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Eco-entrepreneurship at Brazilian Technological Incubators and Science Parks

PARALLEL 3

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Executive Summary

There is growing confidence about how entrepreneurship can improve environmental conditions and innovative companies, science parks and incubators are seen as fundamental, within this context. In Brazil, research into entrepreneurship does not yet cover the environmental aspect. This study aims to analyze the opportunities and challenges of technology parks and incubators, in the Brazilian eco-entrepreneurship related context, in order to understand the motivations, financial returns, products and services, organization and aspects of intellectual property, as well as introduce two eco-entrepreneurial spin-off case studies created in these environments.

Keywords: Eco-entrepreneurship, entrepreneurship, innovation, triple helix, incubators, science parks

1) Introduction

Sustainability is back on the global agenda. After intense debates in the late 70s and early 80s about the limits to growth, rising gasoline prices and deforestation, environmentally related issues received less attention from the European public in the 90s.

The timing was different in the U.S.A., with concern about sustainability, on the part of government bodies and companies, growing during the 1990s. With the new focus on climate change, we have recently seen the discussion about sustainable development return with increasing intensity. The threat of uncontrollable changes in weather patterns led to an unprecedented wave of public concern about the challenges presented by climate change. At the same time there is a growing awareness of social challenges, such as high levels of unemployment and increasing inequality and poverty in developing countries. At the same time, the scale of the sustainability challenge demands radical changes in the pattern of production and consumption and new directions in corporate strategy and consumer behavior (Wüstenhagen *et al.*, 2008).

Entrepreneurship classically emphasizes the identification of new opportunities for creating value for customers or users and commercially developing those opportunities to launch a profitable business (Shane and Venkataraman, 2000).

The opportunities identified can be for new products or services, new markets, new production processes, new raw materials, or new ways of organizing existing technologies, as first pointed out by Schumpeter (1934). Despite the fact that Schumpeter recognized that entrepreneurs can be motivated by non-economic purposes such as a desire for creativity or power, entrepreneurship theories in general stress the profit motive as one of the principal reasons for entrepreneurs and investors to develop a new venture opportunity. While all entrepreneurs deal with building activities that connect suppliers and consumers to create and modify markets, sustainable entrepreneurs differ from conventional ones in that they build bridges between the environment and social progress and market success (Schaltegger and Wagner, 2008).

Eco-entrepreneurship is a sub-area of research within the research into Entrepreneurship. In spite of growing interest in environmental entrepreneurship, the academic literature on the topic is still in a nascent stage, even in developed countries (Libecap, 2009). However, understanding the relationship between the environment and entrepreneurship is essential, and that also includes set-ups such as technology parks and incubators that can contribute to its development.

There is also growing confidence about how entrepreneurship can improve environmental conditions and, within this context, innovative companies, as well as science parks and incubators, are seen as fundamental.

Eco-entrepreneurship embraces a wide range of ideas, concepts, philosophies and practices. At its core, eco-entrepreneurship encompasses identifying opportunities and organizing to follow them up in a holistic way, in order to contribute to community sustainability. For this reason, eco-entrepreneurship can be applied to small businesses, grass-roots organizations, non-profits, foundations, and non-governmental organizations (NGOs), as well as local, regional, national and international government.

An 'ecopreneur' could be defined as "*An entrepreneur whose business efforts are not only driven by profit, but also by a concern for the environment*" (Schuyler, 1998).

However, eco-entrepreneurship should not be seen only as a motivator for creating new business opportunities. Its importance lies in its potential to become a leading force in the transition to a more sustainable business paradigm and demonstrate the benefits of adopting more sustainable practices in business (Sharper, 2010).

The issues raised by the eco-entrepreneurship concept could be associated with the Triple Helix Twins, which generates a mechanism for reproduction and transformation. On the one hand, the yang Triple Helix is related to the different forms of cooperative arrangements among university–industry–government to induce innovation, and on the other hand, the yin one of public–university–government signifies the dynamics of controversy over technological innovation (Etzkowitz and Zhou, 2006).

In Brazil, research into entrepreneurship does not yet cover its environmental aspect. This fact is reflected in entrepreneurship courses at universities, which are generally aimed at identifying opportunities and developing business plans. There is also no information or quantitative data to assess aspects of the market competition and intellectual property conditions for eco-businesses.

