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Review

Plants used for poison fishing in tropical Africa

H.D. Neuwinger*

Hauptstrasse 190, D-68789 St. Leon-Rot, Germany

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Abstract

Fishing with the aid of poisonous plants was formerly very common in Africa. Today this easy and simple method of fishing is forbidden but still practised in remote areas. The poisonous ingredients are pounded and thrown into a pool or dammed sections of a small river. After a time which varies according to conditions the fish begin to rise to the surface of the water and can readily be taken by hand. In general, the fish can be eaten without problems.

325 fish-poisoning plants, spread among 71 plant families with 183 genera, are presented. The closely related groups of Caesalpiniaceae, Mimosaceae and Papilionaceae clearly dominate. It is also remarkable that a great proportion are Euphorbiaceae. The plants most used are *Tephrosia vogelii, Mundulea sericea, Euphorbia tirucalli, Gnidia kraussiana, Adenia lobat, Balanites aegyptiaca, Swartzia madagascariensis, Neoratanenia mitis, Tetrapleura tetraptera* and *Strychnos aculeata.*

Many fishing poisons play an important part in the preparation of arrow poisons and in traditional medicine.

Keywords: Tropical Africa; Ethnobotany; Plant poisons; Fishing; Poison-fishing; Secondary metabolites

Contents

1. Introduction

First, a comment on a name which has established itself in the literature for this kind of plant poison, namely 'fish poison'. In reality, 'fish poison' concerns a poison produced by fish (for example: tetrodotoxin); in contrast, 'fishing poison' is a poison which affects fish (for example: rotenone). The two are completely different.

Fishing with the aid of plant poisons has a long tradition all over the world and is still used in many places in the world today. The source of the poison are plants, which have been discovered by observing nature and by experimentation. The proviso is that people suffer no ill effects after eating the fish.

All over Africa where the conditions are suitable this easy method of fishing has been extensively used from time immemorial. With the advance and spread of civilisation this method of fishing, condemned on account of the wholesale destruction of fish of all sizes and many organisms which are involved, is forbidden in most countries. But in remote areas it is practised as usual. Often a suitable plant is cultivated near a village.

This kind of fishing is mostly done during the dry season. In order to get a highly efficient concentration of poison quickly, it cannot be practised in a larger stream, only in small feeders. In most cases, fishing with poison is collective women's work; they collect the plant material and provide the poison.

* Fax: +49-6227-51784.
E-mail address: hdneuwinger@web.de

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2. Materials

The information on the use of the reported fish-poisoning plants is based on observations and records taken during many years of field trip research on hunting poisons in tropical Africa (1969–1995) and evaluation of herbarium notes. Some are reported in the literature (Bally, 1938; Bossard, 2003; Bouquet, 1969; Claus, 1930; Gaudin and Vacherat, 1938; Howes, 1930; Hulstaert, 1966; Motte, 1978; Rasoanaivo et al., 1993; Sillans, 1952; Tattersfield et al., 1940; Tessmann, 1913; Vergiat, 1969; Walker and Sillans, 1961; Watt and Breyer-Brandwijk, 1962).

3. Methods of poison fishing

Poison fishing is simple and in principle the same in all areas: the poisonous plant parts are scraped into small pieces or pounded and thrown into the water. The poison dissolves rapidly. Barks may be buried in the sand under the water, or dried bark or fruit is roughly pulverised and the powder is sprinkled on the surface of the water. Others use a concentrated plant suspension or the plant material is macerated overnight or made into a decoction.

If latex (milk-sap) is used (e.g. of *Euphorbia* species) it is first collected into small vessels which are then dropped into small pools. A variant is to mix the latex or the pounded plants with earth to a paste, forming the paste into balls and throwing the balls into the water or a stone wrapped in grass is drenched with latex. Others scratch open the succulent *Euphorbia* branches, weight them with stones and let them down into the water.

Most poisons produce first a stupefying or paralysing effect, later death. The time required to affect the fish varies considerably according to the species of plant and fish and the kind and concentration of poison. Depending on various factors, it may take 10 min to several hours for the fish to be affected and rise, still breathing but apparently paralysed, to the surface, where it can then readily be taken by hand. Large fish, such as Tilapia, can resist the poison for a long time and are seldom killed. In general, the fish thus caught can be eaten without problems. On the other hand, for example, fish poisoned with the highly effective roots of the Thymelaeaceae *Gnidia kraussiana* cause diarrhea if eaten.

For optimal results one must look for slow-flowing or stagnant waters or rivers with a low water level: a pool separated from a river, e.g. by a dam, or after the rainy season when the banks are flooded over large areas, turning the swamps and lowlands into small lakes, but also at sea when ebb pools remain. The method of poison fishing in dammed water pools is particularly common.

The plant quantity used depends on the size of the pool or dammed section of a stream; it is always a large amount. Formerly, in extended fishing campaigns in slow-flowing rivers, it could have been more than 100 baskets or some 100 kg of plant material, sufficient to poison all organisms in the stream for a distance of 3–4 km.

4. Plants

There is a great variety of plants used in poison fishing. The specified 325 fishing poisons belong to 71 plant families with 183 genera. Five families contribute with 10 and more genera, 12 families with 3–9 genera, 13 families with 2 genera and 41 families each with 1 genus (Table 1, Fig. 1).

Caesalpiniaceae, Mimosaceae and Papilionaceae, sometimes regarded as subfamilies of the pod-bearing family Leguminosae (Fabaceae), hold by far the first place in the hierarchy of the fishing poisons. The Papilionaceae dominate; the most-used plants in Africa, *Tephrosia vogelii* and *Mundulea sericea*, belong to them, they are the classical fishing poisons. *Tephrosia* is one of the most interesting genera among these plants, not only on account of the large number of species of a toxic nature which it contains, but also on account of the wide range of the genus throughout both hemispheres. One can find *Tephrosia* and also *Mundulea* cultivated for fishing poisons in almost all countries of tropical Africa. Remarkable also is the great proportion of Euphorbiaceae that are fishing poisons of high potency, especially *Euphorbia tirucalli*, which is an excellent fishing poison—easy to obtain and highly effective.

Other widely used fishing poisons besides *Tephrosia*, *Mundulea* and *Euphorbia* spp. are *Strychnos aculeata*, *Adenia lobata* and *A. cissampeloides*, *Blighia sapida* and *B. welwitschii*, *Balanites aegyptiaca*, *Gnidia kraussiana*, *Swartzia madagascariensis*, *Neorautanenia mitis*, *Tetrapleura tetraptera*.

