, C. J. Gilmore, and R. F. Bryan. *J. C. S. Chem. Commun.* 842 (1973).
133. S. M. Kupchan, R. L. Baxter, M. F. Ziegler, P. M. Smith, and R. F. Bryan. *Experientia* **31**, 137 (1975).
134. S. M. Kupchan, A. R. Branfman, A. T. Sneden, A. K. Verma, R. G. Dailey, Jr., Y. Komoda, and Y. Nagao. *J. Amer. Chem. Soc.* **97**, 5294 (1975).
135. S. M. Kupchan, R. W. Britton, C. K. Chiang, N. NayanAlpan, and M. F. Ziegler. *Lloydia* **36**, 338 (1973).
136. S. M. Kupchan, R. W. Britton, J. A. Lacadie, M. F. Ziegler, and C. W. Sigel. *J. Org. Chem.* **40**, 648 (1975).
137. S. M. Kupchan, R. W. Britton, M. F. Ziegler, C. J. Gilmore, R. J. Restivo, and R. F. Bryan. *J. Am. Chem. Soc.* **95**, 1335 (1973).
138. S. M. Kupchan, R. W. Britton, M. F. Ziegler, and C. W. Sigel. *J. Org. Chem.* **38**, 178 (1973).
139. S. M. Kupchan, J. M. Cassidy, J. E. Kelsey, H. K. Schnoes, D. H. Smith, and A. L. Burlingame. *J. Amer. Chem. Soc.* **88**, 5292 (1966).
140. S. M. Kupchan, W. A. Court, R. G. Dailey, Jr., C. J. Gilmore, and R. F. Bryan. *J. Amer. Chem. Soc.* **94**, 7194 (1972).
141. S. M. Kupchan, A. P. Davies, S. J. Barboutis, H. K. Schnoes, and A. L. Burlingame. *J. Org. Chem.* **34**, 3888 (1969).

142. S. M. Kupchan, V. H. Davies, T. Fujita, M. R. Cox, R. J. Restivo, and R. F. Bryan. *J. Org. Chem.* **38**, 1853 (1973).
143. S. M. Kupchan, A. L. Dessertine, B. T. Blaylock, and R. F. Bryan, *J. Org. Chem.* **39**, 2477 (1974).
144. S. M. Kupchan and R. W. Doskotch. *J. Med. Pharm. Chem.* **5**, 657 (1962).
145. S. M. Kupchan, M. A. Eakin, and A. M. Thomas. *J. Med. Chem.* **14**, 1147 (1971).
146. S. M. Kupchan, T. Fujita, M. Maruyama, and R. W. Britton. *J. Org. Chem.* **38**, 1260 (1973).
147. S. M. Kupchan, A. H. Gray, and M. D. Grove. *J. Med. Chem.* **10**, 337 (1967).
148. S. M. Kupchan, R. J. Hemingway, and R. W. Doskotch. *J. Med. Chem.* **7**, 803 (1964).
149. S. M. Kupchan, R. J. Hemingway, and J. C. Hemingway. *J. Org. Chem.* **34**, 3894 (1969).
150. S. M. Kupchan, R. J. Hemingway, A. Karim, and D. Werner. *J. Org. Chem.* **34**, 3908 (1969).
151. S. M. Kupchan, R. J. Hemingway, J. R. Knox, S. J. Barboutis, D. Werner, and M. A. Barboutis. *J. Pharm. Sci.* **56**, 603 (1967).
152. S. M. Kupchan, R. J. Hemingway, and R. M. Smith. *J. Org. Chem.* **34**, 3898 (1969).
153. S. M. Kupchan, R. J. Hemingway, D. Werner, and A. Karim. *J. Org. Chem.* **34**, 3903 (1969).
154. S. M. Kupchan, A. Karim, and C. Marcks. *J. Org. Chem.* **34**, 3912 (1969).
155. S. M. Kupchan, J. E. Kelsey, M. Maruyama, J. M. Cassady, J. C. Hemingway, and J. R. Knox. *J. Org. Chem.* **34**, 3876 (1969).
156. S. M. Kupchan, Y. Komoda, A. R. Branfman, R. G. Dailey, Jr., and V. A. Zimmerly. *J. Amer. Chem. Soc.* **96**, 3706 (1974).
