

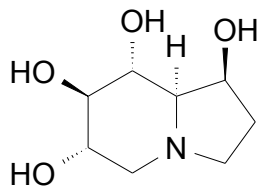
## Toxicology of alkaloids II.

### Toxic amines and aminoacids of plants

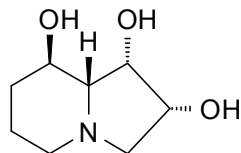
### Toxic plant proteins

- Indolizidine alkaloids

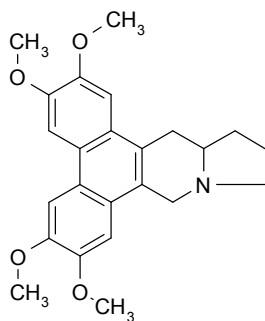
- Castanospermine
  - *Castanospermum australe*,  
*Alexa leiopetala* Fabaceae
  - Black bean tree
  - Inhibitor of  $\alpha, \beta$ -glucosidase
    - Biogenesis glycoproteins
  - Inhibition of sugars utilization
  - Intoxication
    - Nausea, vomiting
    - Deadly for horses and cattle



- Swainsonine
  - *Swainsonia*, *Astragalus*, *Oxytropis*  
Fabaceae
  - Probably product of parasite
    - Fungus *Rhizoctonia leguminicola*
  - Damage of CNS
    - Axonopathy (locoism)
    - Inhibition of  $\alpha$ -D-mannoxidase
    - Inhibition of biosynthesis of glycoproteins
      - » Including hormones, membrane receptors, enzymes
  - Intoxication
    - Skeletal changes
    - Hepatosplenomegalia
    - Depression, exhaustion, nervosity
    - Tendency to aborts
    - Cardiovascular problems
    - Death from exhaustion of organism



- Tylophorine, tylocrebine
  - Phenanthroindolizidine alkaloid
  - *Tylophora* spp.,  
Asclepiadiaceae
  - *Ficus septica* Moraceae
  - Skin irritant, vesicant compounds

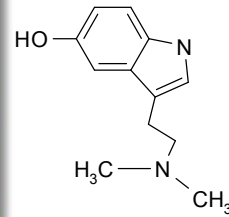


- Tryptamines

- Bufotenine

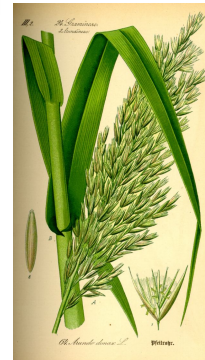
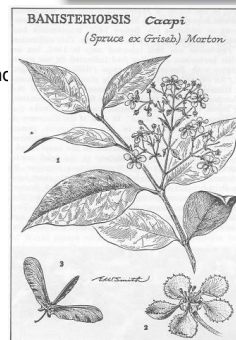


- In water poorly soluble compounds
- *Piptadenia peregrina* Mimosaceae
  - Cojoba Tree
- *Arundo donax* Poaceae
- Several fungi and frogs
- Intoxication
  - Hallucinogenic effect, influence on psychic
    - » Similar to LSD and mescaline
  - Frame of mind: anxiety, perception disorders
  - Mydriasis, hypertension
  - High dosage
    - » Respiratory paralysis
    - » Motoric paralysis



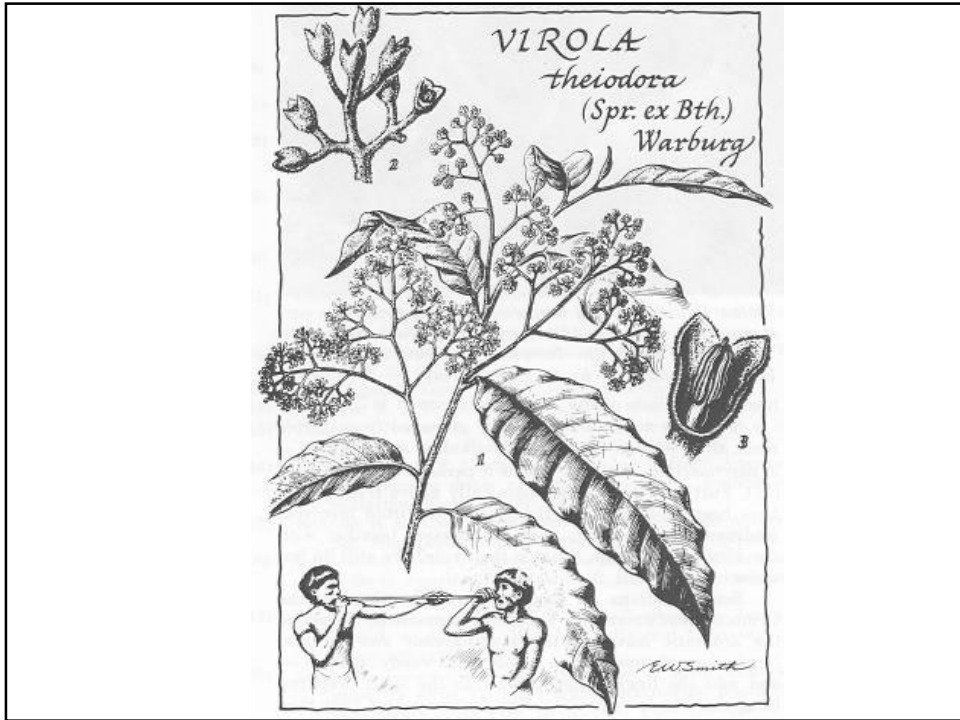
- *N,N*-dimethyltryptamine (DMT)

- *Prestonia amazonica* Apocynaceae
- *Piptadenia peregrina* Mimosaceae
- Shortly effective hallucinogenic compound
  - 0,7-1mg/kg
- Model psychosis
  - Vegetative symptomatology
  - Emotional and perception disorders
  - Illusions and visions
  - Space-time distortions