Concern about climate change is increasing in Brazil, as a result of awareness campaigns and perceptions of climate variations. According to research conducted by the National Confederation of Industry (CNI), 65% of the population believes that global warming is a problem that must be urgently dealt with, whereas in 2009, only 47% of Brazilians held that view. Moreover, 80% of Brazilians say they are concerned about the environment. Industry was pointed out by 38% of respondents as the main contributor to global warming, while 22% say that the citizens are the main culprit for the high temperature and 18% said that it is government. With more knowledge, an increasing proportion of the population is prioritizing environmental protection over economic growth (CNI, 2012).

This study aims to analyze the opportunities and challenges of science parks and incubators, in the Brazilian eco-entrepreneurship related context, in order to understand their motivation, financial returns, products and services, organization and aspects of intellectual property, as well as introduce two eco-entrepreneurial spin-off case studies created in these environments.

The paper proceeds as follows. The following section (Section 2) provides a review of the existing literature on eco-entrepreneurship, the relationship between incubators, science parks and the environment, taking into consideration the Triple Helix Model. Section 3 presents the methodology used in the research. Section 4 then analyses the two case studies. Section 5 concludes the paper, providing suggestions for further research and highlighting implications for entrepreneurs and policy makers.

2) Theoretical Framework

The term sustainable entrepreneurship combines two concepts: sustainability and entrepreneurship. Sustainable entrepreneurship has a variety of definitions. It may be characterized by some basic features of entrepreneurial activity and thus give priority to the initiative and skills of the entrepreneurial person or group seeking success in the market through the environment or social innovations and is less dedicated to management of the system or technical procedures (Schaltegger and Wagner, 2008). Another definition, offered by Hockerts and Wüstenhagen (2010) is related to the Schumpeterian notion of entrepreneurship as an innovative process that creates a market imbalance through the introduction of innovation that subsequently leads to imitation. Therefore, sustainable entrepreneurship may be defined as the process of discovery and exploitation of

economic opportunities that generates market imbalance and provokes the transformation of an economic sector in the direction of a more socially and environmentally sustainable situation.

It is considered an obligation in today's society to create entrepreneurs who understand the fundamentals of entrepreneurship and adjust them to the prevailing circumstances and needs, in order to address the concerns over sustainable development and mitigating the impact of global warming. The creation of environmentally related business opportunities means that an understanding of the relationship between the environment and entrepreneurship is essential. Nevertheless, there is growing confidence about how entrepreneurship can help to improve environmental conditions and, within this context, innovative companies are regarded as very important (Kotchen, 2009).

Since the institutions of higher education play a central role in regard to the environmental movement, both for having trained several leaders of this movement and for having introduced various practices influenced by this movement, the relationship of these institutions with eco-entrepreneurship and the production of eco-innovations is an important factor.

Etzkowitz (2008) discusses the transformation of the university, as a driver of the Triple Helix, through an extension of the traditional academic missions of research and teaching, with a new focus on economic and social development.

The central idea of the Triple Helix model is that the university is increasingly important for innovation in knowledge-based societies, replacing the company as the main source of economic and social development. The interaction between university-industry-government has seen the development of the incubator movement, interdisciplinary research centers and venture capital (Etzkowitz, 2008).

In the Triple Helix model's approach to innovation, the university-industry-government interaction creates a mutually beneficial relationship that seeks regional or national innovation in science and technology. Innovation can generate changes in the physical and social environment, and will inevitably tend to raise issues regarding sustainability. There are many definitions of sustainable development, including that this landmark description that was first presented in 1987: "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs*."(Brundtland Commission, 1987).

In order to include the sustainability dimension in the Triple Helix Model, Etzkowitz and Zhou (2006) conceptualize the Triple Helix as a dual set of helixes or Triple Helix twins. They proposed an alternative formed by a university-public-government (yin) Triple Helix as a complement to the university-industry-government (yang) Triple Helix. The Triple Helix twins create a mechanism for reproduction and transformation: the yang exemplifies the cooperative arrangements between university-industry-government to drive innovation, while the yin represents the controversies surrounding technological innovation. The dynamics of the Triple Helix twins indicates that both influences operate in tandem (Etzkowitz and Zhou, 2006).