157. S. M. Kupchan, Y. Komoda, W. A. Court, G. J. Thomas, R. M. Smith, A. Karim, C. J. Gilmore, R. C. Haltiwanger, and R. F. Bryan. *J. Amer. Chem. Soc.* **94**, 1354 (1972).
157a. S. M. Kupchan, Y. Komoda, G. J. Thomas, and H. P. J. Hintz, *J. C. S. Chem. Commun* 1065 (1972).
158. S. M. Kupchan, S. Kubota, E. Fujita, S. Kobayashi, J. H. Block, and S. A. Telang. *J. Amer. Chem. Soc.* **88**, 4212 (1966).
159. S. M. Kupchan and J. A. Lacadie. *J. Org. Chem.* **40**, 654 (1975).
160. S. M. Kupchan, A. J. Liepa, R. L. Baxter, and H. P. J. Hintz. *J. Org. Chem.* **38**, 1846 (1973).
161. S. M. Kupchan, M. Maruyama, R. J. Hemingway, J. C. Hemingway, S. Shibuya, and T. Fujita. *J. Org. Chem.* **38**, 2189 (1973).
162. S. M. Kupchan, J. L. Moniot, C. W. Sigel, and R. J. Hemingway. *J. Org. Chem.* **36**, 2611 (1971).
163. S. M. Kupchan, C. W. Sigel, L. J. Guttmann, R. J. Restivo, and R. F. Bryan. *J. Amer. Chem. Soc.* **94**, 1353 (1972).
164. S. M. Kupchan, C. W. Sigel, R. J. Hemingway, J. R. Knox, and M. S. Udayamurthy. *Tetrahedron* **25**, 1603 (1969).
165. S. M. Kupchan, C. W. Sigel, J. R. Knox, and M. S. Udayamurthy. *J. Org. Chem.* **34**, 1460 (1969).
166. S. M. Kupchan, C. W. Sigel, M. J. Matz, J. A. S. Renauld, R. C. Haltiwanger, and R. F. Bryan. *J. Amer. Chem. Soc.* **92**, 4476 (1970).
167. S. M. Kupchan, P. S. Steyn, M. D. Grove, S. M. Horsfield, and S. W. Meitner. *J. Med. Chem.* **12**, 167 (1969).
168. S. M. Kupchan, J. G. Sweeny, R. L. Baxter, T. Murae, V. A. Zimmerly, and B. R. Sickles. *J. Amer. Chem. Soc.* **97**, 672 (1975).
169. S. M. Kupchan, M. Takasugi, R. M. Smith, and P. S. Steyn. *J. Org. Chem.* **36**, 1972 (1971).
170. S. M. Kupchan and G. Tsou. *J. Org. Chem.* **38**, 1055 (1973).
171. S. M. Kupchan, G. Tsou, and C. W. Sigel, *J. Org. Chem.* **38**, 1420 (1973).
172. S. M. Kupchan, I. Uchida, A. R. Branfman, R. G. Dailey, Jr., and B. Y. Fei. *Science* **191**, 571 (1976).
173. S. M. Kupchan, T-H. Yang, G. S. Vasilikiotis, M. H. Barnes, and M. L. King. *J. Org. Chem.* **34**, 3884 (1969).
174. S. M. Kupchan, N. Yokoyama, and B. S. Thyagarajan. *J. Pharm. Sci.* **50**, 164 (1961).
175. K. H. Lee, H. Furukawa, M. Kozuka, H. C. Huang, P. A. Luhan, and A. T. McPhail. *J. C. S. Chem. Commun.* 476 (1973).

