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Local use and cultural and economic value of natural dye plants in Peruvian Amazon

M.Sc. Thesis

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SETTING M.Sc. THESIS

For Mrs. Iva Lachmanová

Course: Agriculture in Tropics and Subtropics

This thesis is required by the Head of Department as laid down in the rules of the Master studies at CZU.

Thesis Title: Local use and cultural and economic value of natural dye plants in Peruvian Amazon.

Code for compiling this M.Sc. diploma thesis

The student will do the local survey of the species of dye plants that are used by the artists in the region of Ucayali. The method of the dye processing and the use of dyes will be studied.

1) Introduction
2) Background
3) Aim of the thesis
4) Methodology
5) Results
6) Discussion
7) Conclusions

Extent of the Thesis report: more than 50 pages

Bibliography:
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Declaration

I, Iva Lachmanová declare that this thesis, submitted in partial fulfillment of the requirements for the M.Sc. degree, in the Institute of Tropics and Subtropics of the Czech University of Life Sciences, is wholly my own work unless otherwise referenced or acknowledged.

28 April 2008 Iva Lachmanová

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Abstract

This ethnobotanical survey was conducted to document and preserve traditional ethnobotanical knowledge on dye-yielding plant species in Peruvian Amazon. 23 respondents from four Shipibo villages around Pucallpa (Ucayali Department) consented to participate in this study. Semi-structured interviews and participant observation techniques were used. 18 plant species belonging to 14 families were identified as sources of natural dyes, among which *Swietenia macrophylla* (Meliaceae), *Buchenavia sp.* (Combretaceae), *Terminalia amazonia* (Combretaceae), *Terminalia catappa* (Combretaceae) and *Bixa orellana* (Bixaceae) were mentioned as the most frequently used for traditional dye preparation. The following informations were collected: local name of plants, the part of plants containing dye, obtained colour, preparation of the dye and its application. In addition, plants used in the past in the studied villages are recalled. The traditional ethnobotanical knowledge of indigenous people is being lost at a greater rate than in the past. The collected ethnobotanical data may contribute to the protection of the plant biodiversity and preservation traditional dyeing knowledge.

Keywords: ethnobotany, natural dyes, indigenous knowledge, Shipibo, Peruvian Amazon

Abstrakt

Etnobotanický výzkum byl proveden za účelem zdokumentovat a uchovat tradiční etnobotanické znalosti o druzích rostlin využívaných na výrobu barviv v peruánské Amazonii. Studie se zúčastnilo 23 respondentů ze 4 vesnic kmene Shipibo v departamentu Ucayali, nedaleko města Pucallpa. Informace byly získány formou polostrukturovaných dotazníků a pozorování. Celkem bylo identifikováno 18 druhů rostlin ze 14 čeledí jako tradiční zdroje přírodních barviv. Mezi nečastěji využívané druhy patří *Swietenia macrophylla* (*Meliaceae*), *Buchenavia* sp. (*Combretaceae*), *Terminalia amazonia* (*Combretaceae*), *T. catappa* (*Combretaceae*) a *Bixa orellana* (*Bixaceae*). K jednotlivým druhům byly shromážděny informace o jejich místním názvu; části, ze které se barvivo připravuje; druh barvy, její příprava a použití. Je zde též pojednáno o rostlinách, ze kterých se získávaly barviva v minulosti. Tradiční znalosti domorodých obyvatel ve vztahu k rostlinám se postupně vytrácí. Shromážděná etnobotanická data mohou přispět k ochraně rostlinné biodiversity v dané oblasti a k uchování znalostí o tradičním využití rostlinných barviv.

Klíčová slova: etnobotanika, přírodní barviva, tradiční znalosti, Shipibo, peruánská Amazonie

Content

1. Foreword

Plants provide mankind with a plethora of useful products. In addition to food, they provide fiber, construction material, medicines, dyes and many other products (MacFoy, 1992). But the survival of many species, together with the indigenous knowledge of their use (and hence our own survival and those of the animals) is greatly threatened. Our increasing population means more deforestration to create more farmland (crops and cattle), timber, fuel wood, and more land for housing, and in general more exploitation of the natural resources (Gomez-Belos, 2002) for example, by the unsustainable harvesting of wild plants for timber and medicine without allowing adequate regrowth to take a place (MacFoy 2004).

Since the early civilizations, colorants have been used to give an attractive presentation to human-made products (Delgado-Vargas and Paredes-López, 2002). In ancient times, natural dyes and pigments (some of which were non-wood forest products) were used by all peoples of the world including the Swiss, Chinese, Egyptians, Indians, Europeans, American Indians, Africans, Mexicans, Peruvians, Greeks and Romans.

Natural colorants are used to impart color or to food products (Green, 1995), while natural dyes have been used for many purposes: coloring natural fiber such as wool, cotton and silk, as well as fur and leather (Cristea et al., 2003) and other non food products. Although there are a wide variety of these products in nature, only some are presently commercially important (Green, 1995). These natural dyes from plants, animals, lichens, rocks and soils were quite commonly used throughout the world (Adrosko, 1968) until the turn of the 20th century (Gilbert and Cooke, 2001).

The use of natural dyes has decreased to a large extent due to the advent of synthetic dyes (Bhuyan and Saikia, 2005). They are synthetised by various means, from by-products of fossil fuels, e.g. aniline and other aromatic derivates (Gilbert and Cooke, 2001). It is believed by some that because synthetic dyes were regarded as cheaper; more reliably available; of consistent quality; had greater color fastness; and more stable on foods; this caused the downward spiral of the use of natural dyes (MacFoy, 2004). Some people consider that vegetable dyeing is more complicated than chemical dyeing (Dyer A., 1976), only a few natural dyes by virtue of their unique qualities have retained a significant position in the textile sector (MacFoy, 2004). It has become a common misconception that natural dyes only produce beiges and browns and washed out shades. In reality, the vibrant, fast, natural colours can be produced which are comparable with, and often surpass the colour synthetics (Gilbert and Cooke, 2001).

Recently, dyes derived from natural sources have emerged as important alternatives to synthetic dyes (Bhuyan and Saikia, 2003) due to the current knowledge that many of the synthetic dyes, especially those that are used in the food-stuff industry and cosmetics (Tsatsaroni and Liakopoulou-Kyriakides, 1995), are suspected to release harmful chemicals that are allergic and detrimental to human health (Mahanta and Tiwari, 2005) and also have been reported to have carcinogenic effects (Sewekow, 1988). Further, natural dyes do not cause pollution and wastewater problems (Bhuyan and Saikia, 2003). With the worldwide concern over the use of eco-friendly and biodegradable materials, the use of natural dyes has once again gained interest (MacFoy, 2004; Bhuyan and Saikia, 2003; Mahanta and Tiwari, 2005; Dyer, 1976), thus there is an increased need to investigate the natural ecofriendly ecodyes (MacFoy, 2004).

Once natural dyes made from plants are no longer used, the methods of their preparation will no longer be passed on from generation to generation. Thus there is a great effort to contribute to preservation of the traditional ethnobotanical knowledge about dye yielding plants and traditional dyeing techniques (Guarrera, 2006; Mahanta and Tiwari, 2005; Modesto and Niessen, 2001). Otherwise we are bound to lose vital information on the utilization of natural resources around us (Mahanta and Tiwari, 2005).

2. Introduction

2.1. Geographical characteristics of study area

Pucallpa with current population over 250 000 inhabitants, is the capital of department Ucayali bordering Brazil to the east, along an east–west gradient leading to the foothills of the Andes (Figure 1) (Fujisaka *et al.*, 1999). The Ucayali department, formerly very isolated from other parts of Peru, is now one of the fastest developing Peruvian regions, mainly due to extensive logging (Kloucek et al., 2005).

Figure 1. Map of study area.

Pucallpa is located 842 kilometers from Lima, connected with Huanuco - Tingo María - Pucallpa highway, with altitude of 154 meters above sea level, 8°23’ of south latitude and 74°31’ of west longitude. It is situated on the river Ucayali (Fujisaka *et al.*, 1999) (Figure 2) and is surrounded by the Amazonian forest, which covers about 63% of

Peru (Skladany et al., 2006). Shipibo is the largest indigenous ethno-linguistic group living in this region (Pimentel *et al.*, 2004).

Figure 2. Aerial view of the Ucayali River /Amazon River Basin near Pucallpa (Polesný, 2007).

Communities of Shipibo have access to the forest on the two different geomorphological formations in the region (Putsche, 2000) which correspond to the two higher-level vernacular categories of forest-type "altura" forest, on the well-drained landscape on Pleistocéne alluvium of the interfluvial plateaux and low hills, and "bajio" forest covering the poorly to well-drained landscape on alluvial deposits within the Holocéne floodplain of the main rivers. A third major forest-type, "aguajales", swamps dominated by the palm *Mauritia flexuosa* (aguaje) occupies permanently waterlogged patches in both the Pleistocene and Holocene formations (Lawrence et al., 2005).

2.2. Biophysical characteristics

The area is characterized by humid tropical forest cover and by hot and humid climate that varies only imperceptibly throughout the year. The rainfall ranges from 1500 to 2100 mm annually (Odar and Rodrígues, 2004), with a wet season between November and April and a dry season between May and October (Soudre et al., 2001). However, in the last few years, probably due to high deforestation, the climate has changed slightly and the difference between dry and wet periods is not so sharp (Loker, 1993). The average annual temperature is 25.2 °C, with a maximum of 30.9 °C and minimum of 19.6 °C (Figure 3). The average evapotranspiration is 1200 mm and relative humidity 77% (Kobayashi, 2004).

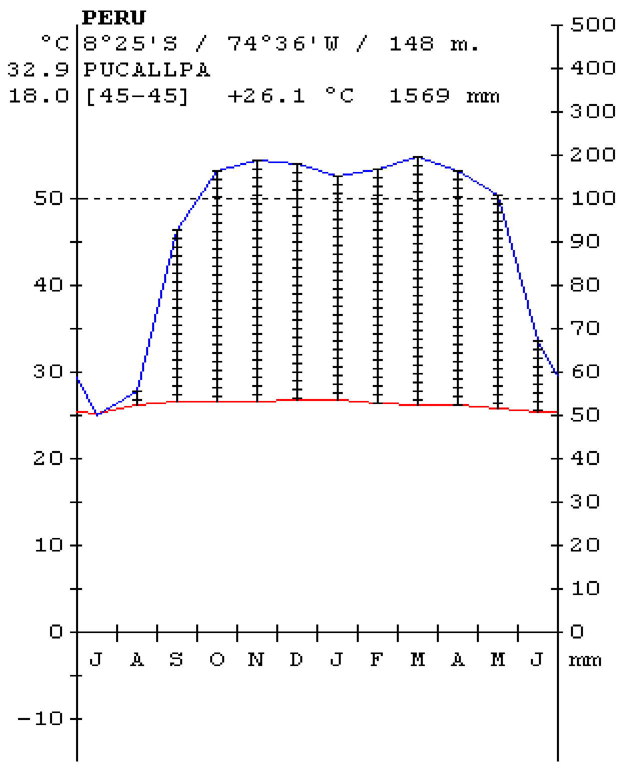


Figure 3. Climate Diagram - Pucallpa, Peru (Rivas-Martínez, 2004).

From February to April, lowland areas are submerged during the Ucayali River's annual flooding. In upland areas, agriculture is the main livelihood activity and a difficult one because of poor soils that do not benefit from the fertility renewal that occurs in the lower areas during the annual deposits left by the Ucayali's annual flooding (Goy and Walter-Toews, 2005).

2.3. Socio-economic conditions

Peru became independent from Spain in 1821. Pucallpa, the capital of the region Ucayali, had population of 230,624 inhabitants in 2005, which is 55 % of total region population, and is one of the most progressive cities in the Peruvian Amazon (Pimentel *et al.*, 2004). It is an important timber center and has the typical problems of the third world cities: bad roads, a lack of even the most basic sanitation facilities, and various other economic deprivations (Portillo, 1994). The population of whole region grew up significantly in last sixty years. In 1940 the Ucayali region had 27,024 inhabitants which grew up to 456,340 inhabitants in 2004 (Pimentel *et al.*, 2004).

Programs such as public health education, antenatal care and child growth monitoring, and referral systems for serious conditions to higher levels of care experience delay and are particularly difficult under these physical environment conditions. (Goy and Walter-Toews, 2005).

Although indigenous people have skillfully used the extensive river/flood plain/lakes and adjacent forest environment for at least 5,000 years, both they and the natural system have been under relentless development and population pressure, global extractive industries, and the conversion of forest into farms or pasture (Skladany et al., 2006).

Upland household incomes are highest during January and February, when crops are sold in the Pucallpa market. Many upland households face food shortages during the dry season in July to September, when the harvest season is months away. In contrast, in the floodplain communities along the Ucayali, incomes are highest at the end of the flood season, in April, when timber extracted from the forest during the flood season is transported on the river to Pucallpa markets. Food shortages are greatest during the wet season, because agricultural lands are submerged and fish disperse into flooded forests, making them difficult to catch (Goy and Walter-Toews, 2005).

Expansion of plantation agriculture, ranching, and deforestation has damaged fragile tropical soils and contributed to soil erosion, river pollution, mudflows, and exacerbation of flooding. The floods of 1993 and 1994 were among the most destructive in the region, wiping out entire crops and causing villages to be abandoned (Goy and Walter-Toews, 2005). Species diversity has also declined because of overextraction; many floral and faunal resources have become extinct (Kvist and Neber, 2001). For example, Amazonian timber is prized worldwide, but the great cedar, rosewood, and mahogany reserves have not been replaced after cutting, causing many tree species to become endangered.

