

Mangrove Forests—The Importance of Conservation as a Bioresource for Ecosystem Diversity and Utilization as a Source of Chemical Constituents With Potential Medicinal and Agricultural Value

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Abstract: This presentation will review the utilization of mangroves in Southeast Asia (especially Thailand and the Philippines), the importance of the mangrove forests to maintaining the biodiversity of intertidal zones of sheltered coastlines such as is found in Phang Nga Bay, Thailand, the species diversity of the mangrove forests, and the chemical constituents (salts, organic acids, carbohydrates, hydrocarbons, benzoquinone, naphthofurans, sesquiterpenes, triterpenes, alkaloids, flavonoids, polymers, sulfur derivatives, and tannins) that have been isolated from mangrove plants and their potential application to medicine and agriculture. Past and ongoing collaborative work on constituents of Thai and Philippine Mangrove plants including *Acanthus illicifolius*, *Aegiceras corniculatum*, *Derris trifoliata*, *Excoecaria agallocha*, and *Heritiera littoralis* will be highlighted.

MANGROVES: BIORESOURCE FOR ECOSYSTEM DIVERSITY

The importance of conservation of the mangrove forests for ecosystem diversity cannot be underestimated. This is due to the fact that mangroves are widespread throughout the world and relate to a wide range of important ecosystem functions.

Mangrove ecosystems are much larger in the tropics (especially in the Indo-Pacific regions). The total mangrove area in the world is approximately 15,429,000 ha distributed

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among many countries. In the tropical Americas (ref. 1) the main species is *Rhizophora mangle* (a red mangrove) while the black mangrove (*Avicennia germinans*) and the white mangrove (*Laguncularia racemosa*) are the most abundant in the tidal estuaries of Mexico, the West Indies, the Bahamas, and Florida. There are approximately 32 species in Ceylon, 27 in Thailand, 41 in the Philippines, and 37 in Indonesia. Mangrove forest ecosystem functions include stabilization of coastlines since they are trees and bushes growing in the salt-water intertidal zones of sheltered coastlines. Preservation of the coastline is critical for maintaining all ecosystem components since the soil must be retained for most organisms to flourish. They also can prevent certain organisms from being destroyed by acting as a buffer against waves. Another important function is to act as tertiary waste treatment systems relative to detoxification of substances, which may endanger certain organisms. Maintenance of seafood diversity is important for most local fishing and shrimping industries. It is known that mangroves decay to form particular matter called "detritus" which is an important nutritional source for shrimp and fish. Finally mangroves are a key component in the global cycle of carbon dioxide, nitrogen and sulfur.

MANGROVES FORESTS: UTILIZATION

Mangrove forests have been utilized for many functions including wood production for lumber, firewood, and charcoal. However it is now important that governments around the world adopt rules to limit this utilization because of (a) the importance in maintaining ecosystem diversity and (b) the possible utilization for other purposes including as a source for chemical constituents with potential medicinal and agricultural value. In addition, certain mangrove plants can be used as fish poisons, animal food, food and drink for man, and for the production of methanol and acetic acid. Table 1 indicates the utilization of several of the more than 30 species of mangrove plants (ref. 2).

