Constellations and natural cycles withinTukano's people.

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Abstract

The main subject of this work is to present some results from a research that shows how the indigenous people who live in the northwestern Amazonian region in the Brazilian territory, developed relations among natural phenomena and astronomical constellations building circular calendars. The constructions of different circular calendar versions used to educational purposes were in the midst of our academic research. A selected group of indigenous people known as Tukano, who live around the Tiquié River, have a calendar which correlates animal's behavior and plants as well as environmental issues within groups of stars and constellations near the sunset. Otherwise there are relations between History of Sciences and Astronomy in Cultures because anthropologists and ethnographers visited this area late in nineteenth century and in the early twenty century, producing remarkable documents about this topic. This kind of investigation became possible because we developed comparisons among constellations described by the first researchers and more recent storytellers' descriptions. These constellations are totally different of our occidental ones and we made these stellar fields comparisons. Working between 2005 and 2007, inside an indigenous school situated in a tribe we verified that the community as a whole became interested in this kind of astronomical studies.

Keywords:*Astronomy in cultures, Astronomy of Tukano's people, Calendar, Ethnoastronomy, IKS-Indigenous Knowledge System.*

Introduction

This work shows how Tukano Indians of the Upper Rio Negro create representations of time passing through circular calendars that are based on their own constellations. These calendars evince the description of natural cycles linking animals, plants also spiritual world, revealing an organization design and a complex relationship with nature as a whole. As the complexity of this subject requires knowledge of a multidisciplinary team, initially we focused our research on the description of the constellations and their proper position in the sky. After that, we actually built some versions of circular calendars within a differentiated indigenous school.

Differentiated indigenous school operate using procedures that respect the traditions and social dynamics of these groups and within a timetable approved by a school plan, predetermined by the Education Secretariat of São Gabriel da Cachoeira – AM - Brazil. Some astronomy workshops were chosen by some teachers and direction of Yupuri School in Rio Tiquié, to the last stage of the school year of 2005 in order to share the knowledge of the elder and wiser with younger students who little knew about the subject. The Socioenvironmental Institute (Instituto Socioambiental - ISA), which is a non-governmental organization that works closely with people of upper Rio Negro arranged all the required infrastructure, providing logistical support and few anthropologists to follow the work. After the first workshop in 2005 two others occurred in 2006 and 2007 respectively.

To get to the most important set of constellations for Tukanos, we compared the given descriptions collected by us with those made by some ethnographers who also dealt with the same subject in the last century (Koch-Grünberg, 1969, pp.58-63); (Lévi-Strauss, 2004, pp. 251-75); (Silva, 1962, pp. 258-64). We not only compared the data obtained in field but also descriptions of the constellations from other ethnicities that upholds bonds with the Tukanos by sharing the same linguistic roots such as Tuyukas and Desanas (Fernandes, 2006); (Hugh-Jones, 1979); (Ribeiro & Kenhíri, 1987).

In the possession of the described constellations we spent some time studying the main phenomenon that connects them to the nature cycles. The heliacal set of some parts of these constellations marks events from natural world, such as floods also planting, fishing, hunting and harvesting periods. In other words, when a part of a constellation sets on the west side and it coincides with the sunset, the Indians of this region await some events such as floods, variations in the number of fishes in the rivers, blossoming, fruition and other events.

Coincidences of celestial and terrestrial annual cycles opened up the possibility of circular representations or circular calendars.

Tukanos ethnic group occupies a vast border of the Amazon region of Brazilian territory. The group with which we developed our work is found in Tiquié River, an affluent of the Uaupés River. This river flows into Rio Negro and after in the Amazon River, the wildly known river in the state that carries the same name, in Brazil. Despite

being Brazilian these Indians are relatives from other Indians who live mainly in Colombia, in Vaupés' Department. The tribes communicate through the intricate network of rivers from that region which enables product change overs and maintenance of some of their common ancestors' traditions.

Methodology applied in the investigation

Astronomy in cultures or cultural astronomy became the most common expressions for defining an interface area of research, which takes into account theoretical and methodological frameworks of social and natural sciences, particularly astronomy. Setting this area of research in a nutshell is no simple task and will not be the aim of this text. The cultural astronomy or astronomy in cultures is thus a research area that sets force mainly from knowledge gathered by traditional astronomy, before several divisions suffered from the eighteenth century in line with the humanities, especially with social sciences and more particularly to the ethnography for most of the investigated cases of living cultures.

The commonly found terms, ethnoastronomy and archaeoastronomy, are related to astronomy in the cultures. While ethnoastronomy is concerned with the relations between heaven and actually existing groups, archaeoastronomy studies the possible relations between humans' cultures that are no longer present, but which left concrete evidences of astronomical knowledge. In ethnoastronomy one takes direct contact with the representatives of a particular social group. A good example of ethnoastronomy is the study of astronomy practiced by indigenous peoples, as we shall see in the present work. In addition, to the indigenous peoples we can also include small farmers or maroon groups. These and few other social groups fit into ethnoastronomy studies. There are many other examples of ethnoastronomy and archaeoastronomy. (Fabian, 2001); (Ruggles, 2015); (White, 2008).