Peruvian Amazon is also highly valued for medicinal plants, such as the four domesticated coca species found in this area. Coca's traditional uses as a beneficial drug for dietary, medical, and ritual purposes have given way to illegal plantings on a large scale for cocaine production. These illegal plantations have deteriorated the forests and soils, and introduced chemicals in order to clear the land for illegal planting (Skladany et al., 2006).

For fifty years, the area around Pucallpa has witnessed deforestation at a rate of 20,000 hectares per year (Portillo, 1994). Very little untouched forest remains near Pucallpa, and even the remaining forest shows some evidence of disturbance, for example, the presence of weedy species. (Fujisaka *et al.*, 1999).

2.4. Population

Peru's population of 27.5 million people consists of about 45% Indigenous (9 major groups shown on Figure 4), 37% Mestizo, and 15% White. The official languages of the country are Spanish, Quechua, and Aymara (Vinding and Parellada, 2003). There are presently thirty indigenous ethnic groups predominantly living in the forests of Peru. They have different origins and are grouped by their language. Only thirty years ago, however, 150 ethno-linguistic groups could be identified. The largest groups are the Ashaninkas, Shipibo and Aguaruna (Skladany et al., 2006).

Figure 4. Distribution of 9 major indigenous groups in Peru with the studied Shipibo group shown (Vinding and Parellada, 2003).

The Shipibo are an Amazonian ethnic group that lives in the Ucayali area, between approximately 6 and 10 degrees of latitude south, in Central Eastern Peru, Region Ucayali, Coronel Portillo Province. There are approximately 23,000 *jonikon* “true people” settled in about 130 villages along the Ucayali river. In the past they considered themselves as free different ethnic groups: *Shipibo* (the *Pichico*-monkeys), *Conibo* (the Eels), and *Xetebo* (the *Rinahuis*, a kind of small vulture). However, presently these free groups constitute almost a single unit that names themselves *Shipibo* (Figure 5)(Valenzuela, 1997). Their mother language, Shipibo, is a member of the Panoan language family, the largest of those in the Peruvian Amazon (Tacelosky, 2001). Presently, most Shibibo speak Spanish as well as their native language (Behrens, 2004).

Figure 5. Shipibo women (Author, 2007)

Contact with mestizos (the local term for Spanish-speaking Peruvians with mixed Spanish and Indian blood, but also used to denote those indigenous people who attempt to deny their heritage by dress, language and custom) varies. Some Shipibo allow mestizos to live among them in the same community; others interact only when they travel to the city or mestizo merchants come to sell and trade (Tacelosky, 2001). Nowadays there exist quite strong coexistence between native people and foreigners (Putsche, 2000).

There are no longer any communities that could be considered isolated (Tacelosky, 2001). Unfortunately, the proximity of most Shipibo communities to the burgeoning cities of Pucallpa and Iquitos makes it inevitable that their culture will soon be altered by mainstream trade, exploitation and encroachment of western values (Behrens, 2004).

The Shipibo's traditional subsistence system was based on swidden horticulture, fishing, and hunting (Pimentel, 2005) and then gradually shifted to agriculture, perhaps when hunting and gathering brought in insufficient food to support them (Follér, 1995). Declining crop yields, along with the decline in fish and game due to commercial hunting and fishing, had led to a need to purchase food occasionally. Income to make these purchases was derived from cash cropping of rice and corn and sale of medicinal product and their unique handicraft (Putsche, 2000).

Shipibo have been implemented their unique art and handicraft since immemorial and the use of natural dyes and coloring materials among Shipibo has been a tradition that persists until these days (Tournon, 2002). Shipibo artisans are well known for their intricate geometric designs on their pottery and colorful fabrics depicting their cosmology (Cairuna, 2003).

3. Study background

3.1. History of natural dyes

Human use of plant pigment extracts dates back as long as recorded history (Davies, 2004). Since prehistoric times, natural dyes have been used for many purposes such as the coloring of natural fibers wool, cotton and silk as well as fur and leather. The dyes were also used to color cosmetic products and to produce inks, watercolors and artist's paints (Cristea, 2005).

The earliest evidence of the use of color comes from cave painting of Cro Magnon which where painted between 10,000 and 30,000 BC. However, it is striking to note that blue (and consequently green) are not used in theses paintings (Gilbert, 2001)

The technology used in the production of natural dyes was known in China as early as 3000 B.C. (Dogan et al., 2003), documenting human use of *Indigofera tinctoria* (indigo) (Driessen, 2003). Anthraquinone, indigoid and flavonoid pigments have been identified in the fourth century AD. Further back than this the use of carthamin extract from *Carthamus tinctorius* (safflower) to dye the wrappings of mummies has been reported (Davies, 2004), and chemical tests of red fabrics found in the tomb of King Tutankhamen in Egypt show the presence of alizarin, a pigment extracted from *Rubia tinctoria* (madder). By the 4th century AD, dyes such as *Isatis tinctoria* (woad), *Rubia tinctoria*, *Reseda luteola* (weld), *Haematoxylon brasiletto*, *Caesalpinia* spp (brazil wood), and *Indigofera tinctoria* were known (Driessen, 2003).

In the 13th century A.D. the production of natural dyes was known among the Indians, Phoenicians, Hebrews, and Venetians and later was passed on to the Greeks and Romans. It was also known in Africa, Mexico and Peru (Dogan et al., 2003). The dyes used in medieval times in Europe show a gradual progress toward the refinement of the natural dyestuffs used in earliest times. A new dye had to undergo severe tests before it was admitted to general usage. It was a long time before indigo superseded woad as the most commonly used black/blue dye. Woad was undoubtedly the most important dyestuff of this period and it was exported to all the important weaving centres on the European continent and in England. Saffron is recorded in later times as being regularly carried across to the markets in Basle areas from 1400 AD, it came from Tortosa in Spain and Tuskany. With *Crocus sativus* (saffron) came *Rubia tinctoria*, *Indigofera tinctoria*, *Haematoxylon brasiletto*, *Caesalpinia* spp, *Isatis tinctoria*. It was the discovery of the passage to India that enabled dyers to import at low prices large quantities of dyestuffs such as *Haematoxylon brasiletto*, *Caesalpinia* spp, *Crocus sativus*, *Carthamus tinctorius*, *Curcuma longa* (turmeric), *Coccus lacca* (lac), and *Indigofera tinctoria* (Robinson, 1969). By the 15th century, dyes from insects, such as *Coccus cacti* (cochineal) (Driessen, 2003) and *Coccus illicis* (kermes), living on oaks *Quercus coccifera*, were becoming more common (Puchalska et al., 2003). India, the country whose dyeing practices have exercised the greatest influence on European dyers from the 16th century, appears to have had a dye industry long before its transactions were recorded in writing, perhaps extending to the period of the Indus Valley civilization 2500 BC. Marco Polo described in detail its indigo manufacture during the 13th century AD, about three hundred years before the Portugese introduced it to Europe (Adrosko, 1968).

The key cities for the dye trade were Constantinople as the eastern bridge-head of the Orient trade and Veniceas that of the West. Through Venice came the dyes from the great dye centres of the East such as Cambay, which was once the greatest export market for *Indigofera tinctoria*. By the 17th century, dyeing cloth "in the wood" was introduced in England: *Haematoxylon campechianum*, *Morus tinctoria* (fustic), etc. (Driessen, 2003).

Until the turn of the 20th century, all color came from the natural world, as there was no other means by which it could be derived. The use of natural dyes to color textiles declined rapidly after the discovery of synthetic dyes in 1856, (Cristea, 2006) when William Henry Perkin, while experimenting with coal tar in hopes of finding an artificial quinine as a cure for malaria, discovered the first synthetic dye stuff which called „Mauve". The color quickly became a favorite of the royal family, and a new industry was begun (Driessen, 2003). Nowadays, most of the colours used in commercial textile dyeing are synthetic. They are synthesised, by various means, from by-products of fossil fuels, e.g., aniline and other aromatic derivates (Kerry and Cooke, 2001).

3.2. Definition and terminology of dyestuffs

Dyestuffs are intensely coloured compound, i.e. dyes, pigments, inks and stains that are applied to a substrate such as fiber, paper, cosmetics, hair, etc. in order to give colour. Plant dyestuffs are extracted by fermentation, boiling, or chemical treatment of plant tissue (Delgado-Vargas and Paredes-López, 2002).

The terms natural dyes, colorants, and pigments are used indiscriminately in both commerce and the literature. According to Wickens, 2001 they can be defined as follows:

- **Natural dyes or dyestuffs**, as distinct from natural colorants, are the natural plant (animal or mineral) products used to impart a desired colour to non-food material such as textiles, wood, leather, etc. by a process known dyeing;
- **Natural colorants** are natural products which are incorporated into foodstuffs to provide an attractive colour to the final product; and
- **Natural pigments** are widely distributed in living organisms (Delgado-Vargas and Paredes-López, 2002). Major pigments of plants are described in Table 1, according to Davies (2004).

Table 1. Major pigments of plants and their occurrence in other organisms (Davies, 2004).

Pigment	Common types	Occurrence
Betalains	Betacyanins Betaxanthins	The *Caryophyllales* and some fungi
Carotenoids	Carotenes Xnthophylls	Photosynthetic plants and bacteria
Chlorophylls	Chlorophyll	All photosynthetic plants
Flavonoids	Anthocyanins Aurones Chalcones Flavonols Proanthocyanidins	Widespread and common in plants, including angiosperms, gymnosperms, ferns, fern allies and bryophytes.

Plant pigments exist in many varied forms, some with highly complex and large tructures. For example, over 600 naturally occurring carotenoid structures have been identified (Britton et al., 1995) and over 7000 flavonoids, including over 500 anthocyanins and a large number of structures have been reported (Davies, 2004). In Table 2 is shown occurence of the major pigments in plant species.

Table 2. Occurrence of the major pigments in plant species.

Plant pigment	Colours produced	Presence in plants (examples)
Quinones	Yellow to red Include black to red to blond	Lawsone (*Lawsonia inermis*), Alizarin (*Gallium* spp), Morindin (*Arthocarpus heterophyllus*, *Maclura pomifera*, *Chlorophora tinctoria*, *Morinda citrifolia*) (Čopíková et al., 2005) **Anthraquinones:** *Rubia tinctoria* (Wickens, 2001)
Anthracenes	Yellow, red	**Anthraquinones:** Alizarin, mungistin and purpurin (*Rubiaceae*) Emodin (*Rhamnus saxatilis*) (Wickens, 2001) **Napthoquinones**: Juglone (*Juglans* sp., *Carya illinoensis*, *Carya obovata*) Alkalin (*Alkanna tinctoria*, *Lithospermum tinctorium*) Hypericin (*Hypericum perforatum*) (Čopíková et al., 2005)
Carotenoids	Red, orange and yellow	**Carotenes:** b-carotene (*Daucus carota* subsp. *sativus*) Lycopene (*Lycopersicon* sp) (Delgado-Vargas and Paredes-López, 2002) **Xanthophylls:** Lutein (*Galega officinalis*, *Achillea millefolium*, *Reseda luteola*, *Genista tinctoria*) Cis-bixin (*Bixa orellana*) Crocin (*Gardenia jasminoides*, *Crocus sativus*) (Čopíková et al., 2005)
Flavonoids	red, violet, blue	**Anthocyanidins and anthocyanins**: Malvidin (*Malva silvestris*, *Vitis vinifera*), Cyanidin (*Rosa* spp., *Cerasus avium*, *Rhodococcum vitis-idaea*, *Cyanus seqetum*) (Čopíková et al., 2005) Carajurin (*Bigonia chica*) Awobanin (*Commelina communis*) Dracorhodin (*Doemonorops propingus*) (Hancock, 1997)
	yellow	**Flavonols and flavones**: Morin (*Artocarpus heterophyllus*, *Maclura pomifera*, *Chlorophora tinctoria*, *Morinda citrifolia*) Quercitron (*Quercus tinctoria*) (Čopíková et al., 2005)
Betacyanins (betalains)	Purple, red, yellow	Amaranthine-I *(Amaranthus tricolor)* Betanin (*Beta vulgaris*) Gomphrenin-I (*Gomphrena globosa*) Miraxanthin (*Mirabilis jalapa*) Portulaxanthin (*Portulaca grandiflora*)

Plant pigment	Colours produced	Presence in plants (examples)
Flavins	Yellow	Very common in all living organisms (Delgado-Vargas and Paredes-López, 2002).
Dihydropyrans	Blue, red	Haematin and haematoxylin (*Haematoxylon campechianum*) (Hancock, 1997) Brazilin and brazilein (*Caesalpinia* spp) (Wickens, 2001)
Indigoid dyes	Blue	*Indigofera* spp, *Isatis tinctoria*, *Polygonum* spp, *Nerium tinctorium*, *Lonchocarpus cyanescens* (Hancock, 1997)
Chlorophylls	Green	In photosynthetic organism (plants, algae, some bacteria) (Davies, 2004) *Urtica dioica*, *Spinacia oleracea*, *Medicago sativa*, *Zea mays* etc. (Hancock, 1997)
Other dyes	Various colours	**Diaroylmethane:** curcumin (*Curcuma longa*) **Neoflavonoid:** berberine (family Berberidaceae, *Mahonia* spp) (Delgado-Vargas and Paredes-López, 2002) **Pterocarpans**: (*Santalum* spp) (Adrosko, 1968)

3.3. Natural dyes of non-vascular plants origin

Lichens are composite organisms of fungi and algae, and have long been used for dyeing textiles. The colors obtained from the dye-bearing lichens range from oranges, yellows and browns to reds, pinks and purples. Their dyes are substantive, extremely fast to light, washing and salt water, and generally require a short, simple extraction process.

