

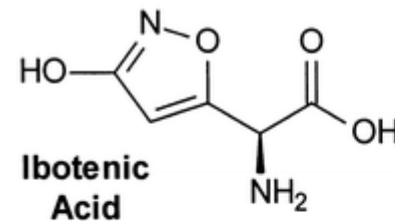
Poisonous fungi

Amanita muscaria

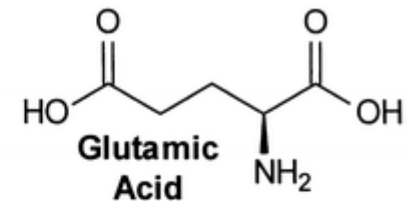
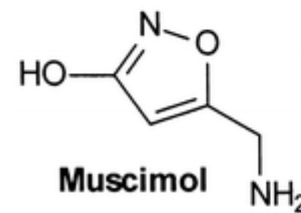
(Fly agaric, Muchomůrka červená)



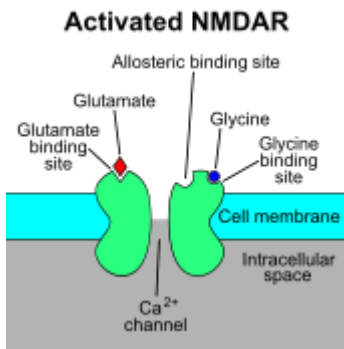
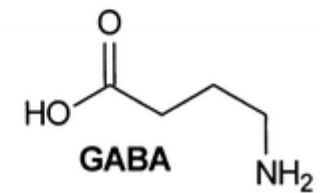
- Contains psychoactive **muscimol** (GABA antagonist) and neurotoxic **ibotenic acid** (NMDA agonist).



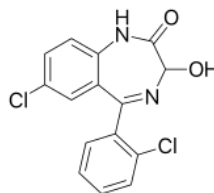
Spontaneous



Glutamic Acid Decarboxylase



Antidote:
benzodiazepines
(Lorazepam)
or atropine



Amanita pantherina

(Panther cap, false blusher, Muchomůrka tygrovaná)

- Contains similar toxins to *A. muscaria* but with much more fatalities



Very often mistaken for *A. rubescens* (true blusher, Muchomůrka růžovka)





Chlorophyllum molybdites

(false parasol, Bedla zelenolupenná)

- The same taxa as *Chlorophyllum rachodes* (Bedla červenající) and *Chlorophyllum olivieri* (Bedla šedohnědá)
- symptoms are predominantly gastrointestinal in nature, with vomiting, diarrhea and colic (usually non-lethal), also in combination with alcohol

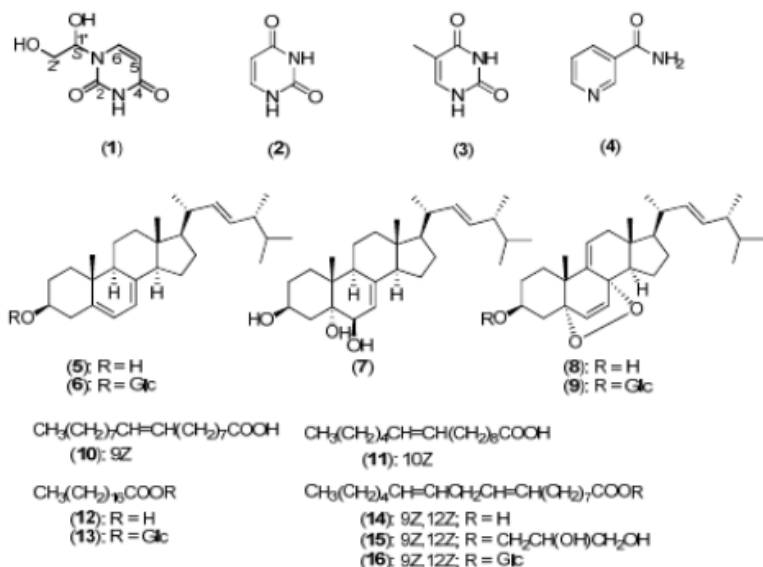


Figure 1: Structures of the isolated compounds (1-16).



Entoloma-hochstetteri

Entoloma species

(Závojenky)

- some species are highly poisonous, ([*Entoloma sinuatum*](#) – Závojenka olovová), [*Entoloma rhodopolium*](#), and [*Entoloma nidorosum*](#)
- Gastrointestinal upset appear in 20 min. to 4 hours
- The fungus has been cited as being responsible for 10% of all mushroom poisonings in Europe.



[*Entoloma austroprunicolor*](#), wiki



Entoloma vinaceum <http://www.mykologie.net>

Fruit body accumulates metals copper, zink, and arsenic. Identity of toxins is still unknown (also contains alcaloids)

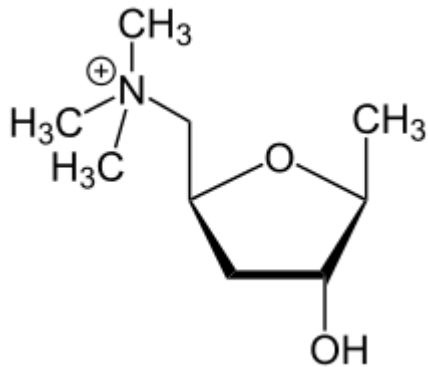


[*Entoloma sinuatum*](#) - závojenka olovová - Mykoweb

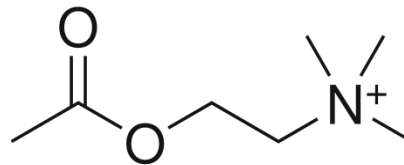
Inocybe and Clitocybe species

(Vláknice a Strmělky)

- Contain muscarin and some species also psilocibine
- Muscarin: agonist of one class of acetylcholine receptors - these receptors are therefore called *muscarinic acetylcholine receptors*.



Muscarine



Acetylcholine



[Strmělka říjnová - Clitocybe brumalis](#)



[Inocybe acutella](#) (Vláknice mokřadní)

Tricholoma species (čirůvky)

- Gastrointestinal upset due to unidentified toxin

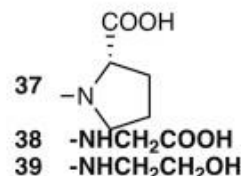
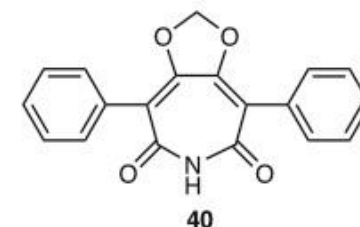
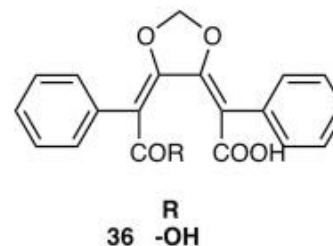
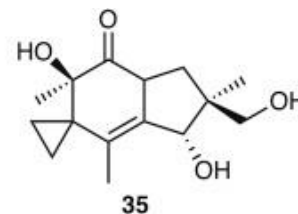


Tricholoma equestre (Man
On horseback, č. zelánka)

Repeated consumption can lead to **Rhabdomyolysis**: damaged skeletal muscle breaks down rapidly. Symptoms may include muscle pains, weakness, vomiting and confusion.



Čirůvka tygrovaná - *Tricholoma pardinum*

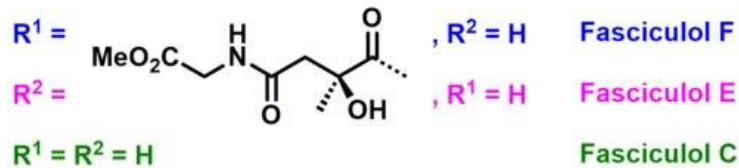
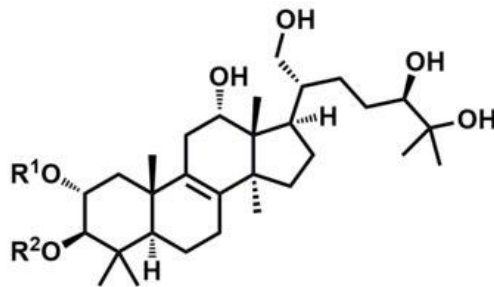


Diarrhea-causing compounds from *Lampteromyces japonicus* and *Tricholoma ustale*. ([Natural Products and Drug Discovery](#), An Integrated Approach, 2018, Pages 309-326)

Hypholoma fasciculare

(sulphur tuf, třepenitka svazčitá)

- gastrointestinal upset, but the toxins **fasciculol E and F** could lead to paralysis and death.



(in mice, with LD₅₀ (i.p.) values of 50 mg/kg and 168 mg/kg, respectively)



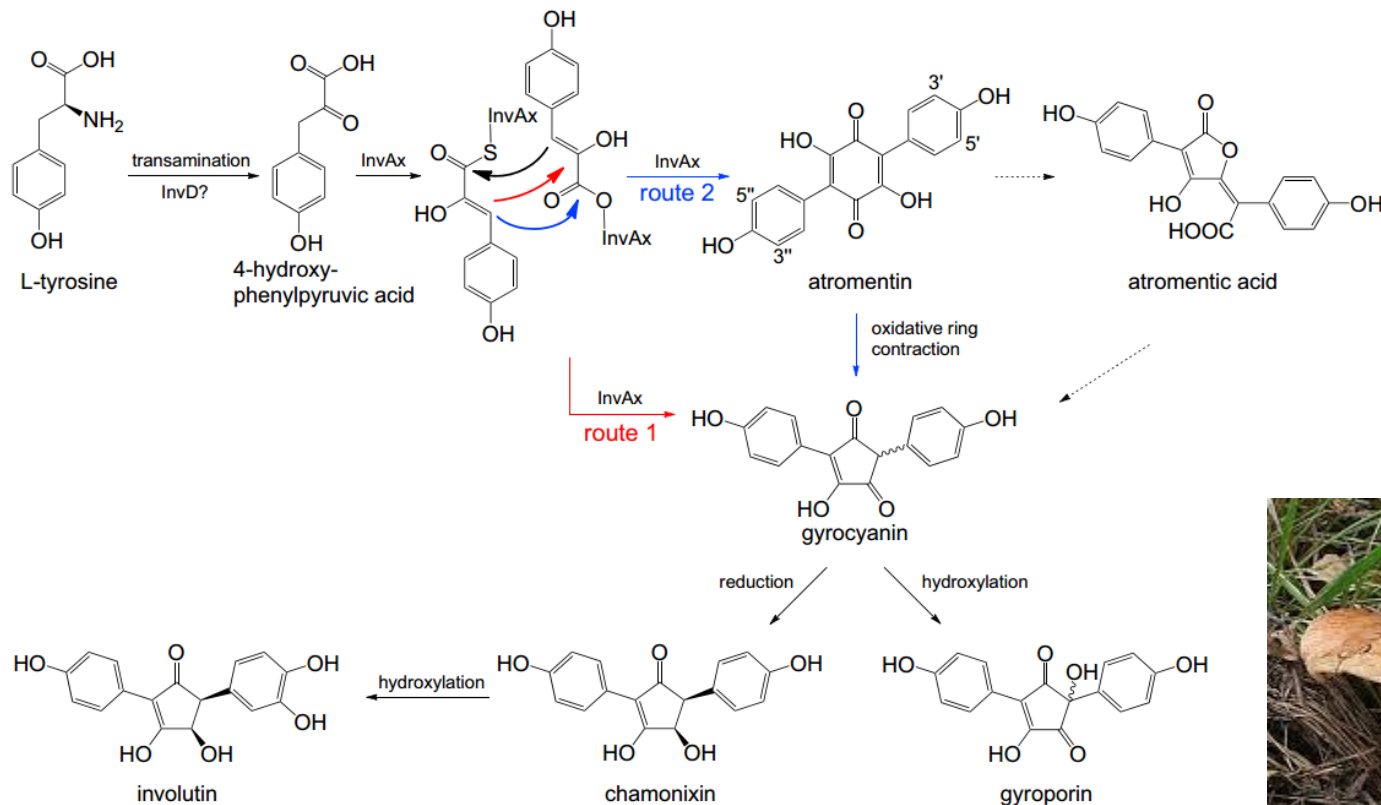
Třepenitka svazčitá - *Hypholoma fasciculare*