176. K. H. Lee, T. Ibuka, H-C. Huang, and D. L. Harris, *J. Pharm. Sci.* **64**, 1077 (1975).
177. K. H. Lee, T. Ibuka, M. Kozuka, A. T. McPhail, and K. D. Onan. *Tetrahedron Lett.* 2287 (1974).
178. K. H. Lee, T. Ibuka, A. T. McPhail, K. D. Onan, T. A. Geissman, and T. G. Waddell. *Tetrahedron Lett.* 1149 (1974).
179. W. Leimgruber, A. D. Batcho, and R. C. Czajkowski. *J. Amer. Chem. Soc.* **90**, 5641 (1968).
180. W. Leimgruber, V. Stefanović, F. Schenker, A. Karr, and J. Berger, *J. Amer. Chem. Soc.* **87**, 5791 (1965).
181. S. Lepetit. *Chem. Abstr.* **65**, 1345g (1966).
182. H. Lin, W. R. Bruce, and M. J. Walcroft. *Cancer Chemother. Rep.* Pt 1 **59**, 319 (1975).
183. J. W. Loder, C. C. J. Culvenor, R. H. Nearn, G. B. Russell, and D. W. Stanton. *Aust. J. Chem.* **27**, 179 (1974).
184. J. W. Loder and R. H. Nearn. *Tetrahedron Lett.* 2497 (1975).
185. J. W. Loder and R. H. Nearn. *Aust. J. Chem.* **25**, 2193 (1972).
186. W. Loeffler, R. Mauli, M. E. Ruesch, and H. Staehelin. *Chem. Abstr.* **62**, 5856d (1965).
187. W. D. Loub, H. H. S. Fong, M. Theiner, and N. R. Farnsworth. *J. Pharm. Sci.* **62**, 149 (1973).
188. C. D. Lozvio and B. B. Lozvio. *J. Nat. Cancer Inst.* **50**, 535 (1973).
189. P. L. MacDonald and A. V. Robertson. *Aust. J. Chem.* **19**, 275 (1966).
190. T. J. McBride, M. Axelrod, and W. P. Cullen. *Proc. Soc. Exp. Biol. Med.* **130**, 1188 (1969).
191. J. R. McCarthy, R. K. Robins, and M. J. Robins. *J. Amer. Chem. Soc.* **90**, 4993 (1968).
192. P. M. McCurry and K. Abe. *Tetrahedron Lett* 4103 (1973).
193. T. C. McMorris and M. Anchel. *J. Amer. Chem. Soc.* **87**, 1594 (1965).
194. A. T. McPhail, K. D. Onan, K. H. Lee, T. Ibuka, and H. C. Huang. *Tetrahedron Lett.* 3203 (1974).
195. A. T. McPhail, K. D. Onan, K. H. Lee, I. Ibuka, M. Kozuka, T. Shingu, and H. C. Huang. *Tetrahedron Lett.* 2739 (1974).
196. H. Maeda. *J. Antibiot. (Tokyo).* **XXVII**, 303 (1974).
197. C. Mannich and G. Siewert. *Chem. Ber.* **75**, 737, 750 (1942).
198. W. H. Marks, H. H. S. Fong, M. Tin-Wa, and N. R. Farnswoth. *J. Pharm. Sci.* **64**, 1674 (1975).
199. J. A. Marshall and N. Cohen. *J. Org. Chem.* **29**, 3727 (1964).
200. D. G. Martin, C. G. Chidester, S. A. Mizsak, D. J. Duchamp, L. Baczynskyj, W. C. Krueger, R. J. Wnuk, and P. A. Meulman. *J. Antibiot. (Tokyo)* **XXVIII**, 91 (1975).
201. D. G. Martin, D. J. Duchamp, and C. G. Chidester. *Tetrahedron Lett.* 2549 (1973).
202. D. G. Martin, L. J. Hanka, and G. L. Neil. *Cancer Chemother. Rep.* Pt 1 **58**, 935 (1974).
203. S. Marumo, K. Sasaki, and S. Suzuki. *J. Amer. Chem. Soc.* **86**, 4507 (1964).
204. T. Matsumoto, H. Shirahama, A. Ichihara, Y. Fukuoka, Y. Takahashi, Y. Mori, and M. Watanabe. *Tetrahedron* **21**, 2671 (1965).
205. A. R. Mattocks. *J. Chem. Soc. (C)* 329 (1967).
206. J. Meienhofer. *Experientia* **21**, 776 (1968).
207. J. Meienhofer, H. Maeda, C. B. Glaser, J. Czombos, and K. Kuromizu. *Science* **178**, 875 (1972).
208. W. A. Messmer, M. Tin-Wa, H. H. S. Fong, C. Bevelle, N. R. Farnsworth, D. J. Abraham, and J. Trojánek. *J. Pharm. Sci.* **61**, 1858 (1972).