Species of particular value include *Cladonia impexa, Evernia prunastri, Hypogymnia physodes, Lobaria pulmonaria, Ochrolechia parella, O. tartarea, Paramelia omphalodes, P. saxatilis, Rocella tinctoria, Umbilicaria pustulata,* and *Xanthoria parietina* (Hancock, 1997).

Monascus fungi have been used in parts of Asia to colour foods such as rice, wine and soybean products (Jacobson and Wasileski, 1994). The traditional cultivation method is to grow the fungus on trays of steamed rice. The pigments produced include carotenoids, iridoids, flavonoids and phycobiliproteins (Hancock, 1997).

3.4. The most important dye sources from higher plants

The analysis of the natural dyes listed in Color Index revealed that almost 50% of all natural dyes used to color textiles are flavonoids (Cristea, 2006) and carotenoids. Athough some flavonoids dye in red, violet or blue-violet, in majority, flavonoids yield yellow and orange dyes (Roquero, 2002). Most of the remaining natural dyes fall within three chemical classes - anthraquinones, naphtoquinone and indigoids (Cristea, 2006).

Natural colors are extracted from the roots, fruits, flowers, bark and leaves of the different types of plant species. Red dye from the roots of *Rubia tinctorum* is used in Europe supposedly from the year 800 AD, the other red-dye plant species was *Caesalpinia echinata*, *Beta vulgaris* (red beet), *Arctostaphylos uva-ursi* (bearberry), *Carthamus tinctorius* (Čopíková et.al., 2005), *Alkanna tinctoria* (alkanna) (Adrosko, 1968), *Morinda citrifolia* (turkey red), *Pterocarpus santalinus* (sandalwood), *Relbunium* spp (Wallert and Boytner, 1996), *Arrabidea chica* (de Mayolo, 1989).

Other known plant dye is also orange dye from the stigmas of *Crocus sativus*. The yellow dye was obtained from *Matricaria recutila*, *Polygala amara*, *Genista tinctoria* (Čopíková et.al., 2005), *Chlorophora tinctoria* (fustic), *Quercus velutina*, *Rhamnus infectoria* (persian berries) (Adrosko, 1968), *Curcuma longa* (Doménech-Carbó et al., 2005), *Polygonum tinctorium* (Japanese knotweed), *Reseda luteola* (Gilbert and Cooke, 2001), *Phellodendron chinense* (Gibbs and Seddon, 1998), *Zea mays* and *Berberis* spp (de Mayolo, 1989).

Brown dye offered *Lawsonia inermis* (henna), *Juglans cinerea* (butternut), *J. nigra* (black wallnut), *Acacia catechu*, *Areca catechu*, *Uncaria gambir*, and many other barks of various trees eg. *Alnus* spp, *Tsuga canadensis* (hemlock) and *Acer rubrum* (Adrosko, 1968); *Theobroma cacao* (Duke, 1987), *Peltophorum pterocarpum* (Robinson, 1969).

The source of green dye can be *Persicaria maculosa*, *Polygonum persicaria*, *Rumex acetosa*, *Urtica dioica*, *Urtica urens* and *Ambrosia artemisiifolia* (Čopíková et.al., 2005).

The blue dye is gained from *Isatis tinctoria* (Oberthur, 2004), *Indigofera tinctoria*, *Sophora tinctoria* (wild indigo) (Adrosko, 1968) and *Lonchocarpus cyanescens.* (MacFoy, 2004).

Black dyes are obtained from *Haematoxylon campechianum* and *Genipa americana* (de Mayolo, 1989).

Writing ink usually consist of a fluid tannin extract with the addition of solutions of iron salts, with which it reacts to form dark blue or greenish-black compounds. In inks the colouring matter is dissolved or dispersed in a solvent or carrier, and on drying the colouring matter is bonded with the substrate. The galls from the twigs of *Quercus pubescens* (aleppo oak), contain 36-58% tannin and were an early and important source of tannin inks. The inks used in ball-point pens are highly concentrated dyes in non-volatile solvent. Interestingly, the arils of the seeds of *Acacia cowleana* contain a powerful solvent of ball-point ink and may have a future industrial or domestic application. Coloured inks are prepared from natural dyestuffs or aniline dyes in combination with alum, water and a gum, e.g. gum arabic. Examples include the betalain dye from the berries of *Phytolacca americana* (inkberry) and brazilwood, the red ink of the latter being especially noteworthy for the presence of both tannin and coloring agent.

The carbon inks, prepared from charcoal, gums and varnish, are known from Chinese writings as early as at least 2600 B.C., and from the Egyptian papyruses of 2400 B.C. Printing inks consist of carbon in combination with rosin, gum arabic, a drying oil, such as linseed or tung oils, fractionated palm and coconut oils, a chemical drier and a soap. The use of woad is currently under investigation at Bristol University for use in injet printers (Wickens, 2001).

3.5. Dyeing textiles

Several types of plant dyes are used for dyeing textiles (Wickens, 2001), they are mainly mordant dyes although some belong to other groups (vat, solvent, pigment, direct and acid). There are no natural dyes of the sulphur, disperse, azoic or ingrain types (Hancock, 1997).

The classes of dyes defined by the application or end-use, and hence the terms most applicable to textile dyeing, are:

- **Direct dyes** forming hydrogen bonds with the hydroxyl groups of the fibres. Dyeing is direct from an aqueous solution of the dyestuff. Such dyes are not fast, e.g. the yellow curcumin colorant and former dyestuff from the tubers of *Curcuma longa* (turmeric), and used as a food colorant. Synthetic direct dyes are now available, of which the azo-dyes are probably the most important (Wickens, 2001).
- **Acid dyes** are dyestuffs containing an aromatic chromophoric group and a group conferring solubility in water, generally with the SO_3H group as its sodium salt. They are relatively simple in application. Examples are to be found among the flavonoid pigments (Wickens, 2001). They are used for fur, nylon and wool fibres (Srisukho, 2001).
- **Basic or catonic dyes** are dyestuffs containing ionic species. Their chlorides are generally water soluble organic salts, oleates or stearates soluble in organic solvents. They are used in printing inks; they have a high fastness and brilliant shades. They are also used in paints and wallpaper pigment (Wickens, 2001) and for dyeing acrylic fibers (Srisukho, 2001). A mordant is usually required when used with natural fibres (Wickens, 2001).
- **Vat dyes** occupy a significant place in the dyeing of textile fabrics (cotton, rayon, polyester, nylon), are insoluble in water but can be reduced, in the presence of a reducing agent in an alkaline medium, to form a water-soluble dye (Pricelius et al., 2007). The water-insoluble dyestuff is precipitated within the fibre on reoxidation, generally in the atmosphere. In to the vat dyes belong *Indogofera tinctoria* (Wickens, 2001), *Acacia catechu* (catechu), *Areca catechu* (betel nut) and *Uncaria gambir* (gambier) (Robinson, 1969).
- **Disperse dyes** form a group of water-insoluble dyes which are generally used from an aqueous suspension, the dyestuffs having a high afinity for the fibre,

especially nylon and other synthetic fibres. The main types are anthraquinone, e.g. alizarin (Wickens, 2001).

- **Mordant dyes** are used to dye textiles that have been treated with a mordant. Such dyes can be very fast, e.g. alizarin and morindin (Wickens, 2001). Color fixing agents, such as mordants, make colors fix with fiber effectively. This process uses temperature from 60 to 100 °C. Natural fixing agents derive from tannin in bitter tasting leaves, eg. *Psidium guajava* (Serrano and Tournon, 1989; Srisukho, 2001), *Eucalyptus* spp (Mongkholrattanasit and Vitidsant, 2007), fruits (eg. *Anacardium occidentale*, *Terminalia catappa*, *Prosopis juliflora*, *Caesalpinia coriaria* and *Acacia farnesiana* from South America), seeds (eg. *Persea americana*), wood (*Chlorophora tinctoria*), barks (eg. Central and South American species *Alnus ferruginea*, *Brysonima crassifolia*, *Rhizophora mangle* and *Swietenia macrophylla*) (Roquero, 2002), galls or excrescences on trees (Robinson, 1969), buds (eg. *Alcea rosea*, *Solidago canadiensis*) (Dyer, 1976).

3.6. Preparation of natural dyes

Fresh or preserved plant materials, including roots, stems, leaves, fruits, and flowers, can be boiled in water to produce a variety of natural dyes (Egan et al., 2004), but the same plant species can give different colours and intensity depending on the part used and its age, the locality and conditions for growth, and the time of year. In craft dyeing generally about twice the weight of plant material to the weight of the fibre used but the density of colour is affected by several variables, such as the heating time and contact time. Relatively little seems to be known about the causes and management of variation in colour and intensity in dye plants (Hancock, 1997).

Plant parts are collected during the flowering or fruiting period. These parts are air dried in shade. They are then ground to a form of powder, and are stored in paper or cotton bags. For dyeing, 1 kg of fibers, 40 l of water and 1 kg of dried and ground plant parts are put into a large boiler pan and boiled over a low-flame fire for one hour with the fibers inside. Time to time the mixture should be stirred to make dyeing homogenous. After one hour boiling, the mixture is left to cool. The next day, dyed fibers are taken out of the pan, rinsed with water, and hung on strings to air-dry (Dogan et al., 2003). During drying, direct sunlight is avoided for retaining brightness of the colors (Kala, 2002).

There is however quite a lot of room for experimation here (Dyer, 1976). According to MacFoy, 2004 for dyeing 3.7m of material, use 322g of plant material in 68.9 litres of water and Kala, 2002 described that for dyeing 1 kg of wool, around 4 l of water is boiled with approximately 50–60 g of fresh plant material.

However, artisans generally are more likely to learn by experimenting and they also keep their knowledge about natural dye preparation from others (Modesto and Niessen, 2001).

If possible, separate pots should be used for each color and iron pots should be avoided as these will produce contamination of the dye (Dyer, 1976; MacFoy, 2004).

The majority of plant dyestuffs fade rapidly when exposed to sunlight or detergents, consequently the importance of a dye is judged by the fastness of the colour. A mordant is used to increase the adherence of the dye to the fabric (Srisukho, 2001). They are usually wood ash, dough yeast, ash, lime, salts of aluminium, iron sulphate, copper sulphatecalcium carbonate, and potassium bichromate (Ozgokce and Yilmaz, 2003), some plant products can also be used as mordants (see Chapter 2.6.).

3.7. Socio-economic aspects of using natural dyes

Color has always been an important element in the cultures of peoples all over the world. It was used not only to embellish an object or an individual but to indicate importance and hierarchical status. Some dyes or dyed textiles were even used to pay taxes. The painstaking activities or searching for the natural sources of dyestuff and selecting, extracting and applying them form a sound basis for their high commercial importance (Wouters and Rosario-Chirinos, 1992). Because of the cultural and economic transformation in society in the past two decades, natural dyes were replaced with synthetic dyes. Synthetic dyes are economically cheap, easy to produce, more profitable and are abundantly available, but economically, they are not as valuable as natural dyes (Ozgokce and Yilmaz, 2003). The cost of naturally dyed textiles is higher than other market alternatives available due largely to the additional labour required in the dye preparation (Modesto and Niessen, 2001).

Although the use of natural dyes in many applications was superseded by synthetic dyes, in recent years there has been a return to the use of natural colourants, and an increased interest in new sources and improving their performance in food applications.

Four plant pigment types are widely used as food colourants: annatto, anthocyanins, betalains (beetroot pigment) and curcumin (the main pigment of turmeric). Together with the insect-derived pigment cochineal, they account for over 90% of the market for natural food colourants (Houghton and Hendry, 1992).

The ecological benefits to the plant have at least some bearing on the potential medicinal benefits for humans (Lila, 2004).

3.8. Recent studies on natural dyes of plant origin

There have been done a lot of studies about natural dyes. In general, the authors described encouraging results with regard to color depth, shade, fastness properties and the possibility of natural dyes to become substituents for the synthetic dyes, mainly in food industry (Bechtold et al., 2003; Pawlak et al., 2006; Mehmet et al., 2006; Wouters, J. and Rosario-Chirinos, 1992; Gould et al., 1998; Tsatsaroni et al., 1995; Tsatsaroni et al., 1998; Bhuyan and Saikia, 2005 etc.).

In the last decade, investigations about possible use of natural dyes in textile dyeing processes have been performed by various authors (Deo and Desai, 1999; Bhattacharya et al., 1998; Nishida and Kobayashi, 1992; Bechtold et al., 2003; Angelini et al., 2003; Angelini et al., 1997; Derksen and Beek, 2002). One study was done in south coast of Peru (Wallert and Boytner, 1996) but it concerned to the analyzation samples from a total of 256 textiles taken from the local museum to find out the evolution of dyeing techniques and technologies in Azapa region

Studies about antimicrobial activity of some natural dyes has also been reported. Singh et al. (2005) have tested if some natural dyes have inherent antimicrobial activity with a view to develop protective clothing from these. Four natural dyes *Acacia catechu*, *Kerria lacca*, *Quercus infectoria*, *Rubia cordifolia* and *Rumex maritimus* were tested in his study against common pathogens; *Quercus infectoria* dye was most effective and showed the best antimicrobial activity against all the microbes tested.