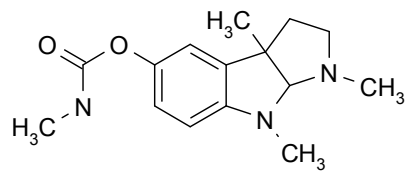
Tukanoan Indian with stems of three "kinds" of caapi preparatory to making hallucinogenic drinks from the bark, Rio Vaupes, Colombia. (Photograph by G. Reichel-Dolmatoff)







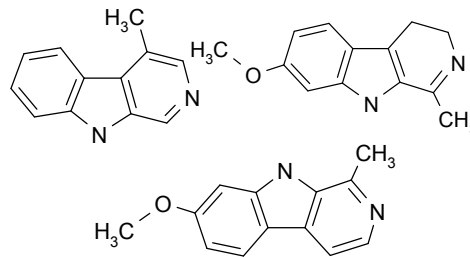
- Physostigmine (eserine)
  - *Physostigma venenosum*  
Fabaceae
  - Competitive inhibitor of acetylcholinesterase
  - Administration i.v. highly toxic
    - Cca 1 mg
  - Symptoms of intoxication
    - Vomiting, colic, salivation
    - Diarrhea, sweating, vertigo
    - Bradycardia, miosis, total exhaustion
    - Respiratory paralysis



Physostigma venenosum Balf.  
Image processed by Thomas Schoepke  
www.plant-pictures.de

- $\beta$ -carboline indol alkaloids

- Harmane, harmaline, harmine
- *Peganum harmala*, *Zygophyllum fabago*, *Tribulus terrestris*  
Zygophyllaceae
- *Passiflora incarnata*  
Passifloraceae
- Inhibitory MAO
  - Elevated levels of neuromediators
    - » Serotonin, noradrenaline
  - Especially in brain
    - » Central effect
  - Early symptoms of intoxication
    - » Nausea, vomiting, pale skin
    - » Signs of aggression
  - Further progression
    - » Half-sleep with dreaming
    - » Hallucinations



*Peganum harmala*



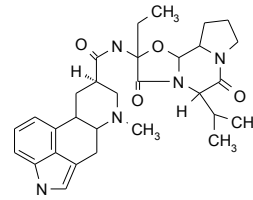
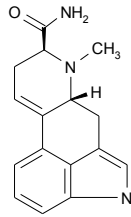
• Ergolines

– Hlavně čeleď Convolvulaceae

- *Rivea corymbosa*, *Ipomoea* spp.

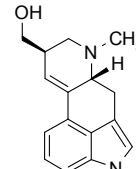
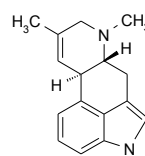
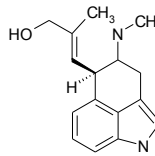
– Ergine (lysergamide)

- Toxic dose 1 µg/kg p.o.
- Mexican ceremonial drugs
  - Ololiuqui, coaxihuitl and further



– Ergosine

- Similarly to ergine
- Inhibition of prolactine secretion



– Chanoclavin

– Agroclavine

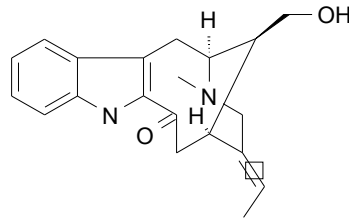
– Lysergol



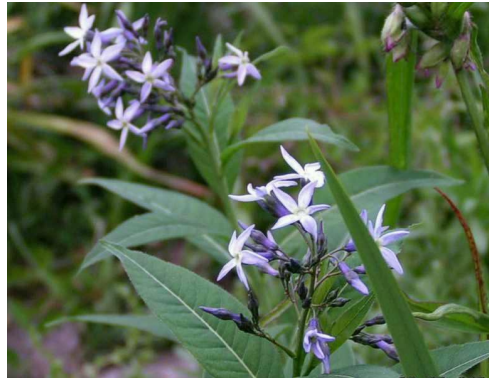
[c] www.azarius.nl



- **Monoterpenoid indols**
  - Large group of compounds
  - Biosynthesis from tryptophan and loganin
  - Apocynaceae, Loganiaceae, Rubiaceae
  - Huge spectrum of biologic activity and toxicity



- **Affinine, affinisine**
  - *Peschiera affinis*, *P. latea*, *Tabernaemontana psychotrifolia* Apocynaceae
  - Toxic dose 300 mg/kg
    - Changes of behavior
    - CNS depression
    - Tremor, ataxia
    - Hypothermia, bradypnoe



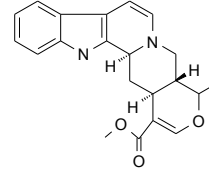
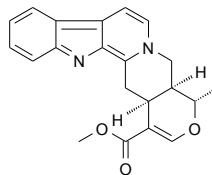
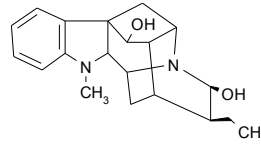
**Ajmalicine (raubasine)**

- *Pausinystalia yohimbe*, *Rauwolfia* spp., *Vinca rosea* Apocynaceae
- Adrenolytic
  - Antagonist of  $\alpha$ -receptors
  - Effect on vasomotoric centers in brain stem
    - » Strong hypotensive

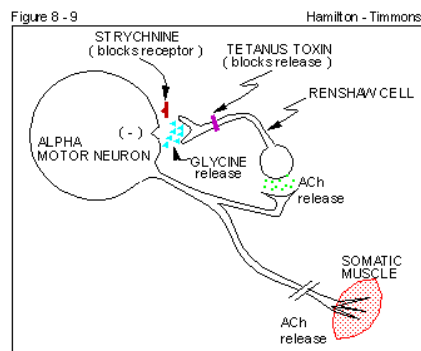
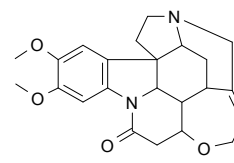
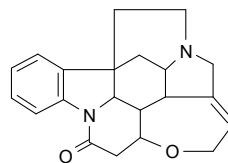