209. K. Meyer. *Helv. Chim. Acta* **35**, 2444 (1952).
210. K. L. Mikolajczak, R. G. Powell, and C. R. Smith. *Tetrahedron* **28**, 1995 (1972).
211. H. Minato, M. Matsumoto, and T. Katayama. *J. C. S. Perkin Trans.* **I**, 1819 (1973).
212. M. Miyamoto, Y. Kawamatsu, K. Kawashima, M. Shinohara, K. Tanaka, S. Tatsuoka, and K. Nakanishi. *Tetrahedron* **23**, 421 (1967).
213. C. G. Moertel, A. J. Schutt, R. G. Hahn, and R. J. Reitemeier. *Cancer Chemother. Rep.* **58**, 229 (1974).
213a. S. Nakamura, K. Maeda, and H. Umezawa. *J. Antibiot. (Tokyo)* Ser. A **XVII**, 33 (1964).

214. K. Nakanishi, M. Ohashi, M. Tada, and Y. Yamada. *Tetrahedron* **21**, 1231 (1965).
215. Y. Nakayama, M. Kunishima, S. Omoto, T. Takita, and H. Umezawa. *J. Antibiot. (Tokyo)* **XXVI**, 400 (1973).
216. N. Neuss, M. Gorman, and I. S. Johnson. "Natural Products in Cancer Chemotherapy," Chapter X, in *Methods in Cancer Research*, Vol. III, Ed. by H. Busch. Academic Press, New York, 1967, p. 633.
217. Y. Nishikawa, K. Ohki, K. Takahashi, G. Kurono, F. Fukuoka, and M. Emori. *Chem. Pharm. Bull.* **22**, 2692 (1974).
218. H. Nishimura, M. Mayama, Y. Komatsu, H. Kato, N. Shimaoka, and Y. Tanaka. *J. Antibiot. (Tokyo)* **XVII**, 148 (1964).
219. R. L. Noble, C. T. Beer, and J. H. Cutts. *Ann. N. Y. Acad. Sci.* **76**, 882 (1958).
220. T. R. Norton and M. Kashiwagi. *J. Pharm. Sci.* **61**, 1814 (1972).
221. T. R. Norton, M. Kashiwagi, and R. J. Quinn. *J. Pharm. Sci.* **62**, 1464 (1973).
222. D. L. Herald, Jr., R. H. Ode, and G. R. Pettit. *J. Chromatogr. Sci.* **14**, 356 (1976).
223. T. Okazaki, T. Kitahara, and Y. Okami. *J. Antibiot. (Tokyo)* **XXVIII**, 176 (1975).
224. T. Oki, A. Yoshimoto, Y. Matsuzawa, S. Hori, H. Tone, A. Takamatsu, T. Takeuchi, M. Ishizuka, M. Hamada, and H. Umezawa. *J. Antibiot. (Tokyo)* **XXVIII**, 479 (1975).
225. S. P. Owen and C. G. Smith. *Cancer Chemother. Rep.* **36**, 19 (1964).
226. R. P. Panzica and L. B. Townsend. *J. Amer. Chem. Soc.* **95**, 8737 (1973).
227. N. A. Pasternak, N. V. Pokidova, V. A. Shenderovich, I. V. Kolosova, and Z. V. Ermolieva. *Antibiotiki* **18**, 227 (1973).
228. E. L. Patterson, B. L. Johnson, S. E. DeVoe, and N. Bohonos. *Antimicrob. Agents Chemother.* 115 (1965).
229. G. R. Pettit, unpublished results.
230. G. R. Pettit. *Synthetic Peptides*, Vol. 4. Elsevier Scientific Pub. Co., Amsterdam, The Netherlands, 1976.
231. G. R. Pettit. *Biosynthetic Products for Cancer Chemotherapy*, Vol. 1. Plenum Pub. Corp., New York, 1977.
232. G. R. Pettit, and D. S. Alkalay. *J. Org. Chem.* **25**, 1363 (1960).
233. G. R. Pettit, J. C. Budzinski, G. M. Cragg, P. Brown, and L. D. Johnston. *J. Med. Chem.* **17**, 1013 (1974).
234. G. R. Pettit, J. J. Einck, C. L. Herald, R. H. Ode, R. B. Von Dreele, P. Brown, M. G. Brazhnikova, and G. F. Gause. *J. Amer. Chem. Soc.* **97**, 7387 (1975).
