Chapter

An Insect Bad for Agriculture but Good for Human Consumption: The Case of *Rhynchophorus palmarum*: A Social Science Perspective

Rafael Cartay, Vladimir Dimitrov and Michael Feldman

Abstract

This article presents a review of the current state of the art in the study of human consumption of insects in the Amazon basin and, in particular, of the larva of the beetle *Rhynchophorus palmarum* which is the insect of greatest consumption by the native indigenous communities of the Amazon basin. It includes detailed information on cultivation, collection and consumption, as well as the dietary, medicinal and symbolic role the *Rhynchophorus* plays in a variety of Amazonian cultures. The article emphasizes aspects related to its role as vector of a plague that damages commercial agriculture of palms and some fruit trees, as opposed to its role as a food source that constitutes a rich source of protein of high biological value.

Keywords: edible insects, Amazonian protein, insect's nutritional value, *Rhynchophorus palmarum*, Amazonian indigenous diet

1. Introduction

Insects have attracted the attention of mankind since ancient times for both negative and positive reasons. Negative, related to their destructive effects on agricultural and industrial crops, causing large economic losses, and their harmful effects on human health, causing huge human losses by transmitting diseases such as Chagas disease, dengue, malaria, yellow fever, chikungunya, leishmaniasis and others. Positive, related to their use as a human food source, of particular importance to help mitigate, in the medium term, critical cases of food insecurity and famine, and feeding other animal organisms [1]. Insects play a key role as regulatory elements of terrestrial ecosystems, fundamental in pollination processes, important as predictors and bioindicators of environmental changes [2] and to evaluate the impacts of fragmentation of plant cover, fire and invasive plants [3, 4]. Insects are also used as bioindicators of plant stress [5], elements to enrich the soil [6], accelerate the recycling of detritus [7] and for the biological control of pests [2, 8, 9]. In many cultures they are useful as effective popular medicines [10–14], and cutting edge medical technology [15]. Insects are highly valued, in many parts of the world, as symbols in religious rituals and in other cultural practices [16–21].

The importance of insects is remarkable from a multidimensional perspective related to human culture [22], and especially in relation with biodiversity. Insects represent the animal group with the most evolutionary success [22]. They also constitute the largest animal biomass on the planet [23], with a higher volume than the rest of the animals together ([24], pp. 67–68). Insects have the advantages of abundance (wide geographical distribution and great adaptability), productive facility (high reproduction rate, easy handling and cultivation, efficiency in food conversion and great potential for internal and external commercialization) [13, 24–26], and a high nutritional value suitable for human and animal uses [13, 25, 27–31]. Insects are, for these reasons, an excellent food alternative for a world with a growing human population, which lives in a scenario characterized by an inequitable distribution of productive land, employment and income, and which faces serious problems in accessing enough quality food for expanding populations [11, 30, 32–41].

Around the world, more than 1 million species of insects have been described by science, while the existence of 5–10 million more is estimated, yet to be described [42], which makes them the group of animals of the greatest diversity on the planet. Of the total described, there are, according to the most conservative estimates, between 1900 [37, 43] and 2000 species of insects [11], used as food by nearly 3000 ethnic groups in more than 102 countries [11, 24].

Considering the relationship between the number of edible insect species with respect to the total number of insect species, we find that only 0.2% of the described species are edible, which represents just 0.033% of the total estimate of insect species, described or not. Of the total number of insects, nearly 60,000 described species live in the Amazon basin. There, the proportion of edible insect species, estimated at about 135 species, gives a figure of 0.00225% with respect to the total of regional insect species. This means that the percentage of edible insect species in the world is negligible (0.2%, of the total described, and 0.033% of the estimated total), and even more so in the case of the Amazon (0.00225%).

