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Evaluation and Analysis of the Procedures and Methods Used to Translate Several Articles from English into Spanish and From Spanish into English for Universidad Nacional

Thesis Submitted to Obtain the
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To my Angels in Heaven, my husband, Alfredo and my mom, Rosita, for their support and love while they were here; to my daughters, Brenda and Leila, for their unconditional love and support throughout this process, and to my granddaughter, Luciana, for her love.

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Abstract

This thesis is focused on the evaluation and analysis of the procedures and methods used to translate several articles from “Revista Mexicana de Biología” from English into Spanish and form Spanish into English. Such articles were translated and analyzed taking into account the different methods and procedures proposed by numerous translators in order to render a more natural and faithful translation that maintains the intention of the author, as well as the translator’s.

Likewise, the instruments used were of great importance to fulfill the analysis of the texts according to Newmark, the analysis of the translation techniques through the process of color-coding, as well as the creation of two glossaries, one in English and one in Spanish, to help the translator keeping the coherence and parallelism of the translated texts.

The main objective of the translator was to reproduce several texts for students who do not speak one the languages and likewise, to provide the UNA (Universidad Nacional Autónoma de Costa Rica) with a high-quality work that allows them to better comprehend the documents in a way that is accurate, natural, and fluent.

Resumen

Esta tesis está enfocada en evaluar y analizar los procedimientos y métodos utilizados para traducir varios artículos de la "*Revista Mexicana de Biología*" de inglés al español y del español a inglés para la Universidad Nacional Autónoma de Costa Rica.

Dichos artículos se tradujeron y analizaron tomando en cuenta los diferentes métodos y procedimientos propuestos por numerosos traductores para realizar una traducción que fuera natural y fiel a la intención del autor y la del traductor. Asímismo, los instrumentos utilizados fueron de suma importancia para aplicar el análisis del texto según Newmark, el análisis de las técnicas de traducción a través del procedimiento de codificación de colores, e igualmente para la elaboración de dos glosarios, uno en inglés y otro en español para ayudarle al traductor a mantener la coherencia y el paralelismo en los textos traducidos.

El objetivo principal del traductor fue reproducir varios textos para la Universidad Nacional Autónoma de Costa Rica y para estudiantes que no hablan alguno de los dos idiomas, e igualmente proveerle a la institución de un trabajo de alta calidad que les permita comprender los documentos en una forma más natural, exacta y transparente.

CHAPTER I

Introductory Framework

In order to communicate a message from one language to another, there are methods and procedures that are going to be implemented in this paper with articles from the library of the Universidad Nacional. The present chapter initiates the research and evaluation of the different aspects, techniques and methods used in this investigation which will be useful for both the UNA and the UIA. Some aspects are: problem statement, objective of the investigation, justification of the study, background and scope. As we all know, translating is one of the most ancient professions in the world and started with the spoken language in ancient times. After that, many people have dedicated their work and time in translating different document, books, articles, etc.

1.1 Problem statement

Translation is an activity carried out by every culture since the beginning of human kind. Translation is to express in a language what it is written or expressed before in another language. Translation typically has been used to transfer written or spoken source language to equivalent target language texts.

To obtain excellent results in a translation, it is necessary to achieve a good comprehension of the text to be translated. It is also important to analyze the methods and procedures that will be applied. This research is based on the translation of several documents for the UNA and the UIA, that will help students from the institution to understand the documents.

The research question will enlighten the readers to understand and learn new issues that will serve as a guide throughout the translation process. In this paper, the researcher will point out the importance of translation, as well as the usage of the procedures that will be applied.

The first written translations were the Bible and biblical texts translated by the Jewish from Hebrew to their own languages. In the second century AD, the Bible was translated from Greek to Latin. (History of Translation, 2012).

In the twentieth century, translation has experimented a huge growth with help of linguists. Translation is present in any form of our environment, including movies, web pages, songs and books. However, people don't notice the importance of translation in our culture.

The purpose of this translation is to reproduce various texts, related to Biology, in order to make them available to students who do not speak any of the language. For these reasons, the present research pretends to show the importance of translation in our daily life, and in this specific case, articles from the magazine "Revista Mexicana de Biología".

1.2 Objectives

An objective is a purpose that can be reasonably achieved within the expected timeframe and with the available resources. The objective summarizes what is to be achieved by the study. It is also a concrete statement describing what the research is trying to achieve. A well-worded objective will be mart, specific, measurable, attainable, realistic, and time-bound. It should also be relevant, feasible, logical, observable, and unequivocal. The objectives should be presented briefly and concisely. They cover the different aspects of the problem and their contributing factors in a coherent way and in a logical sequence. To state the objectives, the researcher should use action verbs, such as identify, evaluate, analyze, find out. Once the researcher has clearly defined the objectives, it will be easier to focus on the study at hand.

The formulation of objectives will help the researcher to avoid the collection of data which is not strictly necessary for understanding and solving problem. The objectives are the specific accomplishments the researcher hopes to achieve by the study.

An objective includes obtaining answers to research questions or testing the research hypothesis. Properly formulated, an objective will facilitate the development of the research methodology and will help to orient the analysis, interpretation, and utilization of data. Research Objectives, Jayesh Patidas (2013).

1.2.1 General objective

- To evaluate the translation procedures and methods used to translate several documents from English into Spanish and from Spanish into English for the Universidad Nacional.

1.2.2 Specific objectives

- To translate the documents from the magazine “Revista Mexicana de Biodiversidad” from English into Spanish and vice versa
- To apply various translation techniques to the documents in order to achieve communicative text
- To evaluate the effect of the translation techniques applied on the documents
- To create a glossary with the most relevant terminology found in both texts
- To apply various translation techniques to the documents in order to achieve and to create a faithful translation

1.3 Justification of the Study

This investigation is for professors and students of the Faculty of Exact and Natural Sciences at U.N.A. The translated articles taken from the magazine “Revista Mexicana de Biodiversidad” published by the “Instituto de Biología de la U.N.A.M” will be used for their trainings, speeches, conferences, and tutorials. This research is important for the staff and students to carry out some academy activities. In this aspect, both, students and professors, will understand the content of the articles published in the magazine.

1.4 Antecedents

It is necessary to look for previous theses and articles that contain the main aspects for a natural translation.

In the article published in the Internet by Ana Zamora Hermosilla, “La traducción y su importancia” (Translation and its Importance) she refers to how translations were carried out in ancient times. As a first sign, archeologists found in the Delta of the Nile River in Egypt, what they called “The Roseta Stone” (“La Piedra Roseta”) as the first sign of writing. This stone contained different signs from different hieroglyphics in different languages, such as Egyptian and Greek. The Rosetta Stone contained three pieces of writing that said the same thing in two different languages. “The pieces were writing in Egyptian and Greek, and three different scripts were used, hieroglyphic, demotic (that was the common script in Egypt) and Greek, that was the language of the rulers of Egypt at that time”. History of Translation, (2012).

The next translation known was the Bible. This book was translated into different languages through history, for example, from Greek to Latin or Jewish.

The story of the translations of both, the Old Testament and the New Testament, lasted a long period. The Old Testament was originally written in Hebrew but there was also some parts that are written in Aramaic. The Latin version of the Old Testament is called “Vetus Latina”. The New Testament was first written or recorded in Greek and other parts were written in Aramaic. When the apostles spread the Christianity, new translations were needed so the documents were translated into Coptic, Ethiopian, Gothic, and Latin. (History of Translation, 2012)

The only translation of the Bible authorized by the Catholic Church at that moment was the one called “La Vulgata”. This translation was made by Saint Jerome and because of his work he is the patron of translators. The first version of this Bible was printed by “Gutemberg in 1452”. (History of Translation, 2017).

In the Middle Ages, the city of Bagdad became the center of translations. Pieces of work related to Philosophy and Science, previously written in Greek, were translated into Arabic. Spain was the main entrance for knowledge of the Arabic world because at that time Spain was dominated by the Arabic, and Jewish and Christian people lived in this country. The city of Toledo was at that time the neuralgic center where these three cultures used to live together, and the way they joined together was shown in several translation projects of the different Alexandrian Greco-Latin classic texts from the Arabic into Latin. The major documents that were translated in the School of Translators of Toledo during the XII century, were the ones related to Theology and Philosophy. (History of Translation, 2017)

Another article related to the history of translation is History of Translation, 2017. This article contains several pieces of information related to translations in Ancient times. This article refers to books like *The Odessy* by Homer. Here they talk about how this book was originally written in Greek, and then it was translated into Latin by Livio Andronico.

The author of this paper found a thesis in the Internet entitled “Competencias documentales del profesional de la traducción: optimización del proceso de documentación en la traducción” by Sonia Arroyo Izquierdo published in 2012 by the “Universidad de Salamanca, Facultad de Traducción y Documentación, Grado en Traducción e Interpretación, Trabajo Final de Grado”. This work is a guide for the documentation process, types of information resources, sear for information, and it also offers some other pieces of advice.

The translator must be updated with the different resources available nowadays. The translator must have cleared the kind of information that he or she is going to need when translating. The excellence in translation depends on the correct understanding and techniques the translator is going to use.

The translator found some works dealing with translation, for example, “School of Education and Foreign Languages. *Effect of the procedures and methods used to translate the Documents* “Plan Nacional de Ciencia, Tecnología e Innovación from Spanish into English for Ministerio de Ciencia, Tecnología y Telecomunicaciones and Social Scientist in Agricultural Research: Lesson from the Mantaro Valley Project, Perú from English into Spanish for Universidad Nacional de Costa Riva, written by Laura Osorio Cano in December, 2017.

The translator found some works dealing with translation. For example, “School of Education and Foreign Languages. “Effect of the procedures and methods used to translate the Documents “Plan Nacional de Ciencia, Tecnología e Innovación from Spanish into English for Ministerio de Ciencia, Tecnología y Telecomunicaciones and Social Scientist in Agricultural Research: Lessons from the Mantaro Valley Project, Perú from English into

Spanish for Universidad Nacional de Costa Rica, written by Laura Osorio Cano in December, 2017.

The translation of both documents was based on different methods, procedures, and techniques. The author of this thesis quoted different authors in order to base the information on trustworthy sources. The author explains how in Ancient times people spoke different languages. At some point in history, these people couldn't communicate among themselves because of the confusion that was caused with the fallen of the Babel Tower. From that moment on, many different languages were created and people needed the help of others to translate what other people were saying.

In this translation, the author explained, step by step, the different methodologies used in this work as well as the different scales for the text analysis, that is, the stylistic scales, the scale of formality, the scale of generality or difficulty and the scale of emotional tone; the text function -informative, expressive and vocative; types of translations – semantic translation, communicative translation; translation techniques – transposition, modulation, amplification, omission, explanation, literal translation, false cognates. In addition, the author included the methodological framework, the research method, selection and description of population; the implemented strategies, the data collection instruments with the color coding. Further analysis and interpretation of the results is made in Chapter V. The paper also included a Glossary with new words in both, English and Spanish, to make easier the understanding of the content.

The title of the second thesis is: *Translation and Analysis of the Procedures and Methods Used to Translate the Documents* "Meditaciones en Familia" from Spanish into English and "Solid Answers" from English into Spanish for "Focus on the Family" by Juan Carlos Calderón Cascante. This thesis is based on scientific methods to prove a theory.

Besides this method, the translation is based on different aspects that help the reader to have a full comprehension on the topic. The author also used different aspects such as analysis of the grammar structures, vocabulary, text style and some other aspects that create a more accurate translation.

1.5 Scope

With this investigation the translator expects to cover the first hundred pages of the magazine “Revista Mexicana de Biodiversidad” from Spanish into English and from English into Spanish. The rest of the pages are going to be translated for other group of students. The use of a good dictionary, and a Biology dictionary is very important and helpful for the researcher because the language of the translation is very technical and scientific. Reading the translation in advance, whether in English or Spanish, will help the author to acquire knowledge on the topics of the translations at hand. Another important aspect is the use of Latin names for most of the nature creatures. As most of them do not have a translation in English or Spanish, the translator decided to maintain the names in Latin.

This research has been designed to have different goals which have been presented at the beginning of the research. Some of the main objectives are the understanding of the texts, as well analysis of the methods and procedures applied throughout the translation process. Another purpose is to provide the UNA and the UIA students with a translation that contains the different methods in both translations.

CHAPTER II

THEORETICAL FRAMEWORK

Theoretical Framework

The theoretical framework is the structure that can hold or support a theory of a research study. It is a group of related ideas that provides guidance to a research project or business endeavor (Theoretical Framework, 1994). Moreover, it can be stated that a theoretical framework is a collection of interrelated concepts. It guides the research determining what things you will be measured, and what statistical relationship the researcher will look for.

In this chapter, the researcher looks to inform the reader valuable information about the steps to be followed in relation to the text analysis, the different types of translation methods, as well as the translation techniques that will be used in the translation process. In addition, it will be provided information about an important tool for the reader, which is the glossary that will work as a point of reference and will give a clear meaning of the words and terms that can mislead the reader.

2.1 Text Analysis

According to Newmark, (1988), understanding the text requires both, a general and a close reading. The general reading is carried out to find out the intention of the texts, this cannot be separated from understanding it, as they go together. Nord, (2005), states that in the process of translation, the researcher must make an intense analysis of the text that is going to be translated in order to have a full understanding of the message. For this reason, in this chapter the reader will find several specific aspects such as text styles, stylistic scales, text function, translation methods, the different translation procedures used by the researcher, and a useful glossary for readers and translators.