Han and Yang (2005) used curcumin as an antimicrobial finish due to its bactericidal properties on dyed textiles; the relationship between the sorption of an interesting natural colorant onto wool and the antimicrobial ability of the dyed wool were investigated.

Son et al. (2007) investigated that berberine, a natural cationic colorant from *Berberis vulgaris*, showed very effective antimicrobial functions showing about 99.9% of bacterial reduction against *Staphylococcus aurens* and *Klebsiella pneumoniae*.

Delgado-Vargas et al. (2000) have approved antimicrobial activity in flavonoids from *Ormosia monosperma* and *Ononis spinosa subsp. Leeiosperma.* ¨

Antimicrobial properties of commercial annatto extracts from *Bixa orellana* against selected pathogenic, lactic acid, and spoilage microorganisms were investigated by Galindo-Cuspinera (2003). The results demonstrate that annatto has an inhibitory effect on *Bacillus cereus*, *Clostridium perfringens*, and *Staphylococcus aureus*.

Utilisation of natural colorants as nutraceuticals (i.e. any substance that may be considered a food or part of a food and provides medical or health benefits, including the prevention and treatment of disease) has also been studied in Delgado-Vargas and Paredes-López (2002).

Very little is written about the ethnobotanic studies of natural dyes. There have been done few studies in northeastern India [Mahanta and Tiwari (2005) reported 37 species used for theirs dyeing properties], Guatemala [where 14 species used in the preparation of dyes in San Juan La laguna were identified by Modesto and Niessen (2001)]; MacFoy (2004) identified 37 dyeing species used in Sierra Leone; in the study of Guarrera (2006) that was done in 4 Italian regions: Latium, Marche, Abruzzo and Sardinia have been found that 29 plants show the dyeing properties. Dogan et al. (2003) identified 123 species used for dyeing in Turkey, while only in East Anatolia Region were found 50 dyeing species (Ozgokce and Yilmaz, 2003).

There have been done three ethnobotanical studies on natural dyes of plant origin in Peru during the last three decades. There were described 56 plant species known to be used as textile dyes or coloring materials for other similar purposes in Peruvian Andes in the study of de Mayolo (1989). While Roquero (2002) made her investigation not only in Peruvian Andes, but also in México, Guatemala, El Salvador, Costa Rica, Ecuador and she has also mentioned some species used in Peruvian Amazon. She has found here 6 dye yielding species, of which one specie was not identified and was found like the only example in broad surrounding of Shipibo village. The ethnobotanic study about dyeing plants in Peruvian Amazon was done by Serrano and Tournon (1989) and 9 species have been found.

Although there has already been one study publicated, our hypothesis was that there has to be more species that are used by Shipibo for their dyeing properties. The use of natural dyes has been tradition in the Shipibo culture (Tournon, 2002) and the sale of natural dyed art and handicrafts becomes the main source of income of most Shipibo in the last decade (Putsche, 2000; Pimentel et al., 2004). The changes of biodiversity in this region due to the heavy deforestration and everydays' logging cause that people find the new species that would replace those that are getting scarce.

4. Objectives

The aim of the present study has been to document and preserve traditional ethnobotanical knowledge on dye-yielding plant species used by the Shipibo around Pucallpa in Peruvian Amazon (Ucayali Department, Peru).

This research should answer the following questions

- Which plant species are used in studied area as coloring agents?
- Which plant parts are used and how are they processed?
- Where the species are collected?
- What is the cultural and economic value of particular species for the local people?

The collected ethnobotanical data should contribute to the protection of the plant biodiversity.

5. Methodology

5.1. Descriptions of studied communities

For data collection four different villages of San Francisco, Yarinacocha, Santa Teresita and Santa Rosa de Dinamarca were chosen. San Francisco is situated 30 km, Yarinacocha 5 km, and Santa Teresita about 25 km from Pucalpa. The last village called Santa Rosa de Dinamarca is located on the Ucayali river six hours by public river taxi, “collectivo“. The people responded were Shipibos from the Pano ethnolinguistic family (see Chapter 2.1.4).

San Francisco is the largest Shipibo village located on the Lake Yarinacocha, an Oxbow lake just off the Ucayali river. Because of its proximity to the city of Pucallpa, a commercial center for the Peruvian lowlands, San Francisco has been heavily impacted by outsiders (Putsche, 2000). San Francisco is home of about 300 Shipibo families which makes it the third largest native community in whole country (Skladany et al., 2006). The main economic profit is selling handicrafts, natural art and medical product and also practicing of traditional healing and rituals that become more and more popular among tourists. The other income is from selling of cash and food crops.

The village Santa Teresita lies on the shores of Cashibococha, a pristine lake near to Pucallpa (Charing, 2007). This village is much smaller than San Francisco and is only little visited by tourists due to not so easy accessibility from Pucallpa. There is about 25 families living, growing cash and food crops, hunting, fishing and making and selling their art and medicinal products.

The small community of Shipibo is located at the fringe of the village Yarinacocha, that is situated near Pucallpa. Some families practice agriculture (they grow corn, cassava, papaya, pineaple and rice), they do not make so much the traditional art and pottery.

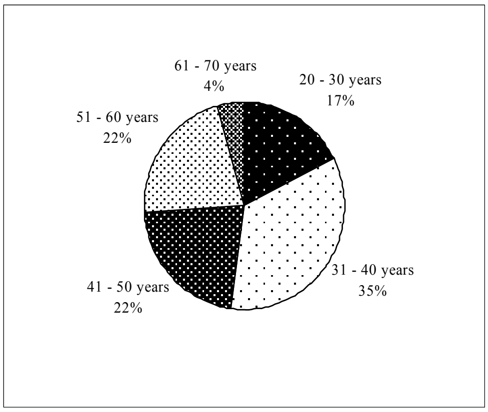
The community Santa Rosa de Dinamarca, located on the River Ucayali, has got about 750 inhabitants living in wooden houses. All households are located 30 to 45 minutes walk from the river band. Most of the land surrounding Santa Rosa de Dinamarca consists of active and fallow agriculture fields and a *purma* [secondary forest that has grown after a farm is left fallow Arce-Nazario (2007)]. Secondary forest is located 2 hours far by walk, but it become more far due to everydays’ logging.

5.2. Data collection methods and field techniques

Initial fieldwork for this study was completed from June to August 2007 in four communities described in Chapter 4.1. (San Francisco, Yarinacocha, Santa Teresita and Santa Rosa de Dinamarca).

We used a range of different data-collecting techniques but in general, more semi-structured interviews and participant observation techniques (Bernard, 1994; Spradley, 1990) were used to acquire information on cultural and social aspects. Much of our fieldwork, particularly during the first month, was conducted in informal contexts, largely involving participant observation. It was in the last months that we conducted more semi-structured interviews, collected plants, prepared dye samples and made voucher speciments. With time, as relationships deepened, communication became more effective.

Because not all asked Shipibos were interested in cooperation, we could not randomly select the participants. A total 23 respondents consented to participate in this study (Figure 6 and Figure 7).



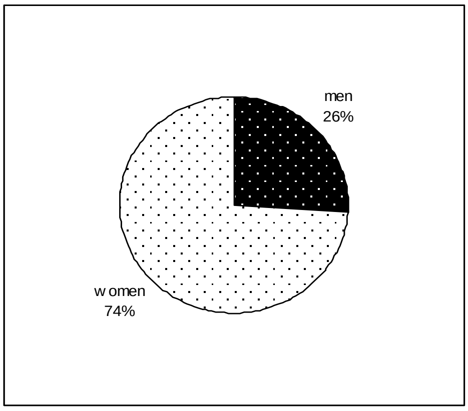


Figure 6. Age structure of respondents. **Figure 7.** Gender structure of respondents.

We conducted interviews in a broad range of settings, including in people's homes, fields, forests or travelling by river. All the interviews were performed in Spanish. Each respondent was visited at least twice. For the first time to answer the questions of the questionnaire consisted of 29 questions with subquestions for several of the main questions. The questionnaire consisted of four sections: 1) basic personal and demographic information, 2) knowledge of dyeing plants; respondents were also reminded to report all uses for each plant, 3) knowledge on traditional processing of natural dyes, dyeing techniques and traditional art, and 4) socioeconomic importance of dyeing with natural dyes. We took notes during all conversations. No information that was provided to us was left unrecordered (Estrada et al., 2007).

The entire survey took from 0.5 to 3 hours, depending on how many plants the respondent knew, where the plants were collected and how long took to prepare dyes if we did so. When each questionnaire was completed, the respondent was thanked for his/her participation. Based on a meeting with the villagers prior to the start of the interviews, it was decided that each respondent who participated would be compensated with a gift (2x2 m piece of cotton cloth for dyeing).

Every effort was made to make good quality fertile voucher specimen of every plant species discussed by informants (Alexiades, 1999). We made frequent field trips with our informants for *in situ* identification of plants the respondents mentioned in interviews and we collected plant samples for herbarium vouchers according to standard practice (Alexiades, 1996). Photo documentation of plants was made to support the determination of plant species. If possible, three samples were taken per plant species. Preference was given to flowering and fruiting plants, but it was not always possible due to the different physiological cycles of plants and limited time of three months for research. We have identified only genus in cases where the fertile samples were absent. We made preliminary identifications of specimens in the field. In case of *Arrabidaea* sp. the genus was identified directly on the field and no voucher speciment was collected. Collected plant samples were individually pressed between newspapers in a wooden press between cardboard sheets and dried. They were mounted on white paper of stansard size 42 x 29,7 cm, labeled and numbered. The collected plant material was authenticated in cooperation with M. Clavo. The vocher specimen collection was deposited in the Herbarium of The National University Ucayali in Pucallpa and it's duplicate in the Regional Herbarium of the Ucayali, Instituto Veterinario de Investigaciones Tropicales y de Altura, Universidad Nacional Mayor de San Marcos, Pucallpa.

6. Results and discussion

In this part, in order to contribute to the preservation of the traditional knowledge and uses of plants, we present an overview of the uses of dyeing plants collected by an ethnobotanic research carried out in the four villages of the Shipibo around Pucallpa in Peruvian Amazon (Ucayali region).

The data collected from the interviews show the dyeing properties of 18 plants (see Table 3), listed in alphabetical order and distributed among 14 families. For each species the vernacular name together with its taxonomic characteristics; plant part used; obtained colour and forms of preparation and application are listed. In comparison with other literature, Serrano and Tournon (1989) have identified 9 plant species used for their dyeing properties by Shipibo, among which 6 species correspond with those found in our investigation. Roquero (2002) has observed only 6 dyeing plant species; all are found also in our study.

Among new findings - not mentioned in the previous studies from Peruvian Amazon [Serrano and Tournon (1989) and Roquero (2002)] - are *Buchenavia* sp., *Brugmansia* sp., *Curcuma longa*, *Croton lechleri*, *Eleutherine bulbosa*, *Iryanthera* sp., *Simira* sp. and *Terminalia amazonia*. However, 3 species [*Renealmia thyrsoidea* (*Zingiberaceae*), *Scutellaria coccinea* (*Labiateae*) and *Trichilia elegans* (*Meliaceae*)] mentioned by Serrano and Tournon (1989) were perceived to have been absent in our present investigation.

Plant species that were used by Shipibo for dyeing their *cushmas* (traditional dresses) in the past when they were harvested in the land surrounding studied communities are listed in Table 4. Recently, these species are not used by Shipibo for dyeing their traditional clothes anymore due to the difficulty to obtain them from the nature. The area around communities already have had most of the natural vegetation cut down due to heavy logging and in addition to this, the reduced areas of natural vegetation are the last resources used by the local population for harvesting fuelwood.

During the present study, one endangered and endemic plant specie having natural dye-yielding properties was recorded. The specie *Swietenia macrophylla* is very scarce among the rich floral diversity of Peruvian Amazon.

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Table 3. Plant species used for preparation of natural dyes in Pucallpa surrounding.

Species (voucher specimen)	Vernacular name Shipibo/Peruvian	Family	Growth habit	Habitat	Plant part used	Colour	Other uses	N° of respondents
Arrabidaea sp.	Yonina/yonina	*Bignoniaceae*	Liane	Tropical lowland forest (Gentry, 1996).	Leaves	Ochre	Medicinal Ornamental	4
Bixa orellana L. (LAC030)	Joshin mashe/achiote	*Bixaceae*	Shrub	Lowland forest , mostly found in second growth or light gap (Gentry, 1996), generally under 1000 m, also widely cultivated (Roquero, 2005).	Seed	Red	Medicinal Ornamental Spice	7
Brugmansia sp. (LAC057)	Kanachiari/floripondio,toé	*Solanaceae*	Shrub	Grow in a moist, fertile, well-drained soil, in full sun to part shade, in frost-free climates (Egg, 1999).	Leaves	Light green	Medicinal Ornamental	1
Buchenavia sp. (LAC011)	Jonosh/yakushapana	*Combretaceae*	Tree	Terrestrial; primary vegetation, in argillaceous soils (Martínez, 1997), Abundant in seasonally inundated forests (Gentry, 1996).	Bark	Ochre	Medicinal Timber Fuel	12
Croton lechleri Mull.Arg. (LAC003)	Jimi mosho/sangre de grado	*Euphorbiacea*	Tree	Grows in somewhat dry areas, forming a part of secondary forests (Desmarchelier and Schaus , 2000). Terrestrial, argillaceous soils, mainly in depressions of streams, wild, nowadays cultivated (Martínez, 1997).	Resin	Dark red	Medicinal Ornamental Timber	2
Curcuma longa L. (LAC055)	Kunrrun/ guisador	*Zingiberaceae*	Herb	Distributed in *purmas* (secondary vegetation), nowadays cultivated (Pinedo et al., 1997).	Rhizome	Yellow	Medicinal Ornamental Spice	4

Table 3. Continued.