The university-industry-government Triple Helix seeks to promote innovation and economic growth, while the university-public -government acts to balance innovation and growth so that it is not harmful to health and to the environment. The interaction of the Triple Helix twins is a form of social organization that is part of a positive business dynamic in civil society (Etzkowitz and Zhou, 2006).

Each part of the equation plays a different role in the development of society. They have different powers to drive innovation and sustainability, respectively. In the innovative Triple Helix the companies, as the major users of innovation, provide the blueprint, the entrepreneurial university provides impetus through knowledge and technology transfer, and government provides a combination of push and pull through its funding programs and regulation of activities (Etzkowitz and Zhou, 2006).

On the other hand, in the sustainable Triple Helix, the public, as the subject, pushes the formation of the helix and its evolution. In each Triple Helix, a third sphere is usually the creative element in

a *Tertius Gaudens* effect (the third party benefits from conflict between the other two). By driving the creative process, initiating dialogue and debate, one can generate or resolve controversy. The model consists of Triple Helix twins interacting, working together as a pair in a yin/yang dynamic that advances sustainable economic and social development (Etzkowitz and Zhou, 2006).

Incubators are organizations that provide an interface between the institutions promoting science, technology and innovation, so they are very suitable for study in the light of the theoretical model named the Triple Helix, which postulates holistic interaction between the three spheres - academia, industry and government - in the development of knowledge and innovation (Etzkowitz and Leydesdorff, 1998).

The incubator is an example of the Triple Helix model of university - company - government relations and is regarded as a hybrid organization, internalizing the relations between the three spheres and encouraging and creating room for interaction. The basic premise of the incubators is that the development of companies can be improved by organizing it in the form of an educational process. What is more, the technology incubator, like other organizations providing an interface between science and technology, is also one of the components of the innovation sphere (Etzkowitz, 2002). Science parks, meanwhile, are also considered to be an example of the Triple Helix model, illustrating the transition from university extension to drivers of urban regeneration, from an enterprise host to a generator of entrepreneurial universities. (Etzkowitz, 2008).

Previous research indicates that incubators can contribute to the environment in three different ways.

The first relates to supporting the creation of sustainable businesses. So incubators should be included among the public policy initiatives in support of the creation of sustainable businesses, due to their ability to support companies developing sustainable businesses through the early stages of their evolution and thereby enhance the success rate of this type of undertaking (Kabiraj *et al.*, 2010).

The second, suggested by Brio and Junquera (2003), indicates that incubators act as catalysts of positive action by the incubated companies, encouraging attitudes that are favorable in relation to environmental management and helping the company representatives to understand the interaction between their business and the environmental sphere.

And the third aspect, presented by Fonseca and Jabbour (2012), involves the inclusion of environmental sustainability indicators for evaluation of the incubator's practices.

As with incubators, science parks possess a high potential for developing new technology and sustainable enterprises, teaching and disseminating activities to a large number of companies for the purpose of promoting sustainable development.

In the last two decades, Brazil has been undergoing a transition from a top down system of innovation to a system that operates on various levels: local, regional, national and multi-national. In this new innovation structure, initiatives arise from various sources, whether companies, government institutions or universities, often working in association. The universities do not only play their traditional roles, but also assume some of the functions of other institutional spheres - business and particularly government - to help disseminate the knowledge produced, either through the creation of organizational mechanisms to transfer knowledge and technology or by playing a strategic role in regional innovation (Etzkowitz and Mello, 2004).

With the approval of the Innovation Law, in 2004, and the finalizing of its legislative details in 2005, the use in companies of non-refundable government resources to foster innovation was allowed in Brazil. Non-refundable public funds may be used for the development of products, processes or services that are considered to be innovative, thereby justifying the state assuming part of the development risk. As a result, programs to foster innovation arose, such as FINEP's Subvenção Econômica (Economic Grants).

In Brazil there has been a favorable environment to stimulate technological innovation in business, including through non-refundable financial resources, since the introduction of the Innovation Law (2004/2005) and the launching of federal government economic programs such as the (2011–2015) Greater Brazil Plan (2011), which seeks to continue and enhance the previously adopted industrial policy measures: PITCE – Industrial, Technological and Foreign Trade Policy (2003-2007) and PDP – Productive Development Policy (2008-2010), introduced in Brazil in 2003 and 2008, respectively.

