The Secret of Generating the Lethal Blowpipe Dart Poison in Borneo :

The latex of *Antiaris toxicaria*, the poison generating procedure by means of a *Licuala* leaf, the heat-sensitive main toxic chemical compound, and the lethal effect of the poison

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ABSTRACT

The blowpipe dart poison in Borneo is generally generated from the latex of the large *Antiaris toxicaria* tree, Moraceae. This latex contains a variety of toxic chemical compounds. The principal toxic agent is a steroid glycoside known as β-Antiarin. A lethal dose (L50) is only about 0.1 mg per kg weight of a warm-blooded animal. To dehydrate the milky latex into a paste, a long carefully implemented procedure is essential because that steroid glycoside compound is extremely heat-sensitive. Therefore, the blowpipe hunters perform the dehydration of the latex with the assistance of a young leaf from the small *Licuala spinosa* palm. The leaf is formed into boat-shape to hold the latex at a carefully determined distance over a small flame for about one week. This is feasible because the young *Licuala* leaf is astonishingly fireproof and durable. This is the secret of generating the lethal poison. If the latex were heated at too high temperature, the glycoside compound would crack and the toxicity would be lost.

Key words: *Antiaris toxicaria,* arrow poison, Beta-Antiarin, Borneo, *Licuala spinosa,* steroid glycoside

INTRODUCTION

The diverse indigenous Dayak tribes, as well as the semi-settled hunters and gatherers of Borneo (Kalimantan) such as the Punan, Berusu, and Basap have traditionally hunted for wild animals with blowpipes and poison darts from ancient time. The blowpipe, which is about two meters long, is made of ironwood *(Eusideroxylon zwageri),* generally known as *ulin* in Indonesia, or of another hardwood species. Among my collection are also some antique blowpipes cut out of a bamboo section.

The 30 cm long blowpipe darts weigh less than 1 g. The darts exit the blowpipe at a speed (V0) of at least 50 m/sec, or about 180 km/h, as ascertained through trials by the author at the German *Bundeskriminalamt* (German Federal Bureau of Investigation) in the city of Wiesbaden in 1985 (Zahorka, 1986: 37). Because of minimal weight and high velocity, the darts' trajectory is flat up to a distance of 25 to 30 meters. Therefore, at this distance, the dart can hit an animal even if only a small part of it is visible or it is shielded by branches and leaves in the dense jungle cover. This would not be possible if using a bow because the flight path of a heavy arrow is not straight but takes on a ballistic curve. Another advantage of hunting with a blowpipe is the nearly soundless shooting.

The agent that brings about the demise of the animal is the poison not the dart itself. Irrespective of which body part of the animal the dart hits, the poison diffuses very rapidly throughout the whole body. A two-centimeter segment of the points of the darts used for hunting small animals, monkeys and large birds is treated with poison. The darts for hunting deer (*Cervus unicolor),* Muntjak (*Muntiacus muntjac*) and wild boar (*Sus barbatus*) are treated with poison to five centimeters down from the point upon which is affixed a sharp arrowhead of bamboo, metal or a pointed tooth from a small animal.

Because of the depletion of the forests in Kalimantan, the present indigenous hunters need a hunting weapon that can be shot over a much greater distance than the blowgun. Therefore, some Basap people living at the Mangkalihat Peninsula, Kalimantan Timur, have constructed sophisticated air guns powered by strings of elastic, which shoot these poison darts accurately at a distance of about 100 meters (Zahorka, 2004a: 10).

THE PLANT SPECIES NEEDED TO GENERATE THE DART POISON

The raw material that generates the poison is the latex of the tall tree *Antiaris toxicaria* (Pers.) Lesch., Moraceae. However, the poison processing is possible only with the use of a young leaf of the small *Licuala spinosa* Thunb. palm.

1. *Antiaris toxicaria* (Pers.) Lesch., Moraceae, can grow up to 50 meters in height and to a diameter up to 1.5 meter or more. The long branchless trunk is straight; the buttocks are smallish, and the small treetop is nearly spherical. It is a rare tree that grows from lowland up into the montane tropical forests. Generally, the lower parts of the trunks display numerous scars, which indicate former latex taping over many decades.

Because of its powerful poison, this tree has been the subject of horror stories since 200 years ago. The 17th century German-Dutch natural scientist Rumphius has written: "This tree grows on barren mountains. The soil below it is desolate and singed. Only a horned snake is living under the tree which cackles like a hen and has glowing eyes in the night" (cit. Beekmann, 1981 in Zahorka, 2000: 19, translated from German by the author). Moreover, the Swedish Borneo explorer Eric Mjöberg published in 1929: "To stay at a close distance to the tree is life threatening and an embankment of bones surround it…" (Mjöberg, 1929: 307, translated from German by the author). Fortunately, this all is pure fantasy. In a more resent book we can read: "There is a fabulous legend that it is deadly merely to sleep in the shade of the *upas* tree", (Smith, 1997: 36).