Newmark (1988) adds that the researcher must read the entire document in order to achieve two things: first, understand what the document is about and second, to analyze it from the translator's point of view. Therefore, it is important to determine the intention and style of writing of the text, the translation techniques, as well as recognizing particular and common translation problems. The intention of the text represents the SL writer's attitude to the subject matter. Newmark says that usually the intention of the translator is identical with that of the author of the SI -text. It can be defined as a mean that helps the translator as a guide to guarantee cohesion between the ideas expressed in sentences of any document. The translator must need to take into account several sources to ensure the cohesion of ideas such as theme and rhyme, anaphoric references, enumerations, opposition or dialectic, conjunctions, initial negatives and punctuation.

2.1.1 Text Styles

The text style is in general the type of document in which the translator will work on. According to Newmark (1988, p. 13), there are four types of texts:

- Narrative: is emphasized mainly on verbs, or for English, "dummy" or "empty" verbs plus verb-noun or phrasal verbs and also in sequences events. (He made a sudden appearance) (He burst in).
- Description: the translations are characterized by mainly focus on linking verbs, adjectives and adjectival nouns.
- Discussion: is a treatment of ideas, with emphasis on abstract nouns (concepts), verbs of thought, mental activity, logical arguments and connectives.

- Dialogue: are the texts focused strictly on colloquialisms.

2.1.2 Stylistic Scales

The stylistic scales help the translator to recognize the type of text to be translated as well as the kind of vocabulary used by the author. Newmark (1988, p. 14), states that the stylistic scales have three different tones: scale of formality, scale of generality of difficulty tone, and scale of emotional tone, and they are explained as follows:

2.1.2.1. Scale of formality: this scale is compound by eight categories:

Officialese: texts that contain officialese formality in the context are mainly the ones used for laws already imposed or strictly governmental documents.

Official: it is almost the same as the officialese one with but with the difference that official one has a more informative purpose.

Formal: these texts are characterized by being used in fields where is required a more complex language, for example business or company documents.

Neutral: there is the neutral formality in texts concerning more on persuading the message among the people with a language that is familiar for every person no matter the educational level.

Informal: it can be taken as similar to neutral, however, informal texts are characterized by containing a low level of education.

Colloquial: it can be taken as a part of the informal, but it is well known by containing colloquialisms among its context.

Slang: it is also similar to the informal one, but different this one is directed only to the specific society that uses that type of language.

2.1.2.2 Scale of Generality or Difficulty:

According to Newmark (1988), this scale determines the level of complexity of the documents. Newmark provides the following list, in which this scale is divided in: Simple, Popular, Neutral, Educated, and Technical.

Simple complexity in texts is basically texts with low difficulty of terminologies

Popular complexity means that the context of a document contains vocabulary of today's life.

Neutral complexity in texts is when there is a balance of difficulty in its context, that is not too complex not too simple.

An educated complexity is found in texts that are used for educational or instructional purposes, most of them are used in universities or schools.

Technical texts that contain technical vocabulary found in documents, such as operator manuals of any device.

2.1.2.3 Scale of Emotional Tone

This scale refers to the vocabulary that the document is written, Newmark (1988 says that this scale can be divided into: intense, and factual tone. The intense tone focuses more on giving the message by using intensifiers. The warm tone in texts provides a message with more gentle vocabulary. And the factual tone can be seen as the combination of both tones, because it aims to convey the message but a gentler way of expression. The understandable tone, here the translator must be sure that the expressions are understood in the target text taking into consideration if they are positive, neutral or negative.

2.1.3 Text Function

It is basically what the purpose of the text is or what intention does the text has. In relation to this, Newmark (1988) explains that there are three main functions of language: informative, vocative and expressive. These functions are the core of the language.

2.1.3.1 Informative: it concerns about any particular topic or knowledge. This function focuses on eternal situations or facts of a topic, for example, ideas or theories. The informative function follows a standard format. Some examples of types of language function are text books, newspapers, scientific technical documents, etc. It is important to mention that there are two aspects that should be emphasized when describing the informative function. First, most of the informative texts are found in international organizations, multi-nationals, private companies, or translation agencies. And second, most of them present a lack of proper grammar structures, resulting a task for the translator to correct them (Newmark, 1988, p. 39). The core of the informative function is external situations, the facts of a topic, reality outside language, included reported ideas or theories.

2.1.3.2 Expressive: reflects the ideas of the speaker, writer, the originator of the utterance to express feelings without the intention of receiving a response, and Newmark (1988), specifies that for the purposes of translation, the expressive texts can be divided in three text-types: serious, imaginative literature, authoritative statements, autobiographies, essays, and personal correspondence. The core of the expressive function is the mind of the speaker, the writer, the originator of the utterance and these texts must be written in a language that is immediately comprehensible to the readership.

According to Newmark (1988), authoritative statements are texts of any nature which derive their authority from the high status or the reliability and linguistic competence of their authors. This is more commonly observed in documents of government authorities. They are characterized by using a vocabulary in the whole context. The personal correspondence in particular is expressive when the readers are quite related with the author’s background. The core of the authoritative statement is very similar to the expressive function, but it differs in that these texts do not bear the mark of an idiolect, one of the characteristics assigned to the expressive function

2.1.3.3 Vocative: As per Newmark (1988), vocative texts are specifically directed to the readership, and to persuade a message. For translation purposes, the vocative function format is seen in notices, instructions, publicity, propaganda, persuasive writing (requests, cases, theses) and possibly popular fiction, whose purpose is to sell the book, entertain the reader as the typical “Vocative text.” The core of the vocative function is the readership, the addressee.

2.1.4 Translation Methods

It refers to the way a particular translation process is carried out in terms of the translator’s objective. It is a global option that affects the whole text. These translation methods include: a) direct translation method; b) oblique translation method, and c) the Newmark’s methods. In Newmark (1988), there are eight types of translations:

- **Word for word translation**: This often demonstrated as interlinear translation, with the TL immediately below the SL words. The SL word-order is preserved, and the words translated singly by their most common meanings, out of context. Cultural words are translated literally. The main use of word-for-word translation is either to understand the mechanics of the source language or construe a difficult text as a pre-translation process.

- **Literal translation**: The SL grammatical constructions are converted to their nearest TL equivalents but the lexical words are again translated singly, out of context. As a pre-translation process, this indicates the problems to be solved.

- **Faithful translation**: A faithful translation attempt to reproduce the precise contextual meaning of the original within the constraints of the TL grammatical structures. If "transfers" cultural words and preserves the degree of grammatical and lexical "abnormality" (deviation from SL norms) in the translation. It attempts to be completely faithful to the intentions and the text-realization of the SL writer.

- **Adaptive translation**: This is the "freest" form of translation. It is used mainly for plays (comedies and poetry; the themes, characters, plots are usually preserved, the SL culture converted to the TL culture and the text rewritten). The deplorable practice of having a play or poem literally translated and then rewritten by an established dramatist or poet has produced many poor adaptations, but other adaptations have "rescued" period plays.

- **Free translation**: Free translation reproduces the matter without the manner, or the content without the form of the original. Usually it is a paraphrase much longer than the original, a so-called "intralingual translation", often prolix and pretentious, and not translation at all.

- **Idiomatic translation**: Idiomatic translation reproduces the "message" of the original but tends to distort nuances of meaning by preferring colloquialisms and idioms where these do not exist in the original. (Authorities as diverse as Seteskovitch and Stuart Gilbert tend to this form of lively, "natural" translation).

2.1.4.1 Semantic Translation

It uses the source language with the exact meaning and translates this same message taking into account the target language grammatical structure main objective of all semantic translations is to focus on meaning. Although naturalness and aesthetics are considered in this method of translation, Newmark (1988) states that the semantic translation attempts to render, as closely as possible the semantic and syntactic structures of the second language, that is, the exact contextual meaning of the original.

The principal objective of the translator every time he is about to use the semantic translation, is the idea and thoughts of the author's whenever the translator perceives that is proper to use it to convey the exact message of the original into the target language. According to Newmark (1988) semantic translation attempts to render as closely as the semantic and syntactic structures of the second language allow the exact contextual meaning of the original. Some of the semantic features are: author-centered, pursuing author's thought process and related to thought concerned with the author as individual, semantic and syntactic oriented, faithful and more literal, informative. Newmark (1988), mentions that the semantic translation is always inferior to its original, since it involves loss of meaning.

Semantic translation differs from "faithful translation" only in far as it must take more account of the aesthetic value (that is, the beautiful and natural sounds of the SL text, compromising on "meaning" where appropriate so that no assonance, word-play or repetition jars in the finished version. Further, it may translate less important cultural words by culturally neutral third or functional terms but not by cultural equivalents – une nonne repassant un corporal- may become "a nun ironing a corporal cloth" – and it may make other small concessions to the readership. The distinction between "faithful" and "semantic" translation is that the first is uncompromising and dogmatic, while the second is more flexible, admits the creative exception to 100% fidelity and allows for the translator's intuitive empathy with the original.

2.1.4.2 Communicative Translation

According to Newmark (1988), in the communicative translation method, the only part of the meaning that is taken into account is the part of the target language message understanding. The communicative translation tries to produce a reaction on the target language reader, that is the same reaction as provided in the original text. Newmark adds that this method is a subjective procedure because it aims to achieve a possible effect on the reader. He also says that generally a communicative translation is likely to be smoother, simpler, clearer, more direct, more conventional, conforming to a particular register of language, tending to under translate, for example to use more generic, hold-all terms in difficult passages.

Communicative translation attempts to render the exact contextual meaning of the original in such a way that both content and language are readily acceptable and comprehensible to the readership.

The type of translation used in this work is the “word for word translation” because of the scientific nature of the articles translated.

In the “word for word translation” the SL word order is preserved, and the words translated by their most common meanings. Cultural words are translated literally. The main use of this method is either to understand the mechanics of the source language or to construe a difficult text as pre-translation process.

2.1.4.3 Semantic vs Communicative Translation Methods

Generally, a communicative translation is likely to be smoother, simpler, clearer, more direct, more conventional, conforming to particular register of language, tending to under translate, i.e., to use more generic, hold-all terms in difficult passages. A semantic translation, on the other hand, tends to be more complex, more awkward, more detailed, more concentrated, and pursues the thought-processes rather than the intention of the transmitter. It tends to over translate, to be more specific than the original, to include more meanings in its search for one nuance of meaning.

A semantic translation is more text focused. Although not necessarily a literal translation, it follows the source text more closely. A communicative translation, on the other hand, is focused on the target text and aims to ensure that the reader will understand the message of the text.

Newmark (1981) states that semantic translation differs from literal translation in that, it respects context, interprets and even explains metaphors for instance. Literal translation, on the other hand, means word for word in its extreme version and even in its weaker form, sticks very closely to its lexis and syntax.

Newmark (1981) believes literal translation to be the basic translation procedure both in communicative and semantic translation, in that, translation starts from there. Importantly, literal translation is held to be the best approach in both semantic and communicative translation.

According to Newmark (1981) only semantic and communicative translation fulfils the two main aims of translation which are first accuracy and second economy. A semantic translation is more likely to be economical than a communicative translation unless for the latter, the text is poorly written.

A communicative translation is often better than it original. Semantic translation is accurate but may not communicate well; whereas communicative translation communicates well but may not be very precise.

2.2 Translation Procedures

The translation procedures are achievements of the translation that help the translator to render a natural and accurate translation for the target text readers. According to Delisle (1999), translation techniques are methods of linguistic transference of the most relevant parts of the source language text that the translator must use to achieve equivalence. The translation procedures (conscious or unconscious, verbal or non-verbal) are used by the translator to solve problems that emerge when carrying out the translation process with a particular objective in mind. They are used for sentences and smaller units of language within the text (as cited in Corrales, Gómez, Mora, and Navarro, 2016).

2.2.1 Transposition

Newmark (1988) states that transposition is also known as shifts. It involves a change in the grammar from SL to TL. He also mentions that there are three types of transpositions: 1) changing from singular to plural, 2) it appears when there is not a source language grammatical structure equivalent in the target language and 3) when the literal translation of a grammatical structure is possible but not natural for the target language culture. For example: “furniture = muebles” “applause = aplausos” “advice = consejos”.

Brinton (as cited in Corrales, et al., 2016) says that transposition is to change the word order, parts of speech, constructions in order to normalize the language of the translation. For example: “En un automóvil que les esperaba = in a waiting car”. In addition, Vinay and Darbelnet (as cited in Corrales, et. al, 2016) say that transposition is replacing one word class with another without changing the meaning of the message. For example: “tan pronto se levante = as soon as he gets up” It is a helpful tool for the translator but is especially directed to help the reader understanding the message from the source language text.

Vázquez-Ayora (1977), states that this is a procedure by which the translator replaces a part of speech of the source language for a completely different target language without losing the message of the source language. It is the substitution of grammatical category of the original message by a different grammatical category of the target language. For example, the English expression: “He held that” whose nucleus is the verb, is translated into Spanish as “en su opinion” whose nucleus is a noun, therefore, it can be said that this is a transposition of verb to a noun. Moreover, López Guix and Wilkinson (1997) mention that transposition is a procedure that modifies the grammatical structure of a part of the text without losing the general sense of the source language, for example: “after she left = tras su partida.”

2.2.2 Modulation

According to Newmark (1988), modulation occurs when the translator reproduces the message of the original text in the TL in conformity with the current norms of the TL, since the SL and TL can appear dissimilar in terms of perspective. He says that modulation is a variation through a change of point of view, of perspective, and, very often of a category thought. For example: “don’t delay = Date prisa” “Get this straight = No te quepa duda” “He’s extremely intelligent = No tiene nada de tonto”. Brinton says that it is a change of conceptual basis images or metaphor in the other language. For example: “Entiendo = I see” “Te veo bien = You look well”.

Vinay and Darbelnet (Corrales, et. al, 2016) said that modulation is a variation of the form of the message, obtained by a change in the point of view. They say that it is justified when literal translation and/or transposition produce a grammatically correct phrase, but that is not natural. For example: “It is not difficult to show = es fácil de demostrar”. The technique is basically used to reproduce the same idea from the original text but changing the grammatical components of it, commonly when the literal translation misses the linguistic level of a text.