<https://en.wikipedia.org/wiki/Hypholoma>

Paxillus involutus

(brown roll-rim, Čechratka podvinutá)

- once thought edible, but now found to destroy **red blood cells** with regular or long-term consumption

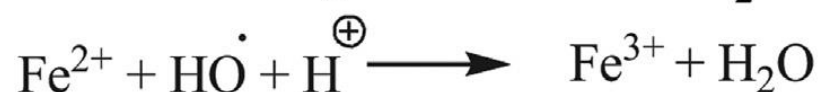
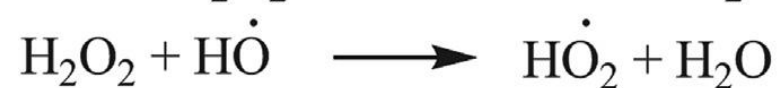


Pigments involved in Fenton chemistry for the initial attack of dead plant matter

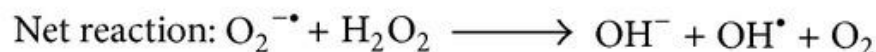
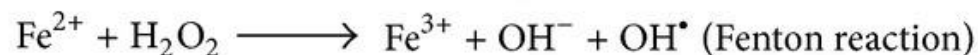


Fenton chemistry

- Iron(II) is oxidized by hydrogen peroxide to iron(III), forming a **hydroxyl radical** and a hydroxide ion in the process.
- Iron(III) is then reduced back to iron(II) by another molecule of hydrogen peroxide, forming a **hydroperoxyl radical** and a proton.
- The net effect is a disproportionation of hydrogen peroxide to create **two different oxygen-radical species**, with water ($\text{H}^+ + \text{OH}^-$) as a byproduct.



Haber-Weiss reaction





Rubroboletus satanas

(Satans bolete, Hřib satan)

Rubroboletus satanas - hřib satan
(myko.cz)

- gastrointestinal irritation. Of these, only *R. pulcherrimus* has been implicated in a death
- **Bolesatine** is a [glycoprotein](#) isolated from the [Rubroboletus satanas](#) mushroom which has a [lectin](#) function.
- It causes [gastroenteritis](#) in humans and, at high enough concentrations, inhibits protein synthesis. At lower concentrations it is a [mitogen](#) to human T [lymphocytes](#).



Rubroboletus pulcherrimus (mycoweb.com)

NH₂-Thr-Trp-Arg-Ile-Tyr-Leu-Asn-Asn-Gln-Thr-Val-Lys-Leu-Ala-Leu-Leu-Leu- Pro- Asn-Gly.... It inhibits protein synthesis in isolated rat mitochondria. (IC₅₀ of 530 nM)

Russula emetica

(the sickener, emetic russula, Holubinka vrhavka)

- causes rapid vomiting. Other Russulas with a peppery taste (*Russula silvicola*, *Russula mairei*) will likely do the same.
- Sesquiterpenoids that have been identified from *R. emetica* include the previously known compounds [lactarorufin A](#), [furandiol](#), [methoxyfuranalcohol](#), and an unnamed compound unique to this species

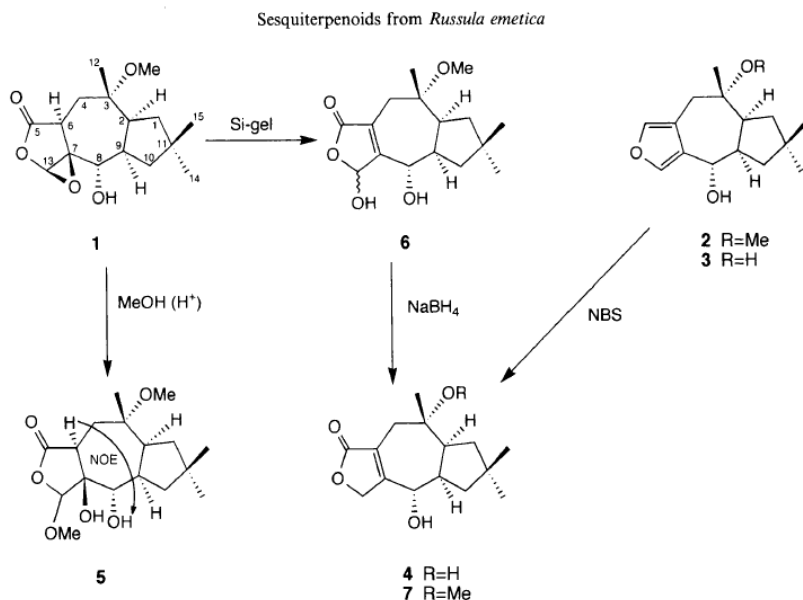


Fig. Structures of Compounds 1–7. NBS, *N*-Bromosuccinimide.



Russula emetica - holubinka vrhavka - myko.cz
myko.cz

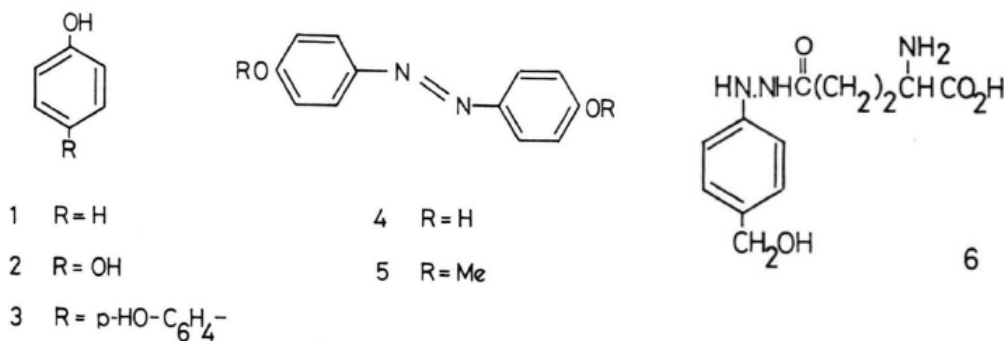
Agaricus species

(Pečárky, Žampiony)

- commonly known as the yellow-staining mushroom or simply the yellow-stainer



After cooking, intense color change to yellow occurs and the smell of Phenol becomes very intense.



Z. Naturforsch. **39c**, 1027–1029 (1984); received September 24, 1984

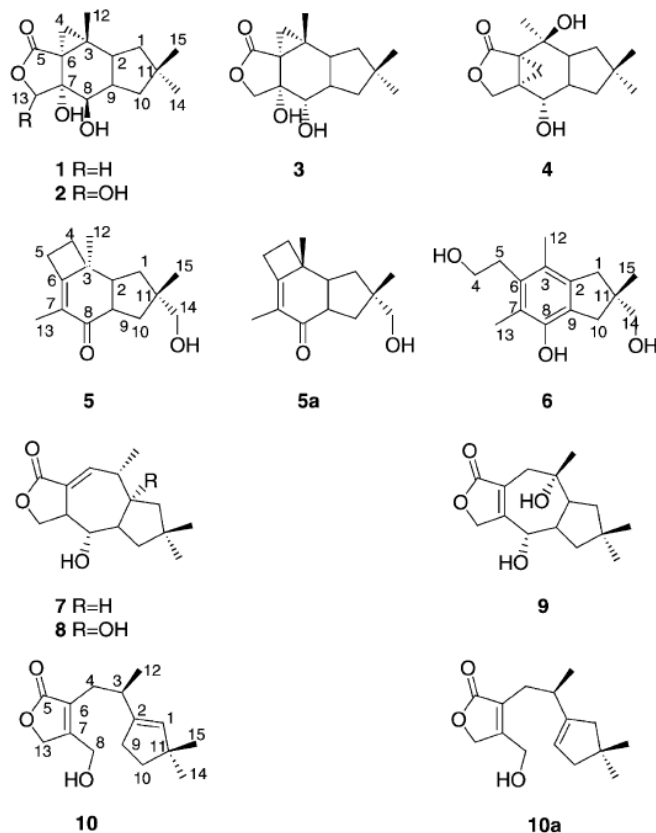


Pečárka zápašná (*Agaricus xanthodermus*),
myko.cz

Lactifluus piperatus

(Blancaccio, Ryzec peprný)

- Muschroom bleeds a whitish peppery-tasting milk when cut. The milk has a very hot and acrid taste, which is removed if boiled. (antibacterial and antiviral activity)



Lactifluus piperatus 2019 (Blancaccio),
Peppery Milk-cap, facebook.com



Ryzec peprný – Wikipedie
cs.wikipedia.org

Wang Y, Yang SP, Yue JM, Chow S, Kitching W.
Novel sesquiterpenes from the fungus *Lactarius piperatus*.
Helvetica Chimica Acta. 2003 86(7):2424-33.

Ramaria gelatinosa

(coral mushroom, Kuřátka)

- causes indigestion in many people, although some seem immune



Ramaria gelatinosa - Wikipedia

Turbinellus floccosus

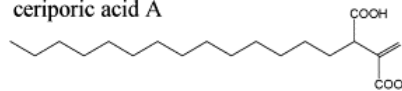
(Chantereles, Stročkovcovité)

- causes gastric upset in many people, although some eat it without problems (fenton reaction)

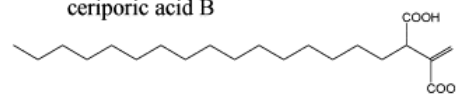


Turbinellus kauffmanii, wiki

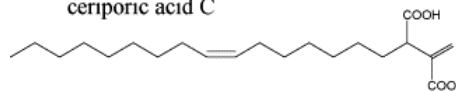
ceriporic acid A



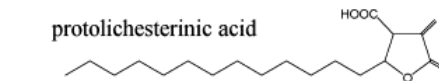
ceriporic acid B



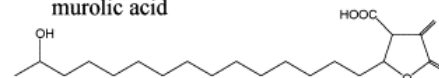
ceriporic acid C



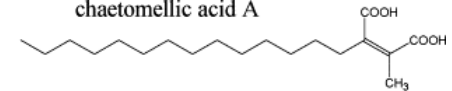
protolichsterinic acid



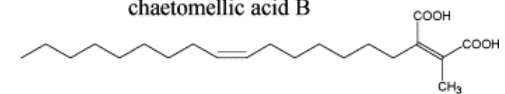
murolic acid



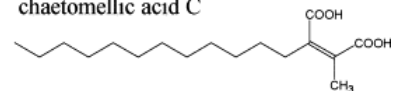
chaetomelic acid A



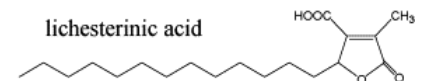
chaetomelic acid B



chaetomelic acid C



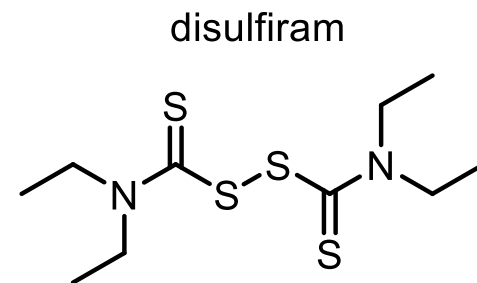
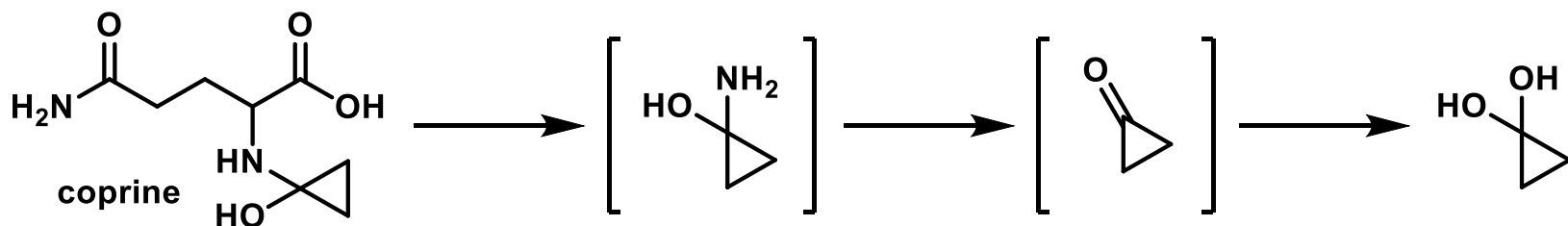
lichsterinic acid



Coprinus comatus

(Shaggy ink cap, Hnojník obecný)

- young mushrooms, before the gills start to turn black, are edible
- When combined with alcohol, it causes "Coprinus syndrome", signs are similar to antabus
- 1-aminocyclopropanol, inhibits acetaldehyde dehydrogenase enzyme. (alcohol flush reaction).