5. Plant activity, toxic agents and mode of action

The toxic constituents of fishing poisons are structurally very different, they belong to such highly different structural types as, e.g. triterpene saponins, diterpene esters, rotenoids, sesquiterpenes, lignans, proanthocyanidin polymeres, polyacetylenic compounds. No structure–activity relationship is recognizable. Most of the plants described need to be studied chemically, pharmacologically and toxicologically for their contents, efficacy and mechanism of action.

The three types of compounds (Fig. 2) mentioned first represent the most important and most common constituents in ichthyotoxic plants. Saponins occur widely in plants and are the best-known toxic constituents in fishing poisons. Esters of alcohols based on the tigliane, daphnane and ingenane group of diterpenes found particularly in Euphorbiaceae and Thymelaeaceae. Rotenoids occur mainly in Papilionaceae. Cyanogenic glycoside are especially found in Passifloraceae, for example, *Adenia* species are used by many tribes from Senegal to Tanzania for fishing poison. A sesquiterpene phenol has been identified as a potent fishing poison from a Meliaceae (Nishizawa et al., 1983).

Most poisons act on the respiratory organs of the fish, producing a stupefying and paralysing effect, later death.

Table 1
Distribution of the quoted fishing poisons into the plant families

Family, genus, species[a]	Plant part	Used in
Acanthaceae		
Adhatoda buchholzii (Lindau) S. Moore	WP	Na
Dischistocalyx hirsutus C.B. Clarke	WP	Ga
Eremomastax speciosa (Hochst.) Cufod.	WP	Gha, Za
Justicia extensa T. Anderson	L, WP	Ga, Co–Ki, Za
Justicia laxa T. Anderson	L	Za
Lankesteria kamerunica Pax	L	Ca
Rhinacanthus virens (Nees) Milne-Redh.	WP	Na
Agavaceae		
Sansevieria sp.	L	Ma, Na
Dracaena mannii Baker	R	CAR
Amaryllidaceae		
Crinum zeylanicum L.	S	Na, Nr
Scadoxus cinnabarinus (Decne.) Friis and Nordal	Bulb	Gha
Scadoxus multiflorus (Martyn) Raf.	Bulb	Gui, Na
Anacardiaceae		
Pseudospondias microcarpa (A. Rich.) Engl.	F	IC
Annonaceae		
Annona muricata L.	F	Ug
Enantia chlorantha Oliv.	StB	CAR
Xylopia hypolampra Mildbr.	StB, L	CAR
Xylopia parviflora (A. Rich.) Benth.	StB, L	CAR
Apocynaceae		
Adenium obesum (Forssk.) Roem. and Schult.	R, L, St	Ca, Su, Ta, Ke
Adenium multiflorum Klotzsch	StB, La	Su, Mo, Co–Ki, RSA
Picralima nitida(Stapf) T. and H. Durand	F (unripe)	Gha
Strophanthus gracilis K. Schum. and Pax	S, wood	Na
Strophanthus hispidus DC.	S	To
Tabernaemontana pachysiphon Stapf	L	Co–Ki
Araceae		
Anchomanes difformis var. pallidus Hepper	R	CAR
Anchomanes petiolatus Hutch.	R	CAR
Culcasia scandens P. Beauv.	St, L, sap	Gha
Xanthosoma sagittifolium (L.) Schott	L	Ga
Arecaceae		
Laccosperma secundiflorum (P. Beauv.) Kuntze	F	IC
Raphia gigantean A. Chev.	F	IC
Raphia hookeri G. Mann and H. Wendl.	F	IC
Raphia mambillensis Otedoh	F	Na, Ca
Raphia vinifera P. Beauv.	S, F	Li, IC, Gha, Na, Ga
Asclepiadaceae		
Anisopus mannii N.E. Br.	WP	CAR
Calotropis procera Aiton f.	La	Su, Eth
Cynanchum tetrapterum (Turcz.) R.A. Dyer	Tw	Ke
Pachycymbium decaisneana (Lem.) Gilbert	Tw	Ma
Pergularia daemia (Forssk.) Chiov.	WP	CAR
Sarcostemmma viminale (L.) R. Br.	L	Ke
Bignoniaceae		
Jacaranda mimosifolia D. Don	L, S	Na

(*continued on next page*)

Table 1 (*continued*)

Family, genus, species[a]	Plant part	Used in
Burseraceae		
Commiphora boiviniana Engl.	F	Co–Ki
Caesalpiniaceae		
Afzelia africana Sm. ex Pers.	StB	SL
Burkea africana Hook.	StB, F	Za, An
Bussea occidentalis Hutch. and Dalziel	L	IC
Cassia abbreviata (Oliv.) ssp. *beareana* (Holmes) Brenan	F	Ta
Cassia arereh Delile	F	Nig
Cassia sieberiana DC	S, F, L	IC, Na
Chamaecrista fallacina (Chiov.) Lock	L, St	Ke
Chamaecrista mimosoides (L.) E. Greene	Sap	Ga, CAR, Co–Br
Erythrophleum suaveolens (Guill. and Perr.) Brenan	StB, R	SL, Ta, CAR, An
Pachyelasma tessmannii Harms	F	Ca, Co–Ki
Piliostigma thonningii (K. Schum.) Milne-Redh.	StB	An
Pseudomacrolobium mengei (De Wild.) Hauman	F	Co–Ki
Senna alata (L.) Roxb.	L	Ca, CAR, Co–Br, Z
Senna didymobotrya (Fresen.) H.S. Irvin and Barneby	L,St	Co–Ki, Eth, Ta, Ke, Zi
Senna reticulata (Willd.) H.S. Irwin and Barneby	B	Co–Ki
Senna septemtrionalis (Viv.) H.S. Irwin and Barneby	F	Eth
Senna tora (L.) Roxb.	L	Co–Ki
Swartzia fistuloides Harms	StB, F	Ga,Mo
Swartzia madagascariensis Desv.	F, S, StB	Na, IC, Ma, Ga, Ta, Zi, Mo, Bo, Mal, Za
Capparidaceae		
Maerua angolensis DC.	L	Ta
Maerua decumbens (Brongn.) de Wolf	R	Zi
Caricaceae		
Carica papaya L.	L	Ga
Celastraceae		
Maytenus serrata (A. Rich.) R. Wilczek	F	Eth
Chrysobalanaceae		
Parinaria congensis Didr.	F	Co–Ki
Combretaceae		
Anogeissus leiocarpus (DC.) Guill. and Perr.	R, L	CAR
Combretum nigricans Lepr.	L, Tw	Se, Ma
Commelinaceae		
Palisota hirsuta (Thunb.) K. Schum.	L	Se, IC
Compositae		
Ageratum conyzoides L.	L	Co–Ki
Catunaregam spinosa (Thunb.) Tirveng.	F	Ta
Erigeron sp.	Tw	Co–Ki
Inula shirensis Oliv.	Tw	Co–Ki
Lactuea homblei De Wild.	WP	Co–Ki
Vernonia cinerera (L.) Less.	WP	Ga
Vernonia gerberiformis Oliv.	WP,L	An, CAR
Vernonia gerberiformis Oliv. subsp. *macrocyanus* (O. Hoffm.) C. Jeffrey	R	An
Vernonia myriantha Hook.f.	Sap	Ta, Mo
Vernonia thomsoniana Oliv. and Hiern	L	Ga
Xeromphis vestita S. Moore	F, StB	Ta
Connaraceae		
Rourea obliquifoliolata Gilg	StB, TwB	Co–Ki