- Ajmaline
  - *Rauwolfia* spp. Apocynaceae
  - Inhibition of glucose utilization in myocardium
  - Toxic dosae
    - Convulsions, arrhythmia, strong fluctuation of blood pressure
  - Antagonist of thrombocyte activation
  - Agranulocytosis after long-termed use
- Alstonine, serpentine
  - *Rauwolfia* spp., *Vinca* spp. Apocynaceae
  - *Strychnos camptoneura* Loganiaceae
  - Strong inhibitors of acetylcholine esterase
  - Negative chronotropic effect

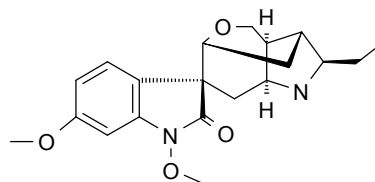


- Brucine, strychnine
  - *Strychnos* spp. Loganiaceae
  - Toxicity
    - Stimulation of vasomotoric and respiratory centre
      - » Block of inhibition aminoacid glycine
    - Spinal convulsant
  - Metabolism
    - Good gut absorption
    - Partially excreted unchanged via urine
    - Metabolism in liver
  - Intoxication
    - High sensitivity on sensoric stimuli
    - Convulsions
      - » Generalized with agonizing pains
      - » Respiratory and metabolic acidosis
    - Rapid onset of effect without warning
      - » Anxiety, twitches of members and face, frightening image
    - Death caused by paralysis, total exhaustion, spastic paralysis of respiratory muscles, anoxia



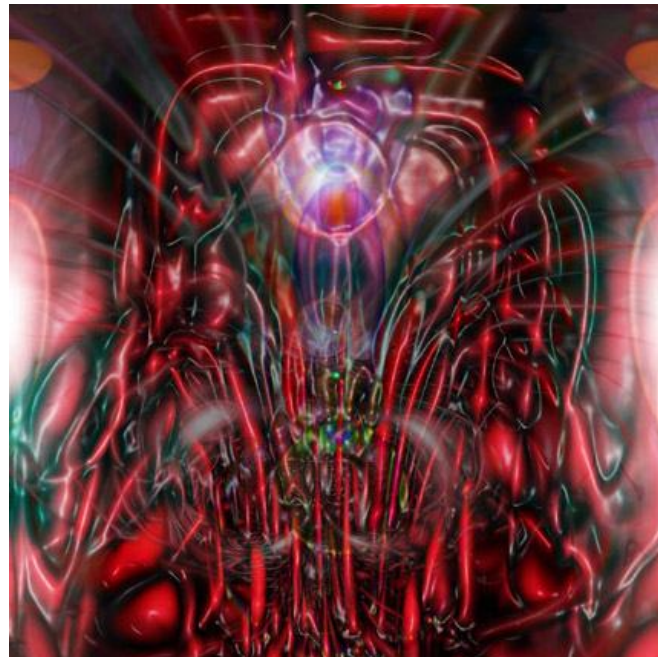
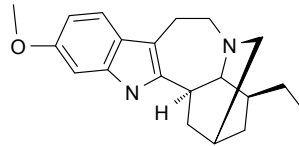
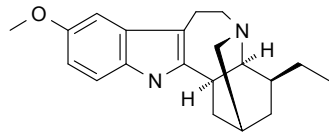


- Gelsemine, gelsemine, gelsemidine
  - *Gelsemium sempervirens*, *Mostua* spp. Loganiaceae
  - Highly toxic
  - Inhibitor of acetylcholinesterase
  - Toxicity
    - Respiratory depression
    - Tremor, discoordination of movements
    - Pralysys of numbsParalýza končetin
    - Urination, defecation, vomiting, salivation
  - Human
    - Vertigo, vision disorders, sweating
    - Muscle weakness, convulsions, respiratory depression



- Ibogaine, tabernathine

- *Tabernanthe iboga*,  
*Voacanga* spp. Apocynaceae
- Activity in CNS
  - Inhibitor of neuronal nicotine receptors
  - Lower dosage
    - » Central stimulation
    - » Tremor, bristlin hair
    - » Salivation, mydriasis
    - » Anxiety, aggression
  - High doses
    - » Hallucination - serotonin effect
    - » Deep depression and anxiety
- Cardiovascular system
  - Negative inotropic and chronotropic effect

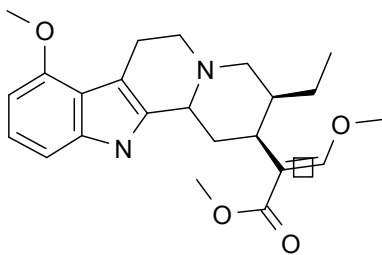






– Mitragynine

- *Mytragina speciosa*,  
*Unacana* spp.  
Apocynaceae
- Sedative effect on  
CNS, narcotic effect



**-Reserpine**

- *Rauwolfia* spp. Apocynaceae

- Toxicity

- Depletion of CA and 5-HT in tissues

- » Inhibition of ATP-MG<sup>2+</sup> mechanism of CA and 5-HT into neuronal vesicles

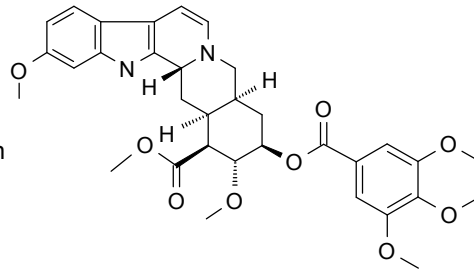
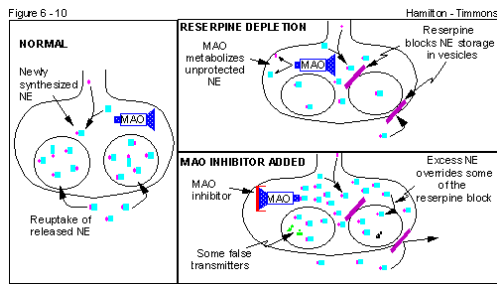
- Intoxication