235. G. R. Pettit and S. K. Gupta. *Can. J. Chem.* **45**, 1561 (1967).
236. G. R. Pettit, C. L. Herald, M. S. Allen, R. B. Von Dreele, L. D. Vanell, J. Kao, and W. Blake. *J. Amer. Chem. Soc.* **99**, 262 (1977).
237. G. R. Pettit, C. L. Herald, and D. L. Herald. *J. Pharm. Sci.* **65**, 1558 (1976).
238. G. R. Pettit, C. L. Herald, G. F. Judd, G. Bolliger, and P. S. Thayer. *J. Pharm. Sci.* **64**, 2023 (1975).
239. G. R. Pettit and L. E. Houghton. *J. Chem. Soc. (C)* 509 (1971).
240. G. R. Pettit, L. E. Houghton, N. H. Rogers, R. M. Coomes, D. F. Berger, P. R. Reucroft, J. F. Day, J. L. Hartwell, and H. B. Wood, Jr. *Experientia* **28**, 382 (1972).
241. G. R. Pettit and Y. Kamano, unpublished results.
242. G. R. Pettit and Y. Kamano. *J. Org. Chem.* **39**, 3003 (1974).
243. G. R. Pettit and Y. Kamano. *J. Org. Chem.* **39**, 2632 (1974).
244. G. R. Pettit and Y. Kamano. *J. Org. Chem.* **37**, 4040 (1972).
245. G. R. Pettit, Y. Kamano, F. Bruschweiler, and P. Brown. *J. Org. Chem.* **36**, 3736 (1971).
246. G. R. Pettit and R. H. Ode. *Lloydia* **39**, 129 (1976).
247. G. R. Pettit, R. H. Ode, R. M. Coomes, and S. L. Ode. *Lloydia* **39**, 363 (1976).
248. G. R. Pettit, R. H. Ode, and T. B. Harvey, III. *Lloydia* **36**, 204 (1973).
249. G. R. Pettit, R. H. Ode, C. L. Herald, R. B. Von Dreele, and C. Michel. *J. Amer. Chem. Soc.* **98**, 4677 (1976).
250. G. R. Pettit, E. I. Saldana, and E. Lehto. *Lloydia* **37**, 539 (1974).

251. G. R. Pettit, P. M. Traxler, and C. P. Pase. *Lloydia* **36**, 202 (1973).
252. G. R. Pettit, R. B. Von Dreele, G. Bolliger, P. M. Traxler, and P. Brown. *Experientia* **29**, 521 (1973).
253. G. R. Pettit, R. B. Von Dreele, D. L. Herald, M. T. Edgar, and H. B. Wood, Jr. *J. Amer. Chem. Soc.* **98**, 6742 (1976).
254. R. F. Pittillo, M. Lucas, C. Wooley, R. T. Blackwell, and C. Moncrief. *Nature* **205**, 773 (1965).
255. R. G. Powell, D. Weisleder, and C. R. Smith, Jr. *J. Pharm. Sci.* **61**, 1227 (1972).
256. R. J. Quinn, M. Kashiwagi, R. E. Moore, and T. R. Norton. *J. Pharm. Sci.* **63**, 257 (1974).
257. R. J. Quinn. M. Kashiwagi, T. R. Norton, S. Shibata, M. Kuchii, and R. E. Moore. *J. Pharm. Sci.* **63**, 1798 (1974).
258. R. F. Raffauf, P-K. C. Huang, P. W. LeQuesne, S. B. Levery, and T. F. Brennan. *J. Amer. Chem. Soc.* **97**, 6884 (1975).
259. K. V. Rao. *J. Med. Chem.* **11**. 939 (1968).
260. K. V. Rao, K. Beimann, and R. B. Woodward. *J. Amer. Chem. Soc.* **85**, 2532 (1963).
261. K. V. Rao and W. P. Cullen. *J. Amer. Chem. Soc.* **82**, 1127 (1960).
262. K. V. Rao, W. P. Cullen, and B. A. Sobin. *Antitumor Antibiotic* **XII**, 182 (1962).
263. A. S. Rao, G. R. Kelkar, and S. C. Bhattacharya. *Tetrahedron* **9**, 275 (1960).
264. K. L. Rinehart, M. L. Maheshwari, F. J. Antosz, H. H. Mathur, K. Sasaki, and R. J. Schacht. *J. Amer. Chem. Soc.* **93**, 6273 (1971).