(continued on next page)

Table 1 (*continued*)

Family, genus, species[a]	Plant part	Used in
Cucurbitaceae		
Cogniauxia podolaena Baill.	F	Co–Ki
Lagenaria breviflora (Benth.) Roberty	S	Na
Luffa acutangula (L.) Roxb.	F, S	Ma
Momordica charantia L.	F + L	An
Dilleniaceae		
Tetracera alnifolia Willd.	L	Na
Dioncophyllaceae		
Habropetalum dawei (Hutch. and Dalziel) Airy Shaw	L, WP	Na, Gha
Dioscoreaceae		
Dioscorea bulbifera L	R	CAR
Dioscorea sansibarensis Pax	Bulbill	CAR, Ta
Ebenaceae		
Diospyros canaliculata De Wild.	StB, L, F	CAR, Za
Diospyros mweroensis F. White	F	Co–Ki
Diospyros physocalycina Gurke	StB	Gha
Diospyros piscatoria Gurke	StB, F	Ca,CAR,Co–Ki,Na,Ga
Diospyros preussii Gurke	StB	CAR
Euphorbiaceae		
Anthostema aubryanum Baill.	StB	Ca
Anthostema senegalense A. Juss.	L, Tw, F	Se
Antidesma laciniatum Mull.Arg.	R, L	CAR
Antidesma venosum Tul.	L,	TwTa
Bridelia ferruginea Benth.	R	Na
Chamaesyce hirta (L.) Millsp.	R	RSA
Croton brieyi De Wild.	L, F, StB	CAR
Croton macrostachyus Hochst. ex Delile	S-oil, S	Eth, Ca
Croton megalobotrys Mull.Arg.	StB	RSA (Transvaal)
Croton mubango Mull.Arg.	StB	An
Croton sylvaticus Hochst. ex Krauss	StB	RSA
Croton tchibangensis Pellegr.	StB, L, F	CAR
Discoglypremna caloneura (Pax) Prain	StB, L, F	CAR
Drypetes arborescens Hutch.	StB, L	CAR
Drypetes dinklagei Hutch.	StB, L	CAR
Drypetes gossweileri S. Moore	StB, F	Ca, CAR
Drypetes klainei Pierre ex Pax	StB, F	Ga
Drypetes leonensis Pax	StB, F	CAR
Elaeophorbia drupifera Stapf	La	Co–Br, CAR, Gha, Co–Ki, Be
Elaeophorbia grandifolia (Haw.) Croizat	La, F	IC, Gha
Euphorbia abyssinica Gmel.	La	Eth
Euphorbia candelabrum Kotschy	Tw, L	Ke, Co–Ki
Euphorbia cooperi N.E. Br. ex A. Berger	La	Mo
Euphorbia desmondii Keayand Milne-Redh.	La	Na
Euphorbia inaequilatera Sond.	R	Za
Euphorbia ingens E. Mey. ex Boiss.	La	Mo
Euphorbia kamerunica Pax	La	Ca, Na, Ma
Euphorbia nyikae Pax	La	Ke
Euphorbia poissonii Pax	La	Na, Be
Euphorbia sapini De Wild.	La	CAR
Euphorbia stenoclada Baill.	La	Mad
Euphorbia tirucalli L	La, L	Ta, Ke, Eth, Co–Br, Co–Ki, Ga, Mad
Euphorbia tisserantii A. Chev.	La	Co–Br
Euphorbia trigona Haw	La	CAR

(*continued on next page*)

Table 1 (*continued*)

Family, genus, species[a]	Plant part	Used in
Euphorbia unispina N.E. Br.	La	Na
Euphorbia aff. *unispina* N.E. Br.	La	CAR
Euphorbia venenifica Kotschy	La	Su
Flueggea virosa (Willd.) Voigt	StB, Tw	Su, Na, Za
Jatropha curcas L.	StB	Su
Mallotus subulatus Mull.Arg.	StB, Tw, L	CAR
Phyllanthus niruri L.	L	Co–Ki
Phyllanthus reticulatus Poir.	L	Co–Ki
Plagiostyles africana (Mull.Arg.) Prain	L	CAR
Pycnocoma cornuta Mull.Arg.	StB	Gha
Pycnocoma macrophylla Benth.	StB	Gha
Spirostachys Africana Sond.	StB	Zi, Nam, An
Spondianthus preussii Engl.	StB	Ga
Synadenium angolense N.E.Br.	La	An
Synadenium bally Werderm.	La	Ta
Synadenium carinatum Boiss.	La	Ta
Synadenium glaucescens Pax	L	Ta
Synadenium perskiifolium (Baill.) Guill.	La	Ke
Flacourtiaceae		
Casearia barteri Mast.	F	Co–Ki
Scottellia kamerunensis Gilg	StB	CAR
Gramineae		
Dactyloctenium aegyptium (L.) Willd.	S	Ta
Guttiferae		
Mammea africana Sabine	StB	Li, Na
Pentadesma butyracea Sabine	StB	Gha
Hypericaceae		
Psorospermum febrifugum Spach	F	Co–Ki
Humiriaceae		
Sacoglottis gabonensis (Baill.) Urb.	StB	Ga
Icacinaceae		
Iodes klaineana Pierre	F	Co–Ki
Lamiaceae		
Plectranthus hadiensis (Forssk.) Schweinf. ex Spreng.var. *tomentosus* (Benth.) Codd	StB, S	RSA
Lecythidaceae		
Barringtonia butonica Forster	F	Mad
Barringtonia racemosa (L.) Spreng.	R, StB	Ta, Ke
Liliaceae		
Aloe buettneri A. Berger	L	Ma
Loganiaceae		
Anthocleistra schweinfurthii Gilg	F	Co–Br
Strychnos aculeata Soler.	WP	IC, Ga, Gha, Na, Ca, CAR, Co–Br, Co–Ki, An
Strychnos camptoneura Gilg and Busse	F	IC, Ca, CAR
Strychnos icaja Baill.	WP	IC, Na, CAR, Co–Ki
Strychnos madagascariensis Poir.	S	Mad
Strychnos potatorum L.f.	F	Zi, Mo, RSA, Mad
Strychnos samba P.A.Duvign.	F	Co–Ki
Strychnos spinosa Lam.	F	Za
Strychnos stuhlmannii Gilg	F	RSA