- Pain in underbelly, diarrhea

- Hypotension, depression, development of Parkinson syndrome

- Chronic intoxication

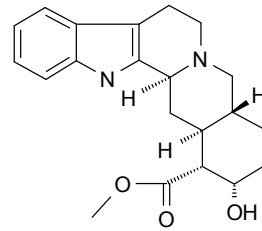
- Potential carcinogen, teratogen



– **Schizogyne**

– **Yohimbine**

- Mixture of  $\alpha,\beta$ -isomers
- *Pausinystalia yohimbe*,  
*Corianthe* spp.,  
*Pseudocinchona* spp.  
Rubiaceae
- *Catharantus*, *Vinca*, *Ruwolfia*  
Apocynaceae
- Short-termed adrenergic effect
  - Antagonist of  $\alpha$ -adrenoreceptors
    - » High selectivity for presynaptic  $\alpha_2$ -adrenergic receptors
- Antagonist of dopamine and serotonin
- Symptoms of intoxication
  - Irritation, tremor, migraine, vertigo
  - Nausea, vomiting, diarrhea
  - Priapism



• **Bis(indol) alkaloids**

– C-curarine, C-dihydroxytoxiferine

- Calebas curare
- i.v. toxicity

– Calebasine

- *Strychnos* spp. (*S. divaricans*, *S. triervis*...)  
Loganiaceae
- South American calebas curare
- Strong neuromuscular blockator
- Deep long-termed loss of blood pressure
- Complex muscular paralysis

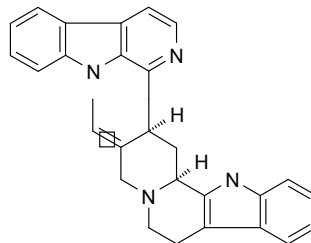






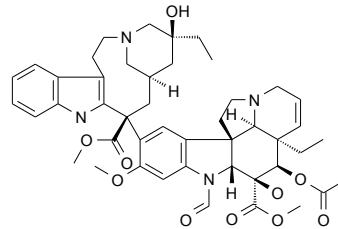
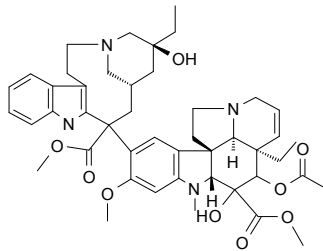
- Toxiferine I (toxiferine C)
  - *Strychnos* spp. (*S. divaricans*, *S. triervis*...)
  - Loganiaceae
  - South American calabash curare
  - Strong neuromuscular blockator 6-8× more effective than tubocurarine

- Usambarensine, usambarine
  - *Strychnos usambarensis*
  - Loganiaceae
  - African arrow poison
  - Muscular paralysis, antagonist of muscarine receptors



– **Vinblastine, vincristine, leurosine, leurosidine**

- *Vinca rosea*, Apocynaceae
- Inhibition of cell division
  - In metaphasis linkage to tubuline
  - Inhibition of mitotic spindle formation
- Inhibition of synthesis of DNA and RNA
- Toxicity
  - More toxic vincristine
  - Central and peripheral neurotoxicity
    - » Parestesia, neuralgia, myalgia
  - Further effects
    - » Alopecia, dyspnoe and bronchospasm
    - » Headache, transient blindness
    - » azoospermia
  - Teratogenic



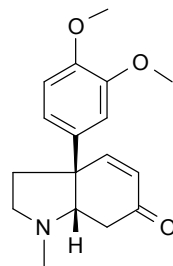
• Other indol alkaloids

– **Mezembrenone, mezembrine, mezembrinol**

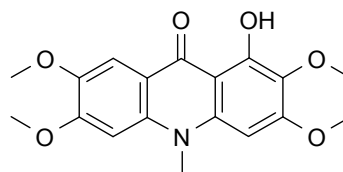
- phenylloxyindols
- *Sceletium* alkaloids  
Aizoaceae
- Narcotic, coca-like effect
- Addictive drug
  - channa



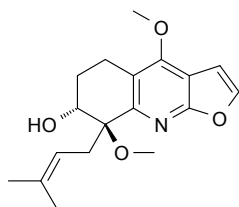
Kosmatec



- Quinoline derivatives
- Biogenetically derived from tryptophan or anthranilic acid
- Not large number of compounds

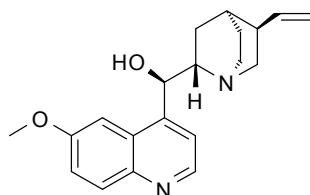


- Arborinine
  - Acridone alkaloid
  - *Teclea* spp. Rutaceae
  - Part of arrow poisons
- Haplophyllidine
  - *Haplophyllum perforatum* Rutaceae
  - Strong CNS depression



#### –Quinine

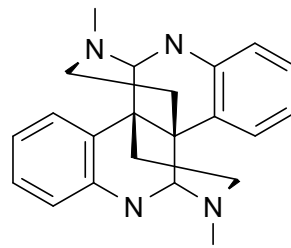
- *Cinchona* spp., *Remija pedunculata* Rubiaceae
- Toxic dose 8-15 g
- Protoplasmatic poison
- Intoxication
  - GIT irritation
    - » Vomiting, nausea
  - Neurologic symptoms
    - » Diplopia, decreased perception of light
    - » desorientation
  - Arrhythmia, hypotension
  - Oliguria, hematuria
  - Spermatocidal, induction of abortus or premature birth