The PINTEC Survey of Technological Innovation (2008), carried out by the IBGE (Brazilian Institute for Geography and Statistics), was aimed at analyzing the technological innovation activities of Brazilian companies. The survey showed that, of the 106,800 companies studied, about 41,300, (equivalent to 38.65%) implemented a new or substantially improved product and/or process between 2006 and 2008. However, 32.10% said that the innovation was in the process, through the acquisition of machinery and equipment (IBGE/PINTEC, 2008). The rate of innovation for new products in the Brazilian market is 4.10% and the rate of innovation of new processes in the domestic market is 2.32% (IPEA, 2011). Although the spin-off companies that develop innovative products and services for the country may be included among the small number of innovative local companies, it appears that they have failed to break the national tendency shown in previous surveys.

However, the process by which the results of research, or a potentially valuable technical idea developed at a university, are transformed into one or more commercially successful products, through the creation of academic spin-off companies, is highly complex, little documented and not sufficiently studied in developing countries, including Brazil (Botelho and Almeida, 2010).

The academic spin-off companies should seek, through university-company-government interaction, to produce the knowledge required for business success. For that to happen, universities must be alert to opportunities for sustainable environmental innovation and teachers and students must be able to create internal space for the development of research, education and sustainable economic development (Etzkowitz, 2008).

One of the leading questions that this new area of research has raised is whether eco-entrepreneurship would differ from the usual entrepreneurship pattern. For some authors, a difference will arise due to the nature of the products created and the intrinsic relationship to the public interest.

3) Methodology

Our analysis was carried out using the literature on the theoretical framework of the Triple Helix model, eco-entrepreneurship and the relationship between incubators, science parks and the environment, and is also based on documentary research and field work. The two case studies took place at two spin-offs in the states of Rio de Janeiro and São Paulo, Brazil. One is from an incubator and the other is from a science park. The gathering of data was performed through interviews with company managers and representatives, using questions based on earlier information. In addition, use was made of the information obtained from marketing documents produced by the companies themselves and posted on their own websites.

4) Findings and interpretation

4.1) Case studies

The selection of companies to be included in the case studies was based on the characteristics of their innovation processes within the Brazilian context.

The first company is Bug Agentes Biológicos, a biotech company that produces biological control agents. These agents are mostly wasps that are parasites of the eggs of the major pests afflicting crops. The company was founded by post-graduate students of São Paulo University's Luiz de Queiroz College of Agriculture (Esalq/USP), stimulated by the master's dissertation of one of the founders. The company was incubated at the Esaltec Technological Incubator and received funding from FAPESP (Foundation for Research Support in the State of São Paulo), through PIPE (Innovative

Research in Small Enterprises), and seed money from Criatec. The company was ranked by Fast Company magazine as the 33th most innovative company in the world in 2011.

As mentioned, Bug Agentes Biológicos is a company that produces and markets biological control agents. These agents are mostly wasps that are parasites of the eggs of the major pests attacking agricultural crops. Bug helps to improve biological control techniques, since all species of plants and animals have natural enemies (parasitoids, predators and pathogens) that attack them during their various stages of life. It is important to restore the original balance of nature that was disturbed by mankind, with the introduction of the agricultural system and biological controls that are currently in use, and among the stages of a pest management program are measures used to keep pests below the economic damage level, along with physical, behavioral and genetic control methods, including plant resistance to insects, among others that take economic, ecological and social criteria into account.

The company was founded in 1999 at São Paulo University's Luiz de Queiroz College of Agriculture, in the municipality of Piracicaba. The creative initiative came from the agronomists Danilo Scacalossi Pedrazzoli and Diogo Rodrigues Carvalho, who at the time were studying for their master's degrees under Professor José Roberto Postali Parra.

One interesting feature was the choice of the name, which reveals aspects of the time it was founded and the market strategy. *"We chose the name Bug because it means insect in English. And also because it was a name known around the world at the time, due to the notorious 'millennium bug', which was expected to affect all the computers on the planet. And yet another reason was to differentiate ourselves from all the 'bio' companies in Brazil...."*[1]

Biological control is not new. What enabled Bug to become one of the largest Brazilian producers of insects for biological pest control was to improve the technique by means of quality control of the organisms produced in the laboratory, where a variety of biological characteristics, such as egg-laying capacity, hatching, pupal weight and percentage of deformities in pupae and adults, are evaluated over the course of generations. Transport is carried out using an innovative form of packaging, developed and patented by the company.