Coprinus comatus – Hnojník obecný (fungi.com, wiki)

Pleurocybella porrigens

(Angel Wing, Hlíva ušatá)

- The mechanism of action for the toxicity of *P. porrigens* has not been definitively established, but several possibilities have been suggested. It has been demonstrated that *P. porrigens* contains an unusual unstable amino acid which is toxic to the brain cells of rats in cell culture studies. (wiki)



"Proof of the existence of an unstable amino acid: pleurocybellaziridine in *Pleurocybella porrigens*".
Angewandte Chemie International Edition. **50** (5):
1168–1170.



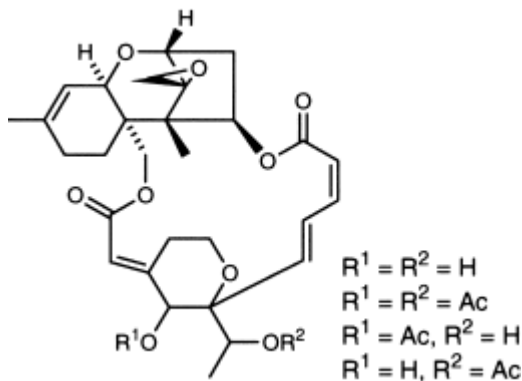
Pleurocybella porrigens (Mykologie.net)

Deadly fungi

Podostroma Cornu-damae

(*kaentake*, poison fire coral)

- trichothecene mycotoxin
- symptoms are system wide and can affect all organs, primarily liver, kidneys and brain. There is also a depletion of blood cells, peeling of skin off the face and hair loss making it look like the victim is suffering from radiation poisoning (or leukemia).



Macrocyclic trichothecenes, roridin E, verrucarins J, and satratoxin H (+acetates).
([https://doi.org/10.1016/S0040-4020\(01\)00824-9](https://doi.org/10.1016/S0040-4020(01)00824-9))



(A) Common gross image of *Podostroma cornu-damae*. (B) Common gross image of young *Ganoderma lucidum*, which is often confused with *P. cornu-damae*. (The Korean Journal of Medicine: Vol. 85, No. 2, 2013)

Cortinarius rubellus, orellanus

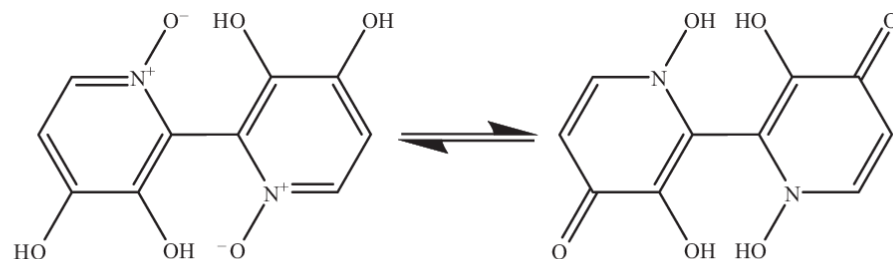
(Deadly webcap, Pavučinec plyšový)

- Contains toxin orellanine it is very potent, may also contain arsenic (no known antidote). It is said that one can be poisoned just by tasting and spitting out a small piece of this mushroom. (lethal dose 30g of fresh mushroom, amanita 50g)



Cortinarius orellanus - pavučinec
plyšový
(myko.cz)

orelleanin



Orellanine (3,3',4,4'-tetrahydroxy-2,2'-bipyridine-N,N'-dioxide)

DOI: 10.1177/0960327115613845

Galerina species

(Čepičatky)

- Autumn Skullcap (*Galerina marginata*)
- small brown-spore saprobic mushrooms, with over 300 species found throughout the world
- occasionally confused with hallucinogenic species of *Psilocybe*
- *Many (though not all) Galerina contain **alpha-amanitin** and other **amatoxins**. *Galerina steglichii* is very rare, bruises blue and contains the hallucinogen psilocybin.*



Galerina marginata - čepičatka
jehličnanová
(myko.cz)

Galerina marginata - Čepičatka jehličnanová (wiki)



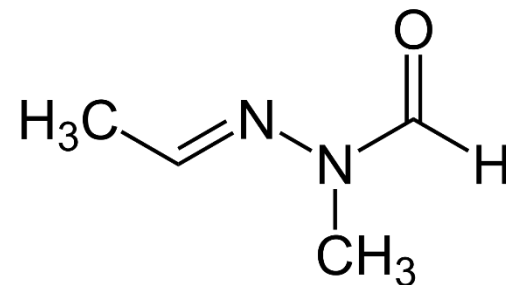
Gyromitra esculenta

(False morrel, Ucháč obecný)

- toxin here is gyromitrin which becomes monomethylhydrazine (MMH) after you eat it. This toxin will primarily affect the liver but also the nervous system and sometimes the kidneys. Symptoms such as diarrhea and vomiting will appear within hours and are followed by dizziness, lethargy and headache (coma and death within the week).



gyromithin



Amanita species

(Destroying angels)

- *Amanita bisporigera* and *A. ocreata* in eastern and western North America, and *A. virosa* in Europe.
- initial symptoms of cramps, delirium, convulsions, vomiting and diarrhea appear with a day of ingestion. Later kidney and, particularly, liver failure. (amatoxins)



Amanita ocreata
(earth.com)



Amanita virosa,
Muchmůrka jízlivá
(first-nature.com)



Amanita bisporigera
(Alchetron, The Free Social
Encyclopedia alchetron.com)

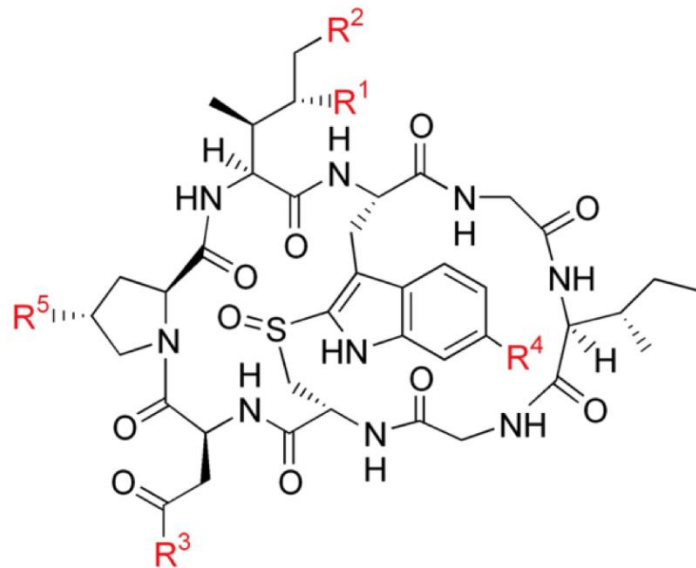


(Mycoweb.com)

Amanita phalloides

(Death cap, Muchmůrka zelená)

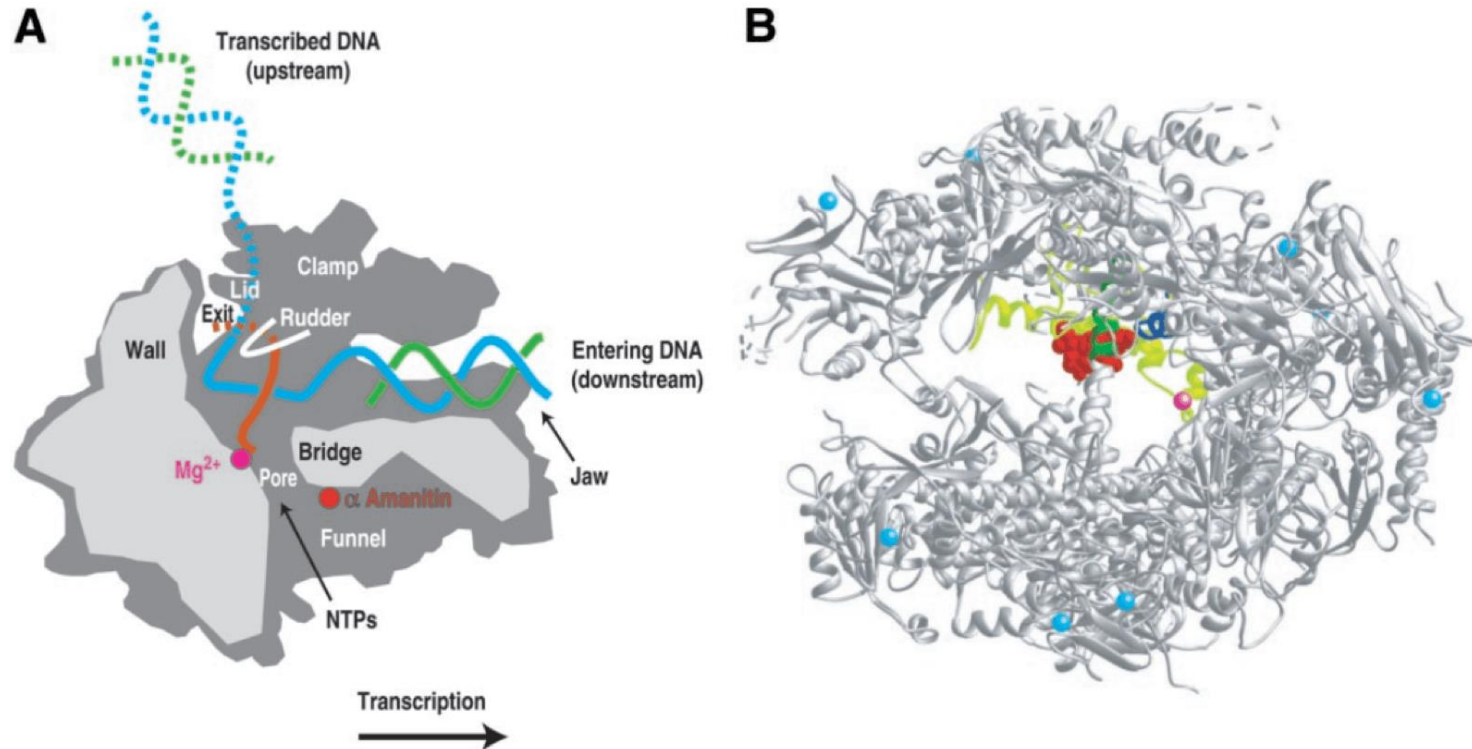
- primary toxic agent is α -amanitin (amatoxin, cyclic octapeptide)
- estimated that 30 grams (1oz) or approx. half a mushroom is enough to kill an adult



Name	R ¹	R ²	R ³	R ⁴	R ⁵
<u>α-Amanitin</u>	OH	OH	NH ₂	OH	OH
<u>β-Amanitin</u>	OH	OH	OH	OH	OH
<u>γ-Amanitin</u>	H	OH	NH ₂	OH	OH
<u>ϵ-Amanitin</u>	H	OH	OH	OH	OH
<u>Amanullin</u>	H	H	NH ₂	OH	OH
<u>Amanullinic acid</u>	H	H	OH	OH	OH
<u>Amaninamide</u>	OH	OH	NH ₂	H	OH
<u>Amanin</u>	OH	OH	OH	H	OH
<u>Proamanullin</u>	H	H	NH ₂	OH	H

Cyclic octapeptide structure of amatoxin and its variants
(creative-biolabs.com)

Amatoxins Mode of Action (MOA)



α -amanitin bound to RNA polymerase II at the bridge helix region and stabilizes the RNA polymerase II elongation complex to prevent DNA translocation and mRNA elongation (*PNAS*, 2002). (taken from creative-biolabs.com)

Amatoxin poisoning: Treatment

- major amatoxins, the alpha-, beta-, and gamma-amanitins, are bicyclic octapeptide derivatives that damage the liver and kidney via irreversible binding to RNA polymerase II
- preliminary medical care, supportive measures, specific treatments used singly or in combination, and liver transplantation.
- detoxication procedures (e.g., toxin removal from bile and urine, and extracorporeal purification) and administration of drugs. Chemotherapy included benzylpenicillin or other beta-lactam antibiotics, silymarin complex, thiocetic acid, antioxidant drugs, hormones and steroids administered singly, or more usually, in combination.