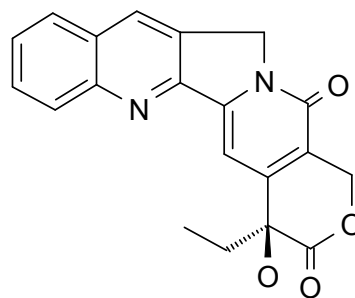
– Calycanthine

- *Calycanthus* spp.,  
*Chionantus* spp.  
Calycanthaceae
- *Palicourea alpina*  
Apocynaceae
- Toxicity
  - Convulsions, cardiac depression, paralysis
  - Stimulation of uterus



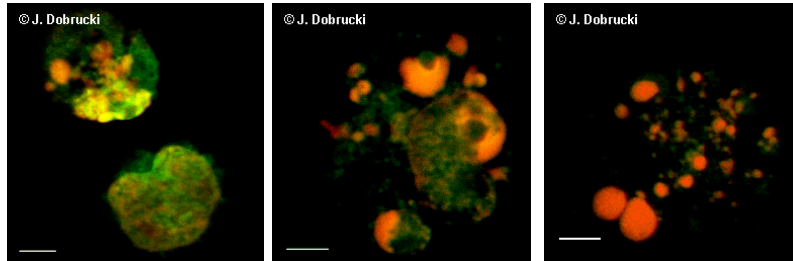
– Camptothecine

- *Camptotheca acuminata*  
Nyssaceae
- Gastrointestin toxicity
  - vomiting, nausea and diarrhea
- myelosuppression, hemorrhagic cystitis, dermatitis
- Important cytotoxicity
  - Inhibition of topoisomerase I
    - » Formation of covalent bonds
- Topotecane, irinotecane



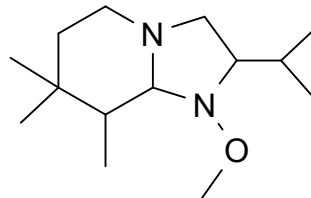
Camptotheca acuminata





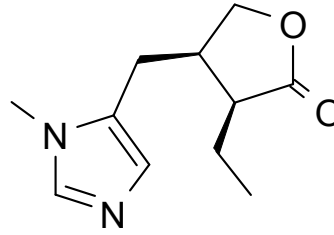
- Imidazol derivatives

- Small group of compounds derived from histidine
- Alchorneine, alchornine
  - *Alchornea floribunda*, *A. hirtela* Euphorbiaceae
  - iporuru

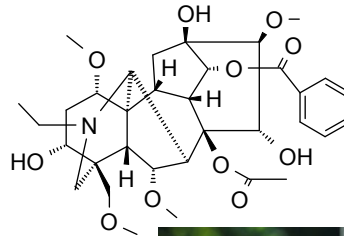


– Pilocarpine, pilosine

- *Pilocarpus* spp. Rutaceae
- Cholinergic activity
  - Salivation, lachrymation
  - Increased stomach secretion
  - Increased gut motility
  - Bronchial constriction
  - Excitation to epileptic state

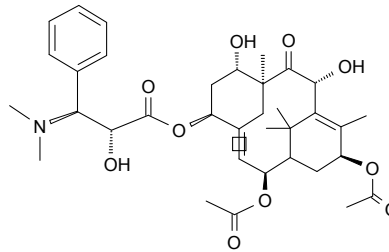


- Diterpenic alkaloids
  - Biologic precursor isoprene
    - Consequent introduction of nitrogen
  - Pseudoalkaloids
  - *Aconitum* spp., *Consolida* spp., *Delphinium* spp. Helleboraceae
  - Ester alkaloids more toxic
  - Non-ester so called atisine alkaloids less toxic
  - **Aconitine**
    - Diterpenic ester compound
    - *Aconitum* spp. Helleboraceae
    - Toxic dose 3-6 mg p.o. (2-15 g of tubers)
    - Cardiotoxicity, neurotoxicity
    - Rapid absorption
      - Good transition through membrane
      - Absorption through the skin
    - Persistent opening of sodium channel of axones
    - Inhibition of repolarisation
    - Symptoma of intoxication
      - Anaesthesia of tongue
      - Nausea, vomiting
      - Diarrhea, colic
      - Paresthesia
        - » „pins and needles“, chills
        - » pains
      - Mydriasis changes to miosis
      - Arrhythmia, paralysis
      - Death
        - » Ventricular fibrillation
        - » Respiratory arrest



– Taxin A

- Pseudoalkaloid
- *Taxus baccata* Taxaceae
- Main alkaloid of yew
- Cattle intoxication from eating of needles
- Suicides
  - 50-100 g of needles for adult man
- Symptoms
  - After 30 minutes
  - Nausea, vomiting
  - Vertigo
  - Painful stomach colic
  - Shallow respiration, arrhythmias
    - » Similar to hypokalemia
  - Death
    - » Respiratory paralysis
    - » Cardiac arrest in diastole



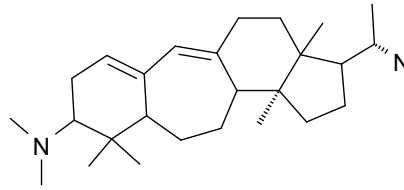
• Steroid alkaloids

- C-21 alkaloids of pregnane type
  - Apocynaceae and Buxaceae
- C-24 alkaloids derived from cycloartenol
  - Buxaceae
- C-27 alkaloids
  - Solanaceae and Liliaceae
- Alkaloids Solanaceae
  - Derivatives of solanine and spirosolane
  - In form of glycosides
  - Physico-chemical properties similar to saponins
  - Inhibitors of acetylcholinesterase
  - Formation of GIT necrosis
- Alkaloids *Liliaceae*
  - Heterocyclus of different biosynthetic origin
  - C-nor-D-homosteroids
  - Effect on heart similar to cardioglycosides
  - Effect on blood pressure
  - *Veratrum* spp.
    - teratogenic