(continued on next page)

Table 1 (*continued*)

Family, genus, species[a]	Plant part	Used in
Malvaceae		
Hibiscus cannabinus L.	R	An
Meliaceae		
Ekebergia capensis Sparrm.	R, L, StB	Na, Co–Ki
Guarea cedrata (A. Chev.) Pellegr.	StB	Co–Ki
Guarea aff. thompsonii Sprague and Hutch.	StB	CAR
Khaya senegalensis (Desr.) A. Juss.	StB	IC
Lovoa trichilioides Harms	StB, L	CAR
Pseudocedrela kotschyi (Schweinf.) Harms	StB-sap	IC
Trichilia dregeana Sond.	StB	Zi, Bo
Trichilia emetica Vahl	StB	Zi, Bo
Turraea vogelii Hook.f.	RB	CAR
Turraeanthus africanus (Welw. ex C.DC.) Pellegr.	StB	IC, Co–Ki
Menispermaceae		
Chasmanthera welwitschii Troupin	L	Ga
Stephania dinklagei (Engl.) Diels	St	SL
Mimosaceae		
Acacia pennata Willd.	L	IC
Albizia adianthifolia (Schumach.) W. Wight	R	Mo
Albizia anthelminthica A. Rich.	L	Eth
Albizia coriaria Welw. ex Oliv.	StB, L	CAR, Ug, An
Albizia ferruginea (Guill. and Perr.) Benth.	L	CAR
Albizia gummifera (J.F. Gmel.) C.A. Sm.	L	Ke
Amblygonocarpus andongensis Exell and Torre	S	CAR
Arthrosamanea obliquifoliolata (De Wild.) Gilbert and Boutique	StB	Co–Ki
Calliandra portoricensis (Jacq.) Benth.	R	Na
Cathormion altisiimum (Hook.f.) Hutch. and Dandy	StB	CAR, Co–Br
Entada africana Guill. and Perr.	L	Ma, CAR
Faidherbia albida (Delile) A. Chev.	F	Za, An
Parkia biglobosa (Jacq.) R. Br. ex G. Don	F	BF
Parkia filicoidea Welw. ex Oliv.	F	Na, Co–Ki, An
Pentaclethra macrophylla Benth.	StB, S	SL, IC, CAR, Co–Br, NA
Piptadeniastrum africanum Hook.f.	StB	Ca, CAR, Co–Ki
Prosopis africana (Guill. and Perr.) Taub.	StB, F	CAR, Co–Ki, Su
Tetrapleura tetraptera Benth.	F	SL, IC, Ga, Co–Br, Co–Ki, Ca
Moraceae		
Streblus usambarensis (Engl.) C.C. Berg	S	Gui
Myrtaceae		
Syzygium cordatum Hochst.ex Sond.	StB	Za
Syzygium guineense (Willd.) DC	StB	To
Syzygium huillense (Hiern) Engl.	StB	An
Olacaceae		
Heisteria parvifolia Sm.	F	Co–Br
Strombosiopsis tetrandra Engl	F	Ga
Opiliaceae		
Opilia amentacea Roxb.	L	IC
Orchidaceae		
Disa welwitschii Rchb.f.	R	Co–Ki
Habenaria clavata (Lindl.) Rchb.f.	R	Co–Ki
Satyrium amblyosaccos Schltr.	R	Co–Ki
Papilionaceae		
Aeschynomene fluitans Peter	Fl + L	An

(*continued on next page*)

Table 1 (*continued*)

Family, genus, species[a]	Plant part	Used in
Andira inermis (Wright) DC.	StB	Ca
Baphia capparidifolia Baker	StB	SL
Baphia nitida Lodd.	L	Ga
Cadia ellisiana Baker	StB	Mad
Cadia rubra R. Vig.	L	Mad
Calpurnia aurea (Aiton) Benth.	S	Eth
Calpurnia subdecandra (L'Her.) Schweick.	S	Eth
Crotalaria arenaria Benth.	WP	Na
Crotalaria coursii M.Pelt.	WP	Mad
Crotalaria ibityensis R. Vig. and Humbert	WP	Mad
Crotalaria retusa L.	WP	Ta
Derris elliptica (Wall.) Benth.	R	Ma
Derris trifoliata Lour.	StB	Ma
Crotalaria sp.	WP	Li
Dewevrea bilabiata Micheli	Wood	Co–Ki
Dolichos buchananii Harms	R	Zi
Dolichos kilimandscharicus Taub.	R	Ke
Dolichos lupiniflorus N.E. Br.	R	Mal
Dolichos zovuanyi R. Wilczek	WP	Co–Ki
Eriosema glomeratum (Guill. and Perr.) Hook.f.	L	Na, Eth, Ga
Eriosema griseum Baker	R	Na
Eriosema psoraleoides (Lam.) G. Don	WP	Co–Ki
Humularia kassneri var. *kibaraensis* J. Duvign.	WP	Co–Ki
Indigofera sp.	L	SL, Li
Lonchocarpus nelsii (Schinz)Heering and Grimme	R	RSA
Lonchocarpus sericeus (Poir.) Humb., Bonpl. and Kunth	F	Se, IC
Millettia barteri (Benth.) Dunn	St, WP	CAR,Co–Br,Co–Ki,Ga
Millettia ferruginea (Hochst.) Baker and ssp. *Darassana* (Cufod.) J.B. Gillett	StB, mature fruit, S	Eth, Mal
Milletita urophylloides De Wild	WP	Co–Ki
Millettia usaramensis Taub	R	Ke
Mundulea sericea (Willd.) A.Chev.	StB, F, L	Tropical Africa, RSA
Mundulea monantha (Baker) Boiteau	R	Ke
Mundulea suberosa Benth.	L, F	An
Mucuna poggei Taub.	Tw	Co–Ki
Neorautanenia mitis (A. Rich.) Verdc.	R, F, B	Co–Ki, Su, Eth, Ta, Za, Mal, Zi
Ostryocarpus riparius Hook.f.	StB, R, L	Li, IC
Pterocarpus angolensis DC.	Sap	Za
Sesbania sericea (Willd.) Link	WP	Gha
Sophora tomentosa L.	StB	Ke
Sphenostylis marginata R. Mey. ssp. *erecta* Verdc.	R	Zi
Stylosanthes erecta P. Beauv.	L	SL
Tephrosia dasyphylla Welw.	L	Zi
Tephrosia densiflora Hook.f.	WP	IC
Tephrosia diffusa Harvey	S, R	RSA (Natal)
Tephrosia elegans Schumach.	WP	IC
Tephrosia linearis (Willd.) Pers.	WP	Mad
Tephrosia macropoda Harvey	R	RSA (Natal)
Tephrosia nana Schweinf.	WP, L	IC, Co–Ki
Tephrosia nyasae Baker f.	L	Mal
Tephrosia purpurea (L.) Pers.	L	Se, RSA
Tephrosia vogelii Hook.f.	L, T	Entire tropical Africa
Passifloraceae		
Adenia cissampeloides (Planch. ex Hook.) Harms	St, StB, Tw,L, WP	IC, Gha, Na, Ca, CAR, Ta, Eth
Adenia lobata (Jacq.) Engl.	St, StB, F, sap	IC, Ca, CAR, Ga, Ta, Co–Ki, Se, SL, Li, An