List of the most important fungi toxins

Toxin	Level of Toxicity	Effect when consumed
Alpha-amanitin	Deadly	Liver damage 1–3 days after ingestion. Principal toxin in genus <i>Amanita</i> .
Phallotoxin	Non-lethal	Gastrointestinal upset. Found in poisonous <i>Amanitas</i> .
Orellanine	Deadly	Kidney failure within 3 weeks after ingestion. Principal toxin in genus <i>Cortinarius</i> .
Muscarine	Potentially Deadly	Respiratory failure. Found in genus <i>Omphalotus</i> .
Gyromitrin	Deadly	Neurotoxicity, gastrointestinal upset, and destruction of blood cells. Principal toxin in genus <i>Gyromitra</i> .
Coprine	Non-lethal	Illness when consumed with alcohol. Principal toxin in genus <i>Coprinus</i> .
Ibotenic acid	Potentially Deadly	Neurotoxicity. Principal toxin in <i>Amanita muscaria</i> , <i>A. pantherina</i> , and <i>A. gemmata</i> .
Muscinol	Non-lethal	CNS depression and hallucinations. Principal toxin in <i>Amanita muscaria</i> , <i>A. pantherina</i> , and <i>A. gemmata</i> .
Psilocybin and psilocin	Non- Poisonous	CNS arousal and hallucinations. Principal effects in psilocybin mushrooms, many belonging to the genus <i>Psilocybe</i>
Arabitrol	Non-lethal	Gastrointestinal irritation in some people
Bolesatine	Non-lethal	Gastrointestinal irritation, vomiting, nausea.
Ergotamine	Deadly	Affects the vascular system leading to loss of limbs and death. An alkaloid found in genus <i>Claviceps</i> .



Psilocybe cubensis (facebook.com)

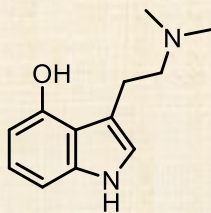
Psilocybe species

(Lysohlávky)

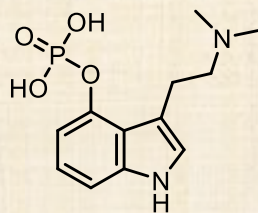


*Psilocybe
Semilanceata*
(wiki)

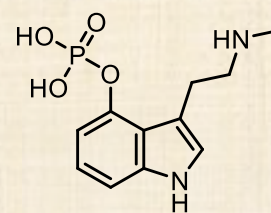
- a genus of gilled mushrooms growing worldwide, most or nearly all of which contain the psychedelic compounds Psilocybin, psilocin and baeocystin.
- ingestion of the psilocybin by alkaline phosphatases present in the body's digestive system, kidneys, and possibly in the blood readily cleave the phosphoryl ester bond from psilocybin, yielding the hydroxyl compound, psilocin. Psilocin is the chemical primarily responsible for the hallucinogenic effects of the *Psilocybe*.
- Psilocin is direct agonist effect on the 5-HT serotonin receptors.



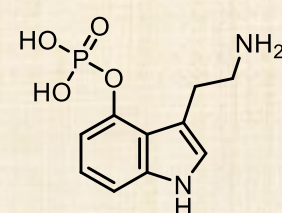
psilocin



psilocybin



baeocystin



norbaeocystin



Psilocybe cubensis
(wiki)



Psilocybe cyanescens
(mycoweb.com)



Psilocybe semilanceata
(first-nature.com)



Psilocybe azurescens
(reddit.com)



Lysohlávka česká
Psilocybe serbica var.
bohemica

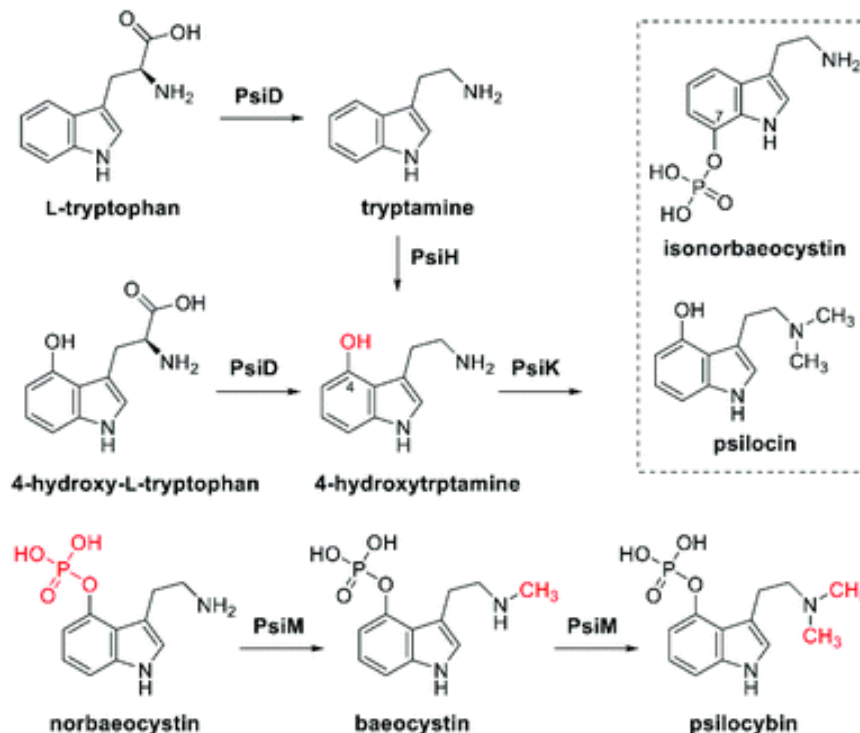
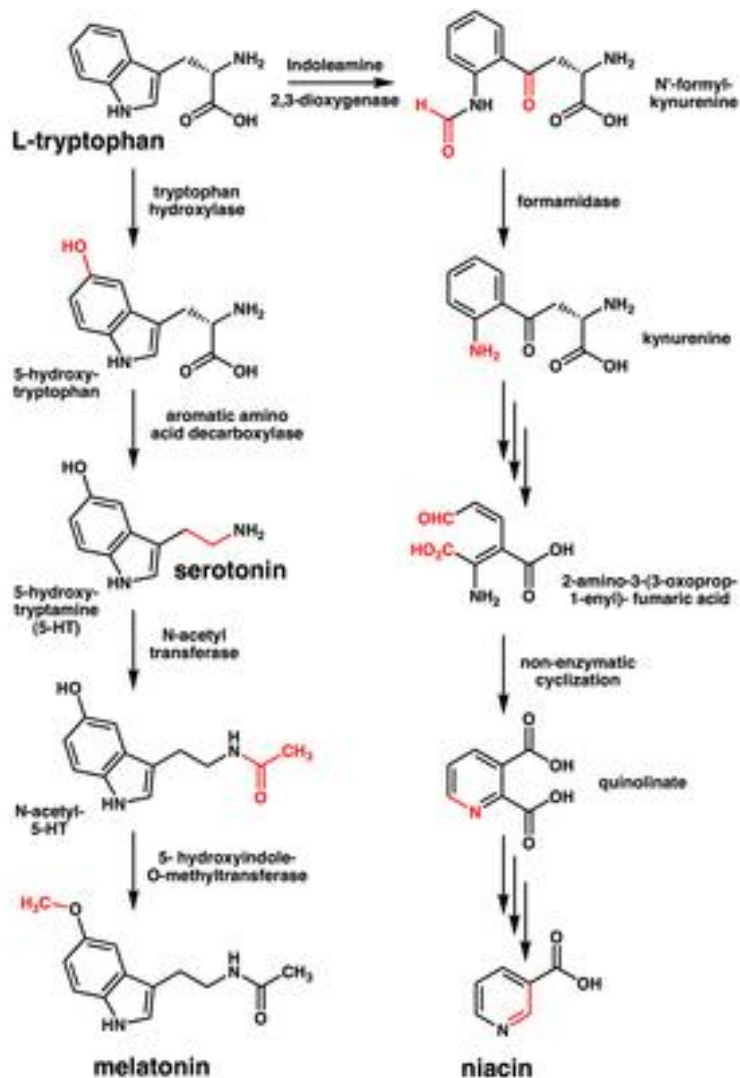


Lysohlávka tajemná
Psilocybe serbica var.
arcana



Lysohlávka moravská
Psilocybe moravica
(researchnet.org)

serotonin vs. psilocin



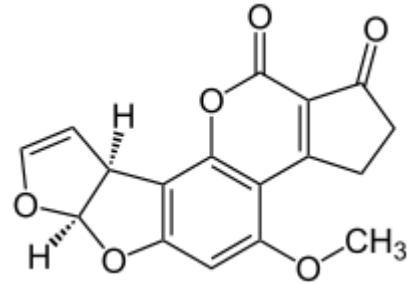
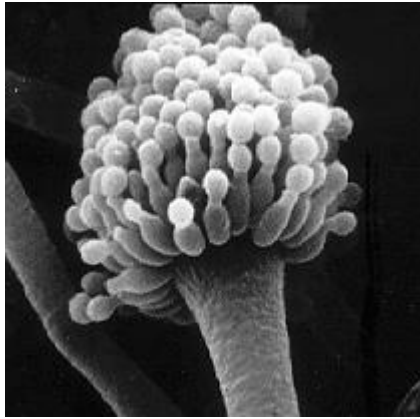
Biosynthesis of psilocybin in *P. cubensis* and *P. cyanescens*.
 Org. Biomol. Chem., 2019,17,
 1027-1036

Mycotoxins

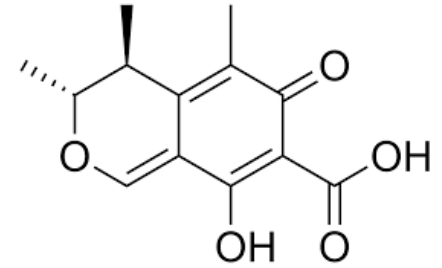
- A mycotoxin (from the [Greek](#) μύκης *mykes*, "fungus" and τοξικόν *toxikon*, "poison"), toxic substances present in mushrooms
- Slight gastrointestinal discomfort to death
- Toxins are secondary metabolites produced by fungus
- Most common mycotoxins: include [aflatoxin](#), [citrinin](#), [fumonisins](#), [ochratoxin A](#), [patulin](#), [trichothecenes](#), [zearalenone](#), and [ergot alkaloids](#) such as [ergotamine](#).