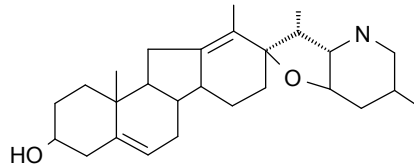
– **Buxamine, Cyclobuxine A, B, C, D**

- *Buxus* spp. Buxaceae
- Convulsants
- Vomiting, colics of GIT
- Diarrhea, muscular pain



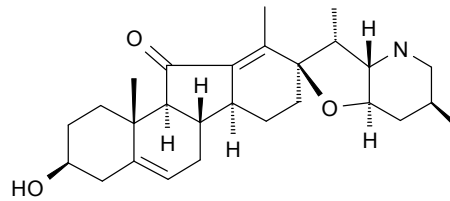
– **Cyclopamine, cycloposine**

- *Veratrum* spp. Liliaceae
- Strong teratogen
  - Malformation of cyclopia type
- Dual mechanism:
  1. Interference with development of vývojem embrional tube
    - Hit into function of neuroembryonal epithel
      - » Inhibition of catecholamine release
    - Craniofacial deformation
  2. Interference with metabolism of cartilages
    - Tracheal stenosis
    - Contraction of metacarpal and metatarsal bones
    - Contraction of tibias



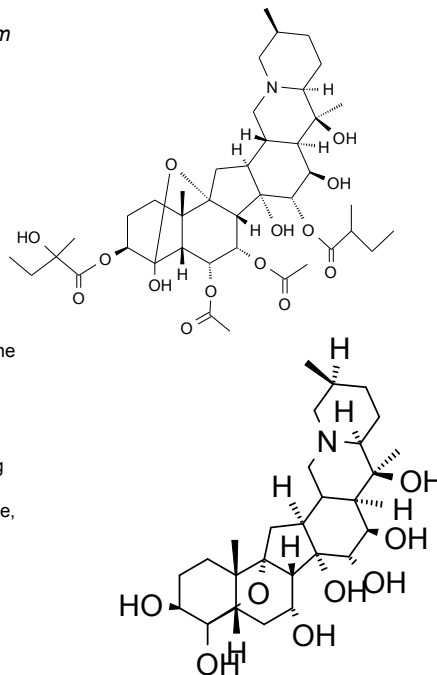
– **Jervine**

- *Veratrum* spp. Liliaceae
- 1g acute toxicity
- Teratogen
- Circulatory failure, diarrhea, convulsions





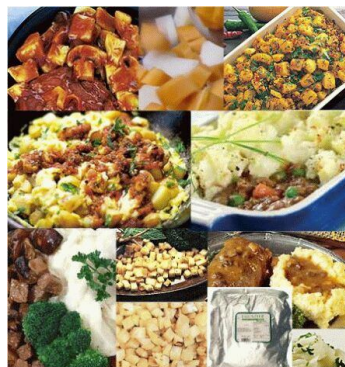
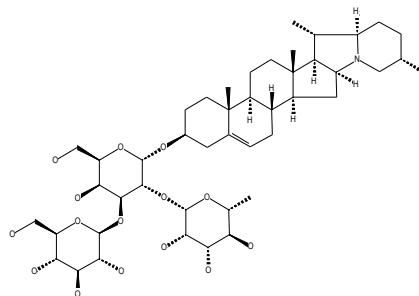
- **Germine, germidine**
  - *Zygadenus venenosum*, *Veratrum* spp. Liliaceae
  - Strong emetics
  - Cardiotoxic compounds
    - Arrhythmias, slowing of excitement transition
  
- **Protoveratrine A and B**
  - *Veratrum* spp. Liliaceae
  - Lethal dose 20 mg
  - Symptoms of intoxication
    - Inflammation of oral mucosa
    - Anesthesia of mucosa membrane
    - Vomiting, diarrhea
    - Sneezing, nasal bleeding, lachrymation, congestion of conjunctiva
    - Dilatation of vessels (influencing baroreceptors)
      - » Lowering of blood pressure, bradycardia, bradypnoe
  - Death
    - Cardiac and respiratory failure





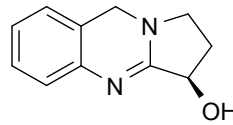
–  $\alpha$ -solanine,  $\alpha$ -chakonine

- Glycosylated form more toxic than aglycon solanidine
- *Solanum* spp. Solanaceae
- Presence of alkaloids in whole plant
- In tubers variable content
  - Increased by different factors
    - » Genetic, ripening, fertilization
    - » Mechanic damage, stressors
- Heat resistance, only removal by hot water
- High glycoalkaloids content
  - Burning and bitter taste
- Low absorption from GIT – advantage, safe
  - Intoxication at more than 1 mg/kg
- Mechanism of intoxication
  - Inhibitors of acetylcholinesterase
  - Damage of mucose layer of GIT
    - » Necrosis, gastroenteritis
- Symptoms
  - Nausea, vomiting, diarrhea
  - Stomach pain, headache, vertigo
  - Halucination, neurologic disorders, coma



- Chinazolinové alkaloidy

- Vasicine, vasicinol, vasicinone



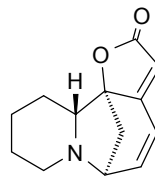
- *Adhatoda vasica*  
Acanthaceae
- *Lunaria* spp.  
Brassicaceae
- *Peganum harmala*  
Zygophyllaceae
- Stimulation of uterus
  - Probably via deliberation of prostaglandins
- Abortive effect
- Fast absorption, upto 30 minut max. concentration in target tissue