Modulation is very complex, according to most translation experts is the one that requires more knowledge of the grammatical mechanics both source and target language. Through this process, the translator main objective is to change the way the message is given without changing the contextual meaning in order to produce the same effect that the source language pretends into the target language.

Moreover, Vázquez Ayora (1977), gives an abundant account of the many modulation types that can be performed with the categories of thought. For example the following paragraph: “Puerto Rico’s linguistic schizophrenia is not a consequence of last Thursday’s (1) restoration (2) of equal legal status for both Spanish and English, although the new law prompted thousands of citizens to demonstrate (3) repeatedly against a decision they considered unfair. It was born of the different coexistence with English, the language of the ruling nation. And also, on the mainland, of the growth of a fascinating and controversial hybrid: Spanglish. On the island, demonstrator called for a return to the Spanish of Puerto Rico not of Spain.” The Spanish version is as follows: “La esquizofrenia lingüística que padece Puerto Rico no nace de (1) la co-oficialidad, restaurada (2) el jueves, del español y del inglés, aunque esta ley ha volcado a la calle (3) y varias veces, a millares de ciudadanos que consideran injusta la decisión. Nace de una historia de difícil coexistencia con el inglés de la potencia administradora. Y también en el continente, del crecimiento en un apasionante y polémico híbrido, el “Spanglish”. En la isla, el español reivindicado en la calle no es “el de España, queremos hablar el español de Puerto Rico.” (El Mundo, 1993).

The previous two paragraphs are examples of how to apply the grammatical mechanics in order to reproduce the message of the original text into the target language.

2.2.3 Omission

As Newmark (1988) states, omission is an imprecise translation procedure, which is practiced intuitively or ad hoc. Here words are omitted. For example: “computer science = informática.” Whereas, Brinton (Corrales, et. al, 2016) says that it is to omit words or phrases which do not alter the meaning of the original, because of different constructions and usages in the two languages. Moreover, Delisle (Corrales, et. al 2016) says that omission is a concentration resulting in concision and economy.

Omission works particularly with the repetition of ideas that can be expressed in a single and simple form when translated into the target language. Omission, instead of being a procedure that changes or modifies the source language text or idea tries to provide an easy to understand and natural speech for the target language readers that explains the same message of the source language text.

2.2.4 Amplification or expansion

Brinton (as cited by Corrales, et. al, 2016) refers to amplification as to insert words or phrases which do not alter the meaning of the original because of different constructions and usages in the two languages. Delisle (as cited by Corrales, et. al, 2016) say that expansion or amplification is to use more words than the SL in order to re-express the idea or to reinforce the sense of a ST word because its correspondence in the TL cannot be expressed as concisely. Moreover, Newmark (1988) argues that amplification is an imprecise translation procedure which is practiced intuitively or ad hoc. Here words are added. For example: “vivificante = life-giving”.

Amplification aims to reinforce the idea of the source text when is translated into the target language text, mostly because of the lack of an equivalence to express the word or idea of the source text into the target language text. In the other hand, amplification is a procedure of translation, which is basically the contrary of omission. This procedure is also named expansion. Amplification is a procedure by which the translator must increase the number of words to define better what the source text may refers to.

2.2.5 Explicitation

This process is aimed to express with a wider vocabulary the ideas of the source language in order to provide a better understanding of the text in the target language reader just like the amplification. This means that sometimes the implicit terms of a language are understandable for one language, but still missing meaning in other language, forcing the translator to bring the implicit to achieve a proper translation of the source text. Delisle (as cited in Corrales, et. al, 2016) states that the translator must modify and clarify from the source text when is translating. Moreover, Newmark (1988), explains that explicitation is known as equivalent of descriptive, as it consists on describing the context in the most adapted way a term of the SL not existent in TL. For example, the Russian word “samovar” is translated as “vasija rusa de cobre con hornillo interior para calentar agua para el té.”

2.2.6 Literal translation

Newmark (1988) stated that in the literal translation the SL grammatical constructions are converted to their nearest TL equivalent, but the lexical words are again translated singly out of context. Lopéx-Guix (as cited in Corrales, et. al, 2016) mentions that literal translation is to translate word by word of a source language to a target language, respecting the linguistic rights of the source language. For example: “I like to play football = Me gusta jugar fútbol.” Moreover, Vinay and Darbelnet (as cited in Corrales et. al, 2016) say that literal translation is translating word for word in a way that does not alter the meaning. For example: “Where are you? = dónde estás?” In the same way, Vázquez-Ayora (1977) says that an idea is expressed in the same way in one language and other language.

Literal translation requires a proper knowledge from both sources and target languages because in fact there are few speeches that can be literally translated. For example: “She is reading. = Ella está leyendo.” Vachon-Spilka (as cited in JP Vinay, 1987) said that literal translation can only function whenever the two languages have the same equivalent words or phrases, which is quite rare because mostly all languages have differences in lexicon and the grammatical or linguistic style and order. In the literal translation, the target language must follow the strict grammatical order from the source language text.

2.2.7 Punctuation changes

Punctuation changes the translator’s voice. The translation can sound in a wide range of emotions depending on punctuation. The full stop is the most powerful punctuation mark whereas the comma offers readers a soft pause. The comma makes a text flow softly. Punctuation can help the translator to clarify meaning; as punctuation does for writing what pauses and changes of voice do for speech.

There are punctuation rules for each punctuation mark: a period is like a stop sign at the end of a sentence or complete thought. It is also used in abbreviations; a question mark comes at the end of a question; use a comma to separate each item in a series or list and after the salutations and closing of letters; use an exclamation point after a word or sentence that expresses strong feelings; use an apostrophe with the letter “s” to show ownership or possession; a colon separates the hours from the minutes when you write the time of the day; quotation marks belong at the beginning and end of words that a person says (Punctuation Marks in English, 2018).

2.2.8 Compensation

Newmark (1988) states that it occurs when loss of meaning in one part of the sentence is compensated in another part. Vázquez-Ayora (1977) says that translators should use compensations when information is added from the SL in a different place of the TL to compensate a loss of sense. Also, Hurtado, A. and Molina (as cited in Corrales, et. al, 2016) say that compensation occurs when it is introduced in other place of the translated text an element of information or stylistic effect that could have not been reflected in the same place in which appears located in the original text.

2.2.9 Equivalence

Newmark (1988), explains that this procedure is known as cultural equivalent, is the closest translation of a cultural term in the SL for another cultural term of the TL. Vázquez-Ayora (as cited in Corrales, et. al, 2016) states that equivalence is the same situation expressed with different modalities. For example: “They are as like as two peas = Se parecen como dos gotas de agua”. Furthermore, Vinay and Darbelnet (as cited in Corrales, et. al, 2016) say that the same situation can be rendered by two texts using completely different stylistic and structural methods. For example: “Too many cooks spoil the broth = Un barco no puede tener dos capitanes.” For Lópex-Guix (as cited in Corrales, et. al, 2016) equivalence is to reproduce a same situation through stilystic and structural resources completely different. For example, “to pull one’s leg = tomar el pelo a alguien” “Raw materials = materias primas.”

2.2.10 Adaptation

According to Vázquez-Ayora, (1977) adaptation is applied when an idea or a message must be evoked, and it does not exist in TL, and it is necessary to create other situation that evokes the same idea. For example: “Blanco como la nieve = Blanco como las plumas del airon (example taken from Nida).” For Brinton (as cited in Corrales, et. al, 2016), adaptation is to communicate the message of the original because sometimes the literal equivalent of an expression in the original language conveys a completely different idea to the reader of the translation, it may be incomprehensible or even misleading. For example: “El torero rubio que hablaba andaluz con acento inglés = The blond bullfighter that spoke Spanish with an English accent”. Moreover, Newmark (1988) mentions that it consists on taking a close equivalent in the TL for a word of the SL within the context, whether it exists or not an exact equivalent. For example: “kind person = persona amable;” “awkward = Difícil.”

2.2.11 Borrowing

Newmark (1988) mentions that a borrowing is known as transference (loan word, transcription) and it is the process of transferring a SL word to a TL text. For example: “by-pass” “establishment” “aerobic,” “tour,” “impasse,” “prestroika.” Moreover, Vinay and Darbelnet (as cited in Corrales, et. al, 2016) express that borrowing is the idea of taking the word from the source language (SL) and maintaining it in the target language.

2.2.12 Calque

Newmark (1988) states that it is a loan word, it is transferring a source language word to a target language, either because the target language does not have a lexicalized correspondence, or for stylistic or rhetorical reasons. For example: “supermarket=supermercado.” For Vinay and Darbelnet (as cited in Corrales, et. al, 2016) it is a special kind of borrowing whereby a language borrows an expression from another, but translates literally each of its elements. For example: “Science-fiction = Ciencia-ficción.”

2.2.13 Sentence inversion

An inverted sentence switches the placement of the “verb” before the subject of a sentence as is in a question. Inverted sentences are required with certain grammar structures or used as a means of sentences stress or emphasis. For example: “Never have I understood less about women.” Generally, an inversion is used to stress the uniqueness of an event and begins with a negative, Inverted Sentences for Advance Learners of English, (2018).

In statements, the subject usually comes before the verb, Inversion is common when a sentence begins with an adverb phrase. It is also common when the sentence begins and is modified by a negative adverb or adverb phrase. For example: Never had she read such a sad book as The *Coldest* Tear.

Sentences are inverted with conditional that omit the word “if” and use *had*, *were*, and *should*. For example: Should he ask; Had I arrive ten minutes earlier. Inversion is also common after the preposition “so + an adjective + that”. For example: So hilarious was the comedian that the audience laughed for ten minutes after the show ended.

2.3 Glossaries

It is important for the translator to develop a glossary with all the content and definitions of the most difficult terminology of any text, field, or subject matter. A multilingual glossary is critical to the successful translation of the material as it is useful to know the meaning of complex vocabulary and new words. According to Gapper (1977), terminology is a group of terms that correspond to a specific scientist, and the study and systematization of those set of terms. There are different kinds of glossaries, for example the bilingual glossaries, vocabularies, monolingual, phraseological glossaries, dictionaries and technical glossaries. The glossary illustrates the definitions and provides further information regarding the terms in the content.

2.3.1 Relevance for the translator

Basically, glossaries explain the most specific vocabulary of the respective field or subject matter. A glossary has essential benefits for the translator and the reader, but it also produces a positive reaction over the translation itself. Acclaro (2013) says that another benefit of the use of glossaries is that a glossary ensures a consistent style and voice, an accurate rendering of the original text and a level of quality that is even throughout. It also will help the target language readers and users of the document.

According to the Business Dictionary (2018) a glossary is an alphabetically arranged reference work that gives brief definitions of words related to a specific topic; also called controlled vocabulary.

2.3.2 Relevance for the translation process

Glossaries are not just developed for the use of the reader to understand difficult terminology, but they also provide assistance to the translator to have a guide of the complex and unique terminology of a specific field. Besides the terminology, it facilitates the translator the translation process when need to look up for phrases or terms faster and understand completely the information of the text. (What is a glossary, 2018).

2.3.3 How to create a Glossary?

Glossaries are not easy to create, you need concentration and order. They are a list with the most difficult words of the source text, so it is important that the translator underlines or highlights those words that are not easy to understand or translate. It also requires a lot of effort, but it can make the difference in the quality and consistency of the finished translation. (How to Create a Glossary, 1995).

The glossary from this research is designed first as a help for the translator in saving time and efforts in looking up for the same word several times and for the students and professors of the Biology area to make clear some terms and words of the articles translated from the Revista Mexicana de Biología, both in English and Spanish. The articles translated here are going to be available in the Library Mariana Campos of the School of Natural and Exact Sciences of the UNA.

Gapper (1977) states that it is impossible to include all the words and terms investigated, but the ones that appear in this glossary are the most frequent in each article. In other words, they are the words that are not easy to find in a common dictionary. In some cases, it is probable that the terms or words (either constituted by one or more words) be the most convenient for the glossary.

Many of the specialized terms are recognized for its acronym or for an apocope. Abbreviations can be included with the main term. In some fields, this is very important for the translation and those aspects should be included. For the convenience of the people who read the translations, it is important to make clear which information is going to be in the glossary. This information should be short, clear and expressed with words that are easy to understand. For the definitions of the words and terms, encyclopedias dictionaries from well-known universities, the dictionary from the Real Academia, the Simon and Schuster's International Dictionary were used to look for the best definitions. A synonym dictionary was also used in some cases. The use of lexical information with information from an encyclopedia and from a dictionary was used, in what it is called a mixed definition.

It is common to find just one equivalent for each term, but it turns out more convenient to include several equivalents for some of the terms due to the existent varieties in different countries, regions or registers. When an equivalent is included, it is preferable to be of the same category. In most cases, it is about nouns, compound nouns or nominal syntagmas. If there is no equivalent of the same grammar category, it is recommendable to add an example of its use so it would be clearer how to use the term in a similar context, (Gapper, 1977).

When a glossary is elaborated, it is important to include information about the use, about the kind of chronological indication, the geographical use of the word, the sociological background, the grammatical connotations, such as gender, if it is singular or plural, the kind of verbs, if the word is a common or a proper noun, etc. In other aspects, it has to be taken into account the scientific term, the Latin origin of the word, (Gapper, 1977).

To give information to the reader about the words or terms of the glossary, it is common to use italics or bold to distinguish indications of its use, specialties or grammar category. VERSALITA or an arrow is used to refer the reader to another term in the glossary. Other marks as a dash or an accent mark are used instead of repeating one word several times in an article. It is also frequent the use of abbreviations for the use of indications to economize space. It is important for the reader what it is indicated with the format, and it is also convenient to elaborate a couple of paragraphs with the instructions of how to use the glossary, (Gapper 1977). The use of parentheses is important too. In cases where a lot of information is necessary, parentheses can be used along with the square parentheses for the different kind of letter to highlight the examples, indications of use and definitions.