When examining the taxonomic concentration of the insect species described and, in particular, edible insects, we find that, approximately, 74%corresponds to four orders: *Coleoptera* (35%), *Diptera* (15%), *Hymenoptera* (12%) and *Lepidoptera* (12%) [44, 45]. There are some insects more consumed than others, individually, such as certain species of crickets, grasshoppers and locusts, while the most consumed in Amazonia are the larvae of the beetles *Rhynchophorus palmarum* and *Rhinostomus barbirothis* [27, 46, 70]. That preference in consumption varies according to areas, and there are notable exceptions. In the Brazilian Amazon, the largest portion of the vast Amazon basin, there are about 135 species of edible insects. Among them, the most consumed species belong to the order of hymenoptera, which include ants, termites, wasps and bees, especially excelling in the consumption of ant species *Atta cephalotes* and *A. sexdens*. The same happens in other smaller areas of the basin, such as the south of the Colombian Amazon, where some indigenous groups like the Andoque, who live in the middle part of the Caquetá River, are notable consumers of parasol ants, of the genus *Atta* [47].

When taking into account the fidelity level of insect consumption in the Amazon basin, i.e., the frequency of their use as a dietary component, it is observed that only 30 species of insects are frequently consumed, highlighting, among them, the consumption of *Rhynchophorus palmarum* (*Rp*, hereinafter). Paoletti et al. [46] reported a consumption of 6 kg/year/per capita of *Rp* larvae. As each larva in its fresh state weighs between 8 and 12 g, it would imply the consumption of 50 larvae per person per month, which is possible. Ramos-Elourdoy and Viejo Montesinos [24] point out that the Yanomami indigenous group consumes more than that, in addition to other insects (ants, wasps and other larvae) and spider, which is not, strictly speaking, an insect [48]. Beckerman [49] reported similar consumption among the Bari of Venezuela. In summary, it can be concluded at this point that, although a large percentage of indigenous insects are not consumed in the Amazon basin, there is a high consumption of some species, such as *Rp*, which appears as a supplement to the diet in many Amazonian indigenous communities [50], together with medicinal uses [51].

The objective of this article is to review the double impact of the larva of *Rhynchophorus palmarum* (*Rp*), both in its destructive effect on cash crops causing significant economic losses, and from the perspective of the valuable benefits it provides to the Amazonian indigenous communities by supplementing their diet, especially during times when there is a shortage of hunting and fishing production.

2. Methodology

To collect the information needed for this research, which is part of a larger investigation, two methods were used. First, the method of in situ observation, carried out directly in a number of native indigenous communities of the Peruvian Amazon, supplemented by informal interviews with members of these communities, particularly those located near the cities of Iquitos and Nauta, in the Loreto region, during the period from May to July 2015. Several popular regional markets were visited, and especially the large market of Bethlehem, to interview small traders, some informal, who regularly offered products derived from about 20 varieties of Amazon palms (parts of the plant: drupe, palmetto or inflorescence of the bud, and related insects). This field work included an excursion for the collection of edible insects (in particular Suri, *Rp*), guided by young people of the Yagua ethnic group, in the Nanay river basin.

The second method consisted of a neat bibliographic-bibliographical review carried out in two specialized libraries located in the cities of Iquitos: the rich library of the Institute of Amazonian Studies of the Peruvian Amazon (IIAP) and the beautiful library of the Center for Theological Studies of the Amazon (CETA) In addition, information was collected over several months in libraries in Lima, particularly the one from the French Institute of Andean Studies (IFEA) and the Institute of Peruvian Studies (IEP). During that time we also interviewed personalities linked to different aspects of Amazonian life: the historian and novelist Róger Rumrrill, the journalist and novelist Juan Ochoa-López, the chefs Pedro Miguel Schiaffino and Pilar Agnini and the anthropologist Alberto Chirif, one of the greatest experts and analysts of the Peruvian Amazon from the perspective of the social sciences.