- Securinega alkaloids

- Sekurinín, virosekurinín, norsekurinín

- Nitrogenous tricycle with butenolide ring
  - Typical for cardioglycosides
- *Securinega suffruticosa*, *Phyllanthus discoides*  
Euphorbiaceae
- Stimulation effect on CNS (spinal cord)
- Affection of autonomous nerve system
- Antagonists at GABA receptor
- Toxic doses 5-10 mg/kg
  - Stimulation similarly to strychnine
  - Convulsions, death via respiratory failure
- i.v. and p.o. administration
  - Extremely fast onset, but rapid metabolism
- High cytotoxicity





## Toxic aminoacids and amines

- Aminoacids
- Production of more than 300 non-protein AMA
- Free or as  $\gamma$ -glutamylpeptids
- Metabolic interaction in strange organism
  - Similarity to protein AMA
    - toxicity
  - Direct antagonists
    - Lowering of intake of AMA through membranes
    - Block of implementation of AMA into protein
    - Problem especially for young and developing organism
    - For fetus - teratogenic
  - Indirect antagonists
    - Inhibition of oxidation of fatty acids
      - Organism switches metabolism to saccharides utilization
        - » Deadly hypoglycaemia
    - Strumigens
    - Metabolism of selenium
      - selenosis
- Protein AMA
  - In supraphysiological concentration
    - Neurotoxins (glutamate, aspartate)

- **GABA**
  - Seeds of Fabaceae, *Pisum*, *Vicia*, *Phaseolus*
  - Inhibition neurotransmitter
- **L- $\alpha$ -amino- $\gamma$ -oxalylaminobutyric acid**
  - *Lathyrus*, *Acacia* Fabaceae
  - Osteolathyrisim
    - Inhibitor of aminooxidase to convert lysyl to lysylaldehyde
      - » Malfunction of collagen networking
      - » Loss of cohezion between cartilage and epiphysis of bone
  - Neurolathyrisim
    - » Neurotoxic syndrome
    - » Mediterranean, India, Asia Minor
    - » Lowered tonus of muscles, consequent paralysis
- **L- $\alpha$ -amino- $\beta$ -oxalylaminopropionic acid**
  - *Lathyrus*, *Crotolaria* Fabaceae
  - Similar to above mentioned, can cause chronic disorders and death
  - Neurolathyrisimus
    - Inhibition of liver aminotrasferase
      - » Increased levels of tyrosine
      - » Increased synthesis of DOPA, dopamine and toxic metabolites





–  **$\beta$ -aminopropionitrile**

- *Lathyrus* spp. Fabaceae
- Osteolathyrism

– **Asparagic acid**

- Protein AMA – ubiquitous
- Toxicologic important high levels in *Centaurea solstitialis* Asteraceae
- Extrapyramidal disease
  - Nigropallidal encephalomalacia
  - Animals on pasture, mainly horses
  - Excitation neurotransmitter
  - Brain damage
  - Manifestation during feeding and drinking - chewing disease
  - Animals with low mobility, to spontaneous physical activity
  - Similar to glutamate



– **L-djenkolic acid**

- *Albizia lophanta*, *Acacia* spp., *Mimosa* spp. Mimosaceae
- Djenkol bean ,velvet bean
  - Vegetable of South-East Asia
- Long-termed intake
  - Formation of needle-shaped crystals in kidneys
  - Mechanic damage of kidney parenchyma



- Hypoglycine B and A
  - Unripen seeds and fruits of *Blighia sapida* Sapindaceae
  - Seeds of maples *Acer* spp.
  - Mechanism of toxicity
    - Inhibition of Cori cycle
    - Inhibition of glucose/glukose-6-phosphate cycle
    - Inhibition of oxidation of fatty acids
    - Inhibition of gluconeogenesis
  - Symptoms
    - Deep hypoglycemia
    - Vomiting
      - » Formation of isovaleric acid via inhibition of leucine metabolism
    - Total degradation of liver glycogen
    - Accumulation of fat in liver
  - Death via general failure
  - Common intoxications



Photo by Dan Shearn, July 1986



### - L-canavanine

- Seeds of different Fabaceae
- Analogue of arginine
  - Arginyl-RNA synthase uses it
  - Incorporation to peptides
    - » Non-functional
    - » Interference with synthesis of RNA/DNA and proteins
  - Interference with arginine metabolism
  - Inhibition of NO-synthase
  - Increased production of superoxide radical
- Toxicity
  - Teratogen
  - Evocation of abortions
  - Hepatotoxic



– **Se-methyl-L-selenocysteine**

– **L-selenocystathionine**

- Seeds of Fabaceae plants  
*Astragalus* spp. *Melilotus* spp.
- Brassicaceae
- Growth on soils with high selenium content
- High intake of selenium toxic mainly for animals
  - selenosis
- Incorporation of selenium instead of sulphur into AMA
- Disruption of protein synthesis
- Inhibition of selenium detoxication – methylation
  - hepatotoxicity