(continued on next page)

Table 1 (*continued*)

Family, genus, species[a]	Plant part	Used in
Adenia schweinfurthii Engl.	WP	Ta
Androsiphonia adenostegia Stapf	Tw, L	CAR
Pentadiplandraceae		
Pentadiplandra brazzeana Baill.	F	Ga, Co–Ki
Periplocaceae		
Parquetina nigrescens (Afz.) Bullock	L, La	Li, Gha, Be, Na
Phytolaccaceae		
Phytolacca dodecandra L'Her.	L, shoots	Ta, Mo, An
Poaceae		
Bambusa vulgaris Schrad. ex J.C. Wendl.	Tw	Co–Ki
Polygalaceae		
Securidaca longepedunculata Fresen.	R	An
Polygonaceae		
Polygonum barbatum L.	WP	Za
Portulacaceae		
Talinum triangulare (Jacq.) Willd.	WP, L	Co–Ki
Rhamnaceae		
Ziziphus abyssinica Hochst.	F	Ta
Ziziphus mucronata Willd.	Fl	An
Rubiaceae		
Brenania brieyi (De Wild.) Petit	S, F	Ca, CAR, Co–Ki
Catunaregam nilotica (Stapf) Tirveng.	F	Su, Ug, Ta
Catunaregam spinosa (Thunb.) Tirveng. subsp. *Spinosa*	F	Ta
Catunaregam spinosa subsp. *taylorii* (S. Moore) Verdc.	StB,L	Ta
Gardenia ternifoia Schumach and Thonn.	F	Su
Hallea ledermannii (K. Krause) Verdc.	StB, F	Ga
Massularia acuminata (G. Don) Bullock	L, F, StB	Li, Co–Ki, IC
Morelia senegalensis A. Rich.	St	Se, SL, Na
Pausinystalia johimbe (K. Schum.) Pierre	StB	Ga
Rothmannia walkeri Pellegr.	F	Ga
Schumanniophyton klaineanum (Pierre) A. Chev.	StB	Ga
Vangueriella discolor (Benth.) Verdc.	L, St	Gui
Rutaceae		
Vepris verdoorniana (Exell and Mendonça) Mziray	RB	IC
Zanthoxylum angolense Engler	StB	CAR
Zanthoxylum gilletii (De Wild.) P.G. Waterman	StB	Ga, CAR, Co–Ki
Zanthoxylum heitzii (Aubr. and Pell.) P.G. Waterman	StB	Ga
Zanthoxylum lemairei (De Wild.) P.G. Waterman	StB	CAR
Zanthoxylum leprieurii Guill. and Perr.	StB	CAR, Co–Br
Zanthoxylum viridis (A. Chev.) P.G. Waterman	StB	CAR
Zanthoxylum xanthoxyloides (Lam.) P.G. Waterman	StB, RB	Gui
Santalaceae		
Okoubaka aubrevillei Pellegr. and Normand	StB	Li
Sapindaceae		
Blighia sapida K.D. Koenig	F (unripe)	Na
Blighia unijugata Baker	St, Tw, L, F	SL, IC, Na, Co–Br, CAR
Blighia welwitschii (Hiern) Radlk.	F, StB, L	SL, Ca, Co–Br, Co–Ki, CAR
Dodonaea viscosa (L.) Jacq.	F, Tw	IC
Eriocoelum macrocarpum Gilg ex Radlk.	F	Co–Ki

(*continued on next page*)

Table 1 (*continued*)

Family, genus, species[a]	Plant part	Used in
Eriocoelum petiolare Radlk.	Fl	CAR
Eriocoelum racemosum Baker	StB	Gha
Paullinia pinnata L.	S	CAR, Su, Co–Ki
Sapindus saponaria L.	F	Co–Ki
Sapotaceae		
Baillonella toxisperma Pierre	S	Ca, Co–Ki
Donella klainei Engl. var. *rotundata* Sillans	StB, L	CAR
Labramia bojeri A. DC.	F	Mad
Manilkara aubrevillei Sillans	StB, L	CAR
Tieghemella heckelii Pierre ex A. Chev.	S	Gha
Scrophulariaceae		
Verbascum ternacha A. Rich.	S	Eth
Simaroubaceae		
Quassia africana (Baill.) Baill.	RB	CAR
Smilacaceae		
Smilax anceps Willd.	R	Co–Ki
Solanaceae		
Datura fastuosa L.	F	Eth
Hyoscyamus muticus L.	WP	Tuareg areas
Nicotiana tabacum L.	L	Na
Schwenckia americana L.	WP	Na, Gh
Solanum aculeastrum Dunal	F	Mo
Solanum incanum L.	F	Mo
Solanum panduraeforme E. Mey.	F	Mo
Thymelaeaceae		
Gnidia kraussiana Meisn.	R	Na, Su, Co–Ki, Mal, Zi, Nam
Synaptolepis alternifolia Oliv.	R	Zi
Tiliaceae		
Grewia sp.	RB, L, F	CAR
Ulmaceae		
Celtis mildbraedii Engl	L	An
Urticaceae		
Laportea alatipes Hook.f.	L, F	Co–Ki
Laportea ovalifolia (Schumach. and Thonn.) Chew	L	Co–Ki
Violaceae		
Rinorea dentata (P. Beauv.) Kuntze	StB	Ca
Vitaceae		
Ampelocissus multistriata (Baker) Planch.	L	Gha, IC
Cayratia debilis (Baker) Suess.	Tw	Ga
Zygophyllaceae		
Balanites aegyptiaca (L.) Delile	StB, R, F	Ma, BF, Gha, Na, Ni, Ch, Ca, Eth, Ug, Ta
Balanites maughamii Sprague	StB	Bo, Nam
Balanites wilsoniana Dawe and Sprague	F	IC

An, Angola; Be, Benin; BF, Burkina Faso; Bo, Botswana; Ca, Cameroon; CAR, Centr. Afr. Rep.; Ch, Chad; Co–Ki, Congo-Kinshasa; Co–Br, Congo-Brazzaville; Eth, Ethiopia; Ga, Gabon; Gha, Ghana; Gui, Guinea; IC, Ivory Coast; Ke, Kenya; Li, Liberia; Ma, Mali; Mad, Madagascar; Mal, Malawi; Mo, Mozambique; Nam, Namibia; Na, Nigeria; Nr, Niger; RSA, Rep. South Africa; Se, Senegal; SL, Sierra Leone; Su, Sudan; Ta, Tanzania; To, Togo; Ug, Uganda; Za, Zambia; Zi, Zimbabwe. St, stem; StB, stem bark; Tw, twig; TwB, twig bark; S, seed; F, fruit;. R, root; RB, root; bark WP, whole plant; La, latex; L, leaf; Fl, flower.