3. Results

The approach to the subject of the investigation can be considered in three parts. In the first we describe the *Rp*, and especially the preferred edible larval state. In the second part we describe the behavior of the *Rp Coleoptera* as a pest, and in particular as a vector of a nematode that causes serious economic losses to commercial agriculture, most notably in the cultivation of African palm and coconut palm, as well as some fruit trees. In the third part we address the topic of *Rp* as an edible insect of importance in the diet of the Amazonian indigenous groups, and as an alternative to contribute, in the medium and long term, to a solution of the serious problems of food insecurity confronting a growing population, without regular access to an abundance of other protein-rich foods and that confronts notable food shortages now and possible catastrophic shortages in the future.

3.1 Description of the *Rp* and its larval stage (form)

The *Coleoptera Rp* belongs to the order *Coleoptera*, family *Curculionidae*, tribe *Rhynchophorini* (see **Figure 1**). The genus *Rhynchophorus* is made up of 10 species. Of these, three are present in the neotropics: *R. cruentatus*, *R. richeri* and *R. palmarum*. The *Rp* is a widely distributed species in the Neotropics, from southeast California and Texas to Bolivia, Peru, Paraguay, Uruguay and Argentina, in an altitudinal range from 0 to 1200 m above sea level [52–54].

The *Rp coleoptera* is known by many common names: cucarrón, cigarrón, weevil, palm weevil, casanga, black weevil, and coconut palm weevil. Its larva is called, in the Amazonian regions, Suri (Peru), Chontacuro (Ecuador), Gualpa (Colombia), Palm Worm (Venezuela), apart from the many other names it is given in different parts of the Amazon basin: mojojoi, mojomoi, mojotoi, casanga, mukint, mujin, and headworm.

It is a matt black beetle, with a size that varies between 2 and 5 cm. In adult state, this coleopter presents sexual diformism, that is, the male is different from the female. The female has the beak curved and smooth, and longer than that of the male. The male is easily recognized because, in addition, he carries a tuft of mushrooms in the dorsal part of the beak. Both male and female show activity both in the day and in the night: they are observed in the fallen trunks of the palms during the early hours of the morning or at the end of the afternoon, although they are more active towards 11 o'clock at night ([55–57], pp. 11–13).

The female lays her cream white eggs, of a size that fluctuates between 1.0 and 2.5 mm, in palm trunks. It deposits them, in an average of 900 units, in vertical position on the soft tissue of the open trunk of the palm, protecting it with a brown waxy substance. After 2–4 days, the larvae emerge, without legs and with a body length of a little more than 3 mm, slightly curved in the belly. From there it begins its development in nine instars, which last between 42 and 62 days, until it reaches instar IX, when it becomes a pupa. It then takes 30–45 days for the adult to emerge, and from 7 to 11 days to leave the cocoon [55, 58].

The females oviposit in the cuts of the petiolar bases of the palms with wounds or rot. There, inside the infected palm, usually near the rotting bud, the insect develops, fulfilling its total life cycle until reaching its final form ([58], p. 21), depending on the material or substrate on which it feeds (colonized substrate). The life cycle ranges from 119 to 231 days, when they are raised in the laboratory [59], and under normal conditions, a minimum of 122 days: 3.5 days as eggs, 60.5 days as larvae, 16 days as a nymph and 42 days as an adult [24, 60, 61]. The females have an oviposition period of up to 43 days. A female can oviposit up to 63 eggs in a day, and

Figure 1.
The final form is the edible white larval stage.

from 697 to 924 during her entire cycle [55, 62–64]. In the final instar, the larva has a length of 5–6 cm, and a weight of 12–30 g [65].

The *Rp* females are attracted by the volatile compounds that emanate from the palms with wounds or rot, seeking to feed on their soft tissues. Thirty-one species of *Rp* host plants have been registered, belonging to 12 families. Among them, the *Palmaceae* family predominates with 19 species, mainly *Elaies guineensis* and *Cocos nucifera*, of great economic importance. Of the 19, there are 11 species of Amazonian palms host of the *Rp*. Among them, *Mauritia flexuosa*, *Maximiliana regia*, *Bactris gasipaes*, *Oenocarpus bataua*, *Euterpe oleracea*, *Astrocaryum huicungo*, of great importance for human nutrition in the Amazon basin. Of the 11, 3 species of palms are very affected: aguaje, morete, muriti or moriche (*Mauritia flexuosa*), ungurahui, ungurahua or seje (*Oenocarpus bataua*) and cucurito (*Maximiliana regia*) [66]. *Rp*, a polyphagous insect, also causes damage to fruit trees such as papaya, mango, avocado, orange, guava, by feeding on ripe fruits. And, in addition, on sugarcane, banana, cacao and pineapple. But there is a difference: in these plants, *Rp* produces damage, but does not behave like a pest. It acts like this only in the case of palms and sugar cane [55, 54].