• **Amines**

– **Ephedrine**

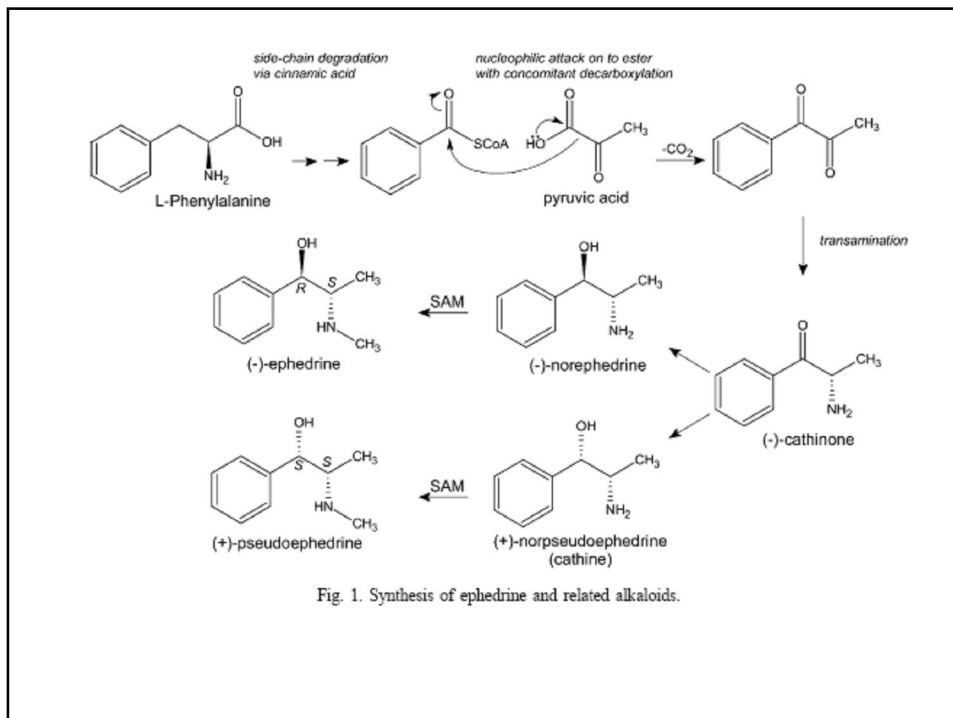
- Aromatic amine
- *Ephedra* spp. Ephedraceae
- Sympathomimetic activity
  - Increase of blood pressure and peripheral vasoconstriction
  - Penetration to CNS
- Acute intoxication
  - Sweating, headache, anxiety
  - Muscular weakness and tremor
  - Mydriasis
  - Palpitation
  - Insomnia



– **Galegine**

- *Galega officinalis* Fabaceae
- Derivative of guanidine
- Damage of mitochondrial function
- Convulsions, breath difficulties, pulmonary edema





### – Khatamines

- Arylalkylamines
- *Catha edulis*, *Maytenus crucorii*  
Celestraceae
- *Ephedra* spp. Ephedraceae
- **Khatine and khatinone** the most important
- **Khatinone**
  - Similar properties to amphetamine
  - During drying converts to norpseudoephedrine and norephedrine
- Drug is used via chewing
  - North-East Africa
  - Fast decomposition prevents large transportation and business
  - Suppression of sleep, stimulation, against fatigue
- Intoxication
  - Anorexia, hyperthermia, stimulation of respiratory centre
  - Mydriasis, arrhythmia, hypertension
  - Psychic symptoms
    - » Anxiety, panic attack, aggressivity



- Toxic proteins
  - Lectins (phytohemagglutinines)
    - Proteins or glycoproteins containing 4-10 % of sugar component
    - Molecules from 4 subunits
      - Connection via non-covalent bonding
    - Ability to bind the sugar residues on the surface of cell
      - D-galactose, N-acetyl-D-galactosamine
      - More binding sites
        - » Ability to li up neighboring cells - agglutination
    - Inhibition of protein synthesis of *eukaryota*
    - Some lectins
      - Inhibition of mitosis
      - Stimulation of lymphocyte maturation
      - Killing of cancer cells
    - Toxicity
      - Binding to cells of GIT mucosa membrane
        - » Inhibition of absorption of nutrients – antinutrition factors
        - » Vomiting, hemorrhagic diarrhea, loss of water and electrolytes
    - Occurrence in plants
      - Seeds and fruits of Fabaceae, Brassicaceae, Ericaceae
    - Content in plants different
      - Influenced by heat treatment

- Abrine
  - *Abrus precatorius*, *A. pulchelus* Fabaceae
  - Mixture of similar compounds **abrine-a and abrine-b**
    - » Each chains A and B
    - » Connection via disulphide bridges
  - A inhibition of proteosynthesis
    - » Cell death
  - B binding to a membrane of GIT cell, enables the entry of A into cell
  - LD for mice p.o. 25 µg, highly toxic compounds
  - Intoxication
    - » Hemorrhagic diarrhea
    - » Electrolyte dysbalance
    - » Arrhythmia, brain edema
    - » Convulsions, cardiovascular collapse
    - » Death



- **Phasine**

- *Phaseolus vulgaris*  
Fabaceae
- Mixture of five isolectines
- High *p.o.* toxicity
- Linkage to cells of GIT epithelium, partially pass into blood circulation
  - » Detoxication in liver or kidneys
  - » Non-metabolized part
    - slowing of growth
    - interruption of hormones synthesis
    - decrease of production of muscle proteins
- Hypertrophy of intestine
- Hypertrophy of liver and pancreas



- **Ricine D**

- *Ricinus communis*  
Euphorbiaceae
- Component of ricine
- 4 lectines
  - » RCL<sub>I</sub> and RCL<sub>II</sub> non-toxic
  - » Ricine D and RCL<sub>IV</sub> toxic
- Dimeric
  - » Chains A and B connected by disulphide
  - » B enables linkage to cell
  - » A is a cytotoxin
- High toxicity
  - » 1 mg in 1 g of seeds is a lethal dose
- Interference with protein synthesis and inactivation of ribosomal subunit 28S
- Very sensitive are glial cells
- Oral intoxication – ricinism
  - » Nausea, headache
  - » Bloody diarrhea, dehydration
  - » EKG changes
  - » Liver necrosis
  - » Coma, death





- **Viscolectins**

- *Viscum album* Viscaceae
- ML I, ML II (viskumin) a ML III
- Specific to D-galactose (ML I)
- Specific to N-acetyl-D-glucosamine (ML III)
- Specific binding to both these sugars (ML II)
- Inhibition of proteosynthesis by inactivation of 60S subunit
- Damage of cell membrane
- Toxic for a panel of animal species

- **Viscotoxins**

- *Viscum album*, *Phoradendron* Loranthaceae
- Specific proteins
- Resistant to proteases and increased temperature
- Toxic for myocardium
- Inhibition of DNA synthesis
- Damage to hepatocytes similar to damage caused by hepB
- Acute intoxication
  - » Vomiting, stomach convulsions, diarrhea
  - » Cardiac collapse