<https://en.wikipedia.org/wiki/Mycotoxin>,

https://en.wikipedia.org/wiki/Mushroom_poisoning

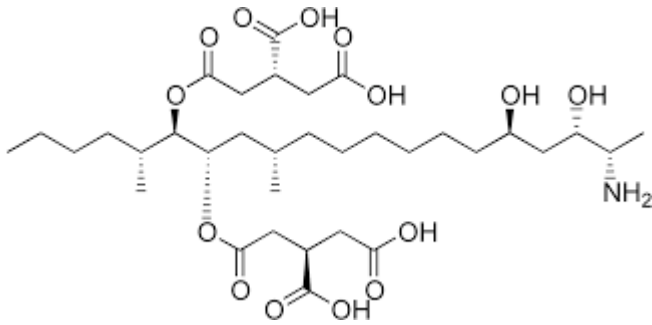


Aflatoxin

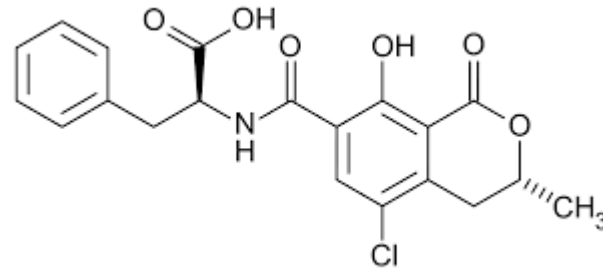


citrinin

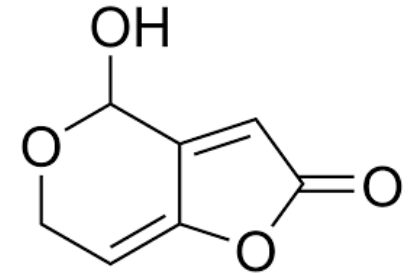
Aspergillus fumigatus (wiki)



Fumonisin

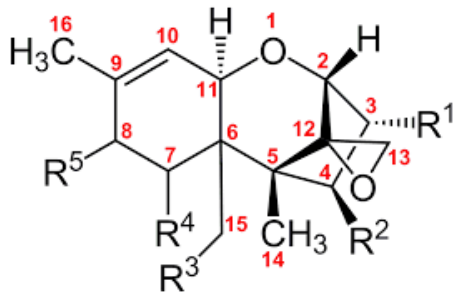


Ochratoxin A

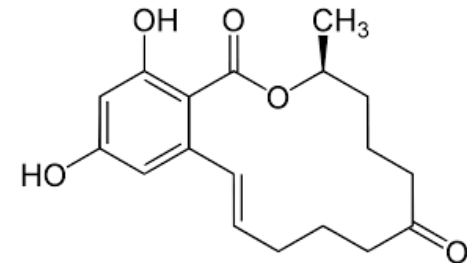


Patulin

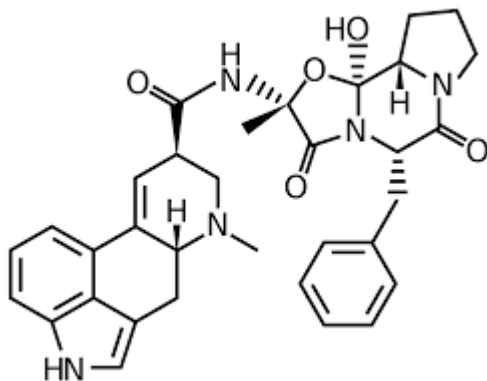




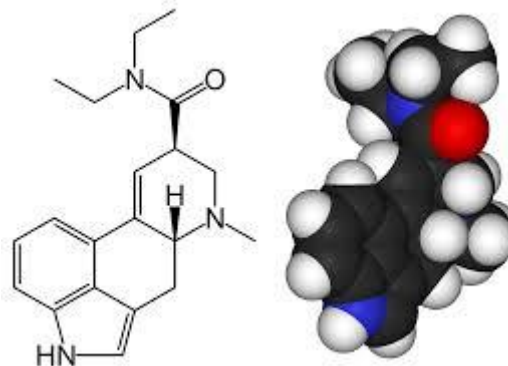
Trichothecene



Zearalenone



Ergotamine



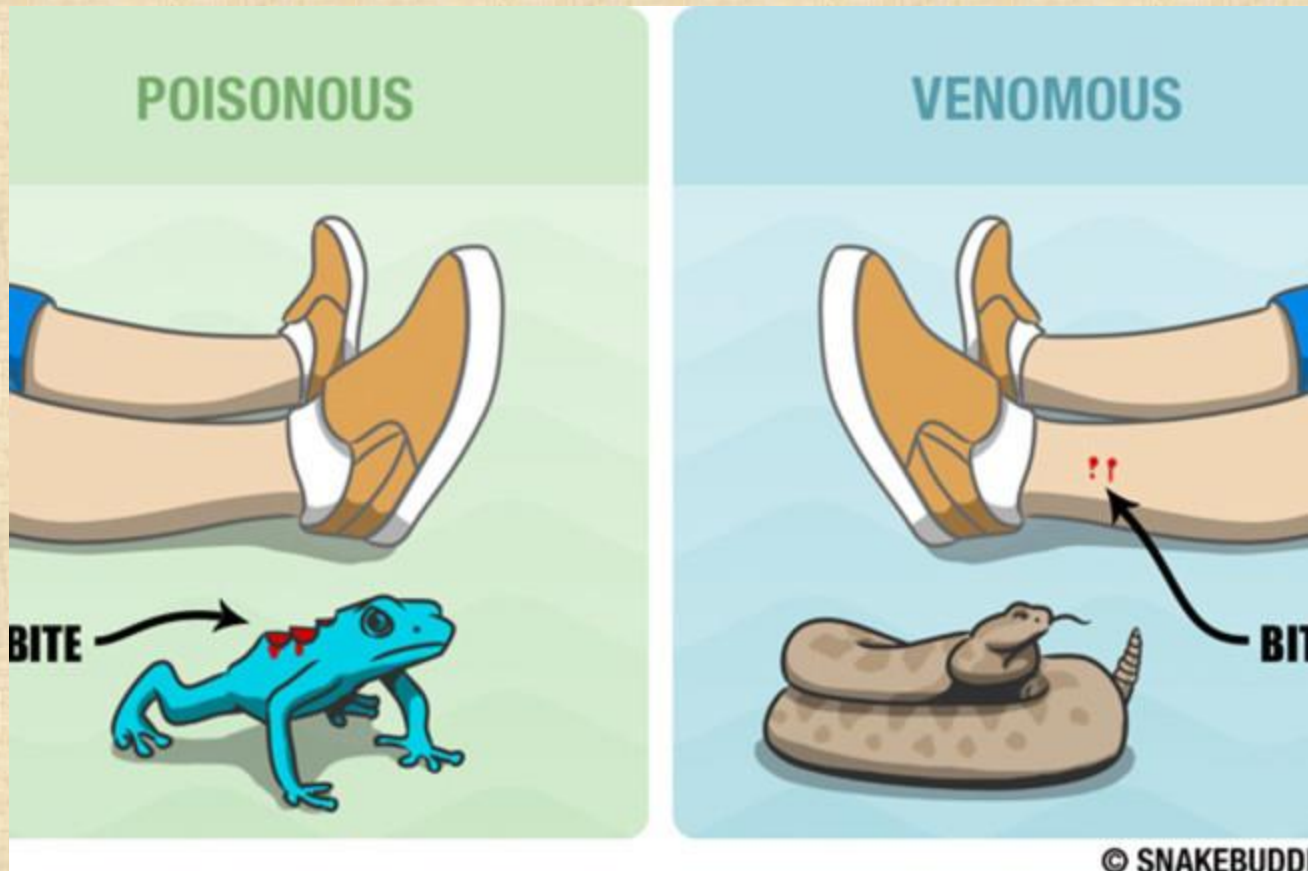
LSD



Claviceps purpurea –
Paličkovice nachová

Some poisons and venoms

(from animal kingdom)



(www.discovermagazine.com)

POISONOUS



POISON DART FROGS



SEA SLUGS



TOADS



SALAMANDERS



SOME GRASSHOPPERS



PUFFER FISH



CUBAN LAND SNAILS



PITOHUI BIRDS



SOME BUTTERFLIES

VENOMOUS



WASPS



SCORPIONS



GILA MONSTERS



SPIDERS



VIPERS

CENTIPEDES

JELLYFISH

CONE SNAILS

MALE PLATYPUSES



1 Sodium channel blockers

-  μ - conotoxins
-  μ - O - conotoxins
-  Cn-11
-  hainantoxin - I
-  protoxin - II

2 Sodium channel activators (site-4 toxins)

-  β - toxins
-  δ - palutoxins
-  μ - agatoxins

3 Sodium channel prolongers

-  δ - conotoxins
-  uncharacterized toxin(s)
-  α - toxins
-  sea anemone sodium channel inhibitory toxins
-  δ - atracotoxins

4 Potassium channel blockers

-  κ - conotoxin
-  apamin
-  short scorpion toxins
-  cnidaria kunitz-type proteinase inhibitors
-  sea anemone type 3 (BDS) potassium channel toxins
-  dendrotoxins
-  κ - atracotoxins
-  CRISP toxins

5 Calcium channel blockers

-  assassin bug toxins
-  ω - conotoxins
-  lamprey salivary CRISP
-  calcicludine
-  calciseptine / FS2
-  ω - neurotoxins
-  CRISP toxins

8 Sodium channel blockers

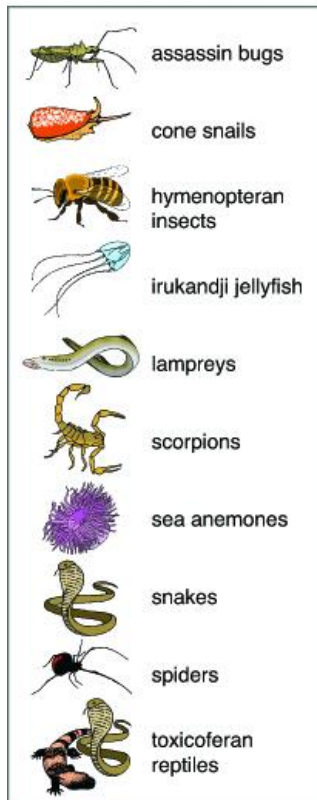
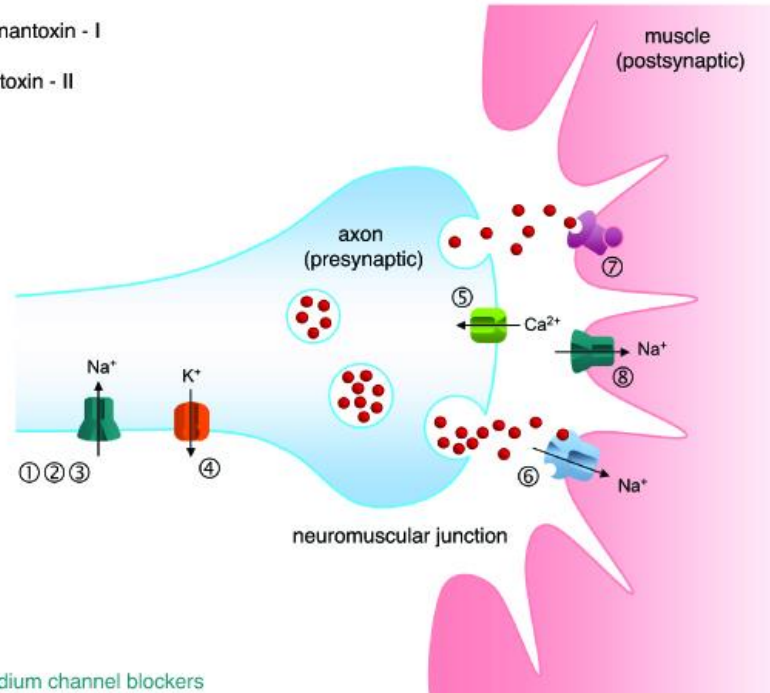
-  μ - conotoxins
-  μ - O - conotoxins

7 Muscarinic receptor antagonists

-  uncharacterized toxin(s)
-  phospholipase A₂ toxins
-  type-A muscarinic toxins
-  type-B muscarinic toxins

6 Nicotinic receptor antagonists

-  α - conotoxins
-  α - neurotoxins



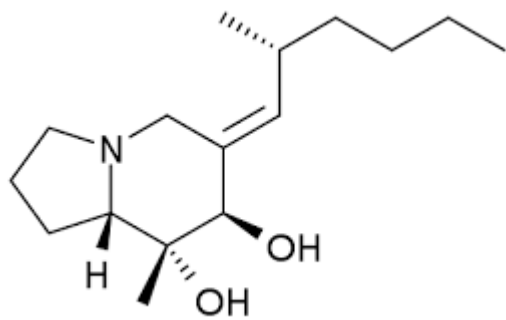
Poisonous animals

Dart frogs - Pralesničky

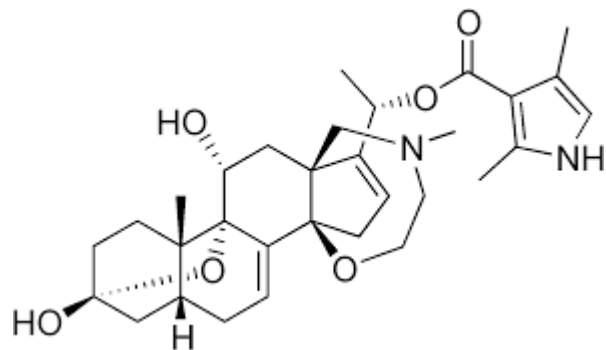
- a group of frogs *Dendrobatidae* family which are native to tropical Central and South America
- secrete lipophilic alkaloid toxins such as allopumiliotoxin 267A, batrachotoxin, epibatidine, histrionicotoxin, and pumiliotoxin 251D through their skin.