3.2 *Rp* as a plague

Rp is a devastating plague affecting some palms of economic importance that constitute commercial plantations such as coconut and oil palms, and of some Amazonian palms of great utilitarian interest for native indigenous communities ([67], pp. 151–156). When *Rp* is attracted to the wounds and rotting in the stems and the bud of the palms, it deposits its eggs in the soft tissues and the tree is infected by the nematode *Bursaphelenchus cocophilus* (*Bc*, hereinafter), which is the main cause of ring syndrome, known as red or small leaf, which has devastated the coconut and African palm plantations located in Central and South America.

The *Bc* nematode is an obligate migratory endoparasite, which lives all of its life inside the palm and without multiplying inside the disseminating insects [55]. The nematode is acquired by the *Rp* larva, which acts as its main vector, maintaining it through the molts until reaching the adult stage. By leaving the diseased palm, it can infect three or four healthy neighboring palms. The combat and control campaign is currently done using traps or plastic containers (olfactory scent traps), placing pheromones of synthetic or natural origin to attract the insects. The traps are placed in the field at a distance of 1–2 hectares in the most infected areas [68, 69].

3.3 *Rp* as food

In the case of the Amazon basin, the larvae of the *Rp* and *Rhinostomus barbirothis* beetles are the most consumed [27, 70], although the primacy corresponds, with a great advantage, to *Rp* [46]. It should be noted, however, that this statement is not generalizable for all countries in the basin. A very notable exception is Brazil, in whose Amazonian region mainly hymenoptera insects (ants, termites, wasps and bees) are consumed ([11], p. 423; [47]).

Rp larvae are a source of proteins and fats used in native Amazonian indigenous communities to supplement their diet, under normal conditions based on hunting, fishing and farming. This source of protein could also play a larger role in the diet in times of need, as the larva *Rp* constitutes, as do edible insects in general, a protein possibility of high biological value and low cost. It is interesting to note that in urban areas of many Amazonian regions, edible insects are freely available. In the Iquitos markets, *Rp* larvae are sold in different presentations: live, cooked and roasted. Vargas et al. ([71], p. 65) pointed out that an average of 3500 units are sold there per day, especially on weekends.

Some researchers several decades ago posed the need to value the consumption of insects as an excellent food resource, widely used among Amazonian Indians, among Mexican rural dwellers and in many Asian and African cultures. These authors [15, 72] considered that protein malnutrition among indigenous groups in the Amazon was relatively low in the area due to its high consumption of insects, fungi, drupes and almonds. That opinion, perhaps a bit exaggerated, can be sustained with some reservations. Riparian natives satisfy their protein needs basically with the consumption of fish. Some riparian groups have an average per capita consumption of 20–50 kg per year, although in some communities they reach consumption levels close to 200 kg per year. In these conditions, the consumption of insects plays a secondary role, complementing the diet, not as a primary component but as a necessary complement.

Just as insect consumption has been overestimated in some studies, so in others such consumption has been underestimated. Many times indigenous people do not recognize this consumption in the food consumption surveys that are applied to them. The Indians in the most advanced process of cultural assimilation do not declare that consumption because they have learned in the cities that this consumption is considered unpleasant and dirty. This concealment does not occur with indigenous groups that are proud of their ethnic identity and boast of such a food practice.