TABLE 1, Utilization of Some Mangrove Species

<i>Acanthus illicifolius</i> and <i>A. ebracteatus</i>	leaf juice used as hair preserver, fruit pulp as blood purifier, dressing for boils and snake bite, leaf preparation used for rheumatism
<i>Aegiceras corniculatum</i> and <i>A. floridium</i>	bark and seed used as fish poison
<i>Avicennia alba</i>	bark and seed used as fish poison, resin used in birth Control, seed ointment relieves smallpox ulceration
<i>Ceriops tagal</i>	source of firewood and tannins, yields high quality dyes, bark stops hemorrhaging (source of anticoagulant)
<i>Derris trifoliata</i>	used to kill fish
<i>Excoecaria agallocha</i>	fish and arrowhead poison in Thailand it is known to cause blindness and skin eruptions in the Philippines it is used as medication for toothache, in Malaysia bark extract is taken as a purgative
<i>Rhizophora species</i>	timber, fishing stakes, piles, firewood, charcoal, and tannins; <i>R. mucronata</i> bark used to treat diarrhea, dysentery, and leprosy; fruit sap used as a mosquito repellent; wine is made from fruit and honey from the nectar.
<i>Sonneratia caseolaris</i>	fruit is eatable, sap is used as a skin cosmetic, leaves are used for goat food.
<i>Sonneratia ovata</i>	fruit is eatable and used to treat sprains, fermented juice used as anticoagulant
<i>Xylocarpus species</i>	firewood, timber, and tannin; bark extract is used to treat cholera

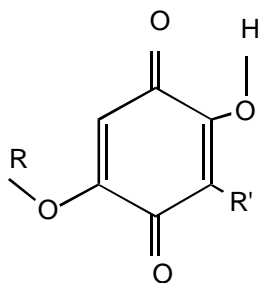
MANGROVES: CHEMICAL CONSTITUENTS

Although the chemistry of mangrove plants has still not been studied as extensively as most other plant species, investigation of the chemical constituents has led to the discovery of several novel compounds many of which are useful for medicinal or agricultural purposes. The following indicates the classes of compounds and some of the constituents reported from the plants of the mangrove forest and their reported medicinal or agricultural value, if any.

- **Salt** – (ref. 3)
-cations (Na^+ , NH_4^+ , K^+ , Ca^{+2} , Mg^{+2})
-anions (F^- , Cl^- , Br^- , NO_2^- , NO_3^- , PO_4^{-3} , SO_4^{-2})
- **Organic Acids** (ref. 3)
-(oxalic, malonic, citric, fumaric, tartaric, and maleic)
- **Carbohydrates** (ref. 4 and 5)
Rhizophora (D-galactose, L-rhamnose, L-arabinose, D-galacturonic, and 4-O-Methyl-D-glucuronic acid)
Heritiera littoralis (fructose, glucose, sucrose trisaccharide, myo-inositol and pinitol)
- **Alkanes** (ref. 6)

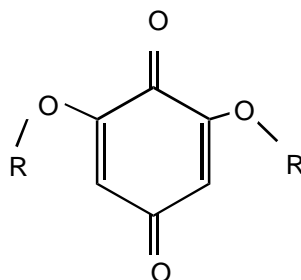
- **Benzoquinones** (ref. 7, 8, 9)

Aegiceras corniculatum



1. R = H, R' = C₁₁H₂₃, Embelin
2. R = H, R' = C₁₃H₂₇, Rapanone
3. R = CH₃, R' = C₁₁H₂₃, 5-O-Methylembelin

Kandelia candel

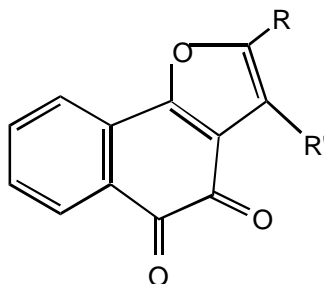


- R = H, 2,6-Dihydroxy-p-benzoquinone
 R = CH₃, 2,6-Dimethoxy-p-benzoquinone

biological activity of O-methylembelin:
 toxic to fish, 1 ppm
 toxic to the fungi *pythium ultimum*

- **Napthoforans** (ref. 10)

Avicennia marina

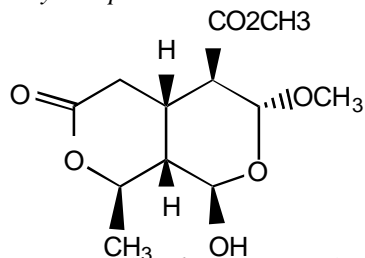


1. R = H, R' = H
2. R = H, R' = OH
3. R = (H₃C)₂C(OH), R' = H

Biological activity: phytoalexins

- **Secoiridoids** (ref. 11)