Species (voucher specimen)	Vernacular name Shipibo/Peruvian	Family	Growth habit	Habitat	Plant part used	Colour	Other uses	N° of respondents
Eleutherine bulbosa Urb. (LAC010)	Jasin huaste/yahuar piri piri, lágrimas de la virgen	*Iridaceae*	Herb	Grows in open fields; widely cultivated (Arévalo, 1994).	Bulb	Pink	Medicinal Ornamental	1
Genipa americana L. (LAC004)	Nane/huito	*Rubiaceae*	Tree	Grow in coastal lowlands, tropical and subtropical forest. Well drained soils as well as periodically flooded river banks (Desmarchelier and Schaus , 2000). Generally, altitude does not exceed 1000m. Also is cultivated (Roquero, 2002).	Fruit	Black	Medicinal Timber Food	5
Mangifera indica L. (LAC006)	Mancua/mango	*Anacardiaceae*	Tree	Tropical lowlands up to 915 m (Morton, 1987), with pronounced dry season (Gentry, 1996).	Bark	Ochre	Food	5
Iryanthera sp. (LAC005)	Jushin, campanpocoti	*Myristicaceae*	Tree	Common throughout the lowland, in dry or humid loam in dense forest (Williams, 1936).	Bark	Brown	Timber Charcoal	5
Persea americana Mill. (LAC056)	Paratai/palta	*Lauraceae*	Tree	Usually on disturbed soils (Egg, 1999).	Seed	Red	Food	1

Table 3. Continued

Species (voucher specimen)	Vernacular name Shipibo/Peruvian	Family	Growth habit	Habitat	Plant part used	Colour	Other uses	N° of respondents
Picramnia sp. (LAC027)	Amí/amí	*Simaroubaceae*	Shrub	Terrestrial, primary forest or flooded areas (Martínez, 1997).	Leaves	Purple	Medicinal Ornamental	3
Psidium sp. (LAC024)	Guayaba/bimpish	*Myrtaceae*	Tree	Lowlands periodically inundated (Martínez, 1997). Also is cultivated (Magness, 1971).	Bark	Ochre	Food	4
Simira sp. (LAC015)	Huacamayo caspi/huacamayo caspi	*Rubiaceae*	Shrub	Terrestrial, primary forest (Martínez, 1997).	Bark	Pink	Timber	1
Swietenia macrophylla King. (LAC016)	Huistiniti/caoba, acajou	*Meliaceae*	Tree	Perrenial tropical forest, humid lowlands or slopes, generally less then 500m (Roquero, 2005). Upper Amazon and its tributaries. Plantations have been established within its natural range and elsewhere (Desmarchelier and Schaus , 2000).	Bark	Brown	Timber	17
Terminalia amazonia (J.F.Gmell. Exell) (LAC012)	Yunshin, huisopocoti/yakushapana	*Combretaceae*	Tree	Terrestrial, primary forest, clay soils (Spichiger et al, 1990), altitudes between 20 and 1200 m with annual rainfall above 1500 mm, and commonly as a riparian (along the rivers and creeks) (Chudnoff, 1984).	Bark	Ochre	Timber	8

Table 3. Continued

Species (voucher specimen)	Vernacular name Shipibo/Peruvian	Family	Growth habit	Habitat	Plant part used	Colour	Other uses	N° of respondents
Terminalia catappa L. (LAC019)	Almendra/almendra, castanilla	*Combretaceae*	Tree	Tropical humid climates with annual rainfall generally 1000– 3500 mm; elevations below 300–400 m. Planted extensively throughout the tropics (Thomson and Evans, 2006).	Bark	Ochre	Medicinal Timber Shade tree	8
Terminalia oblonga (R.& P.)Steud. (LAC013)	Josho, yapapocoti/yakushapana	*Combretaceae*	Tree	Lowland areas, usually till 500 - 900m (Flores, 1994). Resides in poorly drained valley soils, along streamsides and flood plains (Nebel and Meilby, 2005).	Bark	Ochre	Timber Charcoal	5

Table 4. Species used in the past for dyeing traditional dress.

Botanical name	Vernacular name in Shipibo	Family	Plant part	Preparation	Material	Dye
Arrabidaea sp.	Yonina	*Bignoniaceae*	Leaf	Juice	Cotton	Ochre
Picramnia sp.	Ami	*Simaroubaceae*	Leaf	Juice	Cotton	Purple
Brugmansia sp.	Kanachiarri, toé	*Solanaceae*	Leaf	Juice	Cotton	Green
Simira sp.	Huacamayo caspi	*Rubiaceae*	Bark	Decoccion	Cotton	Pink
Eleutherine bulbosa Urb.	Jasin Huaste	*Iridaceae*	Bulb	Juice	Cotton	Pink

From the 14 plant families investigated, family *Combretaceae* is found to be dominant family with 4 species, followed by *Rubiaceae* with 2 species. The remaining 12 families are represented by only one species each (see Figure 8).

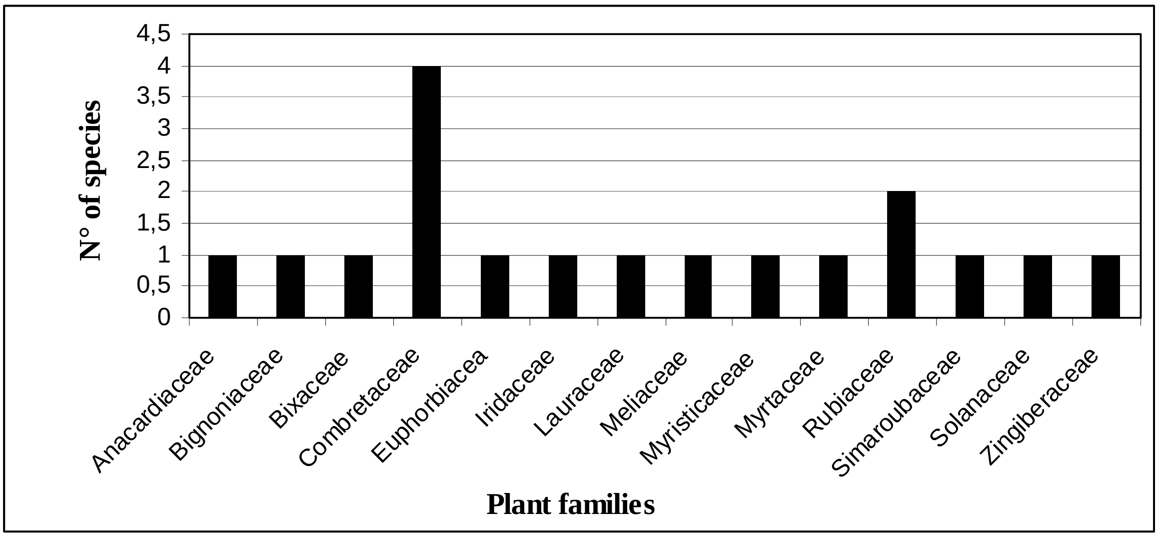


Figure 8. The numer of species according to families.

The species of great importance, those that are used with a higher number of informants (Figure 9), are *Swietenia macrophylla* (caoba), *Buchenavia sp.* (jonosh), *Terminalia amazonia* (yunshin), *Terminalia catappa* (almendra) and *Bixa orellana* (achiote), all of which are readily accesible within the region as they grow wild, they are cultivated or they are bought in market.

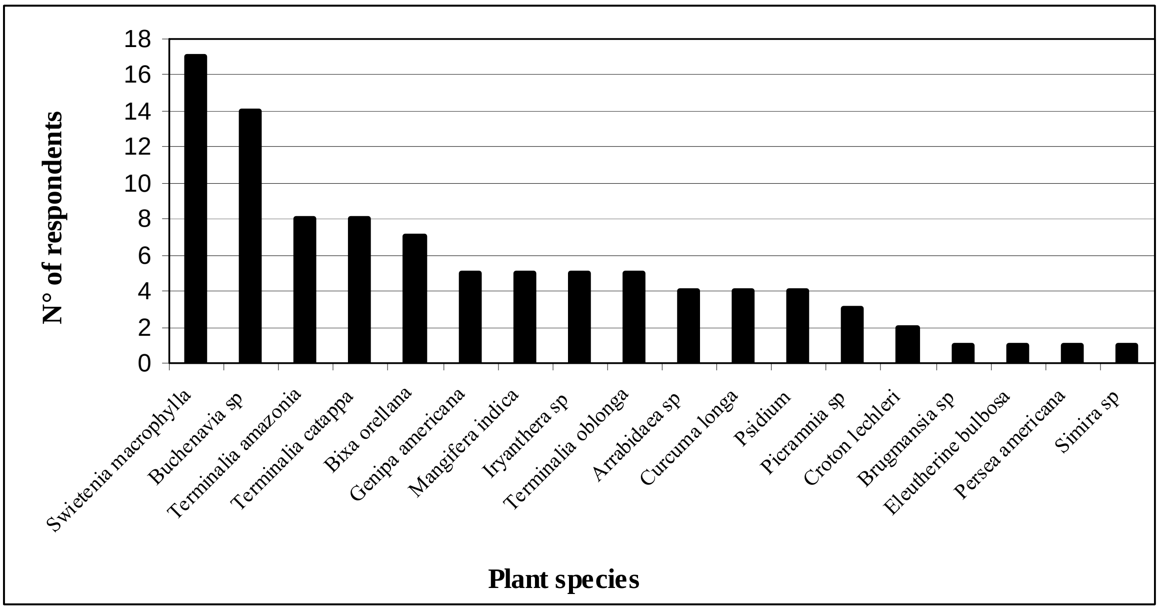


Figure 9. Number of respondents (n=23) who mentioned each species for use for its dyeing properties.

Figure 10 shows the data about where the plants are obtained; if they are collected in the wild site, bought or if they are cultivated on the field. There have been found that most of plants are collected from wild site. Only a few species are cultivated; they are those species with a multipurpose use. *Curcuma longa*, also used for its medicinal properties, as a spice and for its ornamental purposes; *Bixa orellana* used as food seasoning, food colorant and for its medicinal properties; *Psidium* sp. like fruit tree; *Genipa americana* is both medicinal and fruit tree; *Terminalia catappa* is widely used as shade and ornamental tree; *Persea americana* has got medicinal properties and bears tasty fruits; and both *Brugmansia* sp. and *Eleuterine bulbosa* are cultivated for their ornamental and mainly medicinal properties; all are found in the fields of not only our respondents.