The alphabetical order is a matter of format, but sometimes is good to decide what kind of alphabetization is going to be used. This is important when there is a two words term because the researcher has to decide what part or speech is going to be taken into account, for example by the preposition, the articles, the adjectives, if it is going to be only the main noun, or the first word of the term. For example, with the term “ESL” English as a second language, which criteria is used, it is one word or separated words? The greatest risk in a glossary is to mix different criteria in different sections, which is confusing for the readers when they look for a term (Gapper, 1977).

In short, when elaborating a glossary, some aspects must be followed. For example, to decide whether the similar or compound terms will be together in one article, to decide if a simple or complex alphabetization is used, to decide if the terms are going to be ordered in a continuous or no continuous form, to decide if it corresponds how to order the figures and other symbols that are part of the terms.

Once the elements that are going to be part of each entry is chosen, the order of the information has to be carefully determined. Before deliver the glossary to a reduce amount of users to prove its utility and facility in its use, it is imperative a detailed review of the work, Some questions for this review are: do the entries have the same format? Do all have the same order of elements? Do all the definitions have been drafted with a clear and easy language for the understanding according to the level of instructions of the target users? Was it stated if the definitions were taken from another source? Do all the definitions have been drafted with a term of the same grammar category of the one defined? Was the alphabetical order of the entries checked? Was only one system of alphabetization used? Was the orthograph review finished? Was it clear the meaning of all the abbreviations? Is the space inside the entries, in the margins uniform? Once all the corrections are included in this first stage, it is advisable to distribute the glossary among a reduce group of users for their opinions about the glossary, in a determined amount of time, in order to make the modifications needed (Gapper, 1977).

CHAPTER III

Methodological Framework

This chapter intents to give background for the development of the basic parts of the methodological framework. Likewise, it gives a review of the research approach used in this investigation.

3.1 Research Approach

The research approach is very important for the translation process since it helps the translator to use the appropriate instrument. The research approach is based on plans and procedures for the researching that covers in detail the methods of data collection, analysis and interpretation. According to Creswell (2008), there are three research methods: the qualitative method, the quantitative method and the mixed method, which is a combination of the two previous methods. However, in this paper, only the qualitative method is going to be explained, as this is the one this project is based on.

3.1.1 Qualitative method

The qualitative research is a research method that places more emphasis on the study of phenomena from the perspective of insiders. The qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. (Creswell, 2011). This method relies on text and image data and it has unique steps in data analysis and draw on diverse designs. The qualitative approach includes comments by the researcher about their role, and the specific type of qualitative strategy being used. The use of the qualitative has a dramatic influence on the procedures, which, even within the strategies, area anything but uninform. visible. (Creswell, 2011). The qualitative researchers study things in their natural settings, attempting to make sense of, or interpret phenomena in terms of the meanings people bring to them. (Denzin and Lincoln, 1994)

The qualitative approach is mainly used to gain an understanding of underlying reasons, opinions and motivations. Creswell (2009) proposes a series of questions for designing a qualitative procedure. Among these questions, the researcher can mention: review the needs of potential audiences for the proposal if there is some question about their knowledge, present the basic characteristics of qualitative research in the proposal and possible discuss a recent qualitative research journal, article (or study) to see as an example to illustrate the characteristics. He offers a series of tips when writing a procedure for a qualitative proposal: identify the specific approach to inquiry that you will be using; provide some background information about the strategy; discuss why it is an appropriate strategy to use in the proposed study; identify how the use of the strategy will shape the types of questions asked. Therefore, in this research the qualitative method was used to develop the different techniques in order to carry out the several phases of the investigation. The qualitative approach is mainly used to gain an understanding of underlying reasons, opinions and motivations.

3.2 Research Method

According to Creswell (1994), the qualitative research is also described as an unfolding model that occurs in a natural setting that enables the researcher to develop a level of detail from high involvement in the actual experiences. Because this is investigation does not include statistics, the researcher used the qualitative method based on the following reasons. According to Creswell (1994), there are different categories for the qualitative method: ethnography, narrative, phenomenological, grounded theory and case study. He explains each category as follows:

- Narrative research studies the lives of individuals and asks them to provide stories
- Phenomenological research describes the lived experiences of individuals about a phenomenon as described by participants
- Grounded theory derives a general, abstract theory of a process, action, or interactions grounded in the views of participants
- Ethnography studies the patters of behaviors, language, and actions of an intact cultural group in a natural setting over a prolonged period of time. The researcher develops an in-depth analysis of a case, program, event, activity, process, por one or more individuals.
- Case study. It was made famous by the Harvard Business School, even mainly quantitative researchers can relate to the value of the case study in explaining an organization, entity, company, or event. A case study involves a deep understanding through multiple types of data sources. Case studies can be explanatory, exploratory, or describing an event. The conference has a peer-reviewed track dedicated to case studies.

This research is based on the phenomenological method because it leads, ideally, to the type of description and classification of phenomena that is contained in the articles to be translated. It involves a return to experience in order to obtain comprehensive descriptions that provide the basis for a reflective structural analysis that portrays the essences of the experience. This because Creswell (1998) points out that the essence of the phenomenological research is the search for the central underlying meaning of the experience and emphasize the intentionality of consciousness where experiences contain both the outward appearance and inward consciousness based on the memory, image, and meaning. The method for a phenomenological study is similar to that of grounded theory because interviews are conducted.

The goal of qualitative phenomenological research is to describe a “lived experience” of a phenomenon. As this is a qualitative analysis of narrative data, methods to analyze its data must be quite different from more traditional or quantitative methods research. Essentially, the researcher is focused on meaning, the meaning of the experience, behavior, narrative, etc. The purpose of the qualitative method is to understand the social phenomenon from the researcher’s point of view, Moustaka, P. (1994).

This method returns to experience in order to obtain comprehensive descriptions. These descriptions then provide the basis for a reflective structural analysis to portray the essences of the experience. First, the original data is comprised of “naïve” descriptions obtained through open-ended questions and dialogue. Then the researcher describes the structure of the experience based on reflection and interpretation of the research participant’s story. The aim is to determine what the experience means for the people who have had the experience. From there general meanings are derived.

3.3 Information sources

A well-done research paper is full of information which helps the researcher to support the ideas with facts. In order to do this, the researcher must look at many different facts that can be found in primary and secondary sources. (John Hamilton, 2005). There are different kinds of sources which will be used depending on the length of the documents or investigation. The sources can be divided into: primary, secondary and tertiary sources. In this research, primary and secondary sources were used, but first let´s make clear what they are.

- Primary sources: are original materials on which other research is based, including: original written works, poems, diaries, court records, interviews, surveys and original research/field work, and research published in school/academic journals.
- Secondary sources: are those that describe or analyze primary sources including: reference materials-dictionaries, encyclopedias, text books, and books and articles that interpret, review or synthesize original research/fieldwork. The sources used in this work are taken from the investigations done by several international scientists in the field of Biology, archeology and some other fields. The magazine "Revista Mexicana de Biodiversidad" published by the Instituto de Biología de la UNAM includes in each article a statement where it says: "This is an open access item distributed under the Creative Commons CC License BY-NC-ND 4.0."

  As a result, the articles to be translated either from English into Spanish or vice versa, become a secondary source, meaning taken from a magazine that used the investigation for these scientists to support the information in the articles.
- Tertiary sources: are those used to organize and locate secondary and primary sources. For example: indexes: provide citations that fully identify a work with information such as author, titles of a book, articles, and/or journal, publisher and publication date, volume and issue number and page numbers, abstracts: summarize the primary and secondary sources, database: are online indexes that usually include abstracts for each primary or secondary source, and may also include a digital copy of the resource.

3.4 Analysis Categories

In this investigation, the researcher first read the text in order to analyze evaluate the text to transmit the intention of the author, and then identify its emotion, stylistic scale, formality, function, and type. Moreover, the translator is going to translate some articles from The Revista Mexicana de Biología, some from English into Spanish and some from Spanish into English.

The color coding consists on highlighting words or sentences showing each translation technique found – transposition, modulation, omission, amplification, literal translation, equivalence, adaptation, explicitation, and compensation-. The purpose of the color coding on doing this is to show that the techniques explains in the previous chapters need to be applied to the texts in order to have an excellent translation, since these techniques are instrument that help the translator deliver accurate, natural and communicative documents.

On the other hand, the translator created two glossaries, one from English into Spanish and another from Spanish into English. The glossaries contain content and definition of the most difficult terminology of the text. It is useful in that ensures a consistent style and voice, and an accurate rendering of the original text and level of quality that is even throughout the translation. A glossary provides assistant to the translator to have a guide of the complex and unique terminology of a specific field. Moreover, it facilitates the translator the translation process when need to look up for phrases or terms faster and understanding completely of the information of the text.

This research is based on the translation of certain articles, from English into Spanish and from Spanish into English, provided by the library of Exact and Natural Sciences at Universidad Nacional. This entity needs these translations in order to help professors and students that do not speak either languages. In this analysis, the researcher analyzed the text from the translator's point of view in order to identify, analyze, and evaluate the different procedures and methods which will be very helpful for the researcher through the text analysis. Some of the aspects taken into account are: the translation procedures, the translation methods, and the glossary, which will be explained next.

3.5 Data Collection Instruments

In this investigation, the researcher used three different instruments to be applied in the translation process. These instruments are: text analysis, color coding, and the glossary.

3.5.1 Text Analysis Chart

Newmark (1988) states that translation must begin their job by reading the original for two purposes: first, to understand what it is about; second, to analyze it from the "translator's point of view," which is not the same as the author's, in order to select the most suitable translation method and identify the particular and more often problems. Therefore, a chart has been designed with the purpose to show the necessary information for the analysis of the texts. The chart is divided into six rows which are classified on the first column such as text style, which is divided into narrative, descriptive, discussion or dialogue. The second division is formality (officialese, official, formal, neutral, informal, colloquial, slang, and taboo). In addition, the third row is the difficulty of the text (simple, popular, neutral, educated, technical and opaquely technical). The fourth row is the emotional tone of the text (intense, warm factual one, understatement). The fifth row is the text function which can be either informative, expressive or vocative, and finally the sixth row which is the translation type that can be semantic or communicative.

Moreover, it is important to mention that this chart shows an organized and summarized way of how to classify each category in translation if the steps are followed.

TEXT ANALYSIS	TRANSLATIONS FROM ENGLISH INTO SPANISH	TRANSLATIONS FROM SPANISH INTO ENGLISH
Text style		
Formality		
Difficulty		
Emotional tone		
Text function		
Translation type		

Example 1. Text Analysis.
Source: Researcher's own creation

3.5.2 Color Coding – Description of sample

According to Nida (1964), the importance of the translation procedures is that they help the translator to analyze the source and target languages, to study the source language text before making attempts translate it, to make judgements of the semantic and syntactic approximations. The sources used in this work are taken from the investigations done by several international scientists in the field of Biology, archeology and some other fields. The magazine "Revista Mexicana de Biodiversidad" published by the Instituto de Biología de la UNAM includes in each article a statement where it says: "This is an open access item distributed under the Creative Commons CC License BY-NC-ND 4.0."

The color-coding consists on highlighting words or sentences showing each translation technique found. Each technique will be assigned a different color, as it is shown in the table below, these are: transposition-red, modulation-purple, omission-bold in the original, amplification-blue, literal translation-underlined in black, equivalence-light green, explicitation-light brown, compensation-highlighted in green. The purpose on doing this is to show that the techniques explained in the previous chapters need to be applied to the texts in order to have an excellent translation, because the techniques are instruments that help the translator deliver accurate, natural and communicative documents.

Transposition
Modulation
Omission
Amplification
Literal translation
Equivalence
Adaptation
Explicitation
Compensation

Example 2 Color Coding
Source: Researcher's own creation

3.5.3 Glossary

A glossary explains the most difficult vocabulary of the respective field or subject matter. Therefore, its use is essential for the translator because it helps he or she to save time, it ensures the consistent style and voice, it gives and accurate rendering of the original text and a level of quality that is even throughout the translation.

In the present translation, there are two glossaries; one is in English into Spanish and another in Spanish into English. The translator includes in each language the terms that are difficult to find in a dictionary. Likewise, the glossaries are in alphabetical order to make things easier not only for the translator but for the readers as well. Some examples of the glossaries included in the translation are:

ENGLISH-SPANISH GLOSSARY

Acetabulum: Acetábulo – Sustantivo – Cavidad donde encaja un hueso

SOURCE LANGUAGE	TARGET LANGUAGE	GRAMMAR CATEGORY	SHORT DEFINITION

Example 3. Glossary from English into Spanish
Source: Researcher's own creation

SPANISH- ENGLISH GLOSSARY

Anélidos: Anelids – Noun – External layer of the invertebrate's body that segregates the cuticular exo-squeleton

SOURCE LANGUAGE	TARGET LANGUAGE	GRAMMATICAL CATEGORY	SHORT DEFINITION

Example 4. Glossary from Spanish into English

Source: Researcher's own creation

CHAPTER IV

Translated Versions

4.1 Translation from English into Spanish:

Estimación de la diversidad de hongos acuáticos no-cultivables de diferentes hábitats en México

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Resumen

Con la finalidad de explorar la diversidad de hongos acuáticos en México, se presenta una investigación usando un fragmento del ADN ribosomal 18S con un marcador molecular obtenido de muestras de cuerpos acuáticos con diferentes características (marino, salobre y dulce). Los fragmentos de los genes ribosomales se obtuvieron mediante la amplificación de ADN, las secuencias resultantes se compararon mediante alineamientos múltiples con una selección de secuencias de hongos como referencia y posteriormente se analizaron filogenéticamente, permitiendo la identificación y clasificación de secuencias de ADN provenientes de aislados ambientales hasta la categoría de familia, cuando hubo suficientes secuencias disponibles. De las 2.020 secuencias identificadas como hongos, un 23.8% se clasificaron como familia, un 48.5% como orden, un 13% como clase/subfilo y un 47% de las secuencias (todas del mismo lugar) no pudieron ser colocadas inequívocamente en alguno de los grupos de hongos que se tomaron como referencia, pero se encontraron muy cercanamente relacionadas a hongos marinos no cultivables. El phylum más representado fue *Ascomycota*(89.1%), seguido de *Chytridiomycota* (8.1%), *Basidiomycota* (2.8%), y *Mucoromycotina* (1.3%).