Bug's various units work like insect factories, with real production lines. The Piracicaba unit produces *Cotesia flavipes*, which is the agent for good against the sugarcane borer (*Diatraea saccharalis*). The other two units produce the wasp *Trichogramma*. Moreover, thanks to PIPE, the company has a partnership with Esalq, allowing it to conduct research and quality control of the insect production using the college labs.

Until the 1980s, the damage caused by the *Diatraea saccharalis* to sugar and ethanol producers amounted to US$ 100 million per year in the state of São Paulo alone. With the introduction and release of *Cotesia flavipes* in that state, the sugarcane borer infestation rate, which was 8% to 10%, plummeted to 2%, resulting in annual savings of approximately US$ 80 million, by reducing the losses from US$ 100 million to US$ 20 million a year[2]. The main cause of the damage is red rot, which is not directly caused by the caterpillar, but by perforating the sugarcane stalk in order to lodge itself inside and complete its life cycle by turning into a moth, it paves the way for the red rot fungi to attack the plant, causing chemical changes that reduce the production of sugar and alcohol. With a productivity rate of 80 tons of sugar cane per hectare, losses from each 1% of borer infestation amount to 616 kilos of sugar cane, 28 kilos of sugar and 16 liters of alcohol. And whereas combating the pests in the fields using insecticide costs US$ 23 per hectare, control through the *Cotesia flavipes* costs just US$ 7.5 and using *Trichogramma spp* it is US$ 18. Considering that Brazil has 5 million hectares under cultivation, producing 387 million tons of sugar cane, the savings are considerable.[3]

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[1], http://www.inovacao.unicamp.br/pipe/report/080225-bug_agentes.php accessed on January 15, 2013.

[2] Wilson Carlos Pazini, Agronomist, College of Agricultural Sciences, Jaboticabal campus of the São Paulo State University (Unesp), São Paulo, Brazil. http://www.inovacao.unicamp.br/pipe/report/080225-bug_agentes.php

[3] Mauro Sampaio Benedini, Product regional manager at the Canavieira Technology Centre (CTC), a private not-for-profit association for the purpose of technological development in the sugar cane, sugar, ethanol and bioenergy sector. http://www.inovacao.unicamp.br/pipe/report/080225-bug_agentes.php.

The explanation of Fast Company magazine for choosing Bug Agentes Biológicos as one of the world's most innovative companies in 2011 emphasized that Bug mass produces wasps to combat insects and larvae that threaten sugar cane and soybean crops, two of the largest and most profitable agricultural crops in Brazil. Moreover, that in 2011, it began to perfect a way to release the wasps into sugar cane plantations in the same way that insecticides are sprayed on crops, from low-flying aircraft.

Brazil is the world's third-largest agricultural exporter (behind the United States and the EU), and it recently passed the U.S.A. as the largest consumer of pesticides. This high level of consumption is of concern to ANVISA (National Health Surveillance Agency), which released a study on the pesticides market in Brazil, showing a 190% sales increase between 2000 and 2010, more than twice as fast as the world average, which was 93% over the same period. In 2010, according to ANVISA, the domestic pesticide market showed a turnover of US$ 7.3 billion, representing 14.25% of the world total, which amounted to US$ 51.2 billion that year.[4]

In an effort to curb the spread of chemical products in the cultivation of sugar cane, Bug started producing and using the wasp *Trichogramma galloi*, an insect that had not previously been used on that crop, in the plantations. The area in Brazil under sugar cane cultivation that was controlled using this insect increased exponentially, reaching 500,000 hectares. Alexandre said, "It is a biological control program that is on its way to becoming one of the largest in the world." In addition to the insects to control sugar cane pests, the company began producing the wasps *Telenomus podisi* and *Trissolcus basalis*, which are parasites of the eggs of insects that attack soybean plants. Brazil is the world's largest producer of soybeans, with a planted area greater than that of sugar cane.[5]

Among the company's interactions with the three spheres of the Triple Helix one should highlight: the university sphere - Luiz de Queiroz College of Agriculture (Esalq), São Paulo University (USP); government sphere - financial support from the FAPESP program PIPE (Innovative Research in Small Enterprises); and in the company sphere - investors such as the BNDES (Brazilian Development Bank), through the Criatec Fund, a venture capital seed fund.