In Java, Sumatra and Malaysia, the tree is widely known as *pohon ipoh or pohon upas.* However, the various traditional tribal communities in Kalimantan have their own entirely vernacular name. Here are some examples, which I collected in East and Central Kalimantan between 1976 and 2003:

Table 1. Various vernacular name of *Antiaris toxicaria*

Tribal community	Name of tree	Name of the dart poison
Punan Aput	*dajuk*	*upun*
Punan Menalui	*puntajem*	*moshu tajum*
Basap Balui	*boon biru*	*ipoh*
Ot Danum Dayak	*sadiron*	*konyong*
Bahau Dayak	*tasam*	*ipu*
Kenyah Lepo Ma'ut Dayak	*salok*	*salok*
Kenyah Lepo Badgn Dayak	*saluh*	*saluh*
Tumon Dayak	*ketatai*	*ipoh*
Lun Dayeh Dayak	*lawar farir*	*farir*
Benuaq Dayak	*poutn ipu*	*ipu*

2. *Licuala spinosa* Thunb., Palmae, is a small fan palm growing in tropical forests of SE Asia along the equator (McCurrach 1960). The 3-to-5-meter-high stems grow in tufts. The 15 to 18 leaf segments, which are up to 40 centimeters long and up to 15 centimeters wide are widely used for thatching. The Indonesian and Malaysian name for it is *sang*.

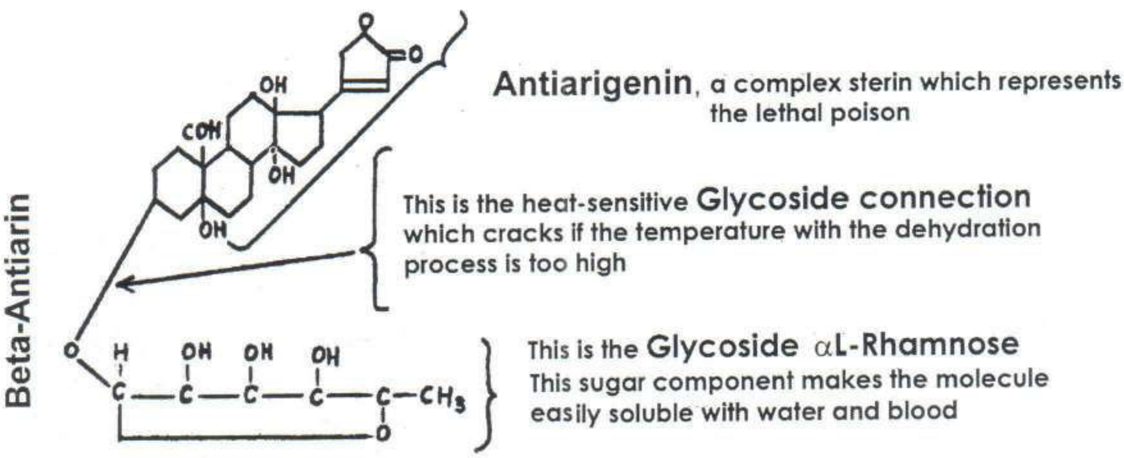
For the dehydration process of the *Antiaris* latex, a very young *sang* leaf, that is still harmonica-like folded and not yet spread out, is used. In this original condition, the leaf is absolutely fire resistant and durable. It is this property of the leaf that holds the secret of generating the dart poison over a fire. The young leaf keeps its shape and will not burn even if put into a hot gas flame. A boat-shaped container made with this leaf must be durable enough to hold the latex throughout the prolonged dehydration process.

THE ACTIVE CHEMICAL COMPOUND

Phytochemical analyses have revealed that the latex of the *Antiaris toxicaria* includes a differing blend (individually and provincially) of at least 30 complex cardenolides, i.e. strong heart poisons (Hegnauer, 1973, Neumüller, 1979). Alkaloids are extremely rare. The chemical structure is clarified with α-Antiarin, β-Antiarin, α-Antiosid, Antiosid, Malayosid, Convallatoxin (which is a Strophantin Rhamnosid), Desglucocheirotoxin and other compounds most of which include Strophantin (Bisset, 1962: 143-151; Dolder, *et al.* 1955: 1364-1396).

The bark, the wood, the roots, and the seed include the same toxic compounds. However, the leaves, the male inflorescence, and the flesh of the fruit are free of them.