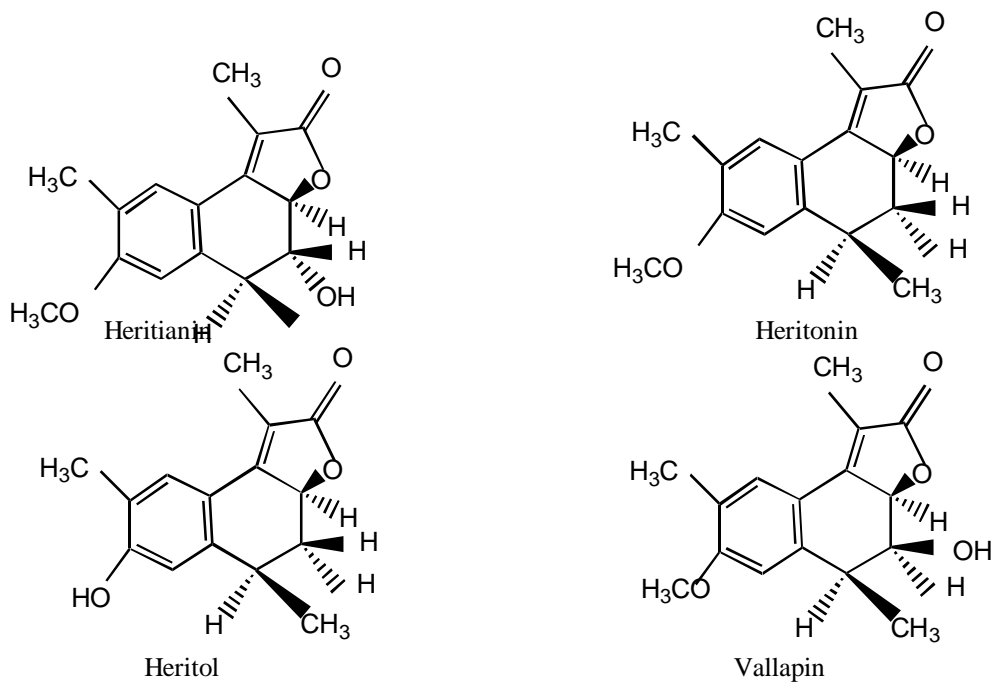
Xylocarpus moluccensis



Biological activity: African Army worm (*spodaptera exemta*) antifeedant

- **Sesquiterpenes** (ref. 12)

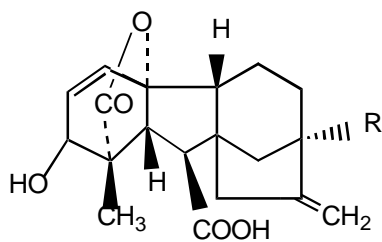
HERITIERA LITTORALIS



Biological activity: Toxic to Fish

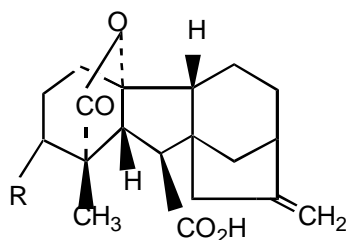
- **Diterpenes** (ref. 13, 14, 15, 16)

Bruguiera gymnorhiza



Gibberellin A₃ (R = OH)
Gibberellin A₇ (R = H)

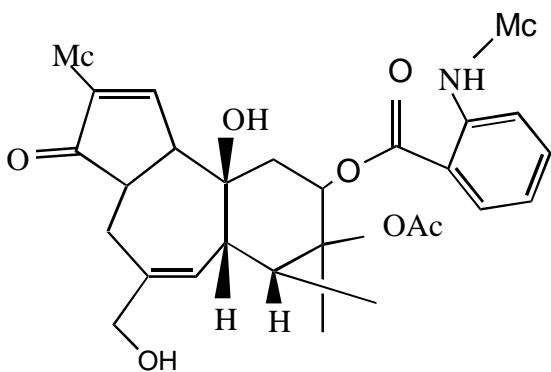
Rhizophora mucronata



Gibberellin A₄ (R = OH)
Gibberellin A₉ (R = H)