Part of these studies has been developed nowadays within Indigenous Knowledge System (IKS) which correlates the traditional indigenous knowledge in resistance to occidental general topics (Hoppers, 2002).

The role of context in cultural astronomy is critical because there is not a single sky for all existing cultures. On the contrary astronomy in cultures investigates how heaven and humans relate in different places and times. Different people have different skies and one of the main methodological matter in this context is the interpretation. (Kelley, 2001); (Ruggles, 2015); (Selin, 2000). Interpretation is a central part of astronomy in cultures and there are many methods to do it. Ethnographic and sociological methods were used on our research. Astronomy in cultures also offers possibilities of comprehension of other sets of knowledge about nature and its relationship with human beings within their own cultures. In addition to the traditional, western axis, astronomy in culture has much more in common with history of science investigations than one may think. In the case of this particular work, it is revealed not only in comparison with ethnographers' texts of the twentieth century, but also with regard to the interpretation of the natural world. At this point our research presented some aspects of social sciences methodology as action research and

participatory research (Thiollent, 2008) which are concerned with the outcomes of the developed calendar.

Results and discussion

In the case of the Tukanos, one should really take into account the understandings of what constellation means and how they are related to the natural world. These constellations do not correspond to our western constellations that were originated from another conceptual framework linked to other references, from other times and regions of the Earth. Often the constellations of indigenous peoples are seen as correlated with the dry periods schemes (summers) and humid periods - rain - (winters). In the case of the Tukanos and from ethnic groups of the same region - Tuyukas, Dessanas and few others who share the same linguistic root - the constellations are used to mark the periods of the main river rising level around which they live. The term accompanying the constellation name is *poero,* which means flooding in Tukano's language.

The floods that match rising river levels are correlated with rainfall that not necessarily occur in the area which the tribe is set, but the headwaters of major rivers (non permanent rivers and streams) also respond to the increase in the level or appearance of the water, as appropriate. So the match is not exactly straightforward, but follows its own rules with time that takes into account the water distribution rate in the main river rising level caused by rains. In other words, it is not necessary to rain in place where the tribe is set to the level of the river increases; and therefore we can say that every river's curve has a slightly different schedule (Cardoso, 2012).

For Tukanos, constellations set along with the sunset indicate floods - called heliacal sunset. The flooding of the jararaca's head or water snake – *Aña duhpua poero* - indicates that when this part of the constellation is setting a specific flood is about to come. Then will be the time of the flood of the jararaca's body – *Aña ohpu poero*. Then after a few days, the eggs bag of this jararaca sets along with the Sun and this period is called *Aña diepa poero*- jararaca's eggs bag flood. Finally, the jararaca's tail sets sunset next to the Sun. It's the *Aña pihkoro poero* - the jararaca's tail flood.

The set of a constellation or from a part of it that is associated with a flood, it is important to reaffirm, that it's when it occurs very close to the so-called heliacal set. In other words, the mentioned star group will set very close to the place where the sun sets. Shortly after sunset, when the sky begins to darken the group of stars considered appears, close to 15º above the horizon near the top of the trees. That's why we have chosen to use the term "close" to the heliacal sunset.

The succession of constellations indicates the order of the floods that can be of short or longer duration depending on several factors (Azevedo, 2010).

In the river lowlands, corresponding to low rainfall marks in rivers headwaters, appear the so-called summers whose names are mainly associated to animals, plants and fruits, usually edible. It is rare that a summer is directly connected to some constellations.

Summers and winters were represented in Tukano's circular calendar because they are important references in everyday timing, management and survival of this people.

The indigenous peoples of this region already controlled time through this way as it was testified by other researchers (Silva 1962, pp. 258-64). The constellations announced the arrival of the floods and, as a consequence, the reduction of available fishes. Summers brought insects, animals and fruits, all edible. This cycles' recognition has also become important to characterizing of the type of calendar we could develop throughout storytellers information and community connoisseurs.

The table below indicates Tukano's main constellations described in a research developed before the one presented here. The corresponding regions are listed and identified in the western sky. (Cardoso 2007, p.130).