[a] The taxonomy of African plants is often controversial and in a permanent state of change. The following plants are named according to the newest African floras and taxonomy, the name of authors are formulated according to Brummitt and Powell (1992).

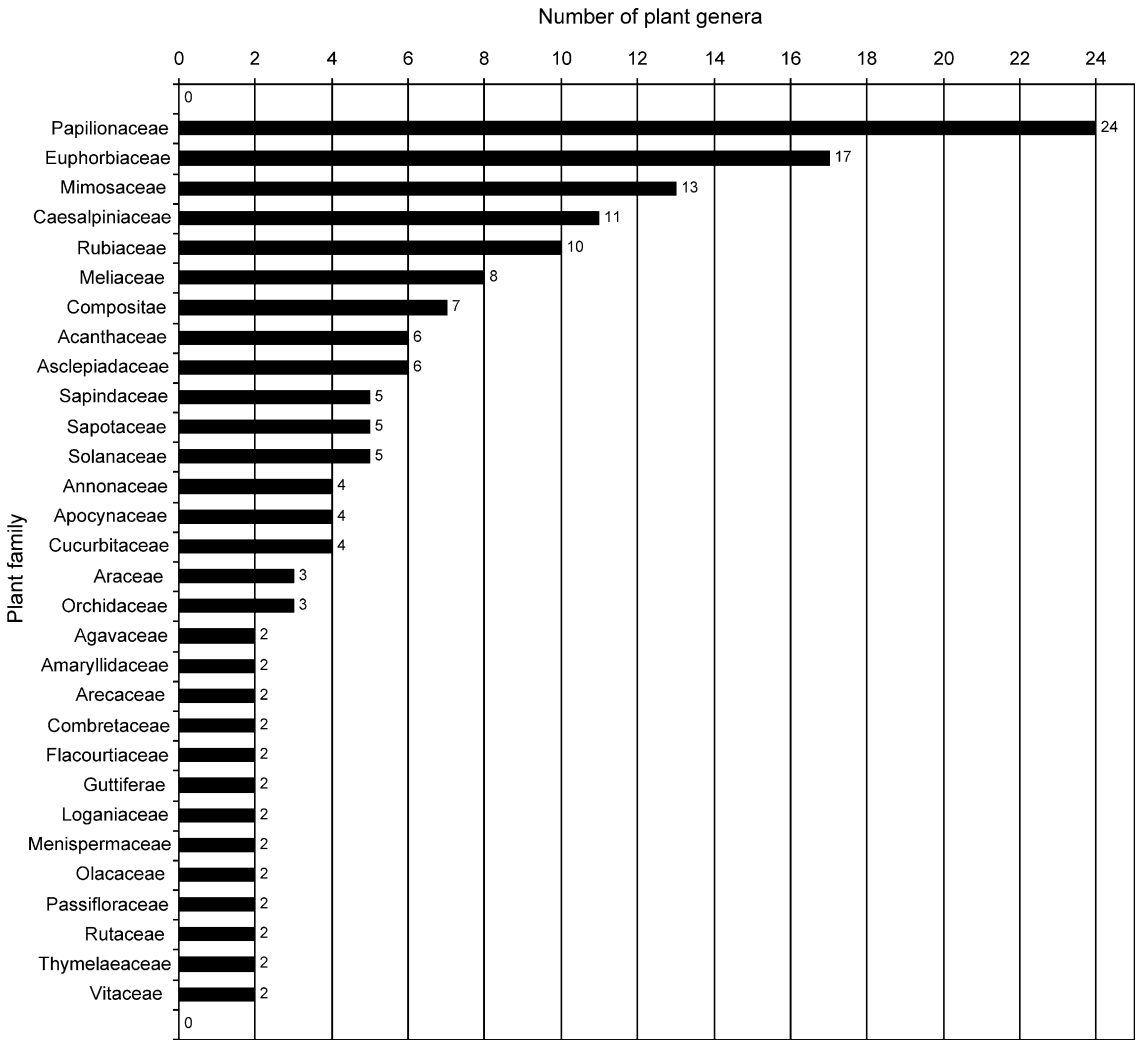


Fig. 1. Distribution of the quoted fishing poisons into plant families. Only families which contribute at least two genera are considered here.

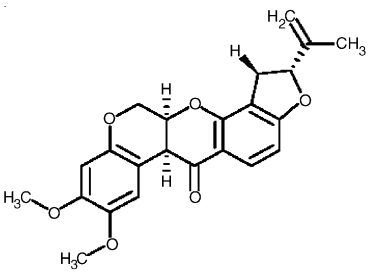
After a short time the fish begins to rise to the surface of water gasping for oxygen. The fishermen gather the stunned fish quickly as they float to the surface. Nwude (1982) records an anaesthetic effect on limbs and roughness of skin of people who wade into streams to collect fish poisoned with *Tephrosia vogelii*; its toxic principles are rotenoids.

The rotenoids are mitochondrial respiratory chain inhibitors, they inhibit cellular respiration in almost every living organism including insects and mammals. They inhibit the oxidation of NADH to NAD (nicotinamide–adenine-dinucleotide): they block the enzymes glutamate- and succino-dehydrogenase and thus H + -transport. There is no more H + for fusion with O to water and energy. The paralysis of these respiratory chains of the cells results in asphyxia of the tissue and paralysis of the organs. Some recent evidence showed that rotenone could induce cell death in a variety of cells, the mechanism is still elusive (Li et al., 2003). In USA, rotenone is a commonly used compound to kill undesirable fish population in farm ponds. For its toxicity to seven species of fish see Meadows (1973).

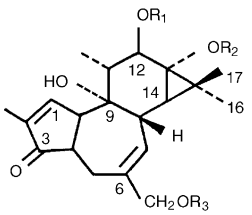
Twenty gram of the leaves of *Tephrosia vogelii* macerated for 1 h in 1 l of water heated to 50 °C paralysed the fish within 1 h and killed them in 3 h, 2 g/l paralysed within 5 h and caused death after 12 h (Gaudin and Vacherat, 1938).