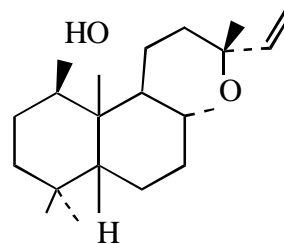
Biological activity: plant growth hormones

SAPIUM INDICUM (EUPHORBIACEAS)



4a-Sapinine

RHIZOPHORA APICULATA

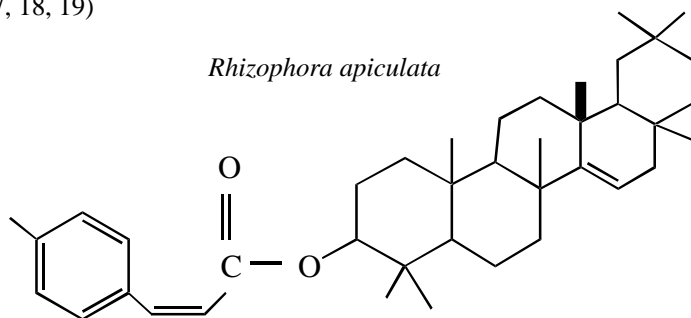


1-hydroxy-epimanoyl oxide

biological activity: irritant

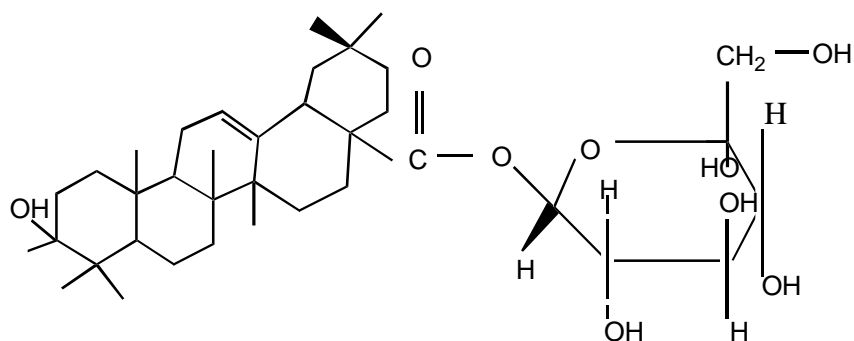
- **Triterpenes** (ref. 17, 18, 19)

Rhizophora apiculata



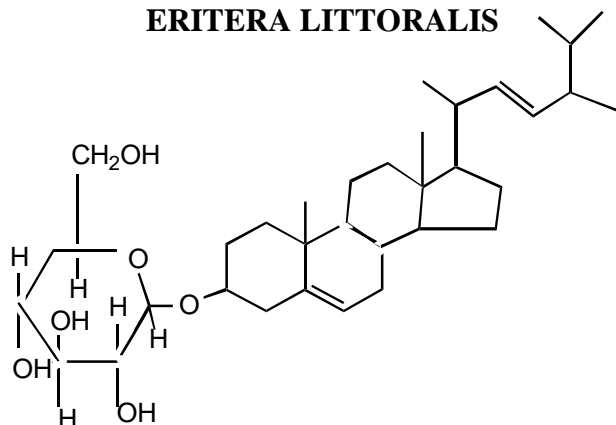
Taraxeryl cis-p-hydroxycinnamate

Acanthus illicitolius



Olean-12-en-28oic acid, -3-hydroxy-beta-D-glucopyranosyl ester

ERITERA LITTORALIS

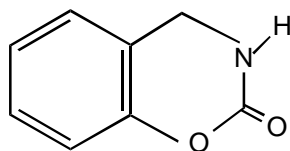


Stigmasteryl- β -D-glucopyranoside

biological activity: antifungal agent, 60% *Pythium ultimum*, 75% *Rhizoctania sol*
boll weevil antifeedant (100% at 3 mg)