Abstract

With the aim to explore the diversity of aquatic fungi in Mexico we present an investigation using a fragment of the 18S ribosomal DNA as a molecular marker obtained from different water bodies (marine, brackish and fresh water). Ribosomal gene fragments were obtained and DNA amplification, the resulting sequences were compared using multiple alignments against a collection of classified reference fungal sequences and then subjected to phylogenetic clustering allowing the identification and classification of DNA sequences from environmental isolate as fungal down to the family level, provided enough reference sequence were available. From our ensemble of 2.020 sequences identified as fungal, 23,8% were classified at the family level, 48,5% at the order level, 13% at the class/subphylum level and 14,7% of the sequences (all from the same site) could not be unambiguously positioned in any of our reference fungal group but were closely related to uncultivated marine fungi. The most frequent recovered phylum was Ascomycota (89.1%), followed by Chytridiomycota (8.1%), Basidiomycota (2-8%) and Mucoromycotina (1.3%).

Introducción

Los estimados actuales de la diversidad de hongos basados en la proporción de plantas-hongos encontrados en países donde ambas poblaciones son suficientemente bien estudiadas sugieren la existencia de 1.5 millones de especies (Hawksworth, 1991, 2001; Mueller y Schmit, 2007). El estudio de la diversidad de hongos es importante porque los hongos descomponen la materia orgánica y comprenden una mayor proporción de biomasa microbiana. Recientemente, el cambio climático global y el mejor conocimiento del papel de los hongos en los ciclos biogeoquímicos han reforzado la importancia del estudio de la diversidad de hongos (Chapin et al., 2000; Wardle y Giller, 1996).

Los estudios de la diversidad de hongos han sido limitados por la falta de métodos microbiológicos apropiados (Kimura, 2006; Torsvik y Ovreas, 2002). La aplicación de los enfoques moleculares tales como extracción, clonación y amplificación del ADN de las muestras ambientales nos permite explorar hoy día la biodiversidad sin la necesidad de cultivos. Al respecto, las secuencias del ADN 18S ribosomal (rADN) han sido usadas extensivamente para explorar la diversidad de hongos (Hunt, Boddy, Randerson, y Rogers, 2004; Le Calvez, Burgaud, Mahé, Barbier y Vandenkoornhuyse, 2009; Monchy et al., 2011; Piquet, Bolhuis, Meredith, y Buma 2011) y muchos selladores específicos han sido diseñados para este propósito (Borneman y Hartin 2000; Moo-van der Staay, De Wachter, y Vaulot, 2001; Vainio y Hantula, 2000). La capacidad de estos selladores para revelar la diversidad de hongos en muestras ambientales está basada en sus especificidades al prevalecer en las secuencias de hongos preferencialmente y también en sus habilidades de representar todas las filas de los hongos al mismo tiempo (Anderson, Campbell, y Prosser, 2003; Hunt et al., 2004). Instrumentos moleculares, incluyendo el análisis de la secuencia de rADN 18S, han sido usados recientemente para redefinir la taxonomía de los hongos basados en análisis filogenéticos multilocus (Hibbett et al., 2007; James et al., 2006). Como consecuencia, nuestra visión de los grupos de hongos tradicionales ha cambiado drásticamente.

Si los hongos terrestres no están ampliamente descritos, los hongos acuáticos son aún menos conocidos. Muchas de las especies acuáticas cultivadas pertenecen a los filos Chytridiomycota y Ascomycota (Mueller y Schmit, 2007; Mueller, Bills, y Foster, 2004; Shearer et al., 2007) y muchos de los microbios que están relacionados con los hongos han sido descritos y pertenecen a los stramenopiles (en particular a los oomycetos e hyphochytriomycetos*)* (Mueller et al., 2004; Vander Auwere et al., 1995). En México, se ha hecho un esfuerzo importante para explorar la diversidad de hongos (Guzmán, 1998). Se ha realizado una exploración de la diversidad de hongos acuáticos con métodos tradicionales, aislando los hongos de agua dulce y de ambientes marinos (González y Chavarría, 2005; Gonzáles, Hanlin, Herrera, y Ulloa, 2000; González, Hanlin y Ulloa, 2001; Heredia, Reyes, Arias Mena-Portales, y Mercado Sierra, 2004).

En ambientes marinos, se encontraron principalmente hongos ascomicetos y mitospóricos aunque se reportó un basidiomiceto (González et al., 2001).

Para explorar la diversidad de hongos acuáticos en México y para demostrar el potencial de un sistema de clasificación basado en un marcador molecular único, presentamos una investigación de diferentes cuerpos de agua (marina, salobre y agua dulce) usando un fragmento de las secuencias de rADN 18S y los resultados de nuestro enfoque de agrupamiento filogenético.

Materiales y métodos

Descripción de las localidades de las muestras

Zempoala, Morelos (agua dulce, 19°01´20’N, 99°16´20’O). Las Lagunas Zempoala comprenden 7 cuerpos de agua prístina localizados en un parque protegido en el estado de

Morelos, entre 2670-368 metros sobre el nivel del mar. El área está rodeada por un bosque templado de pinos, abetos y robles. Las muestras fueron obtenidas de una de las lagunas permanentes.

Carboneras, Tamaulipas (agua salobre, 24°37´41.88” N, 97°42´59.19” O). Un pueblo pesquero y de reposo localizado en el estado de Tamaulipas. Pertenece a la sección central de Laguna Madre.

Mezquital, Tamaulipas (agua marina, 25°14´55.70” N, 97°31´05.54” O). Localizado en el lado este de la parte más ancha de Laguna Madre, está conectado con el Golfo de México a través de un canal de navegación artificial.

Media Luna, Tamaulipas (agua salobre, 25°09´47.64” N, 97°40´16.35” O). Localizado en el lado oeste de la parte más ancha de Laguna Madre, y debido a las pobres condiciones de los caminos y a la ausencia de grandes asentamientos, esta es una de las áreas menos dañadas. La distancia entre los lugares de las muestras de Mezquital y Media Luna es de aproximadamente 12 kilómetros.

El Rabón, Tamaulipas (agua marina hipersalina, 25°26´23.68” N, 97°24´34.79” O). Al final del lado norte de Laguna Madre, esta área ha sufrido serias transformaciones debido a la actividad humana y se ha secado. Recientemente, los humedales han sido restaurados bombeándoles agua marina.

Carpintero, Tamaulipas (agua dulce, 22°14´01.12” N, 97°51´26.67” O). Perteneciente a la cuenca del Río Pánuco y localizada en un parque natural protegido que cubre 7 hectáreas, la Laguna Carpintero es usada actualmente para la pesca y para tierras de crianza de cocodrilos. A pesar de la localización urbana del lugar en la Ciudad de Tampico, está relativamente poco dañada.

Vicente Guerrero, Tamaulipas (agua dulce, 24°03´43.70” N, 98°44´13.44” O). Este cuerpo de agua es una represa construida en 1971 en la cuenca del Río Soto La Marina. Tiene una superficie de 22.1 kilómetros cuadrados a 134 metros sobre el nivel del mar. Con un volumen promedio de 500 millones de metros cúbicos, se usa para deportes acuáticos y pesca deportiva.

Bahía de Banderas, Jalisco (agua marina, 20°38´58.93” N, 105°24´51.94” O). Localizada en la frontera entre los estados de Nayarit y Jalisco en la Costa Pacífica, es la bahía más grande en México, con una superficie de 773 kilómetros cuadrados. La desembocadura del Río Ameca divide la bahía, la cual tiene una alta densidad de población ubicada en Puerto Vallarta.

Cruz de Haunacaxtle, Nayarit (agua marina, 20°44´12.96” N, 105°23´17.35” O). Un lugar costanero con un bajo impacto antropogénico localizado al final de la parte norte de Bahía de Banderas en el estado de Nayarit. La distancia entre los sitios de las muestras de la Bahía de Banderas y Cruz de Huanacaxtle es de aproximadamente 15 kilómetros.

Zacapulco, Chiapas (agua de manglar, 15°04´07” N, 92°45´20” O). Área de manglar poco dañada localizada 200 kilómetros al noroeste de la frontera del estado de Chiapas con Guatemala, en la línea costera del Océano Pacífico. A 14 metros sobre el nivel del mar, la salinidad del estuario oscila con las mareas. La vegetación perenne provee cobijo para el hábitat de muchas aves acuáticas. Los días no se alteran con el cambio de estación y la temperatura varía entre los 25 y 35°C.

Santa Catalina, Querétaro (agua dulce, 20°47´30.6” No, 100°27´01.6" O). Es un reservorio de agua artificial localizado a 25 kilómetros al noroeste de la ciudad de Querétaro en el estado de Querétaro, a 2035 metros sobre el nivel del mar.

Recolección de las muestras

Decidimos recolectar muestras del agua en lugar de materia orgánica para recuperar una selección más amplia de población de hongos en cada sitio, no solamente de aquellos directamente involucrados en el deterioro. Las muestras fueron recolectadas desde 0,5 metros bajo la superficie del agua, usando un envase con una superficie limpia y esterilizada. Los volúmenes de las muestras típicas fueron 20 litros. Toda la muestra se pasó a través de 3 capas de una estopilla esterilizada y después filtrada a través de membranas de 5 p.m PVDF (Millipore). La capa de biomasa se desechó con una espátula de las membranas, se lavó con 3 a 5 mililitros de la misma agua y se pasó por la centrífuga en tres tubos Eppendorf diferentes para repetir el análisis. Los volúmenes finales de la biomasa fueron de 0,1 a 0,3 mililitros. Las pequeñas bolitas se congelaron a -20°C hasta su extracción.

Extracción del ADN

Toda la bolita fue procesada y el total del ADN extraído al usar el equipo de Ultra Clean Soil DNA (MoBio, Carlsbad, USA) de acuerdo con las instrucciones del fabricante. El total de ADN fue analizado para la integridad con un gel de agarosa por electroforesis.

Ampliación del ADN ribosomal

Se amplificó el total de los alícuotas del ADN al aplicar selladores nu-SSU0817 y nu-SSU-1536 (Borneman y Hartin, 2000), un producto sellador blando de aproximadamente 750 bp. Las mezclas de reacción contenían 2.5 mM $MgCl_2$, mezcla de 1 mM dNTPs, 5 μM de cada sellador, 50 ng del total del ADN como plantilla, 1X de reactivo protector y 5U de polimerasa Taq (Altaenzymes, Alberta, Canadá). Las mezclas de reacción fueron objeto de un paso de una desnaturalización inicial de 5 minutos a 95°C seguida por 30 ciclos de amplificación (30 s a 95°C, 30s a 55°C, 45s a 72°C) y un paso de extensión final de 2 minutos a 72°C. Las amplificaciones fueron realizadas en un secuenciador térmico veloz PCR (Thermo Electron Corporation, Estados Unidos). Los fragmentos resultantes fueron separados con electroforesis con un gel de agarosa, el fragmento amplificado fue visualizado con un tinte de bromuro de etidio, extirpado y purificado con un equipo de extracción de gel rápido QIA (QIAGEN, Hilden, Alemania).

Construcción del catálogo

Los fragmentos amplificados fueron directamente clonados en el pGemT-vector-fácil (Promega, Madison, Estados Unidos) y transformados por electroporación en tensión DH5 (alfa griega) de *Escherichia coli.* Los clones contenidos en la inserción fueron detectados por la falta de coloración en la presencia de X-gal e IPTG y recogidos en paletas limpias. Fueron extraídos plásmidos de 6 clones seleccionados al azar de cada catálogo con lisis alcalinos y secuenciados para verificación de inserción. En aquellos casos en que el producto de la amplificación no pudo ser detectado en al menos 4 de los 6 clones o cuando los insertos de secuencia no fueron un gen ribosomal de hongos, el procedimiento se repitió para obtener una mejor cosecha o calidad.

Secuenciación del ADN

Un grupo de 384 clones seleccionados al azar de cada catálogo fue secuenciado en conjuntos de 496 placas. Se recogieron las colonias y se extrajo plásmido del ADN con lisis alcalino. Se verificó la concentración y la integridad del ADN aislado con electroforesis con gel de agarosa y secuenciado con sellador T7 en la Unidad de Secuencia del Centro de Ciencias Genómicas (Universidad Nacional Autónoma de México).

Experimentos de control

Se usó ADN genómico de diferentes organismos como control antes de la amplificación de la muestra. De fuentes *procarióticas*: *E. Coli, Rhizobium meliloti* y

Spirulina maxima. De fuentes de hongos: *Aspergillus nidulans, Debaryomyces hansenii, Yarrowia lipolytica, Saccharomyces cerevisiae, Schizophyllum commune y Bjerkandera adusta*. De una fuente artrópodo usamos ADN de *Centruroides limpidus* y de fuentes de plantas, *Arabidopsis thailana y Phaseolus vulgaris*. En todos los casos las muestras fueron amablemente cedidas por colegas del Instituto de Biotecnología (UNAM) y del Centro de Investigación en Biotecnología (UAEM).