Ibrahim et al. (2000) tested the leaf extract of *Tephrosia vogelii* and *Justicia extensa* on *Tilapia nilotica* in vivo. Both plants are particularly used for fishing poison in Gabon. The toxicity was dose-dependent. The small fish are the first to be poisoned. After boiling for 90 min, the extract of *Tephrosia* retained its toxicity at a high dose (625 mg/l), at weak doses (37.5 and 62.5 mg/l), it loses its toxicity, whereas *Justicia* preserved its toxicity at 62.5 mg/l. The piscicidal agents in *Justicia* are lignans (e.g. Justicidines).

The roots of *Derris elliptica* and the bark of *Derris trifoliata*, which are rich in rotenoids, proved to be very



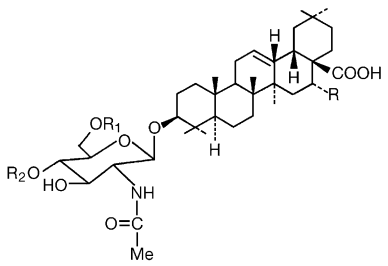
Rotenone



20

13,20-O-diacetyl-12-O(Z,E)-2,4-octadienoyl-4-deoxyphorbol (4-DPT)

R_1 = OC-CH=CH-CH=CH-CH_2-CH_2-CH_3 $R_2 = R_3$ = OC-CH_3



Aridanin, major triterpene saponin from the fruit of *Tetrapeura tetraptera*, which is present in the most effective fishing poisons. (R=R_1=R_2=H)

Fig. 2. Examples of the three basic groups of poisons (rotenoids, diterpene esters, triterpene saponins in fish poisoning plants.

active: 20 g/l caused paralysis after 20 min and killed all the fish after 2 h. Under the same conditions (20 g/l) the leaves of *Mundelea sericea* produced paralysis after 45 minutes and death after 3 h. (Gaudin and Vacherat, 1938).

A similar mechanism of action as for rotenoids—inhibition of ADP-stimulated respiration—has also been reported for diterpene esters (mainly in succulent *Euphorbia* species and *Gnidia*), which are extremely poisonous to fish. Derivatives of 4-deoxyphorbol triester (4-DPT) inhibit the cellular respiration of fish by strong inhibition of mitochondrial oxidative phosphorylation and the NADH oxydase system (Noack et al., 1980). Aquarium fish with a mean weight of 30 g were paralysed and killed by 1.8×10^{-8} M of 4-DPT after 20 min of exposure. (Noack et al., 1980). It is very interesting that the mammalian mitochondrial respiratory chain is also inhibited by 4-deoxyphorbol esters (Betancur-Galvis et al., 2003).

Euphorbia tirucalli contains a wide range of diterpene esters of all three types, tigliane, ingenane, daphnane, among them the rare 4-deoxyphorbol esters. But there are local chemical races with different diterpene profiles (for details see: Neuwinger, 1996, 1998). The latex caused 100% mortality in the fish *Lebistes reticulatus* at 2 ppm, its toxicity is comparable to that of Bayluscide or copper sulfate (Jurberg et al., 1985). For its toxicity to fish see also Kopaczewski (1947).

Daphnane-type diterpenes esters, e.g. 6,7-Epoxydaphnane esters from *Gnidia kraussiana,* are also strong poisons for fish. In Ethiopia, the seed oil of *Croton macrostachyus*, which may also contain diterpene esters, is well-known to fishermen for its very high efficacy. In general, succulent and latex-bearing Euphorbiaceae are superior to rotenone-yielding plants.

Saponins are absorbed through the fish gills, disrupting the exchange of oxygen. The precise mechanism as to how saponins work on the fish has not yet been elucidated.

Gaudin and Vacherat (1938) showed the toxicity of some saponin-containing fish poisoning plants in Mali for the fish

Carassius auratus. They used a 1-hour maceration of the powdered plant material in 1 l of water heated to 50 °C.

1. *Balanites aegyptiaca*: when exposed to 20 g bark/1 liter of water, after 2 h all fish were floating in the lateral position on the water surface, after 3.5 h they were all dead; 2 g bark/1 l of water killed all fish within 12 h.
2. *Swartzia madagascariensis*: 20 g fruit/l caused paralysis within 75 min, and death after 2.5 h, 2 g/l paralysis within 5 and 12 h, respectively.
3. *Entada africana*: 20 g leaves/l paralysed in 15–60 min and killed the fish after 1.5 h; 2 g/l caused paralysis within 30 min, all fish were dead after 6 h.
4. *Luffa acutangula*: 20 g fruit with seeds/l caused paralysis within 15 min and death after 75 min, 2 g/l in 2.5 and 4 h, respectively.

Table 2
Mixtures of different plants used by some ethnics, especially the pygmies in the rainforests of Central Africa

Central African Republic
Prosopis africana (fruit, stem bark) *Amblygonocarpus andongensis* (fruit, seeds)
Pentaclethra macrophylla (stem bark, leaves) *Piptadeniastrum africanum* (stem bark) *Strychnos icaja* (stem bark, leaves) *Manilkara aubrevillei* (stem bark, leaves)
Erythrophleum suaveolens (stem bark, leaves) *Lovoa trichilioides* (stem bark, leaves)
Quassia africana (root bark) *Strychnos aculeata* (fruit)
Adenia lobata (twig bark) *Brenania brieyi* (fruit) *Quassia africana* (root bark) *Strychnos aculeata* (fruit) *Strychnos camptoneura* (root bark) *Tetrapleura tetraptera* (fruit) *Diospyros canaliculata* (fruit) *Eriocoelum petiolare* (flowers)
Nigeria
Balanites aegyptiaca (fruit) *Crotalaria arenaria* (whole plant)
Parkia filicoidea (fruit)
Balanites aegyptiaca (fruit) *Eriosema griseum* (fruit)
Congo-Kinshasa
Euphorbia sp. (latex) *Erigeron* sp. (leafy twigs) *Inula shirensis* (leafy twigs) *Tephrosia vogelii* (leafy twigs) *Tephrosia vogelii* (leaves) *Psychotria walikalensis* (roots) *Capsicum frutescens* (fruit) *Ekebergia capensis* (stem bark) *Diospyros mweroensis* (fruit) *Psorospermum febrifugum* (fruit) *Tephrosia vogelii* (leaves) *Elaeophorbia drupifera* (latex) *Tetrapleura tetraptera* (fruit)

It is quite surprising that Bambara in Mali sometimes add the leafy twigs of *Cissus quadrangularis* to the *Balanites* bark. Perrot (in Gaudin and Vacherat, 1938) carried out remarkable experiments: freshly caught fish in a calabash with water died 10 min after fresh bark of *Balanites aegyptiaca* was added. Leafy twigs of *Cissus quadrangularis* showed no toxicity to fish, but under the same conditions the maceration of equal parts of both plants killed the fish in only 5 min. There is apparently a potentiation of the effect of *Balanites* by *Cissus,* which itself is inactive. Some ethnics, especially the pygmies in the rainforests of central Africa, mostly use mixtures of different plants. Some mixtures are specified in Table 2.

