The Piscicidal Plants in Southeast Asia and Their Active Constituents

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There are many kinds of plants which have been employed for hundred of years as a medicine, insecticide, insect repellent, antiseptic, arrow poison or fish poison. A number of such useful plants has been noted among thousands of higher plants growing in Southeast Asia. For example, *Strophantus gratus*, *Rauwolfia serpentina*, *Digitalis purpurea* and *Cinchona succirubra* were known as medicinal plants; *Derris* species were used as a fish poison and insecticide; *Albizzia procera* was said to repel ants; and *Melia azadirachta* was noted as keeping away insects.

Extensive chemical investigations to reveal the active principles of these useful plants were carried out. From medicinal plants a variety of cardiac glycosides and various alkaloids were isolated and their structures were established.

The isolation of active principles from medicinal plants is sometimes not easy since an appropriate bioassay to search the active principles is not available because of the complex remedial effects of the medicinal plants. The chemical investigation on medicinal plants can, therefore, find out some chemical constituents of the plants, but hardly reveal the active principles.

It is necessary to set up an appropriate bioassay for examining the specified biological activity in order to isolate the active principle from the plant. If the bioassay method is standardized, it is scarecely impossible to isolate the active principles even though they are contained in very small quantities.

Recently more than 10,000 plant extracts were screened for antitumor activity against the Leukemia L-12120 in mice and the Walker 256 carcinosarcoma etc. by two groups of scientists in the U.S.A.[1] Among effective plant species are *Stephania hernandiifolia*, *Elephantopus elatus*, *Acnistus arborscens*, *Catharanthus roseus* and *Acronychia baueri*, from which (±)-tetrandrine, elephantopin and elephantin, withaferin A, vincaleukoblastine, and acronychin were isolated as the active constituents, respectively.

Regarding plant species employed as pesticides, it is considerably easy to isolate and elucidate the active constituents of the plants because the bioassay method is readily set up.

A typical classical investigation on such a natural pesticide was that on rotenone isolated from *Derris* species. Subsequently a lot of plants was examined for insecticidal property and some of them were found to have the property to some extent. Among these effective species, are *Mammea americana*, *Quassia amara* and *Tripterygium wilfordii*, from which mammeins, quassin and ryanodine were isolated as the active constituents, respectively. More recently, *Melia azedarach* that repels insects was chemically studied, and meliantriol was isolated and characterized as the active constituent.

It should be emphasized that all the plants cited above are also known as fish poisons. It is interesting and important to investigate chemical constituents of the piscicidal plants in view of finding out novel compounds having any biological activity. In Southeast Asia about 100 species of plants are reported to have been used as fish poisons[2]. Some of these plants, together with organs employed are listed in Table I.

A few of them were investigated chemically, and the active constituents were isolated, the

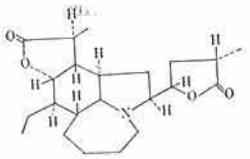
Table 1. Piscicidal Plants in Southeast Asia

Araceae	*Acorus calamus* L.,	root
Stemonaceae	*Stemona burkillii* Prain,	tuberous root
Urticaceae	*Ficus diversifolia* Blume,	latex
Polygonaceae	*Polygonum barbatum* L.,	whole plant
	P. orientale L.,	whole plant
Menispermaceae	*Cissampelos pareira* L.,	root
	Stephania hernandiifolia Walp.,	root
	Anamirta paniculata Coleb. (=*A. cocculus* Wight *et* Arm.)	seeds
Capparidaceae	*Gynandropsis gynandra* Briquet,	seeds
Pittosporaceae	*Pittosporum ferrugineum* Ait.,	leaves and fruits
Leguminosae	*Albizzia acle* Merr.,	bark
	A. procera Benth.,	bark
	Derris elliptica Benth.,	root
	D. malaccensis Prain,	root
	Milletia sericea Benth.,	root
	Pachyrrhizus erosus Urban,	leaves and seeds
	P. tuberosus Spreng.,	seeds
	Pithecellobium ellipticum Hassk.,	bark
	Tephrosia candida DC.,	root, bark and leaves
	Tephrosia vogelii Hook,	whole plant
	T. purpurea Pers.,	whole plant
	Whitfordiodendron pubescens Burkill,	seeds
Linaceae	*Erythroxylon cuneatum* Kurz,	bark and leaves
Rutaceae	*Acronychia resinosa* Forst.,	bark
	A. laurifolia Blume,	root
Buxaceae	*Buxus rolfei* Vidal,	fruits
Euphorbiaceae	*Cleistanthus collinus* Benth.,	bark, root and leaves
	Euphorbia antiquorium L.,	latex
	E. neriifolia L.,	leaves
	E. tirucalli L.,	latex
	E. trigona Haw.,	latex
	Jatropha curcus L.,	latex
	Mallotus apelta Muell.-Arg.,	seeds
	M. philippinensis Muell.-Arg.,	seeds
Guttiferae	*Calophyllm inophyllum* L.,	bark, leaves and seeds
	C. muscigerum Boerl. et Koord.,	bark
	C. soulattri Burm.,	bark and roots
Thymelaeaceae	*Wickstroemia ridleyi* Gamble,	bark
Lecythidiaceae	*Barringtonia acutangula* Gaertn.,	bark and seeds
Myrsinaceae	*Aegiceras corniculatum* Blanco (=*A. majus* Gaertn.)	bark
Ebenaceae	*Diospyros ebenaster* Retz.,	immature fruits
	D. lucida Wall.,	fruits
	D. wallichii King et Gamble,	root, leaves and fruits
Styracaceae	*Styrax benzoin* Dryander,	bark and root
Verbenaceae	*Callicarpa candicans* (Burm. f.) Hochr., (=*C. cana* L.)	leaves
	C. maingayi King et Gamble,	leaves
	Vitex trifolia L.,	bark, fruits and leaves