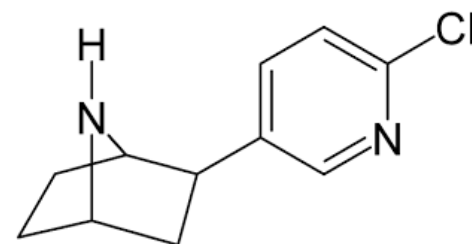
Dart Frogs - Pralesničkovití
joshsfrogs.com



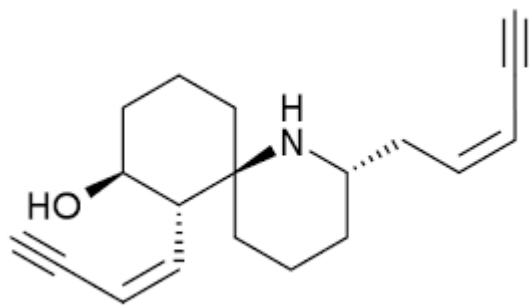
Allopumiliotoxin



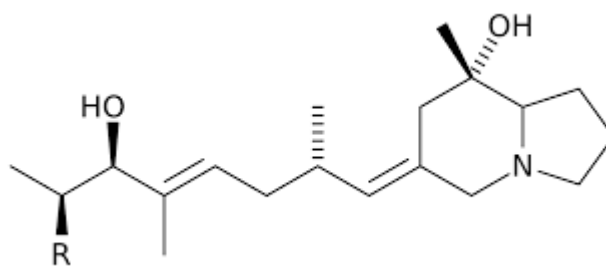
Batrachotoxin



Epibatidine



Histrionicotoxin



Pumilotoxin

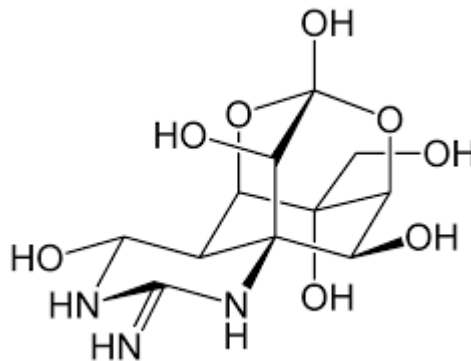


Sea slugs

- The name "sea slug" is most often applied to nudibranchs, as well as to a paraphyletic set of other marine gastropods without obvious shells.



Pleurobranchaea maculata
(mollusca.co.nz)



tetrodotoxin

lethal dose of TTX to humans is 1–2 mg. A human would need to eat 2.6 **grams** of sea slug in order to get a dose of 1mg of TTX. That's not much, probably half a teaspoon of sea slug.

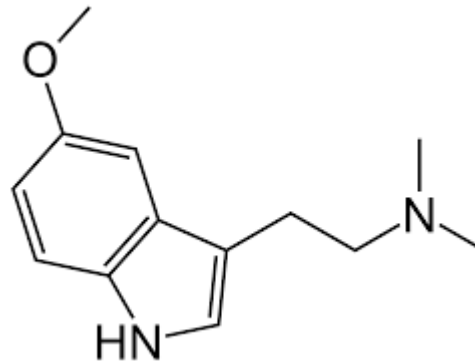
<https://niwa.co.nz/>

Toads

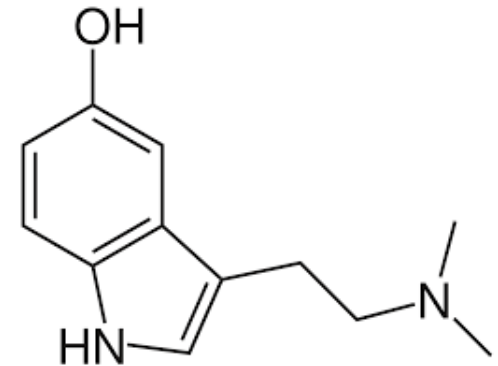
- Also known as the Sonoran Desert toad, is found in northern Mexico and the southwestern United States. Its toxin, as an exudate of glands within the skin, contains 5-MeO-DMT and bufotenin (hallucinogenic).



Incilius alvarius –
Ropucha coloradská



5-O-Me-tryptamine



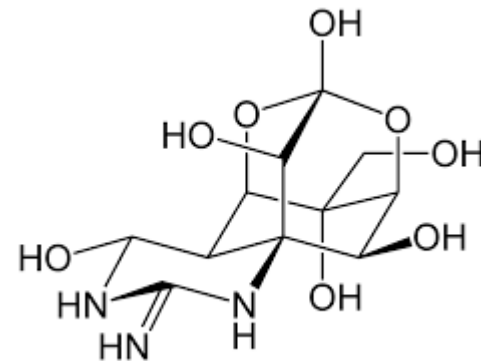
bufotenin

Salamanders

- Certain salamander species (genera *Pleurodeles* and *Tylototriton*) have tubercles running down the sides of their bodies. If the animals are grasped or attacked, they can push their sharp ribs through these as a defence mechanism.
- As the salamanders are actively using these "stinging ribs" to inject their toxins, such species could be considered venomous as opposed to poisonous. (savethesalamanders.com)



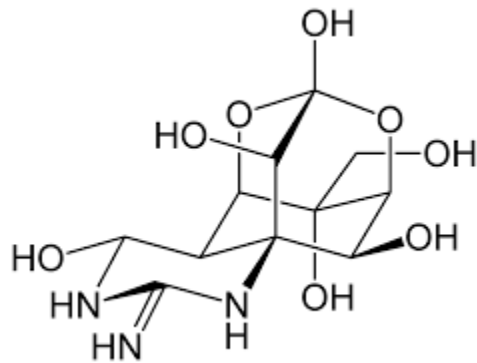
sharp-ribbed salamander,
Iberian ribbed newt
(*Pleurodeles waltl*)



tetrodotoxin

Tetraodontidae - Čtverzubcovití

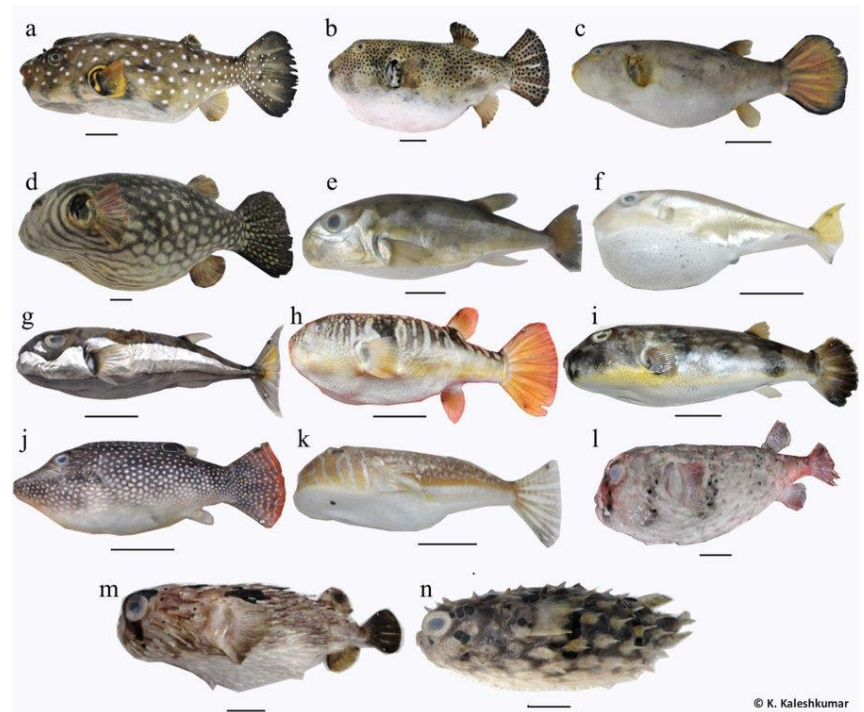
- a family of primarily marine and estuarine fish of the order *Tetraodontiformes* (The *Tetraodontidae* contain at least 200 species of puffers in 29 genera).



tetrodotoxin



Japonská ryba Fugu (Takifugu)
jimeto.cz



Conus geographus – Homolice mapová

- the geography cone or the geographer cone, is a species of predatory cone snail. It lives in reefs of the tropical Indo-Pacific, and hunts small fish.
- geography cone is highly dangerous; live specimens should be handled with extreme caution (a cigarette cone).
- estimated an LD70 value (in humans) of 0.001-0.003 mg/kg. In two cases of envenomation, only 0.0002-0.0005 mg resulted in severe paralysis. Other figures estimate LD50 values of 0.012-0.03 mg/kg. (wiki)

Conotoxin is a mixture of peptides and each of the of conotoxins attacks a different target:

α -conotoxin inhibits [nicotinic acetylcholine receptors](#) at [nerves](#) and [muscles](#).

δ -conotoxin inhibits fast inactivation of [voltage-dependent sodium channels](#).

κ -conotoxin inhibits [potassium channels](#).

μ -conotoxin inhibits voltage-dependent [sodium channels](#) in muscles.

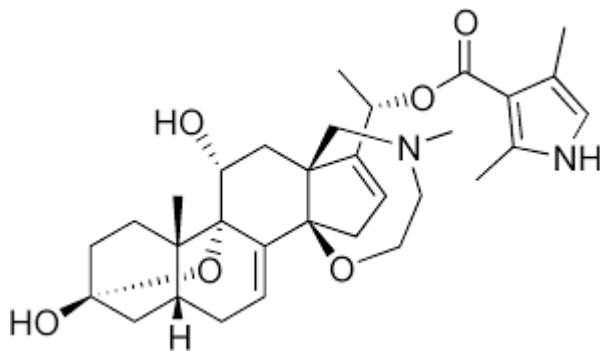
ω -conotoxin inhibits N-type [voltage-dependent calcium channels](#). (wiki)



[Conus geographus](#) - Homolice mapová (wiki)

Pitohui birds – Pištec černo hlavý

- birds that use toxins to defend themselves from predators. No species of bird is known to actively inject or even produce venom, but some birds are known to be poisonous to touch or eat.
- batrachotoxin is one of the most potent alkaloids known: its subcutaneous LD_{50} in mice is $2 \mu\text{g/kg}$. Meanwhile, its derivative, batrachotoxinin A (without pyrrol moiety), has a much lower toxicity with an LD_{50} of $1000 \mu\text{g/kg}$.