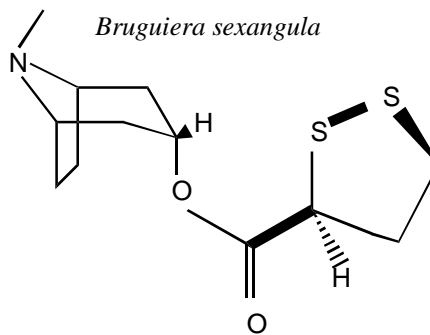
- **Alkaloids** (ref 17, 20, 21)

Acanthus illicifolius



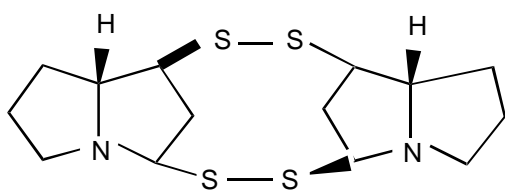
Benzoxazolin-2-one

Bruguiera sexangula

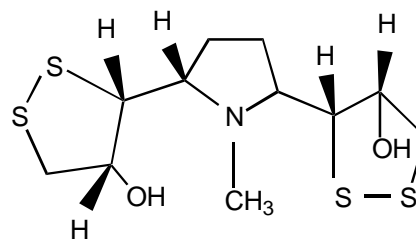


Brugine

Antitumor activity



Cassipourine
Cassiourea gummiflua

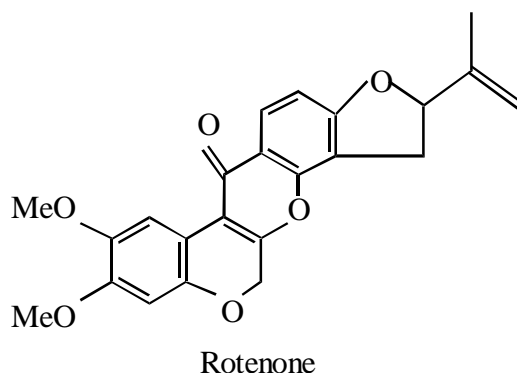


Gerrardine
Cassipourea gerrardii

- **Flavonoids Compounds** (ref/ 22)

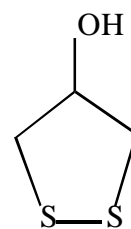
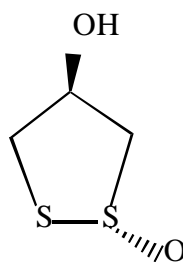
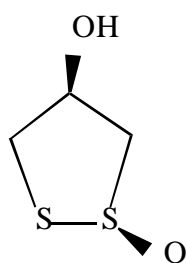
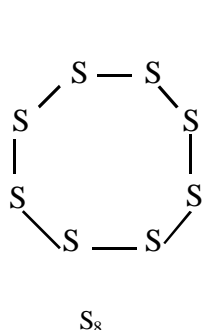
-Isoflavonoids

DERRIS SPECIES



Biological activity: fish toxin and pesticide

- **Sulfur Compound** (ref 23,24,25)



A. illicifolius *Bruguiera cylindrica*

SUMMARY

Mangrove forests occur in most tropical and subtropical regions of the world. This group of plants that grows along the coastline is very important to the ecosystem diversity because they protect the coastline from destruction (maintain the ecosystem diversity) and provide many resources for utilization in the forestry, fisheries, food, agricultural and medicinal industries. This paper has presented the majority of the chemical constituents that have been isolated from plants along with their potential agrochemical and medicinal importance.

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