Although not declared openly, the consumption of insects is common throughout the Amazon basin. That is evident if one makes a visit to any indigenous community. In some native communities of the Loreto region, in the Peruvian Amazon, we directly recorded the consumption of nine species of insects belonging to several orders, although the most consumed was the *Rp*, in close correspondence with the wide geographic distribution and the abundance of some host plants such as *Mauritia flexuosa*, known as aguaje, because in the low jungle there are huge stands of that palm that are known as aguajales ([67], p. 160). The indigenous inhabitants consume the larvae fresh, alive, or dead, roasted or fried. In the urban areas of the Amazon they are served fried in their own fat, or roasted over a direct fire. This form of preparation and consumption constitutes an imitation of traditional indigenous preparation. The most sophisticated urban chefs offer their product in salad, or wrapped in the manner of a Tequeño, or roasting the larvae on a skewer as if it were a Turkish kebab. This is the case in the restaurants of Iquitos, in Peru, or Puyo, in Ecuador, or Leticia, in Colombia, or in Puerto Ayacucho, in Venezuela. Other cooks have incorporated the larva into some typical preparations of the regional cuisine of the Peruvian Amazon. We thus have the juane de chonta (palmito), which mixes palmita, tender edible inflorescence of some Amazonian palms, with suris or palm worms [73]. Brewer-Carías ([74], p. 150) recommends cutting the posterior end of the larva before consuming it raw, to reduce its spicy flavor, probably caused by its digestive juices.

Depending on the season, and rising or falling river levels, which changes the availability of food in the jungle by affecting the relative productivity of hunting and fishing, recollection is used to augment these primary sources. This activity includes wild fruits, drupes of palm trees, fungi, mollusks, small terrestrial animals such as amphibians, and edible insects. The consumption of these insects is very important during some times of the year. Paoletti et al. [46], based on studies by Ramos-Elourdoy and Viejo Montesinos [24], using various sources, recorded much higher consumption among the Yanomami, an indigenous group that inhabits the Venezuela-Brazil border, during particular seasons.

The nutritional value of edible insects is sufficiently proven by numerous laboratory studies. The protein content of edible insects varies between 30 and 40%: from 30% for wood larva to 80% in the wasp *Polybia* sp. [75], which equals, and even exceeds, the values obtained for different types of meat, typically ranging between 40 and 75%. In the specific case of the larva *Rp*, the protein content is 76%, clearly higher than that of beef, which is 50–57%. Something similar can be observed in the fat content of protein sources. In meats this ranges from 17% in fish, to 19% in beef. In the case of the larva of the coleoptera, this value oscillates between 21 and 54%, presenting, in addition, a better composition. The skin, in particular, is rich in oils. These are fatty oils of the unsaturated type: linoleic, linolenic and other polyunsaturated fats [31, 39, 43, 65, 71, 76–78]. Regarding the total caloric value, the *Coleopterous* larvae have caloric values around 560 kcal/100 g, higher than the 430 kcal/100 g of beef [11].

The protein of animal origin is important for its high biological value, which depends on the number and variety of essential amino acids in its content, and its digestibility or ease of assimilation by the human body. The biological value of the protein corresponds to the proportion of protein absorbed and used by the organism. To be used most efficiently, protein is required to have all the essential amino acids in the right proportions. This happens with foods of animal origin such as milk and meat. The protein of edible insects is also of high biological value, similar to that of meats, with a triple advantage over them: it has a lower relative price, is easier to digest and is healthier because it does not have cholesterol [79]. In addition, if a protein of high biological value, such as insects or meat, is consumed and combined with another of lower biological value, such as cassava or plantain, the foods complement each other, and the biological value of the resulting dishes increases. However, the consumption of insects' greatest importance for the conservation of the environment lies in the fact that it has a better efficiency index for the conversion of food into biomass.