Batrachotoxin



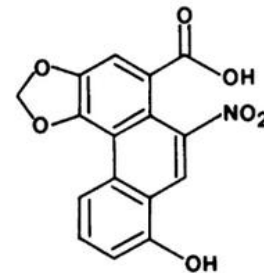
[PITOHUI – Pištec černo hlavý](#)
[\(youtube.com\)](#)

Papilio antimachus - Otakárkovití

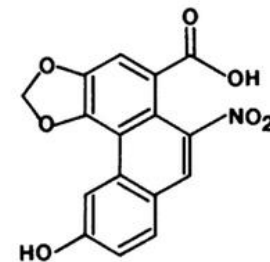
- *Papilio antimachus*, the **African giant swallowtail**, is a [butterfly](#) in the family [Papilionidae](#). With a wingspan between 18 and 23 centimetres (7.1 and 9.1 in), it is the largest butterfly in Africa and among the largest butterflies in the world.
- The butterfly has no natural enemies because it is very toxic.



Papilio antimachus
alchetron.com



Aristolochic acid-IA



Aristolochic acid-C

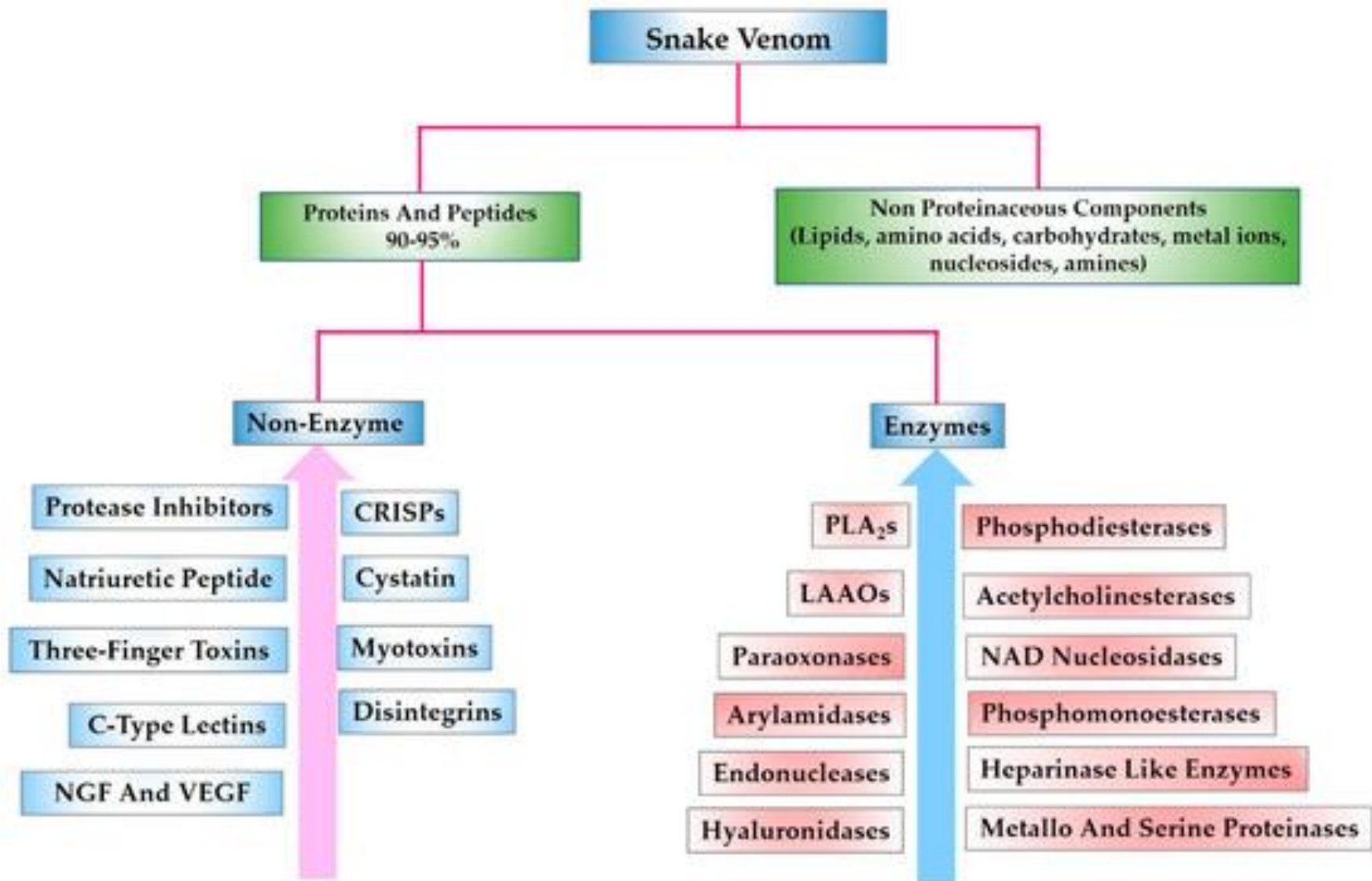
That papilionids are not limited to the sequestration of aristolochic acids is demonstrated by the fact that adults of *Papilio antimachus* (food plant unknown) contain large quantities of unidentified cardenolides (Rothschild, 1970).

(Chemical Defenses of Arthropods)

Venomous animals

Snakes

- Snake venoms consist of 90-95% proteins (dry weight) which are responsible for all the biological effects.
- The most dangerous species venoms contains **neurotoxins** and **hydrolytic enzymes**.
- Venom types: **proteolytic venoms** dismantle the tissues surrounding bite and other molecular targets, **hemolytic venoms** attacks cardiovascular system and the heart, **neurotoxic venoms** acts against nervous system (brain), **cytotoxic** venoms have localized action.
- Venom injection *via* biting (Vipers – zmije, Elapids – korálovci, Colubrids – užovkovití) or spitting (spitting cobras)



Vipers

- Viperidae differ much among themselves in the toxicity of their venoms. Russell's viper (*Daboia russelli*, *Zmije řetízková*), saw-scaled viper (*E. carinatus*, *Zmije paví*), American rattlesnakes (*Crotalus* spp., *Chřestýš zelený*), bushmasters (*Lachesis* spp., *Křovinář němý*), lanceheads (*Bothrops* spp., *Křovinář*), African adders (*Bitis* spp., *Zmije útočná*), night adders (*Causus* spp., *Pazmije vejcorodá*), and horned vipers (*Cerastes* spp., *Zmije růžkatá*) cause fatal accidents.



Zmije řetízková
[wiki](#)



Zmije paví
[wiki](#)



Chřestýš zelený
[wiki](#)



Křovinář němý
[wiki](#)

Elapids

- a family of venomous snakes endemic to tropical and subtropical regions around the world, with terrestrial forms in Asia, Australia, Africa, America, Pacific and Indian ocean regions.
- Venoms are mostly neurotoxic for immobilizing prey and (PLA2 and Three finger toxins (3FTx)). Other toxic components comprise cardiotoxins and cytotoxins, which cause heart dysfunctions and cellular damage.
- e.g. cobras, coral snakes, mambas, grass snakes, sea and swamp snakes, taipan,



Mamba černá
(*Dendroaspis polylepis*)
wiki



Korálovka (wiki)



Korálovec (wiki)

Rozlišení: u korálovek sousedí červený pruh s pruhem černým.
U korálovců pak červený pruh sousedí s pruhem bílým (žlutým).
Nelze 100% spoléhat kvůli barevným variantám hadů (nabla.cz)

Bees, wasps and hornets

- Wasp venom contains a mixture of peptides and enzymes – which break the cell membranes – spilling the cellular contents into the environments.
- Norepinephrin – stops the blood flow
- Hyaluronidase and MCDP (mast cell degranulating peptide) – degrade the connective tissues between the cells to potent the membrane destroying agents.



Vosa obecná - *Vespa vulgaris*
(Deratizator.cz)



Vosa útočná - *Vespa germanica*
(Wiki)



Vespa crabro –
Sršeň obecná
(Adera.cz)

CHEMICAL COMPONENTS OF INSECT VENOMS



Bee Venom



Wasp Venom



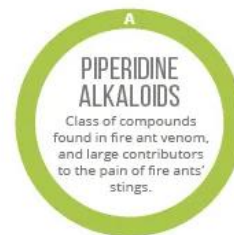
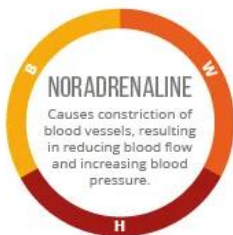
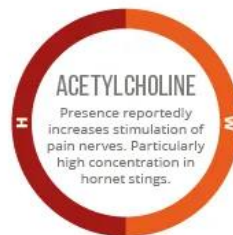
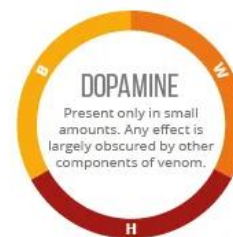
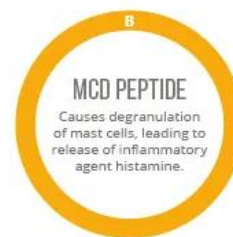
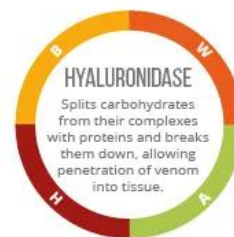
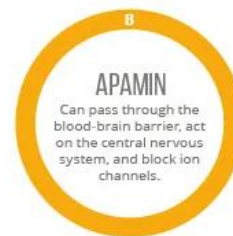
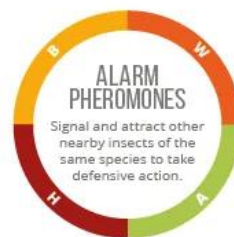
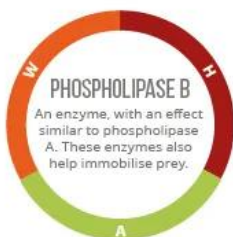
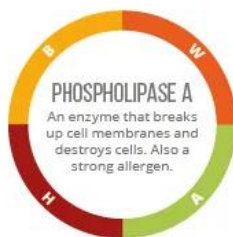
Hornet Venom



Ant Venom

Insect venoms can vary significantly in their composition. They commonly contain a complex mix of proteins, peptides, and enzymes, as well as smaller molecular weight components. This graphic aims to give a broad overview of some of these components.

The circle surrounding each component is colour coded to indicate whether it is present in bee, wasp, hornet, or ant venom. Note that this represents a general overview, and venoms will vary from species to species.