The toxic effect of cyanide to fish is well-known; cyanide is extensively used in Southeast Asia and the South Pacific. The fish are stunned and disoriented. In Africa, widely-used plants containing cyanogenic glycosides are *Adenia lobata* and *A. cissampeloides*; the fish rise rapidly to the surface of the water. When the tissue of a living plant is damaged and cyanogenic compound and enzyme come into contact in the presence of water, the chemical hydrolysis begins quickly and HCN is liberated. On the other hand, these plants also contain saponins and it is doubtful that cyanide is the true toxic principle. In addition, the Bainuk in Senegal cut the *Adenia lobata* liana in small pieces, heat them, pound the warm plant material and throw the pulp into suitable water reservoirs. In this case, liberated HCN (boiling point 26 °C) may be volatised.

References

Bally, P.R.O., 1938: Heil- und Giftpflanzen der Eingeborenen von Tanganyika. Dahlem.

Betancur-Galvis, L., Palomares, E., Marco, J.A., Estornell, E., 2003. Tigliane diterpenes from the latex of Eupohorbia obtusifolia with inhibitoty activity on the mammalian mitchondrial respiratory chain. J. Ethnopharmacol. 85, 279–282.

Bossard, E., 1993. Angolan medicinal plants used also as piscicides and/or soaps. J. Ethnopharmacol. 40, 1–19.

Bouquet, A. 1969. Féticheurs et médicines traditionelles du Congo. Mém. O.R.S.T.O.M., Paris.

Brummitt, R.K., Powell, C.E. (Eds.), 1992. Authors of Plant Names. Royal Botanic Gardens, Kew.

Claus, F., 1930. La capture des poisson au moyen de plantes toxiques. Bull. Agric. Congo Belge 21, 1095–1114.

Gaudin, O., Vacherat, R., 1938. Recherches de la rotenone et du pouvoir ichthyotoxique chez quelques plantes du Soudan français. Bull. Soc. Pharmacol. 40, 385–394.

Howes, F.N., 1930. Fish-poison plants. Bulletin of miscellaneous information Nr. 4. Royal BotanicGardens, Kew.

Hulstaert, G., 1966. Notes de Botanique Mongo Mém. Inst. Roy. Col. Belge, Classe: Sci. Nat. Med. n.s. 15/3, 1–212.

Ibrahim, B., M'batchi, B., Mounzeo, H., Bourobou-Bouroubo, H.P., 2000. Posso. Effect of Tephrosia vogelii and Justicia extensa on Tilapia nilotica in vivo. Journal of Ethnophamracology 69, 99–104.

Jurberg, P., Neto, J.P.C., Schall, V.T., 1985. Molluscicidal activity of the Arelos plant (*Euphorbia tirucalli*) on *Biomphalaria glabrata*, the mollusc vector of Schistosomiasis: Mem. Inst. Oswaldo Cruz 80, 423–427.

Kopaczewski, W., 1947. Etude physico-chimique du latex. V. Le latex d'*Euphorbia tirucalli*. Bull. Soc. de Chimie Biologique 29, 924–926.

Li, N., Ragheb, K., Lawler, G., Sturgis, J., Rajwa, B., Melendez, J.A., Robinson, J.P., 2003. Mitochondrial complex I inhibitor rotenone induces apoptosis through enhancing mitochondrial reactive oxygen species production. J. Biol. Chem. 278, 8516–8525.

Meadows, B.S., 1973. Toxicity of rotenone to some species of coarse fish and invertebrates. J. Fish Biol. 5, 155–163.

Motte, Marie E., 1978: Les plantes chez les Pygmées et les Monzombo de la Lobaye. Thèse. Paris.

Neuwinger, H.D., 1996: African Ethnobotany: Poisons and Drugs. Chemistry, Pharmacology, Toxicology. Chapman & Hall, Weinheim.

Neuwinger, H.D., 1994(1.ed.), 1998 (2.ed.): Afrikanische Arzneipflanzen und Jagdgifte: Chemie, Pharmakologie, Toxikologie. Wissenschaftliche Verlagsgesellschaft, Stuttgart.

Neuwinger, H.D., 1998: Afrikanische Arzneipflanzen und Jagdgifte: Chemie, Pharmakologie, Toxikologie, Wissenschaftliche Verlagsgesellschaft, Stuttgart. Ed. Wissensehaftliche Verlagsgesellshaft, Stuttgart.

Nishizawa, M., Inoue, A., Sastrapradja, S., Hayashi, Y., 1983. (+)-8-Hyroxycalmenene: a fish-poison principle of Dysoxylum acutangulum and D. alliaceum. Phytochemistry 22, 2083–2085.

Noack, E.A., Crea, A.E.G., Falsone, G., 1980. Inhibition of mitochondrial oxidative phosphorylation by 4-Deoxyphorbol triester, a poisonous constituent of the latex of *Euphorbia biglandulosa* Desf. Toxicon 18, 165–174.

Nwude, N., 1982. Plants poisonous to Man in Nigeria. Vet. Hum. Toxicol. 24, 101–106.

Rasoanaivo, P., Petitjean, A., Conan, J.Y., 1993. Toxic and poisonous plants of Madagascar: an ethnopharmacological survey. Fitoterapia LXIV, 114–129.

Sillans, R., 1952. Sur quelques plantes ichtyotoxiques de l'Afrique centrale. Rev. Int. Agric. Trop. Bot Appl. XXXII, 54–65.

Tattersfield, F., Martin, J.T., Howes, F.N., 1940. Some fish-poison plants and their insecticidal properties. Bull. Miscell. Inf.Nr. 5. Royal Botanic Gardens, Kew.

Tessmann, G., 1913: Die Pangwe. Band 1. Berlin, pp.111–112.

Vergiat, A.-M., 1969. Plantes magiques et médicinales des féticheurs de l'Oubangui. J. Agric. Trop. Bot. Appl. XVI, Nr., 335–367.Nr. 6–7–8.

Walker, A.R., Sillans, R., 1961: Les plantes utiles du Gabon, Paris.

Watt, J., Breyer-Brandwijk, M.G., 1962. The medicinal and poisonous plants of southern and eastern Africa Edinburgh and London, 2 ed.