structures of which were established. The others remain uninvestigated or partially investigated, the active constituents of which have not yet been established.

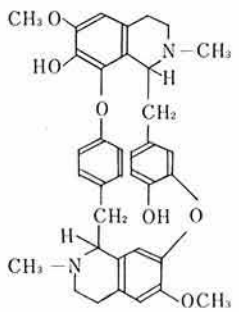
Herewith we wish to summarize the piscicidal plants whose active constituents have been established, and to show the structures[3].

1) *Stemona burkillii* Prain (*Stemonaceae*) is a tuberous herb found in Southeast Asia. Its tuberous root is a fish poison and was used as an insecticide. From the root of *S. tuberosa*, tuberostemonine (I) was isolated and the structure established.



(I)

2) *Cissampelos pareira* L. (*Menispermaceae*) is a small woody climber distributed throughout the tropics. The pounded root is used as a fish poison. The active principles are similar to those of tubocurare in the Amazon (*Chondrodendron tomentosum* Ruiz et Pavon). They are alkaloids of biscoclaurine type, bebeerine (II), (±)-curine, hayatinine, isochondrodendrine, sepeerine, cissampareine (III) and 4″-O-methylcurine[4].



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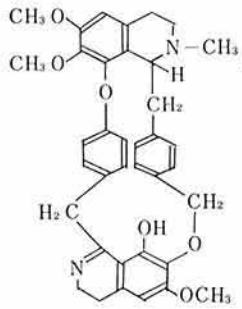
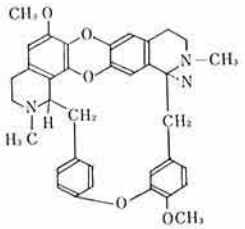


(III)

3) *Stephania hernandiifolia* (Willd.) Walp. (*Menispermaceae*) is a climber found from India to Australia. The tuberous root is extremely poisonous and was used as a fish poison. It was said that the active principles were picrotoxin and the related compounds, but several alkaloids, isotrilobine (IV), (±)-tetrandrine, fangchinoline, (+)-tetrandrine (V), isochondrodendrine have been isolated as active constituents[5]. It is noteworthy that (±)-tetrandrine has been found to exhibit antitumor activity.



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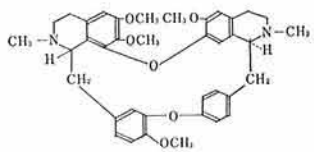
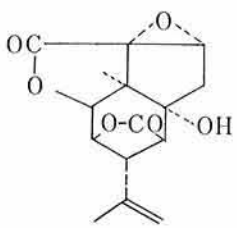


(V)

4) *Anamirta paniculata* Coleb. (*Menispermaceae*) is a small woody climber found throughout Southeast Asia. Its seeds were used as a fish poison. The piscicidal principles are picrotoxinin (VI) and picrotin (VII)[6].



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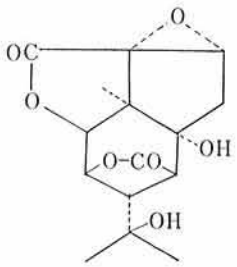

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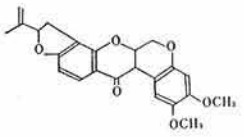
5) *Albizzia procera* Benth. (*Leguminosae*) is a woody climber found in India, Burma, Thailand and Java. The bark was used as a fish poison. The action was confirmed due to a saponin which consists of a triterpene acid as an aglycone and arabinose, rhamnose and glucose as a sugar moiety.

6) *Derris elliptica* Benth. and *Derris malaccensis* Prain (*Leguminosae*) are woody climbers found throughout Southeast Asia. The roots are old famous fish poisons and also insecticides. Besides rotenone (VIII) (10% of the dried root), deguelin (IX), toxicarol (X), elliptone (XI) and tephrosin are contained as active constituents[7]. Rotenone has long been used as one of the three important natural insecticides.