Análisis de la secuencia

Los archivos de la secuencia del ADN fueron proporcionados en formato FASTA y el nombre de cada archivo fue editado manualmente para permitir una identificación clara de cada secuencia en el futuro. Una depuración inicial se llevó a cabo para cada conjunto de 384 secuencias y las muy cortas o ambiguas se eliminaron. El resto de las secuencias se sometieron para una identificación individual contra el Banco de Genes al usar la herramienta BLAST (Altschul et al., 1997). Mientras que la mayoría de las secuencias coincidía con las entradas de orígenes de los hongos, aquellas que claramente correspondían a otra fila se eliminaron. En muestras de fuentes marinas, la remoción fue menos clara basada en el poco número de hongos marinos bien caracterizados, así que decidimos dejar todas las secuencias ambiguas en el grupo para un análisis posterior. Los conjuntos aprobados fueron automáticamente alineados usando el algoritmo Clustal W (Larkin et al., 2007) contenido en la Mega versión 4 (Tamura, Dudley, Nei y Kumar, 2007). La mayoría de la secuencia se alineó en la primera ronda, aunque la optimización de los alrededores de varias regiones requirió un alineamiento manual. Los fragmentos portadores del vector fueron removidos después del alineamiento. Se añadió un conjunto de secuencias ribosomales de organismos bien identificados a cada alineamiento para referencia interna y el grupo fue realineado y manualmente mejorado con Clustal W. Algunas veces detectamos grupos de secuencias experimentales que no se agrupaban con las secuencias de referencia, pero dentro de ellos mismos. En estos casos identificamos cada una de las secuencias mediante la búsqueda de la coincidencia más cercana en las bases de información al utilizar la herramienta BLAST. Para algunas secuencias, la coincidencia más cercana resultó ser una entrada de una especie caracterizada, pero, en otros casos, recuperamos entradas de encuestas ambientales. Se reforzaron las filogenias al incluir secuencias de especies caracterizadas de la lista de secuencias referenciales, y, algunas veces, secuencias de fuentes no cultivadas. Se realizó un agrupamiento de secuencias al usar el algoritmo Neighbor Joining (Saitou y Nei, 1987) contenido en la Mega Versión 4.

Resultados

Amplificación del ADN ribosomal 18S del hongo de una referencia aislada

Se probó un control de ADN genómico de diferentes fuentes para amplificación con selladores nu-SSU-0817 y nu-SSU-1536. Las plantillas de fuentes no fúngicas no fueron capaces de respaldar la amplificación mientras que fuentes fúngicas específicamente amplificaron el fragmento interno de rADN 18S. En 5 de 6 muestras fúngicas (*A. nidulans, D hansenii, Y. lipolytica, S. cerevisiae, y B. adusta*) el tamaño del producto amplificado coincidió con el 762 bp esperado. La calidad de la información de la secuencia se evaluó al secuenciar un catálogo de control generado por amplificación del ADN 18S de *S. cerevisiae*.

Catálogos amplificados de la identificación y análisis filogenético de nu-SSu-0817 y unu-SSU-1536

Se aisló el total del ADN de las muestras de agua de 11 sitios diferentes (ver Sección “Materiales y métodos”), un fragmento del ADN 18S ampliado y clonado en catálogos genéticos para una clonación individual de la secuencia. En esos casos raros donde las secuencias del rADN de grupos filogenéticos diferentes a los hongos se recuperaron, estos fueron removidos de la recolección antes del agrupamiento. La única excepción de este comportamiento fue la muestra de la laguna Carpintero, donde las 146 secuencias recuperadas fueron más similares a las secuencias referenciales de dinoflagelados que de hongos. Este conjunto de secuencias fue retirado de nuestro análisis.

Análisis del agrupamiento de los catálogos

Probamos la habilidad de nuestro marcador molecular, un fragmento del gen rADN 18 que contiene regiones V4-V8, para reconstruir el perfil del comportamiento consistente con la clasificación taxonómica al utilizar nuestro conjunto de secuencias referenciales. Una vez que la robustez del método de agrupamiento fue demostrada, las secuencias ambientales de 10 de nuestros 11 catálogos (después de retirar las muestras de la Laguna Carpintero por las razones descritas arriba) fueron organizadas por localidad junto con las secuencias referenciales fúngicas como se describe en la Sección “Materiales y métodos”. Se realizaron reconstrucciones seriales de los 10 catálogos al aplicar el alineamiento múltiple optimizado manualmente de cada sitio, el cual incluyó las secuencias referenciales recuperadas, hasta que se obtuvo un filograma informativo y robusto. Basados en estos filogramos, identificamos la clasificación taxonómica más probable de las secuencias ambientales por su agrupamiento con secuencias referenciales.

Con la metodología descrita arriba, fuimos capaces de identificar 529 de las secuencias ambientales a un nivel familiar, 1077 en el nivel de orden y 288 al nivel de Clase/Subfilo. Solamente 326 secuencias, todas del mismo sitio, no se agruparon con ninguna de las secuencias de referencia, pero sí los clones no cultivados de fuentes marinas. El filo más abundante encontrado fue *Ascomycota* (1458 secuencias), seguida por *Chytridiomycota* (133 secuencias). Pocas veces se recuperaron secuencias pertenecientes al filo *Basidiomyota* (45 secuencias) y al subfilo *Mucoromycotina* (21 secuencias), así como a las secuencias no fúngicas pertenecientes a *Choanoflagellidae y Eccrinales* (29 secuencias).

Estimación de la diversidad

Se estimó la diversidad de las Unidades Taxonómicas Operacionales Moleculares (UTOM) usando el Índice Shannon, el cual da una medida de los números de ambas especies y la igualdad de su abundancia como se presenta en el Cuadro 4 (Shannon, 1948). El valor de los rangos del índice de valores bajos (especies reducidas riqueza e igualdad) a valores altos (especies extendidas igualdad y riqueza). En este trabajo, el valor de la diversidad más baja se obtuvo de Media Luna y Bahía de Banderas, muestras con un UTOM identificado en cada (H' = 0). En contraste, el valor de la diversidad más alta se obtuvo en la laguna Zempoala (H'=2,285), un poco más alta que el total de la diversidad por familia (H'=2,130).

Para determinar si los diversos grupos estuvieron presentes al azar en las diferentes localidades de muestras o si hubo una predominancia de cierto grupos en una localidad dada, se realizó la prueba Friedman para la clasificación de dos vías. Toda la población fue distribuida usando 10 sitios diferentes (cuadras) y 18 grupos taxonómicos clasificados a nivel de la orden (tratamientos). La aplicación del procedimiento Friedman a la información resultó en un valor de X2 de 35.71 y 17 grados de libertad.

Discusión

En ambientes acuáticos la descomposición de la materia orgánica ocurre a través de una compleja pero bien definida función fúngica (Barlocher y Kendrick, 1974; Gessner.

Thomas, Jean-Louis, y Chauvet, 1993). El enfoque más común usado para los estudios de la diversidad fúngica acuática involucra la recolección de material orgánico de fuentes naturales tales como deshechos de plantas o de carnadas artificiales y la estimación de la riqueza de las especies basada en el microscopio. Usando este enfoque, la riqueza depende de la habilidad de las especies en la comunidad para esporular. Alternativamente, los métodos moleculares se pueden aplicar para la identificación de las especies fúngicas, independientemente de su estado metabólico o etapa del ciclo de vida. Estudios comparativos llevados a cabo con hojas deterioradas indican que ambos enfoques son complementarios en la elucidación de la composición y dinámica de la población (Nikolcheva, Cockshutt y Barlocher, 2003).

Desafortunadamente, se les ha prestado poca atención a los hongos acuáticos, así que es difícil comparar nuestros resultados con aquellos de otros grupos. Los estudios disponibles se enfocan principalmente en los hongos adheridos a materia orgánica (principalmente madera), lo que limita el de los hongos de madera en descomposición o a específicos cuerpos de agua, principalmente lagos o ríos. También es cierto que la mayoría de éstos usan técnicas de cultivo tradicionales para explorar la biodiversidad, y lo cual es también una limitación. Muchos de estos estudios se refieren sólo a ciertos grupos de hongos (levaduras, por ejemplo).

Pequeñas secuencias de subunidad del ADN ribosomal (18S rADN) han sido usadas como marcadores moleculares para reconstruir la taxonomía fúngica (Bruns et al., 1992); Hibbett et al., 2007; James et al., 2006) y para describir la diversidad fúngica en suelos y cuerpos de agua (Anderson et al., 2003; Hunt et al., 2004; Monchy et al., 2011; Piquet et al., 2011). Pequeñas secuencias de subunidades de rADN han sido usadas para explorar la diversidad biológica y se ha desarrollado un software especializado para discriminar entre secuencias procarióticas y eucarióticas (Bengtsson et al., 2011). Secuencias de 18S rADN aún son ampliamente usadas para explorar muestras ambientales. El conjunto de selladores usados aquí fue diseñado para la amplificación del ADN ribosomal fúngico, en particular un fragmento interno de un gen de una partícula ribosomal 18S entre varias regiones V4 y V8 (Borneman y Hartin, 2000). En el documento original estos selladores no pudieron ampliar el ADN aislado de organismos que no fueran hongos y se demostró una especificidad operacional por la amplificación meta de las secuencias ribosomales 18S fúngicas de las muestras del suelo (Anderson et al., 2003).

La designación de especies cultivadas individualmente, basadas en los marcadores moleculares, presentan la debilidad intrínseca de la falta de un método sólido estadísticamente. En algunos casos la identificación está basada en una similitud total de secuencias de consultas a secuencias referenciales en bases de datos públicos en alineamientos emparejados que utilizan límites diseñados arbitrariamente. Con el fin de reforzar la robustez taxonómica de nuestro trabajo, hemos adoptado el concepto del rango de intervalo de identidad, originalmente creado por la clasificación de especies bacterianas nodulantes de plantas (Lloret et al., 2007; Martínez-Romero, Ormeño-Orillo, Rogel, López-López, y Martínez-Romero 2010).

Nuestro enfoque está basado en el agrupamiento de secuencias experimentales y un conjunto de secuencias de referencia taxonómicamente clasificadas que abarcan conocidas filas fúngicas y linajes basales. Esto da suficiente información para reconstruir la clasificación taxonómica de los organismos. Algunas veces los patrones de agrupamiento fueron sensibles para la distribución de secuencias experimentales a menos de que más secuencias de referencias fueran incluidas. En estos casos, identificamos grupos de entradas experimentales que les hacía falta secuencias de referencia y los usamos para recuperar su mejor pareja en la base de datos. La inclusión de estas nuevas secuencias de referencia en los alineamientos estableció la topología del árbol. Cada grupo fue identificado taxonómicamente usando la clasificación de las secuencias de referencia localizadas dentro, a niveles diferentes, del filo a la familia.

La variabilidad secuencial de fragmentos de 18S rADN apoya la reconstrucción grupal de nuestras secuencias de referencia ensambladas con consistencia taxonómica. Esto incluye la identificación de un subgrupo de Chitridiomicetos pertenecientes al género *Rozella*, el cual es conocido por agrupare separadamente (Hibbett et al., 2007). Es importante anotar que fuimos capaces de recobrar secuencias de todas las filas fúngicas, indicando una pequeña parcialidad para el procedimiento de recolección o la amplificación de selladores usados. De toda la recolección, 23,8% de las secuencias pudieron ser identificadas a un nivel familiar, 48,5% a un nivel de orden y 13% a un nivel de clase/subfilo.

El papel importante de la degradación de madera y de hojas ha sido adscrito a los ascomicetos acuáticos ya que los basidiomicetos son escasos en hábitats de agua y otros organismos como las bacterias raramente tienen la habilidad de mineralizar la lignina completamente (Simonis, Raja, y Shearer, 2008). Así, no fue sorprendente que el *Ascomicota* fue el filo recuperado más frecuentemente y el *Sordariomicetos* la clase recobrada más frecuentemente. La aparición de ascomicetos no identificados fue documentada en solo 3 de los sitios de muestras, apoyando la idea de que este filo es el mejor caracterizado aun en hábitats acuáticos. El segundo filo más abundante descrito en ambientes acuáticos es *Chitridiomicota*, y en correspondencia, fue el segundo grupo más frecuente de nuestra secuencia con 41% de las secuencias identificadas a nivel familiar.

La gran cantidad de clones analizados nos permitió evaluar la diversidad mediante el índice Shannon, obteniendo valores que fueron de 0 a 2,363. Con una sola excepción, estos valores están bajo aquellos descritos para poblaciones fúngicas terrestres (1,87-2,82) (Klaubauf et al., 2010), sugiriendo que los hongos acuáticos son menos diversos que los de su contraparte terrestres. El único lugar con una alta diversidad fue Zempoala, un ambiente prístino localizado en una zona templada. Los lugares menos diversos fueron Media Luna y Bahía de Banderas, ambos lugares costeros con un alto impacto humano. La combinación de organismos identificados fue específica para cada lugar, como se demostró con la aplicación directa de la prueba Friedman para la clasificación de dos vías. Este resultado enfatiza la especialización de organismos y, por lo tanto, la necesidad de regular la evaluación de la biodiversidad local en ambientes acuáticos.

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Digéneos intestinales en tortugas de agua dulce Phrynops hilarii y Acanthochelys spixii (Testudines: Chelidae) del sur de Brasil

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Resumen

El propósito de este trabajo es incrementar el conocimiento sobre la diversidad de digéneos parásitos de tortugas de agua dulce en el sur de Brasil. *Phryops hilarii y Acanthochelys spixii* son especies comunes de la fauna del Río Grande do Sul; sin embargo, poco se sabe acerca de los helmintos que parasitaban a estos huéspedes. En este contexto, se examinaron 14 A. *spixii* y 5 P hilarii en busca de helmintos. El presente estudio registra A. spixii como un nuevo huésped para los digéneos *Cheloniodiplostomun sp. (Proterodiplostomidae) y Telorchis platensis* (*Telorchiidae)*. Además, los digéneos *Cheloniodiplostomum testudinis y Telorchis birabeni* son registrados por primera vez en P. hilarii en Brasil.