The principal toxic agent of the dart poison is the glycoside **β-Antiarin**. The original latex contains about 1.5 to 2 weight percentage of it. The molecule of β-Antiarin consists of two components. One is the complex Sterin **Antiarigenin**, which is the toxic component. The other is the glycoside **α-L-Rhamnose,** which is a sugar compound. This sugar component is connected to the Antiarigenin by a heat-sensitive oxygen bridge (glycoside connection). This sugar makes the whole molecule rapidly and readily soluble in water and in blood. However, if the latex is heated too high a temperature during the dehydrating process, the glycoside connection cracks and the sugar component becomes free. In that way, the toxicity of the latex is lost.



H-ions occupy all free valences. The chemical sum formula is $C_{29}H_{42}O_{11}$

THE ARROW POISON GENERATING PROCEDURE

With the bush knife, the latex collector cuts a deep notch into the bark. Instantly, the yellowish latex pours out. If a considerable mass is wanted, the latex is collected in a bamboo container for the moment. When small amounts are needed, the latex is collected directly into the boat-shaped *Licuala* leaf container.

A small fire is lit and a simple construction of several small branches is set about 70 centimeters high above it. For at least several days, the top of this trestle will be the resting place above the fire for the *Licuala* container with the latex inside. In case of rain, the container will find a temporary position above the fireplace in the house. The process of dehydration requires great patience and care. A medium quantity of latex affords a week's work. During the process, the latex darkens to a deep brown color. As the processing continues, the viscosity becomes more and more glutinous and the final color is a metallic black. Temperature control requires the most attention. If the latex gets too hot, the glycoside connection of the β-Antiarin cracks and the sugar component becomes free. If this happens, the glutinous mass will taste sweet and the toxicity will be lost. This fact is well known by the indigenous tribes. Therefore, during the dehydration process, they repeatedly taste the mass carefully with the tongue. It has to taste extremely bitter. If it tastes sweet, all the efforts will have been in vain. Although this procedure has already been published in various books and magazines (v.a. Zahorka, 1976: 57f; 1987: 26; 2000: 22), incorrect information, such as "The mixture is boiled over a fire…" (Boer, *et al.* 1999: 128). is still widespread. Boiling would cause the toxicity to entirely dissipate.

To poison the darts, the tips are simply dipped into and turned round in the thick toxic paste. This arrow poison is very durable and effective for years if not heated. Old poisoned darts in museums are dangerous even after decades of display. The comment "… it cannot be stored and must be used fresh." (Boer, *et al.* 1999: 128) is incorrect. The traditional hunters prepare new poison about once a year. If stored poison gets too hard, it is made glutinous again by adding the sap of pressed *Derris elliptica* roots, which contain a neurotoxin and a haematotoxin. Some authors claim that other poisons are added, such as snake poison, strychnos or the like (Pötsch-Schneider, 1982). None of the tribes I have spent time with across Kalimantan since 1976 have ever confirmed this. No other ingredients can enhance the lethal effectivity of β-Antiarin.

THE PHYSIOLOGICAL EFFECTS ON HUNTING GAME

Like *omai*, the arrow poison of the Mentawaians (Zahorka, 2004b: 34), the *Ipoh* or *Upas* poison acts in a lethal manner only if applied in a parenteralic manner. Death results from cardiac failure. Intestinal absorbance rarely occurs. Therefore, the meat of bagged game is edible. For security reasons, a small piece of meat is cut off at the spot where the poison dart hit the animal. Boiling and frying the meat also destroys the poison.

Animals hit by a poison dart, irrespective of which part of the body is pierced, start to twitch after a few seconds. This state lasts some minutes as the animal's condition worsens and convulsions occur. The animals lose consciousness at an accelerating rate. The throes of death last longer with large animals like wild boar or deer. Death is ultimately due to cardiac failure. The cardiac glycoside affects the Na+K+ATPase activity of the heart muscle membrane (Boer, *et al.*: 127).

Reports on dosage specify that 0.3 mg would be lethal for a rabbit. One mg causes death in dogs (Boer, *et al.*: 127), while 0.1mg is the lethal dosage (L50) per kg weight for cats (Zahorka, 1986: 58). The toxicity of β-Antiarin is much higher than that with curare.

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Captions for the 8 photographs:

Figure 1. Basap blowgun hunters at an old *Antiaris toxicaria* tree. The scars resulted from latex tapping.

Figure 2. Kenyah blowpipe hunters with *Licuala spinosa* in the rear.

Figure 3. From left: The harmonica-like young *Licuala* leaf, the prepared container, and a young leaf that is not yet spread out.

Figure 4. Collecting the latex with the boat-shaped *Licuala* container.

Figure 5. A photo of about 1895 by Charles Hose. The caption reads: "A Kenyah making dart poison". A note on the container was not made.

Figure 6. A Kanyah making dart poison in 1999. The procedure is still the same. Only the men's fashion has changed.

Figure 7. During rain, the dehydration process is performed in the kitchen.

Figure 8. A Basap of the Balui group with a traditional blowpipe an a poison-dart-shooting air gun powered by strings of elastic.

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