LETHAL DOSES OF VENOM

Honey Bee	2.8mg/kg
Yellowjacket	3.5mg/kg
Giant Hornet	4.6mg/kg
Harvester Ant	0.12mg/kg

Centipedes - Stonožky

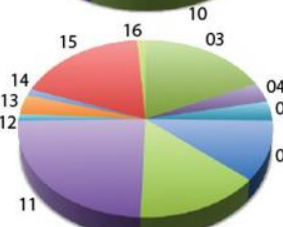
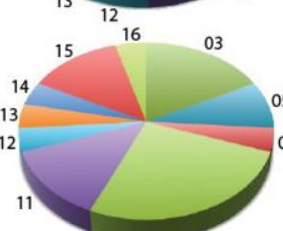
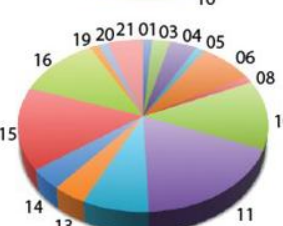
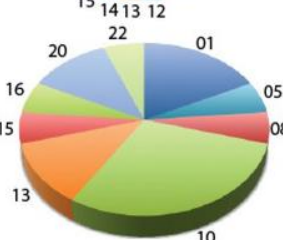
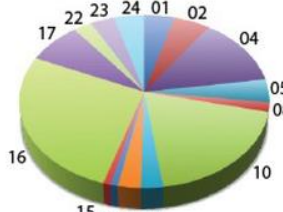
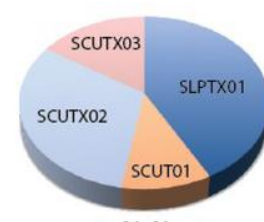
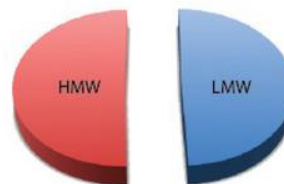
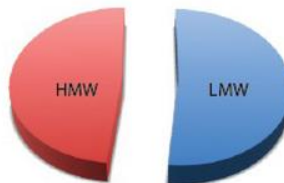
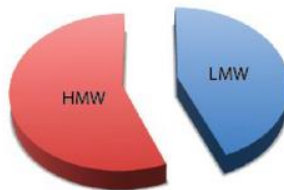
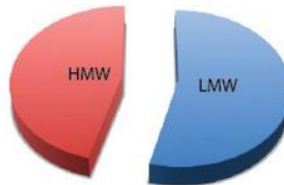
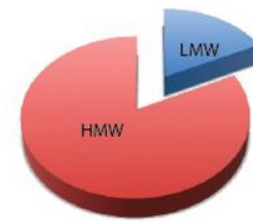
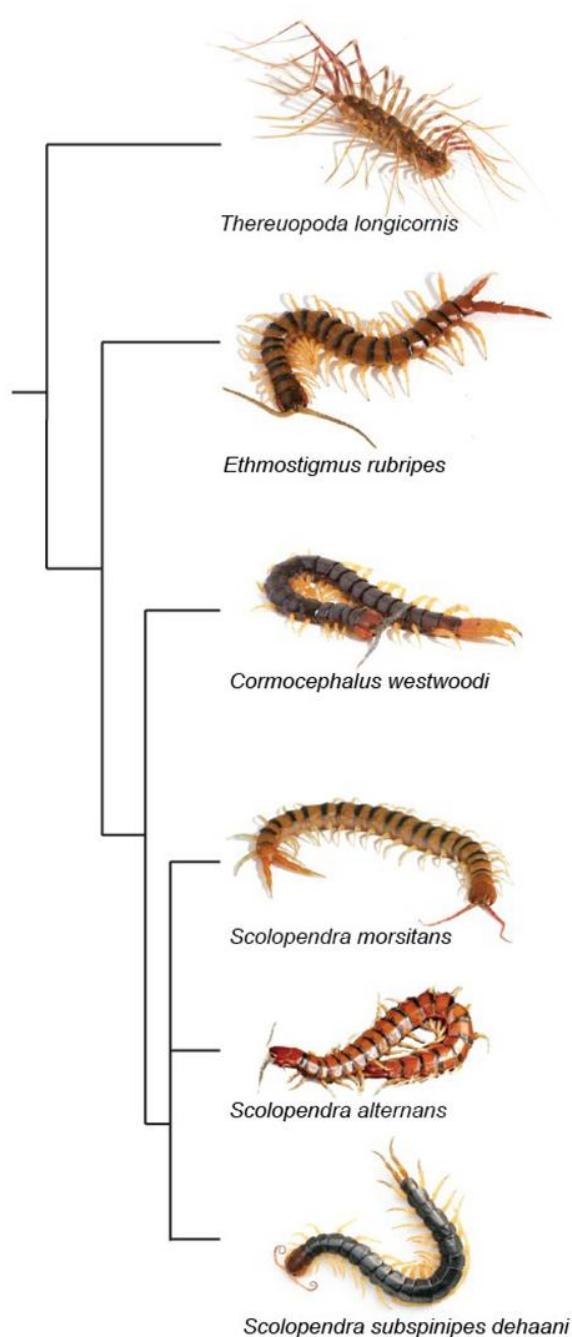
- are predatory arthropods belonging to the class *Chilopoda* of the subphylum *Myriapoda*.
- number of legs, ranging from 30 to 354.
- centipedes are generally venomous and could inflict a painful bite.



Scolopendra Galapagoensis
(image: [Scolomorph](#) / Flickr)



Giant Scolopendridae – Stonoha obrovská
(image: Pinterest)



- high-molecular-weight venom proteins (HMW, red) and low-molecular-weight venom peptides (LMW, blue)
- scutigeroxin family (SCUTX)
- Metalloproteinases, serine proteases, γ -Glutamyl Transpeptidase, glycoside hydrolases, phospholipase A2,
- Centipede β -Pore-Forming Toxins, CAP – proteins - ion channel modulators, vasodilators, myotoxins.
- (Toxins 2015, 7(3), 679-704;
<https://doi.org/10.3390/toxins7030679>)

Heloderma suspectum – Korovec jedovatý

- Venom: kallikrein-like serine proteinases and phospholipase A2 (type III) enzymes. A neuroendocrine convertase 1 homolog.
- peptide toxins are secreted as proforms that are activated by proteolytic cleavage following secretion as opposed to being activated intracellularly. (J. Proteomics. 2015 Mar 18;117:1-11. doi: 10.1016/j.jprot.2015.01.004)



Heloderma suspectum (Biolib.cz)



(animalspot.net)



Semanticschoolar.com

Deathstalker (*Leiurus quinquestriatus*)

- is a species of scorpion, a member of the *Buthidae* family. It is also known as the Palestine yellow scorpion, Omdurman scorpion, Naqab desert scorpion.
- Chlorotoxin is the first reported high-affinity peptide ligand for Cl^- channels and it blocks small conductance chloride channels.



Leiurus quinquestriatus –
Štír nejedovatější
(wiki)



Under the UV light
(Rebloggy.com)



Chlorotoxin
(wiki)

Sydney funnel-web spider

Atrax robustus

- Is listed by Guinness World Records as being the “most venomous” spider in terms of toxicity to humans. While a lethal dose of venom is currently unknown, the spider’s lethality to the crab-eating macaque has been noted as 0.2 milligrams per kilogram. An average venom yield from a male Sydney Funnel Web Spider is 176 milligrams.



Brazilian Wandering Spider—*Phoneutria Fera* (listverse.com)



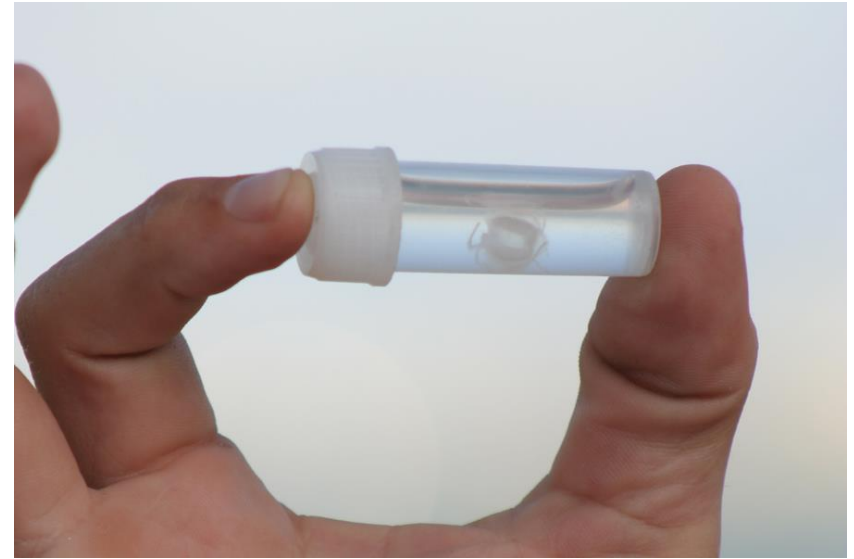
Atrax robustus – Sklípanec jedovatý (listverse.com)



Chilean Recluse Spider—*Loxosceles Laeta* (lisverse.com)

Jelly fish - Irukandji

- **Irukandji Syndrome**, victim will feel severe pain that last for up to 12 hours; burning sensations; nausea and vomiting; excruciating stomach cramps, muscle cramps; serious cardiac problems; **and a strange psychological symptom**: the victim is to experience feelings of impending doom, which makes them actually beg for death. “Patients believe they’re going to die and they’re so certain of it that they’ll actually beg their doctors to kill them just to get it over with,” (leisurepro.com)
- peptides and glycoproteins – e.g. congestin, thalassin, eginatoxin. (biotox.cz)



Irukandji (leisurepro.com)



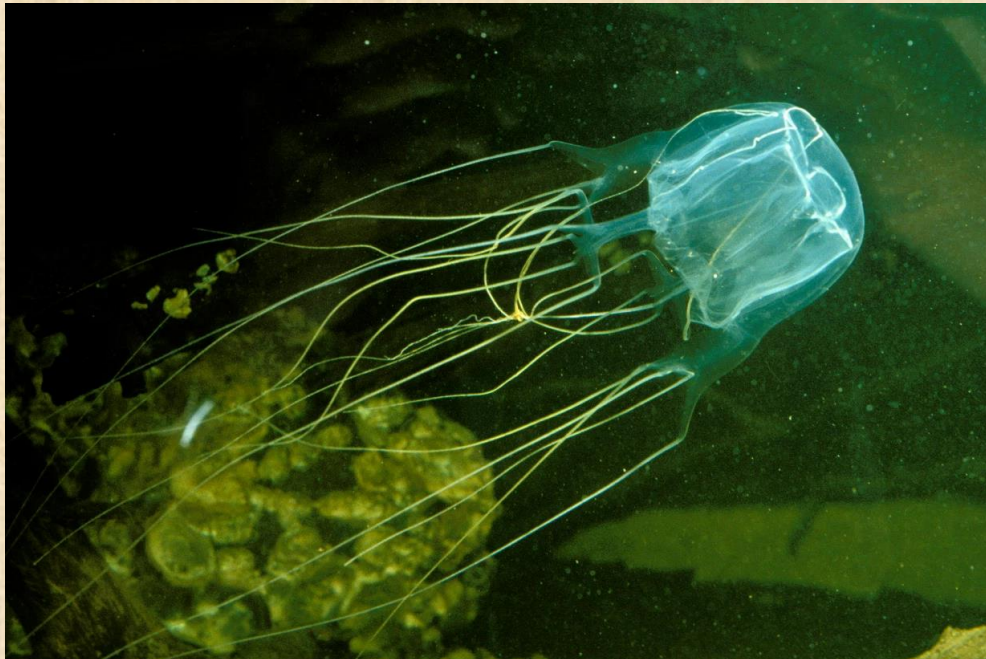
Chironex Fleckeri (Sea Wasp)
(leisurepro.com)



Chiropsalmus Quadrigatus – čtyřhranka
útočná (pinterest)

Who is the winner? Competition

- **1st** Box jellyfish (čtyřhranky) – the most venomous animal in the world (one species has venom to kill up to 60 adults)
- causing hyperkalemia which can lead to cardiovascular collapse and death as quickly as within two to five minutes with an LD50 of 0.04 mg/kg, making it the most venomous jellyfish in the world (to laboratory mice).



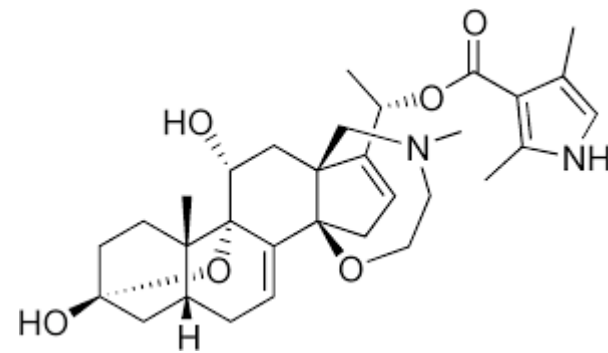
(wiki)

Pralesnička strašná (Golden poison frog)

- is a poison dart frog endemic to the Pacific coast of Colombia. (bachratotoxin)



Phyllobates terribilis
(wiki)



Batrachotoxin

2nd competition: Deadliest poisons

- 1) polonium ($7/10^{12}$ mg/adult)
- 2) Botulinum toxin (clostridium botulim) (ng/adult)
- 3) Ricin (castor beans) (mg/adult, no antidote)
- 4) VX (0.4mg/adult)
- 5) Bachratotoxin (BTX) (0.2g/adult)
- 6) Maitotoxin (*Gambierdiscus toxicus*)

(www.valuewalk.com)