Palabras clave: Helmintos; Parásitos; Cheloniodiplostomum; Telorchis; Acanthochelys spixii; Phyrnops hilarii

Abstract

The work was aimed to increase knowledge on the diversity of parasitic digeneans in freshwater turtles from southern Brazil. *Phrynops hilarii* and *Acanthochelyss spixii* are common turtle species of the Rio Grande do Sul fauna; however, little is known about the helminths parasitizing these hosts. In this context, 14 A. *spixii* and 5 P. *hilarii* were necropsied and helminthologically examined. The digenean species *Cheloniodiplostomumsp* (*Proterodiplostomidae),* and *Telorchis platensis (Telorchiidae*) were reported for the first time in A. spixii. This is the first report of *Chelobniodiplostou testudines,* and *Telorchis birabeni* in *P. hilarri* form Brazil.

Introducción

El conocimiento de la diversidad de helmintos en tortugas de agua dulce de Sur América consiste en informes llevados a cabo principalmente en Uruguay, Argentina y Brasil. (Fernandes y Kohn, 2014). Recientemente, en el sur de Brasil, la fauna de helmintos de estos huéspedes ha sido investigada resultando en nuevos registros de especies de Nermatoda y Digenea, así como la proporción de infecciones en tortugas de agua dulce de Emydidae y Chelidae (Bernardon, Valente y Müller, 2014); Mascarenhas y Müller, 2013, 2015 a,b; Mascarenhas, Souza, Coimbra y Müller, 2013).

Phrynops hilarii (Duméril y Bibron, 1835) (Chelidae), conocida como la tortuga Saint-Hilaire de cuello lateral existe en Brasil, Uruguay, Paragua y yArgentina (Djik, Iverson, Rhodin, Shaffer, y Bour 2014). En Brasil, existe en los estados de Santa Catarina y Rio Grande do Sul (Djik et al., 2014.

La tortuga cuello espinoso, Acanthohelys spixii (Duméril y Bibron, 1835) (Chelidae), se puede encontrar en Uruguay, Argentina y Brasil (Djik et al., 2014). En Brasil, existe en los estados de Bahia, Goiás, Minas Gerais, Sao Paulo, Paraná, Santa Catarina, Rio Grande do Sul, y en el Distrito Federal (Brasil, Horta, Fraxe-Neto, Barros, y Colli, 2011; Djil et al., 2014). En el estado de Rio Grande do Sul, esta especie está asociada con ambientes de lagunas arenosas, humedales y estanques estacionales o semi permanentes (Bujes y Verrastro, 2008).

En relación con el conocimiento de los helmintos de las 2 especies hay algunos estudios llevados a cabo en Uruguay, Argentina y Brasil. El estudio actual tiene el objetivo de informar la presencia de Digénea en las tortugas de agua dulce, P. hilarii y A. spixii, y contribuir al conocimiento de la biodiversidad de parásitos helmintos en estos huéspedes.

Materiales y métodos

Los especímenes de tortugas examinados fueron recolectados entre octubre del 2011 y noviembre del 2014; víctimas mortales en las autopistas en la región sur del Estado de Rio Grande do Sul (Brasil), en los municipios de Pelotas; Capao do Leao; Rio Grande; y Santa Vitória do Palmar. Un total de 14 especímenes de A. spixii (5 machos y 9 hembras), y 5 P. hilarii (1 macho y 4 hembras) fueron necropsados. Nueve huéspedes fueron congelados (7 A. spixii y 2 P. hilarii), y 10 fueron procesados inmediatamente después de muertos (7 A. spixii y 3 P. hilarii). El estómago, así como también los intestinos largos y cortos se abrieron y lavaron con agua corriente en un tamiz de 150 p.m. para separar los helmintos. Fue inspeccionado el material retenido en el tamiz y las membranas mucosas bajo un estereomicroscopio. La cavidad fue lavada también y su contenido examinado. Los digéneos fueron fijados en AFA (etanol de 70°, formalina 37% y ácido acetílico glacial) y luego preservados en etanol de 70°. Algunos especímenes fueron manchados en hematoxilina de Delafield o Langeron de Carmina, y montados como diapositivas permanentes en bálsamo Canadá e identificados de acuerdo a Lombardero y Moriena (1977), Dubois (1979), Mañé-Garzón y Gil (1961 a,b), Travassos, Freitas, y Kohn (1969). Se depositaron comprobantes en el Colecao de Helmintos do Laboatorio de Parasitologia de Animais Silvestres (CHLAPASIL/UFPel) (nombre en portugués), Estado de Rio Grande do Sul, Brasil; Colecao Helmintológica do Instituto Oswaldo Cruz (CHIOC), Estado de Rio du Janeiro, Brasil y Colecao de Invertebrados, Museo de La Plata (MLP-He), La Plata, Argentina. Las medidas se expresaron en milímetros (mm), y los promedios aparecen en paréntesis. Los índices parasitológicos: prevalencia, porcentaje de intensidad de la media, y abundancia de la media de infección, se estimaron de acuerdo con Bush, Lafferty, Lotz, y Shostak (1997). El rango de variación del parásito fue presentado de acuerdo con Bush, Fernandez, Esch, y Seed (2001). Los fotomicrógrafos fueron tomados con un Microscopio

Olympus BX 41, mediante un sistema adaptable de cámara. Las placas fotomicrográficas fueron preparadas al utilizar Adobe Fotoshop CS5.

Descripciones

Familia Proterodiplostomidae

Cheloniodiplostomum sp.

Basado en 18 especímenes adultos (8 fueron medidos). El cuerpo fue dividido en 2 partes por constricción a nivel del borde posterior del testículo anterior. El largo del cuerpo es 1.2-1.45 (1.32), el largo del cuerpo delantero es 0.77-0.98 (0.85), el ancho del cuerpo delantero (a nivel del acetábulo) 0.40-0.55 (0.49), el largo del cuerpo trasero 0.38-0.56 (0.47), ancho del cuerpo trasero (a nivel del testículo anterior) 0.26-0.35 (0.33), largo de la ventosa oral 0.03-0.05 (0.05), ancho de la ventosa oral 0.03-0.07 (0.05), largo de la faringe 0,04-0.05 (/0.04), ancho de la faringe 0.02-0.05 (0.04), largo del esófago 0.02-0.07 (0.05), largo del acetábulo 0.05-0.06 (0.05), ancho del acetábulo 0.06-0.07 (0.07), largo del apéndice 0.07-0.12 (0.10), ancho del apéndice 0.08-0.15 (0.11), largo del ovario 0.04-0.08 (0.06), ancho del ovario 0.06-0.14 (0.10), largo del testículo anterior 0.07-0.12 (0.20), ancho del testículo anterior 0.14-0.20 (0.17), largo del testículo anterior 0.08-0.12 (0.10), ancho del testículo posterior 0.17-0.23 (0.20), largo de los huevos 0.09-0.11 (0.10), ancho de los huevos 0.05-0.07 (0.06), (se midieron 11 huevos). Se presentaron de 1 a 2 huevos por helminto.

Resumen taxonómico

Huésped: Acanthochelys spixii (Duméril y Bibron, 1835)

Lugar infectado: intestino delgado e intestino grueso.

Lugar de la muestra: Capao do Leao, Rio Grande do Sul, Brasil.

Prevalencia: 7.1% (1/14)

Intensidad promedio: 128

Abundancia promedio: 9.1.

Rango de variación: 128

Especímenes depositados: 587 – 594 (CHLAPASIL-UFPel); 36733, 38044a, 38044c (CHIOC); 6839-6841 (MLP-He)

Cheloniodiplostomunm testudinis (Dubois, 1936) (Fig. 4-6).

Basados en 35 especímenes (se midieron 5 adultos y 5 inmaduros). Adultos: cuerpo dividido en 2 partes por una constricción localizada a nivel del ovario y del testículo anterior. Largo del cuerpo 1.47-1.80 (1.71), largo del cuerpo delantero 1.02-1.32 (1.25), ancho del cuerpo delantero (a nivel del acetábulo) 0.28-0.37 (0.33), largo del cuerpo posterior 0.41-0.52 (0.45), ancho del cuerpo posterior (a nivel del testículo anterior) 0.25-0.3 (0.27), longitud de la ventosa oral 0.04-0.06 (0.05), ancho de la ventosa oral 0.03-0.07 (0.05), longitud de la faringe 0.05-0.06 (0.16), ancho de la faringe 0.03-0.05 (0.04), longitud del esófago 0.06-0.13 (0.08), longitud del acetábulo 0.03-0.06 (0.05), ancho del acetábulo 0.04-0.05 (0.05), longitud del apéndice 0.15-0.19 (0.17), ancho del apéndice 0.11-0.15 (0.13), longitud del ovario 0.07-0.10 (0.08), ancho del ovario 0.07-0.09 (0.08), longitud del testículo anterior 0.16-0.21 (0.18), ancho del testículo anterior 0.20-0.23 (0.22), longitud del testículo posterior 0.11-0.17 (0.14), ancho del testículo posterior 0.23-0.24 (0.23), longitud de los huevos 0.08-0.10 (0.09), ancho de los huevos 0.04-0.06 (0.05), 18 huevos medidos. Presencia de 1 a 10 huevos por helminto.

Inmaduros: Cuerpo dividido en 2 partes por una constricción leve a nivel de la borde anterior del testículo anterior. Longitud del cuerpo 0.85-1.17 (0.99), longitud del cuerpo anterior 0.67-0.91 (0.79), ancho del cuerpo anterior (a niel del acetábulo) 0.22-.0.32 (0.28), longitud del cuerpo posterior 0.18-0.22 (0.20), ancho del cuerpo posterior (a nivel del testículo anterior) 0.17-0.22 (0.19), longitud de la ventosa oral 0.04-0.05 (0.04), ancho de la ventosa oral 0.04-0.05 (0.04), longitud de la faringe 0.04-0.05 (0.04), ancho de la faringe 0.02-0.04 (0.03), longitud del esófago 0.08-0.12 (0.09), longitud del acetábulo 0.04-0.05 (0.05), ancho del acetábulo 0.05-0.06 (0.05), longitud del apéndice 0.09-0.15 (0.12), ancho del apéndice 0.10-0.14 (0.11), longitud del ovario 0.02-0.07 (0.03), ancho del ovario 0.08-0.10 (0.09), longitud del testículo anterior 0.02-0.05 (0.03), ancho del testículo anterior 0.06-0.11 (0.09), longitud del testículo posterior 0.02-0.07 (0.04), ancho del testículo posterior 0.07-‘.16 (0.10).

Resumen taxonómico

Huésped: Phrynops hilarii (Dumeril et Bibron, 1835

Lugar de la infección: intestino delgado

Lugar de la muestra: Pelotas, Rio Grande do Sul, Brasil (31°45’02.8” S-52°20’38.7” O)

Prevalencia: 60% (3/5).

Porcentaje de intensidad: 57.7.

Porcentaje de abundancia: 28.8.

Rango de variación: 53-62.

Especímenes depositados: 595-604 (CHLAPASIL-UFPel); 35999, 36734, 38045a-38045e (CHIOC); 6836-6838 (MLP-He).

Comentarios

De acuerdo a la llave propuesta por Dubois (1979), el género *Cheloniodiplostomum* Sudaricov, 1960, incluye 2 especies, C *testudines* (Dubois, 1936), *C. brevis* (MacCallum, 1921) [= *C. ciosterni* (MacCallum, 1921), y *C. delillei* (Zerecero, 1947).

Cheloniodiplostomum brevis fue descrito en *Kinosternon scorpioides* (Linnaeu, 1766) en Trinidad (MacCallum, 1921), y *C. delillei* en *Chelydra serpentine* (Linnaeus, 1758) en México (Zerecero, 1947). En Suramérica, *C. testudinis* se informó en *Testudo* sp y *Phrynops geoffroanus* (Schweigger, 1812) en Brazil (Fernandes y Kohn, 2014; Slva, 2014) y en *P. hilarii* en Argentina (Lombardero y Moriena, 1977).

Las descripciones e informes para las especies *Cheloniodiplostomum* son cortos, excepto por el de Zerecero (1947) quien describió *C. dellilei* en detalle. Considerando la falta de información morfológica, cambios en el grupo taxonómica, y con el propósito de generar información más rica para una identificación morfológica más detallada, se sugiere una revisión completa para las especies del género.

Cheloniodiplostomun sp., en el presente estudio, es muy similar a *C. dellilei*; sin embargo, la posición de vitelaria en *Cheloniodiplostomum* sp. está cerca de la bifurcación del intestino ciego diferente a *C. dellilei* que se extiende desde el acetábulo.

Las diferencias observadas entre *C. testudinis* y *Cheloniodiplostomum* sp en el presente estudio fueron: longitud, ancho y forma del cuerpo; ubicación de la constricción que divide el cuerpo en 2 partes, un cono genital bien desarrollado en *Cheloniodiplostomum* sp., siendo un poco abultado en *C. testudinis* (Fig.6). El número de huevos difiere, en Cheloniodiplostomum sp. existen entre 1 a 2 huevos (128 especímenes examinados), en *C. testudinis*, de 1 a 10 huevos (115 especímenes examinados).

La morfometría de *C. testudinis* descrita por Travassos et al. (1969), y Lombardero y Moriena (1977) es similar a la encontrada en el presente estudio; sin embargo, notamos un tamaño del cuerpo más pequeño (1.71 x 0.9 mm), ovario (0.08 x 0.22mm), y huevos (0.09 x 0.05mm); aunque el esófago era más grande (0.08 x 0.09mm). Los especímenes adultos y los inmaduros de *C. testudinis* en *P. hilarii* mostraron diferencias morfométricas pequeñas.