The value of an animal as a source of nutrients depends mainly on its nutritional contribution and on the efficiency with which this animal converts the food consumed into biomass [75, 80]. In this respect, the animal that gains the most weight for each gram of food consumed is more efficient. To obtain 1 kg of beef, 13 kg of food is needed. For chicken, the most efficient among the commonly consumed animals, 6 kg is required. On the other hand, only 2 kg are needed for insects, showing a high rate of conversion efficiency. For Costa-Neto [81] and Krajick [75], insects are more efficient in relative terms than other animals, because they are invertebrate, cold-blooded animals. The disadvantage they present is that their consumption is seasonal and their production is not currently significant in terms of volume sufficient to supply the potential market. This situation can be reversed, and we are beginning to see large-scale cultivation in some countries of the world, such as Thailand, Mexico and Spain.

Recollection of insects is an activity carried out by the far majority of Amazonian indigenous communities. To analyze its cultural dynamics and dietary contribution, it is necessary to understand the changes produced in the larva. The timing of the *Rp* instar stages are important to determine the period of collection in the jungle, behavior that the natives know perfectly and transmit as ancestral knowledge, ethnoetology as it is called by Posey [48]. To be collected, the instar must be at least 1 week old since its incubation period, to ensure that it is a viable larvae, that it has reached a major stage in its evolution, with a weight close to 12 g, that it is as fat as a finger and has a color between cream and brown. Guzmán-Mendoza [18] points out that it is important to distinguish the onset of the larval stage in order to consider a larvae as food. The ideal conditions occur after about 2 months of life, after the period of infestation has occurred, which does not always occur immediately after the cutting of the palm. There are periods more favorable than others to infest the downed logs. Ramos-Elourdoy et al. [82] point out that the period of greatest infestation occurs, in the Amazon basin, between August and October, depending on the environmental zones and the rainy season, during which stem rot accelerates, making the trunk softer and propitiating the perforation by the insect. This can occur naturally or be induced by humans.

When human action intervenes, the collecting activity goes much further, becoming in practice a work of cultivation or protoculture, as Ramos-Elourdoy and Viejo Montesinos [24] called it. In this case, the indigenous person fells the palm, and in the downed trunk makes an incision approximately 10 cm × 10 cm, leaving a mark to identify the place. Two months later he or she returns to the site, knowing what to look for and where to look [83]. The collector comes back this time with an ax and a container to collect the larvae. He or she then opens the bark of the trunk with the ax, and extracts 30–40 larvae each time, part of the harvest of a day. A whole palm tree can produce over 500 larvae. Then, the collector takes the larvae home to consume with the family. The period of greatest collection goes, in the Peruvian Amazon, from July to October, both in the Lower and Upper Amazonian basin. Depending on the season, the identity of the collectors changes. If it is a hunting or fishing season, and men are absent from the community, women and children are responsible for the collection.

The "cultivation" or "proto-culture" of *Rp* is not a simple task. Araujo and Becerra [27] and Arango-Gutiérrez [84] point out that the Yekuana and Piaroa ethnic groups, from the Venezuelan Amazon, induce and promote the breeding of *Rp*, a highly esteemed insect in their culture, to which they attribute great food virtues. They collect the larvae from the fallen palm trunks and transport them to their homes, where they are fed with pieces of soft plant tissues from selected palm trunks. For this purpose they prefer tissues of the seje palm (*Jessenia bataua*), arguing that, when consumed, they give the larvae a better flavor. For the "cultivation" of the *Rp*, they intentionally chop healthy palms, section their trunks longitudinally to attract and concentrate a greater number of infesting individuals on the food source, favoring copulation and oviposition. After a lapse of 35–45 days, they harvest the larvae and consume them, simmering them until they are crispy. Bukkens [76] notes that the collection is planned and highly predictable relative to initiating the infestation of the downed trunk.

Neto and Ramos-Elourdoy ([11], p. 430) point out that the collection of edible insects depends on four factors: food restrictions and taboos, traditional customs, personal taste or taste preference of the group and the search for food security to guarantee survival. Another factor could be added: seasonality, because in the rainy season the process of insect infestation is accelerated. These authors also argue, together with Miller [85], that the use of an insect as food is related to four variables: the environment, the availability and accessibility of insects, the mode of production and the forms of reproduction of the insect and culture and food restrictions. In several native communities the collection and cultivation of insects corresponds to indigenous women and children, and they exhibit a festive spirit while accomplishing this task, which they perform even in times of abundance of hunting and fishing products.