Tukano	***English***	***Reference sky area of the non-Indians.***	**Month of the Julian-Gregorian calendar (non-Indian) that the constellation is setting in Rio Tiquié (approximate).**
Mhuã	**Jacundá (fish)**	**Stars of Aquarius e Pisces area.**	***February – early to middle February***
Dahsiew	**Fresh watershrimp**	**Mainly stars of Aquarius.**	***February – early to middle February***
Yaí	**Puma or Jaguar**	**Mainly stars of Cassiopeia and Perseus**	***March until the first half (beard and begin of the puma's head). March second half (puma's body). Puma's tail sets by mid to end of April - very close to the Pleiades.***
Ñohkoatero	**Group of Stars**	**Pleiades**	***April – from the middle to the end of the month***
Waikhasa	**kind of grill to cook fish**	**Hyades**	***April/May – end of April to middle May.***
Sioyahpu	**Instrument to carvewood**	**Orion**	***May – middle to the end of the month.***
Yhé	**Egret**	**Coma Berenices**	**August and September – the hole constellation sets**

Aña	**Jararaca**	**Scorpio/ Sagitarius**	**September, October and November – from latte nov. to December.**
Pamõ	**Armadillo**	**Aquila/ Dolphin**	**December**

Table 1: Tukano's Constellations with non-indigenous correspondence.

The summer and winter terms are understood in most of the northern and northeastern regions of Brazil as periods, usually of short duration, associated with drier weather forecast usually more humid or rainy, respectively. So when one says that *it's summer time* that means it won't rain. It makes no sense to speak of seasons in the traditional way in those places. In the Amazon region, fall or spring doesn't exist in the form that we are familiar to witness in the southern region of the country, for instance.

The Tukano's survey took into account differences in relation to other ethnic groups who share the same linguistic root. In the workshops that took place in *Yupuri School*, some storytelles of other tribes -Dessana and Tuyuka people - were also there. They also offered great contributions, but without significantly altering the main concepts associated with the constellations of that region (Fernandes, 2006).

Another fact that stands out is that traditional buildings longhouses called Malocas have guidance. They are buildings that have roof gable. Their ridges represent the projection of the Celestial Equator, and therefore, have the same direction of the east-west line over the horizon.

The buildings can be seen, in a sense, as maps of that cosmology as it was already pointed out by earlier studies than ours (Reichel-Dolmatoff, 2008, pp. 425-38). Would the Malocas be representations of natural phenomena associated with plants or maps? We used part of this concept to build sky charts considering the ridge of the longhouses as the Celestial Equator and represented along with the students of the Yupuri School, the Tukano's constellations of both hemispheres of the sky one in each roof gable (Cardoso, 2007, p. 367).

Facing this strong evidences that related constellations and natural cycles one had to set the notion of cycle itself in the form of a calendar. The indigenous peoples of this region grasp that the processes are cyclical because they live this fact every day when they experience the occurrence and frequency of natural phenomena.

Along the constellations' cycle that present themselves again with occurrences that are successively repeated, such as the appearance of certain insects - including those that are part of the nourishing of these peoples - flowering, fruition, fish moving through the river, land preparation for planting, harvesting, rituals that accompany the best harvests and blessings in general.

The Tukanos have signaled that in addition of realizing the sequential nature of events, there are some phenomena causally linked, while others present with the same cycle, but they are not necessarily connected by a cause-effect relationship (Cardoso, 2007, p.151).

In the case of constellations, in particular, there is unanimity in the chosen storytellers in my research to affirm not causal connection between the decline of the

constellations and the succession of cyclical events listed here. The phenomena are synchronous, but with no causal connection, in other words.

As there was a tradition in the representation of calendars in circular shape, the Tukanos were interested in reviving this presentation to their own calendar. Inspired by a model displayed by the Colombian relatives in a meeting held prior to my arrival they insisted in the form of a calendar that displayed cycles.

Figure 1- Dynamic Circular Calendar - circles representing constellations and natural events - author's photo.

The idea of making these cycles into something dynamic was inspired by the concept of *volvelles* (Helfand, 2002) or in older computation of instruments such as astrolabes. Our contribution to Tukano's calendar corresponded on gathering in only one piece all cycles allowing them to act dynamically, with the horizon as a reference line. The proposal was to build concentric circles with successively larger radii, juxtaposed to each other in memory of assembling a tower of Hanoi.

The constellations were represented in the first circle. Notably, the closest constellations of the celestial equator were called as constellations of the *main cycle*. This was due to the clusters of stars that pass through the Zenith region of the area occupied by the tribe, and that are strongly linked to the river flood cycles.

The Tukanos and other ethnic groups that occupy the Amazon region have established very close to the Equator line. So, even occupying latitudes do not significantly deviate from the zero degree mark. This means that the celestial equator passes almost at Zenith of these locations and, as a result, these constellations are not far from the celestial equator so they rise and set very close to the cardinal points - east and west - respectively. The Amazon is, in general, a huge plain.

The constellations of the main cycle that are near the eastern horizon at the time of the Sun set remain in the sky almost all night long to the observer. For someone trained in recognizing constellations, it won't be difficult to follow the approach of a given constellation to the west horizon, night after night.