The second company is Extracta Moléculas Naturais, located in the Bio-Rio Science Park, Rio de Janeiro. It was chosen because of its initiative in setting up a Biodiversity Chemical Database, a collection of 30,000 samples of extracts isolated from Brazilian plant biodiversity, in the Atlantic Forest (Rio de Janeiro) and Amazon Forest (Belem). This collection is the first private collection accredited by CGEN (Genetic Heritage Management Council), under the aegis of the Ministry of the Environment. The company does not work with endangered plants.

Extracta Molecules Natural was founded in 1998 by a group of scientists at the Federal University of Rio de Janeiro (UFRJ). One of its founders, the doctor, PhD in medicine and professor at UFRJ, Antonio Paes de Carvalho, has had a long career as a researcher-entrepreneur. In 1983, together with his brother Gabriel Paes de Carvalho, an engineer, he founded his first company, Biomatrix Ltda., and they chose to work in the area of plant biotechnology, since a business analysis indicated that, due to the role of agriculture in the country's economy and the development of research in this area, it would be the best economic sector in which to set themselves up. The preliminary studies were funded by venture capital from Rio de Janeiro (Petróleo Ipiranga, Monteiro Aranha and private individuals). Professor Carvalho was also the founder of the Brazilian Association of Biotechnology Companies (ABRABI) and its president for the period from 1986 to 2006, and originator, General Secretary and President of the BioRio Foundation, which managed the Rio de Janeiro Biotechnology Hub. He is also the founder and controlling shareholder of AVFS Participações e Consultoria Ltda., a company raising venture capital for high-tech start-up enterprises.[6]

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[4] http://www.ihu.unisinos.br/noticias/508812-agrotoxicos-um-mercado-bilionario-e-cada-vez-mais-concentrado,
A report by Raquel Júnia, published in April through the Joaquim Venâncio Polytechnic School of Health (EPSJV/Fiocruz), accessed on March 03, 2013.

[5] Alexandre de Sene Pinto, a founding partner of the company http://revistapesquisa.fapesp.br/wp-content/uploads/2012/05/Pesquisa_195-26.pdf, accessed on March 03, 2013.

[6] Biomatrix Ltda. was a company producing micropropagated seedlings through *in vitro* cultivation. The name was changed to Biomatrix S.A. in 1985, when Agroceres became the controlling shareholder. The company specialized in woody plants (especially eucalyptus) and the production of virus-free seed potatoes and its new bi-national potato business with Argentina was taken over by Agroceres. In 1986, the company set up in Teresópolis, in the state of Rio de Janeiro. In January 1990, since the business had not yet reached break-even point, Agroceres suspended its activities. In 1992, a Plant Biotechnology Program

Extracta Molecules Natural was the first private company to obtain a special license from the Ministry of the Environment to access the Brazilian genetic heritage and set up a collection of commercial samples of the country's biodiversity. The authorization was granted by CGEN (Genetic Heritage Management Council) in June 2004. Creating the conditions for setting up this collection had begun five years earlier. In 1999, the firm closed a US$ 3.2 million contract with Glaxo Wellcome (now GlaxoSmithKline), at that time the largest technology outsourcing agreement in the southern hemisphere. Glaxo's interest was to have a large number of natural elements extracted from Brazilian flora tested against specific biological targets, thereby enabling identification of potential new drugs. Three years after the contract was signed, Extracta had isolated 10 pure compounds for Glaxo. Following the merger of Glaxo and SmithKline, the new company did not want to exercise the contractual option of an exclusive sales license. The agreement was terminated in 2003, with the donation of all the equipment, materials collected and future rights to Extracta. It was from that material that the Extracta Biodiversity Chemical Database was formed, with more than 30,000 samples, the largest plant sample database for research, development and innovation in Latin America. In total, there are the ten pure compounds already mentioned, an additional 14, plus 10,608 alcoholic extracts and 29,847 fractions, making a total of 40,479 substances ready to be tested against any biological target. It is the largest and most detailed collection of natural products in Latin America. An industrial secret, this material is the heart of the business.[7]

According to its website, "Extracta neither produces nor sells plant extracts. As a research services company it sells only knowledge and technology".[8]

Using the Extracta Biodiversity Chemical Database, bio-prospecting and the development of new active ingredients is carried out, which is applicable to a broad range of industrial interests in the health, agriculture and environmental management fields.