3.4 *Rp* as a symbol

It is known that when consuming food, symbols, meanings, and signifiers are consumed at the same time. In such a way, the consumption of insects goes beyond obtaining nutrients in moments of scarcity or to supply deficiencies of proteins and fats. Every food substance must be viewed from a three-dimensional perspective, because it provides, at the same time, nutrients, medicines and symbols. The consumption of insects in the different regions of the Amazon basin is inscribed within a culture, whose members use symbols to communicate, as individuals and as a social entity, and to express them and think about their culture. Foods contain messages or stories that serve, along with other cultural elements, to insert

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themselves into the worldview or matrix of a culture. These messages are transmitted inter-generationally and incorporated, with adjustments, into the dietary patterns of a social group [86]. An excellent illustration of the symbolic consumption of insects is the study carried out by Acuña-Cors [87] in an indigenous community of the Reyes Metzantla, in Puebla, Mexico. Also notable are the mentions made by Macera and Casanto ([88], p. 242) of the symbolism associated with the suri larva (*Rp*) among the communities of the Ashaninka indigenous Amazonian ethnic group. For its members, the larva suri (imooqui) has an owner or tutelary god, the Imoobo, which must be asked for permission before consuming the insect. In the Asháninka legend, the Imoobo is an old woman who ends up being addicted to eating so much suri. Jara ([47], p. 226), meanwhile, it is said that the Andoque and Desana, indigenous peoples of the Colombian Amazon, large consumers of *Rp*, see in the metamorphosis of the insect the expression of a transforming magical power. The beetle, regarded as the father of the larva, is attributed a male generative power, which penetrates with its beak, the symbolic phallus, the perforated trunk of the palm, which corresponds to the vagina. The larva is, for them, a hybrid animal/vegetable product that is produced within a process of shamanistic transformation. Mexican indigenous groups, such as the Mazahua, in the state of Mexico, consider insects as mediators between the earthly and the supernatural worlds. Using them, the Indians raise supplications to God asking him, for example, to send them rain ([44], p. 85). The Yucuna, from the Colombian Amazon, distinguish three types of *Rp* beetle larvae, which they call mojojoi: the mumuna, small; the huachurú, the median, and ñamaja, the largest ones. Here the larvae are collected by women and children, and are subject to barter or gifting. Giving them is a demonstration of affection, which they deliver by wrapping them in pieces of palm leaves and tying them with vine fiber ([83], pp. 83).

The symbolism of insect consumption is different when it occurs among non-Amazon urban consumers. In this context, the edible insect leaves everyday life to become an exotic matter that, in some cases, produces amazement, and can become an object of consumption and gastronomic tourism. However, in most cases consumption of insect is viewed with horror by visitors from other cultures, who consider insects dirty, disease-ridden pests, and which arouses feelings of apprehension and disgust, which can even cause phobias and neuroses and even physical illness.

4. Discussion

The subject of edible insects has been attractive for popular magazines, but not as much for scientific research. Even in Latin America, where insects are consumed in almost all countries, there are still a lot of reservations about the matter, as if it were an exotic food practice exclusive to the most backward and unimportant indigenous communities. There have been few researchers who address this area of study, the exceptions being mostly European and American investigators. Among Latin Americans, researchers from Brazil and Mexico stand out, and some have made great contributions in the field [89]. Most of the studies done in Mexico are devoted to the study of insects grouped in *Coleoptera* and *Lepidoptera* [90], while research on insects from the Amazonian basin focuses on insects belonging to the groups of the *Coleoptera* and *Hymenoptera*, using the methodological support offered by applied ethnology [89]. Throughout the Amazon basin, the larvae most consumed are the *Rp* larvae ([27], of which few monographs have been written in relation to their abundance, leaving some areas untouched. There is a lack of comparative studies of the nutritional values of edible insects, as well as the biological value of the proteins they provide. It would also be interesting to understand the way indigenous groups put together their nomenclature, their classification systems and the specifics of consumption of such insects [91]. Little is known about the medicinal uses of these insects, which Ramos-Elourdoy [92] so emphatically raises, with the name of "nutracéutical entomofauna". We are just beginning to study the optimal manner to "cultivate" them in the jungle and to "raise" them domestically. Little is known about the efforts being made in Mexico, Thailand or Spain to foster large-scale insect production, in order to meet current and potential regional and global demand.