After about six months of the birth of a constellation in the eastern region of the sky, after the Sunset in the opposite region, one will notice how this constellation was approaching the Sun in its setting. It is as if the sky and stars were solidary to him and decided to move on to the west - east to west - while the Sun seems to stay in the west, in the darkness evening. It is a matter of reference. We can explain this event in our cultural frame with Earth's motion around the sun.

Using the Earth as a reference to a particular chosen point of view, we may note that, as it moves eastward one see the Sun through the zodiacal region in the same direction - from west to east or direct sense.

As in the hands of a clock, we look at constellations' changes of positions while time passes.

The other calendar circles represent manifestations, events that involves plants and animals, common occurrences that are related to the communal life in a very broad way and all that is somehow repeated. Therefore, it is not just the events related to survival, but also the relations between these individuals and the transcendence, or even with their spirituality and myths.

The second circle represented by the Tukano in this calendar edition shows categories for what one generally calls, climates. The term does not have the same technical meaning used in climatology. Climate here is being understood as a general state of the atmosphere synonymous. In this circle are also represented the variations of river levels.

They are usually linked to constellations' descriptions through the uses of the term flood as we have seen throughout this work.

Figure 2 - Dynamic Calendar shaft endowed, inserted in an assembly that separates what is above the horizon - author'sphoto.

There are many names for atmospheric states as a function of changes through a day in Amazon. The day can get cloudy and rainy, and then evolve into a clear day with clouds or sometimes sunny. These situations have different names, and are represented as being connected to the short periods when the characteristic reaches a certain river level.

The third circle was dedicated to representing the main fishes that move up or down the river. In previous versions of the calendar, one produced two circles with the fishes in separate. It was thought reasonable to gather these two groups into a single circle. Fish, among other beings of Tukano's worldview, carry with them great importance in social and spiritual life of these people since they are usually called people-fish. Several individual events such as diseases and human behaviors are credited to them. This term that categorizes various types of "people" is not unique to fish, and the Tukano also use stones, trees and other elements, sometimes giving them more or less importance in the narrative of a specific myth.

The circle below this one - see figure 1 - was dedicated to the animals that go up and down the river shores and that feed from the fish or that the people depend on them in some way. In one classification that is present in other organization of that calendar's

representation, another category appeared: flying animals. In it we could find insects, birds and even bats that are mammals, according to our classification. Note that flying animals is a category that can provide a broader description of living beings. This is a kind of indicator that helps us to grasp the conceptions of this people cosmos or worldview.

Flowering and fruition were represented in the subsequent circle. The connection between these events, were represented in the same circle. They are also associated with a specific type of rite that relates to the harvest, the blessings and the distribution of food within the community as a whole. One of those rituals is called *dabukuri* and appears along with the blessings in the circle above of the flowering and fruition because after harvesting the Tukanos believe that the food needs to be purged of evil spirits before being consumed. Nature as a whole is presented full of impurities and evil. It is necessary that the *kumu* or blesser do this cleaning through rites and words of power.

The last and most distant circle represented in the calendar - see Figure 1 - is the Moon's phase. In Tukano's conception the Moon, in this case, is a jaguar that slowly eats an agouti. When it comes to the stage that we call full, she had already eaten the agouti finally swallowing its skin. In the full moon she finishes eating all the agouti and loses some weight until the next hunting that occurs in the next cycle.

Final considerations

The Tukano's calendar does not have a final version and other initiatives as well as variations on the same theme have occupied the members of this community, especially the AIMA - Indigenous Agents of Environmental Management. Working in partnership with anthropologists of Socioenvironmental Institute (ISA) these indigenous researchers developed some river level's readings, relating them dynamically with other events and constellations, similar to what we did in our research.

The potential of this theme, involving constellations that are not part of Western array of knowledge associated with measurements of chronological time and environmental issues, represents, today a field of research that goes further than the astronomy in cultures. Some proposals begin to emerge in the work of researchers who deals with physics teaching (Araújo, 2014) for example. It seems that there are also elements of history of science (Lima, 2004); (McCluskey, 2015) and obviously ethnography (López, 2015) present researches of astronomy in the cultures. It is not surprising that these approaches occur. We are talking about interface areas and therefore we must consider several research development opportunities that cannot be conducted throughout restrictive methodologies. In a world with so many general models allegedly applicable in all cases without distinction as the only solution, we believe that we need to investigate, develop and grasp how inhabitants of a geographic location and a certain chronological time built their answers about the world. How they built their worldviews. This is exciting in astronomy in the cultures.

How to produce a history of the science of people that were cut off from the mainstream hegemonic knowledge production? How to give voice to the operating explanations of natural world created by wiser and healers? How to consider local production of knowledge as possible keys to understand the current environmental challenge?

To these we could safely gather so many other questions. Astronomy in cultures is not an answer, but an investigative amount of methods to range of issues that we have in the 21st Century.

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