Extracta has a wide network of institutions with which it interacts: in the university sphere - notably, the Federal University of Rio de Janeiro (UFRJ), the Carlos Chagas Filho Biophysics Institute, the Professor Paulo de Goes Microbiology Institute, the Biology Institute (RFA Herbarium, accredited by CGEN), the Institute of Biomedical Sciences and Institute of Chemistry, the Federal University of Pará (UFPA): Department of Chemistry and Extraction Center; the Emilio Goeldi Museum of Pará: MG Herbarium (accredited by CGEN); the State University of Rio de Janeiro (UERJ): Microcirculation Research Laboratory, and the Foundation in Support of Research Development (FADESP - Federal University of Pará). In the sphere of government, interaction is conducted with research support foundations that grant funding for R & D, such as FAPERJ (Carlos Chagas Filho Foundation for Research Support in the State of Rio de Janeiro); FINEP (Funding Agency for Studies and Projects), and with the government regulatory body CGEN (Genetic Heritage Management Council / Ministry of the Environment); and in the company sphere - AVFS Participações e Consultoria Ltda., ABRABI (Brazilian Association of Biotechnology Companies), and a hybrid organization, the Bio-Rio Foundation, running the science park where Extracta is located.

4.2. Analysis

The case studies presented in the previous section refer to two different spin-off companies; one linked to the pharmaceutical sector and the other in agribusiness; one located in a science park, and the other from an incubator; of different sizes, stages of development and technological density, among other characteristics.

From the point of view of the study, what we want to analyze are their relations with the concept of eco-entrepreneurship and contributing to sustainable development, as well as the interactions of two hybrid organizations (science park and incubator) with the spheres of the Triple Helix twins.

The relationship of the companies to the concept of eco-entrepreneurship and the contribution to the sustainable development of an economy and a society depends on how their core businesses deal with solutions to environmental and social problems, whether they provide environmentally and socially superior products, and whether their sustainable innovations substantially influence the

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was set up at the UFRJ to seek convergence between plant improvement and the new plant biotechnology. Almeida, M. Interview with Antonio Paes de Carvalho, Extracta Moleculas director, in January, 31, 2013.

[7] Almeida, M. Interview with Antonio Paes de Carvalho, Extracta Moleculas director, in January, 31, 2013.

[8] http://www.extracta.com.br/?sec=4&lang=en

mass market and society in general. The contribution may be considered substantial if it meets at least one of three conditions: it has a strong influence on the market, due to a sizeable market share; it has a strong capacity to create superior solutions that are environmentally sustainable; or it has strong social and political influence that includes the development of trends, fashions, values, political opinions and structures. In its most advanced forms, sustainable management becomes sustainable entrepreneurship if it fulfills all the requirements (Schaltegger and Wagner, 2008).

Sustainability management by companies can also be analyzed according to the proposal defined by Schaltegger and Wagner (2008) based on the priority in formulating the company's sustainability goals. Therefore, one considers: 1) low - when the environmental and social requirements are seen as tasks; 2) Medium - if sustainability issues are treated as complementary to normal business; and 3) High priority - if sustainability is considered as integrated within the core business.

From this perspective, when analyzing the three companies being studied, one sees the following, as shown in Table 1.

Table 1 – Sustainability Management

Company	Sustainability Management Priority
Bug Agentes Biológicos	High
Extracta Moléculas Naturais	Medium

Source: The author

The core business of Bug Agentes Biológicos is focused on the production and sale of biological control agents for agriculture, a technique that circumvents the need for pesticides in agriculture, which are highly damaging to the environment and living creatures. Thus, sustainability management is a high priority, since sustainability is integrated into the core business.

As for Extracta Moléculas Naturais, its mission "is to add value to the Brazilian genetic heritage, through the discovery and development of innovative products for industry, with emphasis on human health, agriculture, environmental protection and new products in the areas of energy and mining." Sustainability is marginal to its core business, since it is necessary that biodiversity be maintained in order to continue to study the forests and collect new extracts, and conduct laboratory research to identify their possible applications. The decision not to study endangered plants shows respect for nature. However, one can see that sustainability issues are treated as complementary to normal business, and for this reason its environmental management is classified as medium.

Since this is ongoing research, data have not yet been collected that would enable us to assess the sustainability management in relation to the two other criteria: market influence and social and political influence.