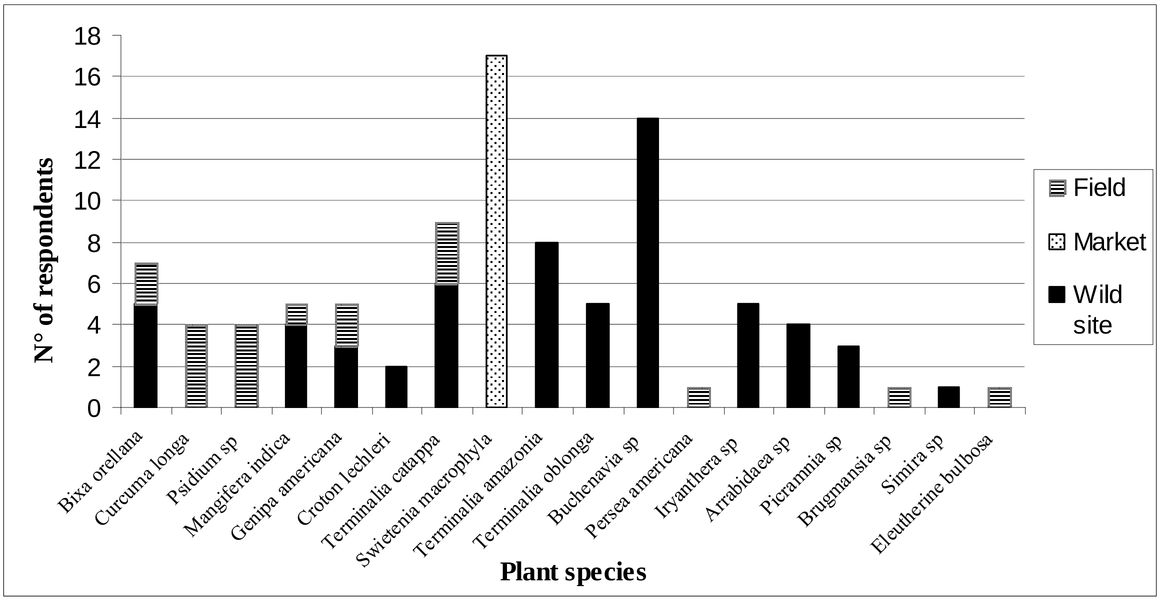
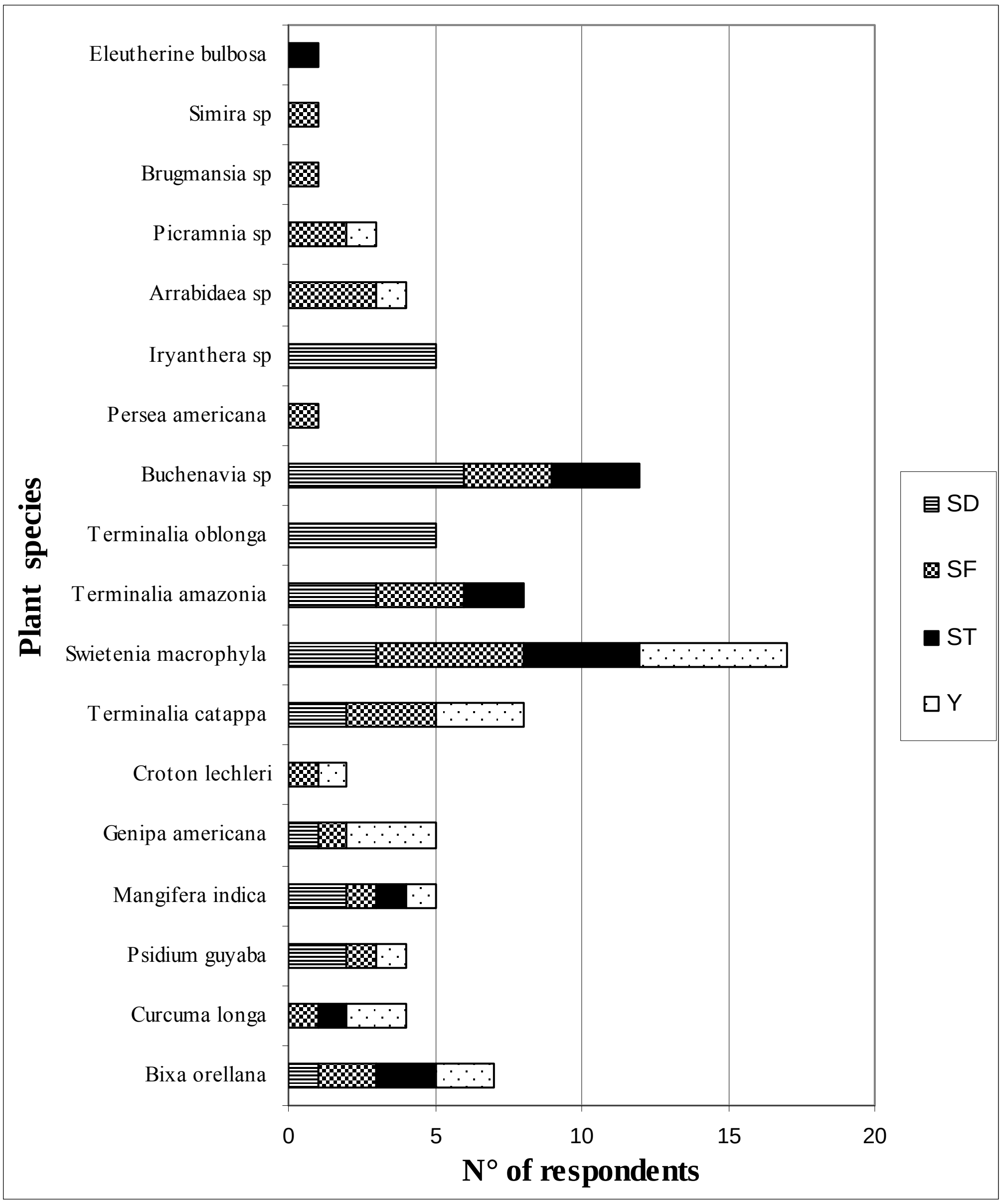


Figure 10. Acquisition sources of dye yielding plant material.

When comparing total number of individually reported plant species reported for each village, there was a little difference among the four villages studied. From 18 plant species investigated, there was found 83% in San Francisco, 56% in Santa Rosa de Dinamarca, 56% in Yarinacocha and 39% in Santa Teresita.

Species *Bixa orellana*, *Mangifera indica* and *Swietenia macrophylla* were refered to be used in all villages studied. Species *Simira* sp., *Brugmansia* sp. and *Persea americana* are used only in the village San Francisco; while *Eleutherina bulbosa* was mentioned only in the village of Yarinacocha. There are two species, *Iryanthera* sp. and *Terminalia oblonga,* that were reported only in Santa Rosa de Dinamarca. *Iryanthera* sp. occure in pristine vegetation 3 hours far by foot from the village and it is getting scarce as rapid as the logging companies carry on the cutting of valuable timber from the forest.



SD-Santa Rosa de Dinamarca; SF-San Francisco; ST-Santa Teresita; Y-Yarinacocha

Figure 11. Plant species use frequency among the studied communities.

Various plant parts, i.e. bark (*Swietenia macrophylla*, *Terminalia catappa*), leaves (*Brugmansia sp*.), fruits (*Genipa americana*), seeds (*Bixa orellana*), bulb (*Eleutherine bulbosa*), rhizome (*Curcuma longa*) and resin (*Croton lechleri*) of the recorded species (Figure 12) were found to be used traditionally by the Shipibo for extracting dyes utilizing indigenous extraction techniques. The uses relate to the dyeing cotton materials, however the results document some dyeing customs concerning the cosmetic (hair dye, body paints) and food sectors (food colorants).

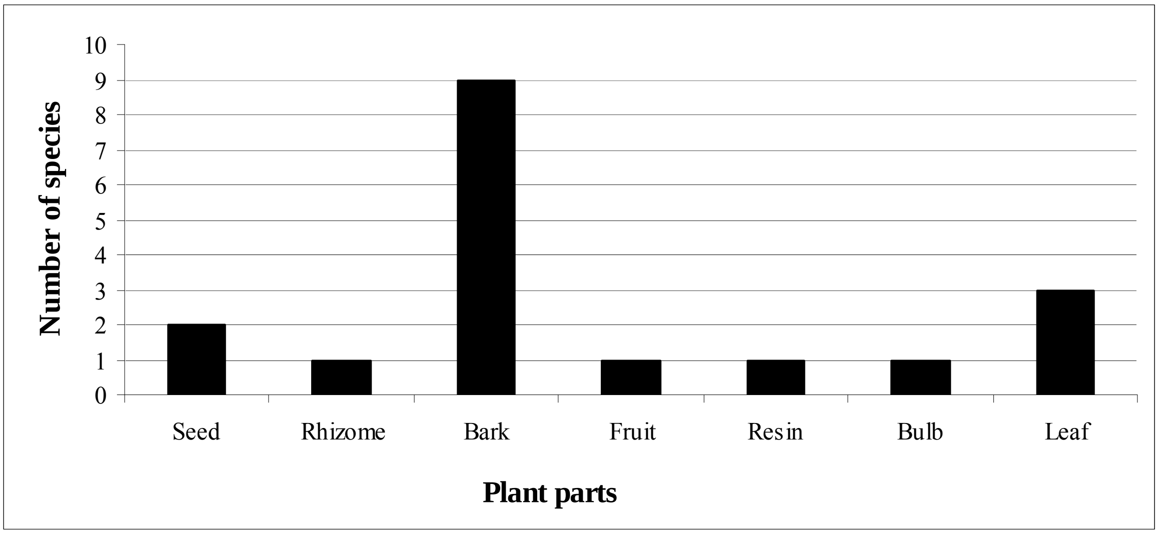


Figure 12. Representation of plant parts used for dyes preparation.

According to our study, 8 different colours are obtained from the reported plants, but a broad variation in shade and color depth can be achieved by applying mixtures of natural dyes in various combinations. It was identified that the colours obtained from the number of species are as follows: black from 1 species, brown 8 species, green 1 species, purple 1 species, pink 2 species, red 3 species, yellow from 1 species and ochre from 7 species. There is no evidence about any plant species that yields blue dye among the villages studied.

In agreement with de Mayolo (1989), black dye is obtained from the fruits of *Genipa americana*. However, we have found that black colour is also obtained when the cotton cloth painted with tannin dye is treated with special mud with high content of feruginous and aluminous ions. This tannin dye is obtained by decoction of barks from species of *Buchenavia* sp., *Mangifera indica*, *Psidium* sp., *Terminalia oblonga*, *Terminalia amazonia*, *Terminalia catappa* and sometimes *Swietenia macrophylla*. We have observed two kinds of special mud that Shipibo widely use in their traditional dyeing techniques as described in Chapter 6.1. The most used dye in the Shipibo handicraft is brown obtained from *Iryanthera* sp. and *Swietenia macrophylla* directly, or by their mixture with different plants. Through this, the various shades of brown are obtained. Green colour is obtained from the leaves of *Brugmansia* sp., or can be prepared by mixing of yellow (*Curcuma longa*) and black (*Genipa americana*) in a different ratio. Purple dye is extracted from *Picramnia* sp., pink from *Simira* sp. and *Eleuterine bulbosa*. Red colours provide species

Bixa orellana, *Persea americana* and *Croton lechleri*; yellow is extracted from *Curcuma longa* as was mentioned above, and ochre from *Arrabidaea* sp., *Mangifera indica*, *Psidium* sp., *Buchenavia* sp., *Terminalia amazonia*, *Terminalia catappa* and *Terminalia oblonga.*

6.1. Methods of dyes preparation and their use

Little is known about methods utilized by Shipibo to produce dyes and how the dyes are applied. Description of methods of extracting the dye from each specie is decribed in Table 5.

Dyes from leaves of *Brugmansia* sp., *Picramnia* sp. and *Arrabidea* sp. are prepared by crushing the leaves with small amount of water, strained through a sieve and immediatelly used for painting. The dye in this condition can be preserved 3-4 months without any change of dyeing properties.

Immature fruits of *Genipa americana* are cut in halves and the flesh with seeds (it changes from a clear to blue-black colour when exposed to air) are removed and are put into the pot with a little amount of water (seeds from 4 fruits are mixed with 150 ml of fresh water). The mixture is left to boil on the open fire untill the water boil away (about 30 minutes). Then the pot is removed from fire and covered with lid. The mixture in the pot is left at least 2 hours undisturbed and at the end the liquid is filtered through a piece of thin cloth. The thick black liquid obtained can be directly used or stored. Some respondents boil the mixture in slightly different way. We observed one women add to this mixture juice from 2 ripe lemons, while another add the rotten fruit of *Genipa americana* after the pot is removed from the fire. In most cases this dye is obtained by cooking the flesh with seeds without additional plants and substances. The photo documentation of the dye preparation is illustrated in appendix. This dye is widely used among Shipibo women as a hair dye; it is also used for body paints. In the study of de Mayolo (1989) was noted that the fruits of *Genipa americana* are placed in banana leaves, roasted over a low fire, and then rubbed on cloth or used as a body paint.

There is a difference in preparing dyes from seeds of *Bixa orellana* in different studies. In references of de Mayolo (1989) and Roquero (2002) the seeds are ground to a powder and mixed with animal fat and water to concoct a paint, which can be dehydrated and stored in small cakes. While in the investigation of Mahanta and Tiwari (2005), the seeds are crushed and put in a pot to which little water is added, the pot is kept undisturbed for 20-25 days during which period the content of the pot get fermented. The fermented content is then boiled to get a thick liquid and the extract is filtered through a piece of cloth to yield the dye. We have observed that Shipibo prepare this dye by abrasion of the outer layer of seeds in small amount of water; the mixture is strained through a sieve and the dye obtained can be directly used for body paints and painting. This dye is suitable for 3-4 months of storage. The possible fermentation does not influence properties of the dye. Three respondents add this dye into the decoction from bark of *Swietenia macrophylla* in ratio 1:5. Through this, the brown-red dye is obtained and used for dyeing cotton clothes. The dried seeds are used by Shipibo as a food colorant for rice and meat dishes. The use of seeds of *Bixa orellana* as a food colorant is worldwide (Giuliano et al., 2003; Delgado-Vargas and Paredes-López, 2002; Hancock, 1997; Wickens, 2001; Roquero, 2002; Adrosko, 1968; Čopíková et al., 2005). According to Green (1995) Peru exports added value extracts of *Bixa orellana* to the west for use in colouring hard cheeses, butter, other dairy products, salad dressings, confectionery, bakery products, ice creams, beverages, snacks etc.

Dark, red-brown resin from bark and sapwood of *Croton lechleri* is a source for red dye. Resin is caught early in the morning or in late evening into the calabash and used immediately without any other processing. Dye can be stored up to 3 month, possible fermentation does not influence properties of the dye.

Dyes from barks are prepared by decoction without adding any other substaces. The amount of plant material and water used depend on the amount of cotton cloth to be dyed; the state of the bark (fresh or dry); the time of the year when plant material is collected; the age of the tree from which the bark is collected. The fresh or dried bark is placed into the dyepot with stream water (the ratio of the fresh bark and water varies from 1:3 to 1:5), soaked for at least half an hour and than boiled untill the dye is more dense and fluorescent. Time of boiling depends on the amount of plant material, water used and size of the pot in which the dye is boiled. The decoction obtained is then sieved through to get the dye liquor, discarding the bark. There are some differences in the traditional dyeing methods where the great versatility of tannins in dyes from barks is used. The present study coincide with that stated previously by Serrano and Tournon (1989) in which the use of special mud is mentioned. We have found that Shipibo widely use 2 kinds of mud with high content of aluminous and feruginous ions to turn their paintings black. The use of ferruginous mud was observed also in studies of Roquero (2002) in Amazonia and de Mayolo (1989) in Andes. Some modalities that have been practiced in dyeing with tannin dyes made of barks are described below.