265. J. Romo and A. Romo de Vivar. *Fortschr. Chem. Org. Naturst.* **25**, 90 (1967).
266. P. Rondini and V. Carminati. *Z. Krebsforsch. Klin. Onkol.* **31**, 577 (1930).
267. J. Ruckstuhl and K. Meyer. *Helv. Chim. Acta* **41**, 2121 (1958).
268. J. S. Sandberg, F. L. Howsden, A. DiMarco, and A. Goldin. *Cancer Chemother. Rep.* Pt 1 **54**, 1 (1970).
269. W. Sandermann and M. H. Simatupang. *Chem. Ber.* **97**, 588 (1964).
270. J. P. S. Sarin, H. S. Garg, N. M. Khanna, and M. H. Dhar. *Phytochemistry* **12**, 2461 (1973).
271. T. Sasaki, Y. Arai, T. Ikekawa, G. Chihara, and F. Fukuoka. *Chem. Pharm. Bull.* **19**, 821 (1971).
272. T. Sasaki and N. Otake. *J. Antibiot. (Tokyo)* **XXVIII**, 552 (1975).
273. K. Satoh, K. Komiyama, C. Kitao, Y. Iwai, K. Atsumi, R. Oiwa, M. Katagiri, I. Umezawa, S. Ōmura, and T. Hata. *J. Antibiot. (Tokyo)* **XXVII**, 620 (1974).
274. W. Schegel, Ch. Tamm, and T. Reichstein. *Helv. Chim. Acta* **38**, 1013 (1955).
275. F. A. Schmid and J. Roberts. *Cancer Chemother. Rep.* Pt I **58**, 829 (1974).
276. W. Schroeder and H. Hoeksema. *J. Amer. Chem. Soc.* **81**, 1767 (1959).
277. N. K. Sen, J. K. Chakrabarti, W. Kreis, Ch. Tamm, and T. Reichstein. *Helv. Chim. Acta* **40**, 588 (1957).
278. K. Sheth, E. Bianchi, R. Wiedhopf, and J. R. Cole. *J. Pharm. Sci.* **62**, 139 (1973).
279. K. Sheth, S. Jolad, R. Wiedhopf, and J. R. Cole. *J. Pharm. Sci.* **61**, 1819 (1972).
280. S. Siddiqui, D. Firat, and S. Olshin. *Cancer Chemother. Rep.* Pt I **57**, 423 (1973).
281. P. P. Singh, R. L. Whistler, R. Tokuzen, and W. Nakahara. *Carbohyd. Res.* **37**, 245 (1974).
282. P. E. Sonnet and M. Jacobson. *J. Pharm. Sci.* **60**, 1254 (1971).
283. R. L Stevens and T. F. Emery. *Biochemistry* **5**, 74 (1966).
284. C. L. Stevens, K. Grant Taylor, M. E. Munk, W. S. Marshall, K. Noll, G. D. Shah, L. G. Shah, and K. Uzu. *J. Med. Chem.* **8**, 1 (1964).
285. C. C. Stock, H. C. Reilly, S. M. Buckley, D. A. Clark, and C. P. Rhoads. *Nature* **173**, 71 (1954).
286. A. Stoll and W. Kreis. *Helv. Chim. Acta* **17**, 592 (1934).
287. A. Stoll and J. Renz. *Helv. Chim. Acta* **33**, 286 (1950).
288. A. Stoll, J. Renz, and A. Brack. *Helv. Chim. Acta* **35**, 1934 (1952).
289. A. Stoll, A. V. Wartburg, and J. Renz. *Helv. Chim. Acta* **36**, 1531, 1557 (1953).
290. See ref. 59a.
291. V. V. Subba Reddy, H. N. Jayaram, M. Sirsi, and T. Ramakrishnan. *Arch. Biochem. Biophys.* **132**, 262 (1969).