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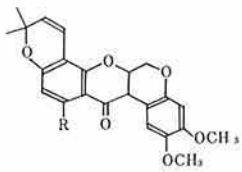

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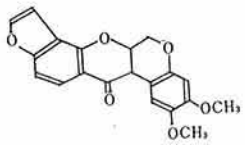

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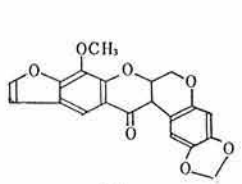
7) *Milletia sericea* Benth. (*Leguminosae*) is a large woody climber found throughout Malaysia. The root is used as a fish poison. The active principle seems to be rotenone since the Formosan *M. taiwaniana* Hayata was found to contain rotenone.

8) *Pachyrrhizus erosus* Urban (*Leguminosae*) is a herbaceous climber, native of tropical America. It's leaves and seeds were used as fish poisons. Rotenone, pachyrrhizone (XII), pachyrrhizin (XIII) and erosnin (XIV) were isolated from the seeds.



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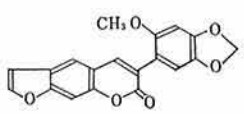

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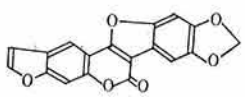

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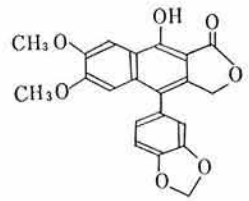
9) *Cleistanthus collinus* Benth. (*Euphorbiaceae*) is a tree common in the more open forests of the tropics. The bark and root are recorded to be used as criminal poisoning, and the leaves as fish poison. From the leaves was isolated diphyllin (XV), to which the piscicidal action was ascribed. Methyl ether of diphyllin, justicidin A was isolated with justicidin B as the active constituents of Formosan fish poison,



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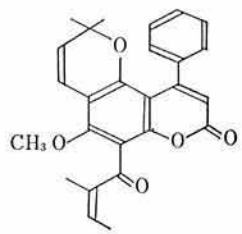
Justicia hayatai var. decumbens Yamamoto.

10) *Calophyllum inophyllum* L. (*Guttiferae*) is a big tree distributed throughout Southeast Asia. It was used as a medicine in India. The seeds, bark and leaves were employed as fish poisons. From the seeds calophyllolide (XVI), (±)-inophyllolide (XVII) and calophyllic acid (XVII) were isolated by Prof. Polonsky[8]. Calophyllolide was reported to have anticoagulant activity. As the piscicidal constituents of the leaves we isolated (+)-inophyllolide and the four related compounds (XIX)[9].



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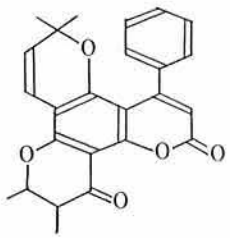

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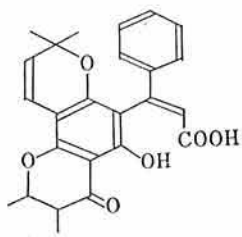

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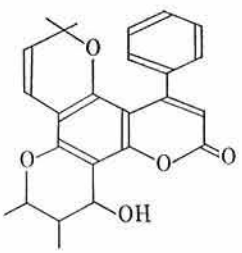

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These 4-phenylcoumarines are allied to mammeins, isolated from *Mammea americana* as the piscicidal and insecticidal principles. The piscicidal activities of these calopyllolides were

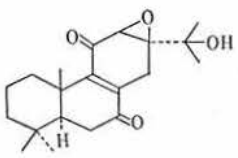
found to be rather weak.

11) *Barringtonia acutangula* Gaertn. (*Lecythidaceae*) is a tree of moderate size found on sandy shores. Its bark and seeds are fish poisons, which are ascribed to poisonous saponins.

12) *Aegiceras corniculatum* Blanco (=*A. majus* Gaertn.) (*Myrsinaceae*) is a bush commonly occurring throughout Southeast Asia. The bark and seeds contain saponins and on this account are fish poison.

13) *Callicarpa candicans* (Burm. f.) Hochr. (=*C. cana* L.) (*Verbenaceae*) is a shrub growing from Bengal to Caroline Islands. Its leaves have been used as a fish poison in Palau and Philippine Islands. The chemical studies on the active principle were started by Prof. Mitsui. We recently established that the active principle is a tricarbocyclic diterpene carrying α-oxo-ene-1, 4-dione function, which was named callicarpone (XX)[10]. Its piscicidal activity was found to be as strong as that of rotenone, but no insecticidal activity was observed. It has been found that callicarpone has antifungal activity and herbicidal activity.

Callicarpa longifolia Lam. was said to be fish poison, but has been confirmed to have no piscicidal activity.



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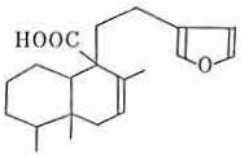

(XXI)

Callicarpa maingayi King et Gamble is a tree found throughout Southeast Asia. We isolated maingayic acid (XXI) recently as the piscicidal constituent.

As summarized above, very few species have been investigated to find their active constituents. Most of them have not even been screened for the piscicidal activity. To find novel biological active compounds, more extensive studies on chemical constituents of these species of plants should be continued.

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