- Brown and ochre clothes: the material (cotton cloth) to be dyed is subsequently soaked in the warm dye prepared from barks of one or various tree species. The number of soaking depend on the color depth that is desired. After each soaking the cotton cloth is overspread onto the grass, so the top part exposed to sun gets darker shade because of tannins contained in the dye. The cloth is left one day before the new dyeing is repeated. Usually, the clothes are soaked in the dye not more than 6 times and not less than 4 times.
- The black paintings on brown clothes: traditional ornaments are painted on the cotton cloth that is previously dyed for the colour required (as described above). Shipibo use the mixture of special mud with a little water added for painting the unique ornaments. Paintings are contoured twice with the same mud. After, the painted cloth is exposed to the sun and left for 10-15 minutes to dry. At the end, this painted cotton cloth is washed in the fresh water, rinsed and dried. The reaction of ferruginous and aluminous ions contained in the mud with tannins contained in the dyed clothes cause that the drawings turn to black [(also see Roquero (2002) and Serrano and Tournon (1989)].
- The black paintings on white cotton cloth: fresh or dry barks from different kind of species (*Mangifera indica*, *Psidium* sp., *Buchenavia* sp., *Terminalia amazonia*, *Terminalia catappa* and *Terminalia oblonga* combined together almost in equal parts by weight are used for preparation of dye. The dye is prepared in the same way as mentioned above. The spiritual ornaments are painted on white cotton cloth with the prepared dye and the ornaments are two times contoured. The same kind of mud is poured over the dried cloth and it is exposed to sun for 10-15 minutes. The paintings turn black while the cloth remain white.

Those special ornaments depicting their cosmology based on one plant called "piri-piri", which juice from rhizomes they drop into the eyes of young Shipibo girls. This juice cause dreams about sophisticated designs and geometric patterns that are quite unique. In agreement with Tournon (2002) and Cairuna (2003), there are many theories about the meaning of the unique intricate Shipibo geometric patterns. We were informed that the patterns represent the shapes of the Anaconda.

Table 5. Preparation of dyes from the identified plant species.

Species	Part used	Way of use	Used for	Colour	Description of dye preparation	N° of dye application
Arrabidaea sp.	Leaf	Juice	Painting on cotton material. Hair dye.	Ochre	Leaves are crushed with small amount of fresh water; mixture is filtered through a piece of thin cloth to yield dye. Used immediately.	2-3 times. 1-2 times contoured in case of painting.
Bixa orellana L.	Seed	Macerate	Dyeing cotton material. Painting. Body paints. Colouring food.	Red	Dye obtained by abrasion of the outer layer of seeds in small amount of water. Can be store for 4-5 months. No mordant is used.	4-5 times dyed. 1-2 times contoured in the case of painting.
Brugmansia sp.	Leaf	Juice	Painting on cotton material.	Light green	Leaves are crushed with small amount of fresh water; mixture is filtered to yield dye. No mordant is used. Used immediately for painting.	1-2 times contoured.
Buchenavia sp.	Bark	Decoction	Dyeing cotton material. Painting on white cotton cloth.	Ochre	Dry or fresh bark is placed in a dye pot with stream water, soaked for 0,5-2h and then boiled till the dye is more dense and fluorescent. The spiritual ornaments are painted on white cotton cloth. On to the dried cloth, the special mud is poured over, exposed to sun for 10 minutes and then washed. Due to oxidation, the paintings turn black.	1-2 times the ornaments are contoured.
Croton lechleri Mull.Arg.	Resin	Resin	Painting on cotton material.	Dark red	Resin is cough into the calabash or jar early in the morning or in late evening. No mordant is used. Used immediately.	1-2 times contoured.
Curcuma longa L.	Rhizome	Juice	Painting on cotton material. Colouring food.	Yellow	Fresh rhizome is scraped on the tongue from *paiche* (fish *Arapaima gigas*), filtered through a piece of thin cloth. No mordant is used.	1-2 times contoured.

Table 5. Continued

Species	Part used	Way of use	Used for	Colour	Description of dye preparation	N° of dye application
Eleutherine bulbosa (Mill.)	Bulb	Juice	Painting on cotton material.	Pink	Juice is squeezed out and the dye liquid is used immediately. No mordant is used.	1-2 times contoured.
Genipa americana L.	Fruit	Decoction	Painting on cotton material. Hair dye.	Black	Seeds with flesh from immature fruits are boiled in water (4 fruits : 100 ml water) until the water evaporate; then it is left covered for 2 hours. Thick mixture is filtered through a piece of thin cloth. No mordant is used.	1-2 times contoured.
Iryanthera sp.	Bark	Decoction	Dyeing cotton material.	Brown	Dry or fresh bark is placed in a pot with stream water, soaked for 0,5-2h and then boiled till the dye is more dense and fluorescent. The material to be dyed is subsequently immersed in the dye and overspread on to the grass where it is left to dry.	4-6 times
Mangifera indica L.	Bark	Decoction	Dyeing. Painting on white cotton clothes.	Ochre	Used only in combination with other plant species. Dry or fresh bark is soaked in water for 0,5-2h and then boiled till the dye is more dense and fluorescent. The spiritual ornaments are painted on white cotton cloth; when dried the special mud is poured over and cloth is left to dry on the sun. After 10 minutes, the mud is washed and paintings turn black because of oxidation of mud and tannin dye.	1-2 times contoured.
Persea americana Mill.	Seed	Juice	Painting on cotton material..	Red	The seeds are crushed with a small amount of water, mixture is squeezed, strained through and the dye obtained is immediately used. No mordant used.	1-2 times contoured.
Picramnia sp.	Leaves	Juice	Dyeing cotton material. Painting.	Purple	Leaves are crushed with small amount of fresh water; mixture is filtered to yield dye. Used immediately. No mordant is used.	1-2 times contoured.

Table 5. Continued

Species	Part used	Way of use	Used for	Colour	Description of dye preparation	N° of dye application
Psidium sp.	Bark	Decoction	Dyeing cotton material. Painting on white cotton cloth.	Ochre	Used only in combination with other plant species. Dry or fresh bark is soaked in water for 0,5-2h and then boiled till the dye is more dense and fluorescent. The spiritual ornaments are painted on to white cotton cloth. Then the special mud is poured over and the cloth is left to dry on the sun. The mud is washed after 10 minutes and the paintings turn black because of oxidation of mud and tannin dye.	1-2 times contoured.
Simira sp.	Bark	Decoction	Painting on cotton material.	Pink	Dry or fresh bark is soaked in water for 0,5-2h and then boiled till the dye is very dense.	1-2 times contoured in painting.
Swietenia macrophylla King.	Bark	Decoction	Dyeing cotton material. Painting on cotton material.	Brown	Dry or fresh bark is soaked in water for 0,5-2h and then boiled till the dye is dense and fluorescent. The material to be dyed is subsequently immersed in the dye mixture and overspread on to the grass where it is left to dry. For painting the dye is prepared very dense.	4-6 times in the case of dyeing. 1-2 times contoured in painting.
Terminalia amazonia (J.F.Gmell. Exell)	Bark	Decoction	Dyeing cotton material. Painting on white cotton cloth.	Ochre	Dry or fresh bark is placed in a pot with stream water, soaked for 0,5-2h and then boiled till the dye is more dense and fluorescent. The spiritual ornaments are painted on white cotton cloth. On to the dried cloth the special mud is poured over and cloth is exposed to sun. The mud is washed after 10 minutes and the paintings turn black.	1-2 times contoured

Table 5. Continued

Species	Part used	Way of use	Used for	Colour	Description of dye preparation	N° of dye application
Terminalia catappa L.	Bark	Decoction	Dyeing cotton material. Painting on white cotton cloth.	Ochre	Dry or fresh bark is placed in a pot with stream water, soaked for 0,5-2h and then boiled till the dye is more dense and fluorescent. The spiritual ornaments are painted on white cotton cloth. On to the dried cloth, the special mud is poured over and cloth is exposed to sun. The mud is washed up after 10 minutes and the paintings turn black.	1-2 times contoured
Terminalia oblonga (R.& P.)Steud.	Bark	Decoction	Dyeing cotton material. Painting on white cotton cloth.	Ochre	Dry or fresh bark is placed in a pot with stream water, soaked for 0,5-2h and then boiled till the dye is more dense and fluorescent. The spiritual ornaments are painted on white citron cloth. On to the dried cloth the special mud is poured over and cloth is exposed to sun. The mud is washed up after 10 minutes and the paintings turn black because of oxidation of ferruginous mud and tannin dye.	1-2 times contoured

6.2. Description of plants used for dyeing purposes

Bixaceae

Bixa orellana L.

Small to large trees, leaves are ovate or oblong-ovate with entire margins, a palmately 5-veined truncate to broadly subcordate base, and a long slender petiole with a distinct but short pulvinus at its apex. The stellate trichomes are absent (Gentry, 1996). The inner bark is distinctly yellow, the twigs also contain a trace of reddish-orange latex. The rather large 5-petaled white to pink flowers have numerous yellow stamens with free filaments. The fruit is two-valved capsule, the seed covered by orange-red aril. Inflorescence with large whitish pink or pink flowers. The fruit is an ovoid capsule, 4cm long, brown coloured, covered with soft, reddish spines; with several small seeds covered by red or orange coloured pulp (Gentry, 1996).

Meliaceae

Swietenia macrophylla King.

They are medium-sized to large trees growing to 20-45 m tall, and up to 2 m trunk diameter. The leaves are 10-30 cm long, pinnate, with 3-6 pairs of leaflets, the terminal leaflet absent; each leaflet is 5-15 cm long. The leaves are deciduous to semi-evergreen, falling shortly before the new foliage grows. The flowers are produced in loose inflorescences, each flower small, with five white to greenish-yellowish petals. The fruit is a pear-shaped five-valved capsule 8-20 cm long, containing numerous winged seeds about 5-9 cm long (Desmarchelier and Schaus, 2000).

Rubiaceae

Genipa americana L.

Canopy trees. Large obovate leave (drying black in commone species); stipules triangular and subfoliaceous, thicker at base. Very characteristic thick cream to tannish-yellow corolla with the tube at least 1 cm long and the anthers inserted between the bases of the corolla lobes. Fruit large (4-9 cm), round, glabrous, oxidizes blue-black when cut and stains skin the same color (Gentry, 1996). The pulp of mature fruit is juicy, bittersweet with specific aroma and taste. The seeds are numerous (ca. 300) (Encarnación, 1983).

Euphorbiaceae

Croton lechleri Mull. Arg.

An extremely large tree. Although tall, the trunk is usually around 25 cm in diameter and is covered by smooth, mottled bark (Encarnación, 1983). It has large, bright-green, 3-veined leaves, either serrate or entire but always with stellate or peltate trichomes, and a capsular 3-parted fruit. Latex is conspicuously red (Gentry, 1996).

Combretaceae

Terminalia catappa L.

Pagoda-shaped tree with spreading, coarse-leafed crown. growing to 25-30m. Bark is grey, fissured, flaky but not ridged. Large and simple leaves, flowers are small, greenish-white in short elongated clusters, appearing on upper leaf axils. Described as having a foetid smell. The 1-9 flowers on the tip are female, the rest male, or the whole spike male, fruits has got almond-shape, green turning brown fibrous shell surrounding an edible nut (Thomson and Evans, 2006).

Terminalia amazonia (J.F.Gmell. Exell)

Trees up to 35 m, bark is thin (1 cm), dull, and grayish brown or grayish yellow and has shallow vertical fissures, it exfoliates medium-sized flecking plates. Leaves are petiolate, simple or obovate, with entire margin, are slightly pubescent, 4,5-11 x 2,5-6 cm large. The inflorescences are racemes bearing numerous hermaphroditic flowers 15 cm long. Fruit ripening occurs from February through May; fruit is a five-winged samara (Flores, 1994).

Terminalia oblonga (R.& P.) Steud.

Occasional evergreen (or briefly deciduous) canopy tree (30-35m), clad in extremely smooth, pale-orange or tan bark that often exfoliates in paper-thin sheets. Large, thin, and planar buttress roots are always present, merging with the bole at a height of about one meter. Leaves (14 by 9 cm) are smooth, light green, simple and alternate: they are arranged in whorl-like clusters around the tips of the twigs. Flowers are borne in axillary racemes that emerge just before the foliage. Each long and string-like raceme (15 cm) contains about 55 minute (3 mm in diameter) petalless, green flowers. Fruits mature as double-winged, flat and papery brown samaras containing a single, elliptical seed in the center (3 cm by 1.5 cm) (Flores, 1994).

Buchenavia sp.

An emergent deciduous canopy tree, naturally spread throughout neotropical forests from 23° N to 23° S. Fruits are one-seeded yellow drupes, usually starts fruiting at the end of the rainy season. Fruiting is not synchronic among trees and lasts *ca*. three months. Unconsumed fruits are naturally dropped beneath the parents thereby producing immense “seed shadows” on the ground (Santos et al, 2006).

Myrtaceae

Psidium sp.

A small tree to 10 m high, with smooth, thin, copper-colored bark that flakes off, showing the greenish layer beneath. The leaves are entire and typically have close-together strongly parallel secondary and intersecondary veins. Inflorescence dichasially branched or reduced to single pedicelate flowers; flowers 5-merous (Gentry, 1996). The fruit, exuding a strong, sweet, musky odor when ripe, ovoid, or pear-shaped, the flesh contain numerous, hard, yellowish seeds (Encarnación, 1983).

Zingiberaceae

Curcuma longa L.

Perennial plant that grows 1 to 1,5 m high with large oblong leaves, yellow white sterile flowers appear on a spike like the stalk. The lamina is green above and pale green below, and is 30 -40 cm long and 8 -12 cm wide. Approximately 30 flowers are produced in a spike. Inflorescence is a central spike of 10 -15 cm in length (Araújo and Leon, 2001).