292. Y. Sumiki, K. Isono, J. Nagatsu, and T. Takauchi. *J. Antibiot.* Ser. A **13**, 416 (1960).
293. G. H. Svoboda. *Lloydia* **24**, 173 (1961).
294. G. H. Svoboda, I. S. Johnson, M. Gorman, and N. Neuss. *J. Pharm. Sci.* **51**, 707 (1962).
295. G. H. Svoboda, G. A. Poore, P. J. Simpson, and G. B. Boder. *J. Pharm. Sci.* **55**, 758 (1966).
296. S. Tafur, W. E. Jones, D. E. Dorman, E. E. Logsdon, and G. H. Svoboda. *J. Pharm. Sci.* **64**, 1953 (1975).
297. M. Takechi and K. Hayashi. *Biochem. Biophys. Res. Commun.* **49**, 584 (1972).
298. T. Takeuchi, M. Miyamoto, M. Ishizuka, H. Naganawa, S. Kondo, M. Hamada, and H. Umezawa. *J. Antibiot. (Tokyo)* **XXIX**, 93 (1976).
299. T. Takita, Y. Muraoka, T. Yoshioka, A. Fujii, K. Maeda, and H. Umezawa. *J. Antibiot. (Tokyo)* **XXV**, 755 (1972).
300. Ch. Tamm. "The Antibiotic Complex of the Verrucarins and Roridins," in *Progress in the Chemistry of Organic Natural Products,* **31**, Ed. by W. Herz, H. Grisebach, and G. W. Kirby. Springer-Verlag, New York, 1974, p. 63.
301. D. S. Tarbell, R. M. Carman, D. D. Chapman, S. E. Cremer, A. D. Cross, K. R. Huffman, M. Kunstmann, N. J. McCorkindale, J. G. McNally, Jr., A. Rosowsky, F. H. L. Varino, and R. L. West. *J. Amer. Chem. Soc.* **83**, 3096 (1961).
302. G. S. Tarnowski, F. A. Schmid, D. J. Hutchison, and C. C. Stock. *Cancer Chemother. Rep.* Pt I **57**, 21 (1973).
303. F. Thudium, O. Schindler, and T. Reichstein. *Helv. Chim. Acta* **42**, 2 (1959).
304. M. Tin-Wa, C. L. Bell, C. Bevelle, H. H. S. Fong, and N. R. Farnsworth. *J. Pharm. Sci.* **63**, 1476 (1974).
305. V. V. Titievskaya, V. A. Gorbunova, S. M. Akopyants, Yu. B. Budevich, R. N. Kuchkarev, M. M. Nivinskaya, N. I. Perevodchikova, L. G. Ryazanova, V. A. Skryuchenkova, and N. F. Usmanova. *Antibiotiki* **16**, 953 (1972).
306. R. L. Tolman, R. K. Robins, and L. B. Townsend. *J. Amer. Chem. Soc.* **90**, 524 (1968).
307. S. J. Torrance, R. M. Wiedhopf, and J. R. Cole. *J. Pharm. Sci.* **64**, 887 (1975).
308. R. Toubiana and A. Gaudemer. *Tetrahedron Lett.* 1333 (1967).
309. R. Tschesche. *Naturwissenschaften* **51**, 359 (1964).
310. R. Tschesche, F. Inchaurrondo, and G. Wulff. *Annal. Chem.* **680**, 107 (1964).
311. R. Tschesche, R. Kottler, and G. Wulff. *Annal. Chem.* **699**, 212 (1966).
312. A. T. Tu and J. B. Giltner. *Res. Commun. Chem. Pathol. Pharm.* **9**, 783 (1974).
313. A. Ulubelen. *Pharmaceutisch Weekblad* **108**, 1186 (1973).
314. A. Ulubelen and J. R. Cole. *J. Pharm. Sci.* **55**, 1368 (1966).
315. A. Ulubelen, W. F. McCaughey, and J. R. Cole. *J. Pharm. Sci.* **56**, 914 (1967).
316. H. Umezawa. "Principles of Antitumor Antibiotic Therapy," Section XIII, in *Cancer Medicine*, Ed. by J. F. Holland and E. Frei, III. Lea and Febiger, Philadelphia, 1973, p. 817.