On the symbolic aspects of the consumption of insects, and the comparative cultural representations between the different ethnic groups of Central America and Mexico, as well as of South America, there is much work to do. Little research has been done on insect consumption between the populations of the Caribbean islands and black African-American populations. The elaboration of didactic manuals is necessary to develop popular enterprises related to the "cultivation" of edible insects. The specialists in the culinary arts must write recipes that introduce novel ways to facilitate the consumption of insects, overcoming the reservations that people have concerning their consumption. On the subject, only entomologists, ethnozoologists and applied anthropologists have been concerned thus far, but not nutritionists, for whom it should be a major concern. They, and various health organization, have the difficult task of developing efficient campaigns, attractive from the point of view of "taste", to promote the consumption of insects of high nutritional value, as an effective tool in reducing the serious problems of chronic malnutrition that affects a large percentage of the child population of developing world, constituting a situation of food insecurity that impacts the political, socioeconomic and public health realities in these countries. This study tries, at a minimum, to be a critical revision of the current state of the art around this topic, but it leaves many unanswered questions that must be approached by other investigators interested in the subject.

5. Conclusions

Edible insects represent an important source of protein and fats in the diet of the indigenous Amazonian population, particularly during times when the availability of products derived from hunting and fishing is reduced, these being the main and usual sources of necessary proteins. The protein derived from insects is of high biological value, due to its excellent content of essential amino acids, both in variety and quantity. It also results in easy digestibility, a relatively low energy cost and a high efficiency index in feed/biomass conversion. These attributes make the consumption of edible insects an attractive alternative that could be used, in the medium term, to tackle the serious problems of chronic malnutrition worldwide, if the adequate measures were taken to promote its large-scale production and consumption.

The *Rp*, in particular its larva, is the insect most consumed by native indigenous communities throughout the Amazon basin. In many cases it is more than a product that is the object of simple collection, because its "cultivation" is induced by the indigenous population, using ancestral knowledge and proven techniques. Its consumption, within an indigenous society, acquires a broad and deep connotation: as food, medicine and symbol.

Despite its abundance and importance in the diet of indigenous people of the Amazon, as an alternative source of protein and fats, the *Rp* has been little studied by the members of the South American academia and, in general, by Latin American experts, except for the pioneering studies of a few Mexicans and

Brazilians. Most of the current contributions on the subject come from American and European researchers. However, for a decade, interest in edible insects has been increasing among researchers from the countries that make up the Amazon basin, especially from Colombia, Ecuador, Venezuela and Peru, focusing mainly on aspects related to the nutritional value of the insect. There is, however, a lot to investigate in relation to the socio-cultural aspects involved in the use of edible insects in the Amazon, as well as the feasibility of larger scale production and consumption in areas without a cultural history of insect consumption.

Author details

Rafael Cartay[1,3], Vladimir Dimitrov[1,2]* and Michael Feldman[1,4]

1 Research Department, Clarivate Analytics Ecuador, Manta, Manabí, Ecuador

2 Institute of Organic Chemistry with Centre of Phytochemistry (IOCCP), Bulgarian Academy of Sciences, Sofia, Bulgaria

3 Research Department, Univ Tecn Manabi, Portoviejo, Manabí, Ecuador

4 Boston University, Boston, Massachusetts, USA

*Address all correspondence to: vladimir.dimitrov@investigador.ec

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