Myristicaceae

Iryanthera sp.

The second most important genus in Amazonia. Vegetatively distinct in the malpighiaceous trichomes. Typically the leaves are strikingly coriaceous, glabrous-appearing and narrowly oblong with close-together prominent brochidodromous secondary veins. The flowers are mostly cauliflorous or ramiflorous, the inflorescences usually densely racemose. The distinctive fruits are broader than long (Gentry, 1996).

Bignoniacea

Arrabidea sp.

Opposite-leaved liana with a small narrow-tubed white flowers. Fruits are dehiscent and with winged seeds (Gentry, 1996).

Simaroubaceae

Picramnia sp.

Shrub to small trees, very characteristic vegetatively in the alternate assymetrically ovate leaflets with cylindrical legumelike pulvinuli. Frequently lacks bitter taste. Inflorescence very characteristic, a pendent spike or raceme of inconspicuous unisexual flowers, producing small elllipsoid 1(-2)-seeded red, orange, or black berries (Gentry, 1996).

Solanaceae

Brugmansia sp.

Very characteristic, small, shrubby cloudforest trees with large thin leaves, huge pendent flowers (> 15 cm long), ting irregularly or subspathaceously (Gentry, 1996). Flowers are 20-25 cm long, the corolla generally white, pink or yellow is a funnel-shaped (Valíček, 2002) and constricted at the point of emergence from the calyx so as to leave a space. Fruit not spiny, a woody-fleshy, indehiscent “capsule” (Gentry, 1996).

Rubiaceae

Simira sp.

Midcanopy to canopy trees, especially common in dry forest. Unique in wood of some species (including centers of twigs) turning pinkish or red-violet when exposed to air. Vegetatively distinctive in long, narrowly triangular terminal stipule and usually truncate leaf bases; rather large leaves with many secondary veins. Fruit large, round, usually splitting into 4 valves, the seeds winged, horizontally stacked into fruit (Gentry, 1996).

Iridaceae

Eleutherine bulbosa Urb.

Low growing (50 cm) bulbous plant with pleated lanceolate leaves and small, white, evening-blooming flowers. A large foliage leaf insertedb at the apex of the vegetative part of the stem; and dark red, rather than brown, bulb scales (Goldblattand and Snow, 1991).

Lauraceae

Persea americana Mill.

Trees with dense and round treetop, about 20m tall. Leaves are oval, entire, alternate and coriaceous, 10-20 cm long, inflorescence is paniculate. Fruit is berry with pear shape of various colors from shiny green to grayish green and purple, containing single brown, globular seed (Valíček, 2002).

Anacardiaceae

Mangifera indica L.

Tall tree, leaves are aromatic and narrower and more acuminate than in simple leaved native species; are alternate, simple, 15-35 cm long and 6-16 cm broad, dark green as they mature. Flowers are produced in terminal panicles 10-40 cm long (Martínez, 1997); each flower is is small and white with five petals, with a mild sweet fragrance. The large fleshy single seeded fruits ripe three to six months after flowering. Ripe fruits vary in color from yellow, orange to red (Egg, 1999)

6.3. Socioeconomic aspects of using natural dyes among Shipibo

Dyeing comes from traditional knowledge that has been collected and transferred from generation to generation (Gomez-Belos, 2002). At present, many Shipibo in each community almost nation wide possess knowledge, skill, equipment, and raw material for dyeing their clothes and handicraft. Local dyeing has the flexibility to develop into various products, for instance, clothes, furniture decorations, ceramics etc. Women are the real keepers of this indigenous knowledge on harvesting wild plants, preparing natural dyes and dyeing (Modesto and Niessen, 2001; Mahanta and Tiwari, 2005; Guarrera, 2006; Boytner et al. 2002).

The increasing of tourism, construction of road network, better education, and also invasion of modern supply systems and outside products and correspondingly, knowledge of synthetic dyes was also brought in and slowly the indigenous natural dyes are being replaced by synthetic dyes, especially among the new generation. In agreement with Guarrera (2006) and Mahanta and Tiwari (2005), the choice of multiple colors, easy availability, and lesser time taken in preparing these dyes have made synthetic dyes more popular. In all communities studied, Shipibo have started to use synthetic dyes for dyeing all kinds of handicrafts. Only for cotton they keep on dyeing with natural colors because cotton clothes dyed with natural dyes are more valuable and desired among customers. During our investigation only one respondent refered to use synthetic black dye for painting the traditional ornaments on cotton cloth. This black dye was purchased from Pucallpa market.

In agreement with Putsche (2000) and Pimentel et al. (2004), the natural dyed products as dresses, tea-clothes, bed-clothes, ceramics and other handicrafts are the main source of income for the most Shipibo womens, especially in the places where agriculture is not the main source of income, eg. in the community in Yarinacocha and in few families in San Francisco and Santa Teresita. In community of Santa Rosa de Dinamarca the natural dyed products are an extra source of income because they do not have much posibilities to travel to sell own products in the city's markets; they live far away and transfer is expensive.

The sale of textile products can be generated not only domestically but also for export, as was also mentioned in the study of Modesto and Niessen (2001). Producing of natural dyes is economically cheap, the only expenses for this work are costs of the bark of *Swietenia macrophylla* and cotton cloth. One sac of bark (5 kg) costs 20-25 soles (7,7 – 9,7 USD) and 1m^2 of cotton cloth costs from 7 to 15 soles (2,7 to 5,8 USD), prices depend on the thickness of cloth and on the places where are sold. The prices are higher in the city than in villages. For example, 1m^2 of thin cotton cloth costs 7 soles (2,7 USD) in Yarinacocha, while the same size of cloth costs 10 soles (3,3 USD) in Pucallpa. The other expenses can be for yarn for needlework in case of needled dress, skirt, table-cloth, tea-cloth, counterpane or shawl.

The prices of dyed cotton clothes depend on their size, dyed techniques used and if they are decorated with needlework. For example, price of the tea-cloth of 30x30 cm needled with special Shipibo ornaments vary between 20 and 40 soles (7,3 to 13,3 USD); natural dyed and needled skirt costs from 100 to 150 soles (33,5 to 50 USD); the same price is for bed-clothes of 150x200 cm painted with their unique symbols. Various kinds of dyed bags are also desired; the prices varies from 30 to 80 soles (10 to 27 USD), depends on the size and style. The higher prices are in the city market and usually foreign tourists pay much more higher price than domestic tourists.

The products are usually sold in the traditional tourist markets that are in each community or Shipibo. Womens, sometimes with their children, travel to Pucallpa city or Yarinacocha village to sell hand made and natural-dyed products on the street. However, they are occasionally distributed through small shops in Pucallpa. Some women also travel around the most touristic places all over the Peru (Iquitos, Cuzko, Arequipa, Puno, Lima) to sell their products there. Natural dyed products are very well accepted by domestic tourist, but foreign tourists are the main customers. Only one respondent noticed that sends own products to Lima and to United States.

7. Conclusions

Natural dyes are an integral, essential, and culturally important part of the life and subsistence strategies of the Shipibo; the use of natural dyes to colour textiles and other crafts has a long history in Shipibo communities. Naturally dyed and painted cotton clothes become the main source of income for the most Shipibo womens, especially in the places where agriculture is not the main source of income.

A literature and field survey was conducted to document and preserve traditional ethnobotanical knowledge on dye-yielding plant species used by the Shipibo in four villages around Pucallpa in Peruvian Amazon (Ucayali Department, Peru).

We have identified 18 plant species from 14 families as sources of natural dyes, among which *Swietenia macrophylla* (*Meliaceae*), *Buchenavia sp.* (*Combretaceae*), *Terminalia amazonia* (*Combretaceae*), *Terminalia catappa* (*Combretaceae*) and *Bixa orellana* (*Bixaceae*) are mentioned as the most frequently used for traditional dye preparation. When comparing total number of individually reported plant species responded for each village, there was a little difference among the four villages studied. 15 plant species were refered to be used in village San Francisco, 10 in Yarinacocha, 10 in Santa Rosa de Dinamarca and 7 species in Santa Teresita.

Apart from dyeing cotton clothes, the colours obtained from the natural dyes could also be used as watercolours on paintings by making them thicker; as well as using them for their use as food colourants (*Bixa orellana*, *Curcuma longa*), hair dyes (*Genipa americana*) or body paints (*Bixa orellana*, *Genipa americana*).

We have found that most species were refered to various purposes, mainly for the traditional medicine (*Croton lechleri*, *Eleutherine bulbosa*, *Genipa americana*, *Bixa orellana, Curcuma longa, Terminalia catappa*), food (e.g. *Genipa americana*, *Psidium* sp.) or for timber and wood-cuttings (e.g. *Swietenia macrophylla*, *Terminalia catappa*, *Terminalia oblonga*, *Simira* sp.).

Currently in some villages, due to the cheapness and the ease of application, local artists have slowly started to use synthetic dyes. However, it is well known that authentically and from the quality point of view cotton clothes dyed with natural dyes are more valuable and the buyers pay higher prices. In agreement with Putsche (2000) and

Pimentel et al. (2004), the natural dyed products become the main source of income for the most Shipibo, especially in the places where the income from agriculture is decreasing.

Peruvian Amazon, with its diverse flora, is a storehouse of not only economically important plants, particularly the natural dye-yielding species. There is a large plant resource base, but too little is exploited. Therefore, more detailed investigations on dyeing plants for identification purpose and the use of them by Shipibos should be encouraged.

The traditional ethnobotanical knowledge of indigenous people is being lost at a greater rate than in the past. Once natural dyes made from plants are no longer used, the methods of their preparation will no longer be passed on from generation to generation. The collected ethnobotanical data may contribute to biodiversity conservation and preservation traditional dyeing knowledge.

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9. Appendix

Apx 1. Photo documentation of dyeing plants used among Shipibo in Peruvian Amazon.

Arrabidaea sp.

Bixa orlleana L.

Brugmansia sp.


Buchenavia sp.


Curcuma longa L.



Croton lechleri Mull. Arg.

Eleutherine bulbosa Urb.

Genipa americana L.

Mangifera indica L.



Iryanthera sp.



Persea americana Mill.


Picramnia sp.

Psidium sp.

Simira sp.

Terminalia amazonia J. F. Gmell. Excell

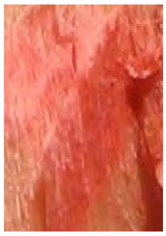
Swietenia macrophylla King.


Terminalia catappa L.


Terminalia oblonga R.&P. Steud.



Apx.2. Samples of the dyes from plants.

			
Arrabidaea sp.	*Bixa orellana*	*Brugmansia* sp.	*Buchenavia* sp.(lower part of the sample was treated with mud)
			
Croton lechleri	*Curcuma longa*	*Eleutherine bulbosa*	*Genipa americana*
			
Iryanthera sp.	*Picramnia* sp.	*Simira* sp.	*Swietenia macrophylla*
			
Terminalia amazonia (lower part of the sample was treated with mud)	*Terminalia oblonga*. (lower part of the sample was treated with mud)	*Swietenia macrophylla* *Terminalia catappa* *Psidium* sp.	*Mangifera indica* *Terminalia catappa* *Psidium* sp.

Apx. 3. Preparation of the dye from *Genipa americana*.

	
Immature fruits are cut in halves.	Seeds with flesh are removed and put into the pot.
	
Little water is added into the mixture.	Mixture is boiled until the water evaporate.
	
The pot is left covered for 2 hours outside of the fire place.	The thick mixture obtained is filtered through a piece of thin cloth to get the dye.

Apx 4. Preparation of the dye from barks.

		
Harvesting of the bark.		Dye obtained by decoction of the bark.

	
Cotton cloth is immersed in the dye.	After dyeing, the cotton cloth is exposed to the sun and left to dry.

	
Cotton cloth dyed for desired shade is painted with mud; after the painting is finished, the cloth is left to dry on the sun.	After the mud is washed, the paintings turn black.

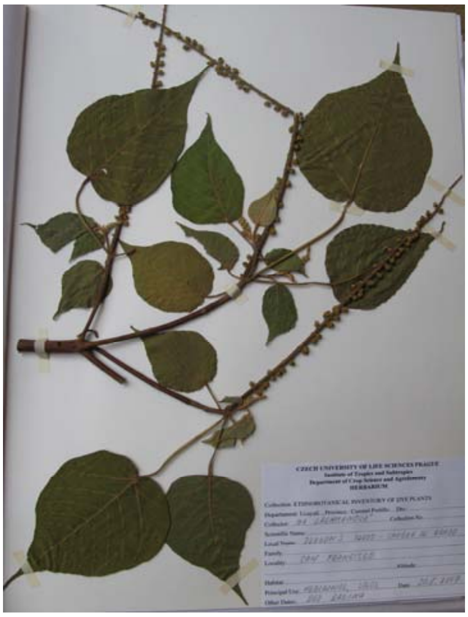
Apx 5. Painting with tannin dye on to the white cotton cloth; after the treatment with mud, the paintings turn black.

Apx 6. Preparation of the dye from *Bixa orellana*.

	
Seeds are removed.	Dye obtained by abrasion of the outer layer of seeds in small amount of water.
	
The mixture is strained through a sieve and the dye obtained is directly used.	

Apx 7. Voucher specimen of *Croton lechleri* and *Iryanthera* sp.



Apx 8. Voucher specimen of *Terminalia amazonia* and *Eleutherine bulbosa.*