317. H. Umezawa. *Pure Appl. Chem.* **28**, 665 (1971).
318. I. Umezawa, K. Komiyama, H. Takeshima, T. Hata, M. Kono, and N. Kanda. *J. Antibiot. (Tokyo)* **XXVI**, 669 (1973).
319. H. Umezawa, K. Maeda, T. Takeuchi, and Y. Okami, *J. Antibiot. (Tokyo)* **19**, 200 (1966).
320. H. Umezawa, T. Yamamoto, T. Takeuchi, T. Osato, Y. Okami, S. Yamaoka, T. Okuda, K. Nitta, K. Yagishita, R. Utahara, and S. Umezawa. *Antibiot. Chemother.* **4**, 514 (1954).
321. H. R. Urscheler, Ch. Tamm, and T. Reichstein. *Helv. Chim. Acta* **38**, 883 (1955).
322. J. M. Venditti and B. J. Abbott. *Lloydia* **30**, 332 (1967).
323. D. L. Voaden and M. Jacobson. *J. Med. Chem.* **15**, 619 (1972).
324. R. B. Von Dreele, G. R. Pettit, G. M. Cragg, and R. H. Ode. *J. Amer. Chem. Soc.* **97**, 5256 (1975).
325. M. E. Wall and M. Wani. Int'l. Symposium for the Chem. of Nat. Prod. (Abstrs. of), 7th, Vol. E138, 614 (1970).
326. M. E. Wall, M. C. Wani, C. E. Cook, K. H. Palmer, A. T. McPhail, and G. A. Sim. *J. Amer. Chem. Soc.* **88**, 3888 (1966).
327. A. H-J. Wang, I. C. Paul, K. L. Rinehart, Jr., and F. J. Antosz. *J. Amer. Chem. Soc.* **93**, 6275 (1971).

328. M. C. Wani, H. L. Taylor, and M. E. Wall. *J. C. S. Chem. Commun.* 390 (1973).
329. M. C. Wani, H. L. Taylor, M. E. Wall, P. Coggon, and A. T. McPhail. *J. Amer. Chem. Soc.* **93**, 2325 (1971).
330. J. S. Webb, D. B. Cosulich, J. H. Mowat, J. B. Patrick, R. W. Broschard, W. E., Meyer, R. P. Williams, C. F. Wolf, W. Fulmor, C. Pidacks, and J. E. Lancaster. *J. Amer. Chem. Soc.* **84**, 3185 (1962).
331. A. J. Weinheimer and J. A. Matson. *Lloydia* **38**, 378 (1975).
332. A. J. Weiss, G. Ramirez, T. Grage, J. Strawitz, L. Goldman, and V. Downing. *Cancer Chemother. Rep.* **52**, 611 (1968).
333. S. G. Weiss, M. Tin-Wa, R. E. Perdue, Jr., and N. R. Farnsworth. *J. Pharm. Sci.* **64**, 95 (1975).
334. R. M. Wiedhopf, E. R. Trumbull, and J. R. Cole. *J. Pharm. Sci.* **62**, 1206 (1973).
335. R. M. Wiedhopf, M. Young, E. Bianchi, and J. R. Cole. *J. Pharm. Sci.* **62**, 345 (1973).
336. P. F. Wiley, R. R. Herr, F. A. MacKellar, and A. D. Argoudelis. *J. Org. Chem.* **30**, 2330 (1965).
336a. P. F. Wiley and F. A. MacKellar. *J. Org. Chem.* **41**, 1858 (1976).
336b. P. F. Wiley, H. K. Jahnke, F. MacKellar, R. B. Kelly, and A. D. Argoudelis. *J. Org. Chem.* **35**, 1420 (1970).
337. H. B. Wood (National Cancer Institute), private communication.
338. J. Wulff. *J. Chromatogr.* **18**, 285 (1965).
339. O. Yonemitsu, Y. Sato, S. Nishioka, and Y. Ban. *Chem. Ind.* (*London*) 490 (1963).
340. Y. Yoshioka, T. Ikekawa, M. Noda, and F. Fukuoka. *Chem. Pharm. Bull.* **20**, 1175 (1972).
341. Y. Yoshioka, T. Sano, and T. Ikekawa. *Chem. Pharm. Bull.* **21**, 1772 (1973).
342. G. Zbinden. *Proc. Int. Symp. Chemother. Cancer* 303 (1964).
343. K-Y. Zee-Cheng, K. D. Paull, and C. C. Cheng, *J. Med. Chem.* **17**, 347 (1974).