Although the three companies were established to explore anticipated opportunities arising from the growth of the environmental movement, through the growing appreciation of the importance of biodiversity (Extracta) or criticism of the Green Revolution (Bug Agentes Biológicos), that does not mean that there was no technological controversy or competition with established models.

In the two cases analyzed, the interaction with the three spheres university-company-government, as well as contraposition in relation to the "Public" element of the helix, are summarized in Table 2.

Table 2 – Triple Helix Interactions

Company / Sphere	Bug Agentes Biológicos	Extracta Moléculas Naturais
University	Luiz de Queiroz College of Agriculture (Esalq), of the São Paulo University (USP)	Rio de Janeiro Federal University Pará Federal University State University of Rio de Janeiro Emilio Goeldi Museum FADESP

Industry	Brazilian Development Bank (BNDES), through the Criatec Fund, a seed capital fund.	Brazilian Association of Biotechnology Companies
Government	FAPESP Program Innovative Research in Small Enterprises (PIPE)	FAPERJ Finep Genetic Heritage Management Council / Ministry of the Environment (CGEN)
Hybrid	EsalqTec – Technological Incubator ESALq/USP	Bio-Rio Foundation Science y Park
Public	Critical of the use of pesticides proposed under the Green Revolution	Appreciation of biodiversity and alternative health treatment methods

Source: The author

Table 2 shows the three (yang) spheres of the Triple Helix, exemplifying the cooperative arrangements between university-industry-government to drive innovation and economic growth.

In the innovative Triple Helix, the companies, as the main users of innovation, provide direction to the helix, the entrepreneurial university provides impetus through knowledge and technology transfer, and government provides a combination of push/pull through its funding programs and regulation of activities. On the other hand, the Triple Helix yin (public – university – government) represents the dynamic of the controversy revolving around technological innovation (Etzkowitz and Zhou, 2006).

In the case of Bug Biological Agents constant opposition to the pesticides industry indicates that the "challenge in the business of biological pest control is to demonstrate the efficiency of the system and overcome the resistance of the farmer... It is necessary to show that biological controls produce similar results to chemical ones and in many cases can be even better, without causing harm to employees and the environment"[9].

In the case of Extracta, there are differences, because not only is there a high level of risk in the innovation process, but also an adverse environment that hinders its full development. In Brazil, investment in pharmaceutical R&D is low. The Brazilian pharmaceutical market, in spite of being among the top 10 globally, has not been able to attract a pharmaceutical company with a reasonable degree of technological density. The industry concentrates almost exclusively on the production of medicines and marketing. Hence the more technology and science intensive health-related activities have not been incorporated within the pharmaceutical chain.

5) Conclusions - Policy implications and directions for further research

A key feature of this research was to initiate the study of eco-entrepreneurship in Brazil, an area as yet untapped, from the point of view of research into entrepreneurship.

Another aspect was to begin a mapping and analysis of companies that, by their characteristics, can be classified as eco-entrepreneurs, so that one can understand in the future whether this particular segment has faced greater difficulties than other companies setting up in Brazil.

This also facilitates understanding, through case studies, of the potential of incubators and technology parks to promote the creation of environmentally sustainable companies within the Brazilian context. To this end, it would be useful to extend the research into other dimensions that would allow assessment of the sustainability management in relation to two other criteria: market influence and social and political influence, as well as to increase the number of companies studied.

Consequently, analysis from the point of view of the Triple Helix Twins is shown to be appropriate, since the interaction between the University-Industry-Government helix and the University-Public-

[9] Heraldo Negri de Oliveira, one of the owners of Bug Agentes Biológicos. Available at http://www.amcham.com.br/regionais/amcham-sao-paulo/noticias/2012/desafio-no-negocio-de-controle-biologico-de-pragas-e-mostrar-eficiencia-do-sistema-e-vencer-resistencia-do-agricultor-segundo-dono-da-bug/?searchterm=None, accessed on May 20, 2013.

Government helix makes it possible to specify the controversies and difficulties encountered by these companies in the innovation process.

Incubators and technology parks, as hybrid organizations of the Triple Helix Twins that participate in public policy on innovation, also help to offset the adverse conditions encountered by innovative companies creating technologies that challenge large established corporations. So, from the perspective of eco-entrepreneurship and eco-innovation, they are elements of support to environmental sustainability.

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