Los especímenes de *Cheloniodiplostomum* sp. descritos para *P. hilarii* (Bernardon et al., 2013) fueron examinados y se cree que son *C. testudinis*, sim embargo, la preparación de los especímenes de *Cheloniodiplostomum* sp. no permitió la identificación específica.

Familia Telorchiidae

Telorchis platensis Mañé-Garzón et Gil, 1961 (Fig. 7-10)

Basado en 6 especímenes (fueron medidos 4). Cuerpo elongado 3.6-4.2 (3.9) de longitud, 0.425-0.725 (0.56) de ancho (a nivel del ovario). Espinas en el tegumento presentes. Ventosa oral 0.14-0.15 (0.14) de largo, 0.14-0.16 (0.15) de ancho, pre-faringe presente. Faringe 0.06-0.07 (0.06) de longitud, 0.05-0.07 (0.06) de ancho. Longitud del esófago 0.09-0.19 (0.15). Longitud del acetábulo de la parte interna del intestino ciego 0.17-0.2 (0.19) y ancho 0.16-0.19 (0.18). Longitud del testículo anterior 0.18-0.213 (0.21) y 0.22-0.25 (0.24) de ancho, y testículo posterior 0.21-0.25 (0.23) de longitud y 0.22-0.32 (0.25) de ancho. Longitud del ovario 0.15-0.19 (0.18) y 0.15-0.21 (0.19) de ancho. Longitud de los huevos 0.037-0.042 (0.04) y 0.017-0.022 (0.021) de ancho.

Resumen taxonómico

Huésped: Acanthochelys spixii (Duméril et Bibron, 1835)

Lugar de la infección: intestino largo

Lugar de la muestra: Pelotas, Rio Grande do Sul, Brasil (31°43’49.1” S 52°22’43.3” O).

Prevalencia: 7.1% (1/14)

Porcentaje de intensidad: 6.

Porcentaje de abundancia: 0.4.

Rango de variación: 6.

Especímenes depositados: 569-574 (CHLAPASIL – UFPel).

Telorchis birabeni Mañé-Garzón et Gil, 1961 (figs. 11-14)

Basado en 4 especímenes (2 fueron medidos). Cuerpo elongado 6.93-7.13 (7.02) de longitud, 0.32-0.37 (0.35) de ancho (a nivel del ovario). Espinas en el tegumento presentes. Ventosa oral 0.23-0.28 (0.25) de longitud; por 0.22-0.28 (0.25) de ancho, pre-faringe presente. Faringe 0.18-0.25 de longitud por 0.13-0.16 (0.14) de ancho. Hay ausencia de esófago. Acetábulo 0.14-0.19 (0.16) de longitud, por 0.15-0.19 (0.17) de ancho. Testículo anterior 0.23-0.30 (0.26) de longitud por 0.24 de ancho, y testículo posterior 0.28-0.35 (0.31) de longitud por 0.21-0.22 (0.21) de ancho. Ovario 0.14-0.21 (0.17) de longitud por 0.17-0.19 (0.18) de ancho. Huevos 0.022-0.025 (0.023) de longitud por 0.012 de ancho.

Resumen taxonómico

Huésped: Phrynops hilarii (Duméril y Bibrón, 1835)

Lugar infectado: intestino delgado

Lugar de la muestra: Pelotas Rio Grande do Sul, Brasil.

Prevalencia: 40% (2/5).

Intensidad promedio: 5.

Abundancia promedio: 2.

Rango de variación: 3-7.

Especímenes depositados: 575-578 (CHLAPASIL - UFPel).

Observaciones

La especie de *Telorchis Lühe*, 1899 existe en reptiles, anfibios, y especialmente en tortugas de agua dulce en Norte América, Sur América, Europa y Asia (Font y Lotz, 2008). En América, *Telorchis corti Stunkard*, 1915 es la especie distribuida más ampliamente registrada desde Canadá hasta el sur de Brasil (McDonald y Brooks, 1989; Macarenhas y Müller, 2013).

Telorchis birabeni y *T. platensis* fueron descritas en Uruguay en *P. hilarii*, e *Hydromedusa tectifera* Coipe, 1870 (Chelidae), respectivamente (Mañé-Garxón y Gil, 1961 a, b). *Telorchis birabeni* se reportó en *P. hilarii* en Argentina (Lombardero y Moriena, 1977) y *P. geoffroanus* en Brasil (Silva, 2014).

En lo que respecta a *T. platensis* en el presente estudio, en los 6 especímenes examinados se observó que la parte del intestino ciego terminaba entre el testículo anterior y el testículo posterior, nunca excediendo la zona testicular. Esta característica no fue mencionada en la descripción de *T. platensis* por Mañé-Garón y Gil 1961 b). Los especímenes recolectados en *A. spixii,* en el presente estudio, abrigaban testículos y ovarios aproximadamente 2 veces más grandes que los especímenes uruguayos.

Telorchis birabeni tiene una parte posterior del cuerpo característica que constituye una formación cupuliforme, la cual abre un poro excretorio. De acuerdo con Mañé-Garzón y Gil (1961 a,), esta característica, única entre las especies *Telorchis,* justifica la descripción de un nuevo género para estas especies. Una revisión de las especies de *Telorchiidae* de Sur América podrían contribuir a la descripción de un nuevo género.

En ambas especies (*T. platensis y T. birabeni*) observamos la presencia de espinas tegmentales en mayor número en la región anterior, y una disminución de los acetábulos. La presencia de espinas en el tegumento es característica de las especies *Telorchis;* sin embargo, dichas espinas se pueden perder si el huésped fue congelado antes de ser examinado, como lo sugirieron Mascarenhas y Müller (2013). Los huéspedes de los cuales los *T. platensis* y *T.birabeni* fueron recolectados no fueron congelados; los helmintos fueron fijados inmediatamente después de la recolección, permitiendo la preservación de las espinas en el tegumento.

Telorchis es conocida por tener un grado considerable de una variación morfológica intraespecífica, la cual ha llevado a discutir el número de especies dentro del género. *Telorchis corti* se considera la más problemática de las especies, ya que 13 sinónimos han sido registrados en Norteamérica (McDonald y Brooks, 1989).

Mañé-Garzón y Gil (1961) reconocieron la necesidad de una revisión exhaustiva del género, la cual fue llevada a cabo más tarde por MacDonald y Brooks (1989) con las especies norteamericanas, y solo 11 de 31 especies descritas fueron consideradas válidas. En Suramérica, a 14 especies de *Telorchi* les pusieron nombre, siendo reportadas en tortugas y culebras de agua dulce (Fernandes y Dohn, 2014; Lenis y Vélez, 2011; Mascarenhas y Müller, 2013). En general, las características usas por los autores para diferenciar entre las especies fueron: tamaño del huevo, tamaño de la ventosa; extensión de la vitelaria, y la longitud del esófago (Mañé-Garzón y Gil, 1961 a,b,c; Mañé-Garzón y Holemann-Spector, 1968, 1973). Estas características fueron consideradas muy variables en el análisis de *Telorchiidae* en Norteamérica (MacDonald y Brooks, 1989). Sería interesante llevar a cabo una revisión de las especies *Telorchis* en Suramérica, de la misma forma que la de Maconald y Brooks (1989), para buscar establecer caracteres taxonómicos más juiciosos para la diferenciación de especies dentro del grupo y luego comparar los resultados con las especies de Norteamérica.

Discusión

El estudio de los parásitos de la fauna helminto asociada con tortugas de agua dulce en el sur de Brasil contribuye al conocimiento de la biodiversidad de parásitos en animales salvajes. El primer informe de los parásitos helmintos en *A. spixxi* fue hecho por Mascarenhas et al. (2013), con informes de la ocurrencia de nematodos en este huésped. Algunas especies de Digénea fueron descritas en *P. hilarii* en los años 60s en Uruguay; sin embargo, Bernardon et al. (2013) informó por primera vez Nematodos en este huésped.

El Digénea *Cheloniodiplostomum* sp. y el *Telorchis plantensis* son mencionados por primera vez en *Acanthochelys spixii*. Los helmintos *Cheloniodiplostomum testudinis* y *Telorchis birabeni* son citados por primera vez siendo parásitos de *Phrynops hilarii* en Brasil.

Los animales muertos en carreteras pueden ofrecer resultados interesantes para la investigación helmintológica, tal y como se observó en tortugas de agua dulce, suministrando información importante acerca de la diversidad de sus parásitos, y de la biología de los huéspedes, que puede contribuir a la conservación de las especies involucradas y sus hábitats.

Reconocimientos

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Estructura de semillas y desarrollo de plántulas in vitro de ciertas especies de Laelinae (Orchidaceae)

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Resumen

En este trabajo se realizó un análisis comparativo de semillas y plántulas en especies neotropicales de la subtribu *Laeliinae (Cattleya loddigesii, C. tigrina, Hadrolaelia purpurata, Laelia anceps, Schomburgkia gloriosa, y Sophronitis cernua*). Se describe el proceso de germinación de semillas y el desarrollo de plántulas cultivadas in vitro. Las semillas presentan un tegumento con un engrosamiento visible en las paredes. El embrión tiene un suspensor multicelular alargado. En la primera etapa del desarrollo de la plántula, el embrión se transforma en un protocormo con rizoides y tejido meristemático en el que aparecen los brotes primordiales. La raíz primaria se produce después de las hojas, es de tipo triarca o tetrarca con velamen. En conclusión, las características estructurales asociadas con la cubierta seminal, el desarrollo ontogenético de la hoja y el sistema vascular de la raíz, son indicadores significativos para la identificación de las especies estudiadas de Laeliinae.

Abstract

Seeds and seedlings of neotropical Laeliinae species (*Cattleya loddigesii*, *Cattleya tigrine*, *Hadrolaelia purpurata*, *Laelia anceps*, *Schmburgkia gloriosa*, y *Sophronitis cernua*) were studied. The seed germination process and the seedling grown in vitro are described. Seeds of the studied species are unitegmic and have conspicuous thickening in the anticlinal and inner periclinal cell walls. The embryo consists of a relatively long and multicellular suspensor. At first stage of seedling development, the embryo differentiates

into a protocorm with rhizoids and meristematic tissue. The budding occurs on the protocorms. The endogenous taproot is produced after the first leaves have emerged. The root is triarchy or tetrarch and it possesses velamen. Structural characters related to seed coat, suspensor, ontogeny of leaves, and vascular system of the root are significant indicators for the separation of Laeliinae species.

Introducción

Las especie Laeliinae (Orchidaceae) son estrictamente neotropicales y comprenden cerca de 50 géneros con 1.500 especies (Dressler, 1981, 1993), es la tercera sub-tribu más grande en la familia después de *Pleurothallidinae* y *Oncidiinae* (Van den Berg et al., 2009). La especie *Laeliinae* muestra una diversidad morfológica grande y una gran divergencia taxonómica (Van den Berg et al., 2009). Dressler (1981) incluyó en esta sub-tribu los géneros *Cattleya Lindl.*, *Laelia Lindl.*, *Schomburgkia Lindl*. y *Sophronitis Lindl*.; Van den Berg et al. (2005-2009) en un amplio análisis filogenético con Laeliinae, apoyó la inclusión de las especies *Schomburgkia y Sophronitis* en *Laelia* y *Cattleya*, respectivamente. Para el presente estudio de los géneros Laeliinae, seguimos el sistema de acuerdo con la Lista de Especies de Flora de Brasil (Lista de especies da Flora do Brasil, 2012).

Van den Berg et al., (2009), señaló que los factores principales de diversificación con Laeliinae continúa siendo un campo rico para investigación, debido a la gran variedad de características morfológicas, el gran número de especies, y los grupos infra-genéricos y genéricos. Además, ambas las semillas como la estructura de la fruta han sido abandonadas en la Orchidaceae (Dressler, 1993); Barthlott (1976) estableció que las estructuras de las semillas son especialmente útiles a niveles de tribu y sub-tribu.

Las estructuras reproductivas de las orquídeas tienen un amplio potencial morfogenético, condicionado por el alto totipotencia de sus células, las cuales contribuyen a un sistema reproductivo complejo (Batygina, Bragina and Vasileyeva 2003). Además, esos autores señalaron que el grupo de información, el avance del conocimiento teórico sobre las estructuras reproductivas, y los métodos de micropropagación de las plantas puede ser útil para programas de conservación, además del beneficio de la introducción de poblaciones secundarias bajo condiciones naturales.

En este ámbito, se logró un estudio comparativo de la estructura de la semilla en 6 especies de orquídeas Laliinae : *Cattleya loddigesii Lindl., Cattleya tigrina A.Rich, Hadrolaelia purpurata* (Lindl.) Chiron y V.P.Castro, *Laelia anceps* Lindl., *Schomgurgkia gloriosa* Rchb. y *Sophronitis cernua* Lindl. Además, se realizaron observaciones adicionales en la anatomía de las plántulas para *H. purpurata, S. gloriosa* y *S. cernua*. Este estudio contribuye al conocimiento estructural de este grupo de plantas florales, el cual puede ser útil para futuros tratamientos taxonómicos para las orquídeas Laeliinae y puede ayudar a aclarar las relaciones estructurales y naturales acerca de los órganos de las plántulas.

Materiales y métodos

Semillas de 6 especies de orquídeas (*C. loddigesii, C. tigrina, H. purpurata, L. anceps, S. gloriosa y S. cernua*) de diferentes orígenes fueron esterilizadas sumergiéndolas en 15% de una solución de hipoclorito de sodio (NaClO). Con el fin de asegurar la viabilidad de las semillas, se analizaron muestras a través de la prueba de tetrazolio para este fin, usado una solución de 2,3,5, trifenilo de tetrazolio (Singh, 1981). Solo las semillas que alcanzaron por lo menos el 50% de viabilidad fueron elegidas para el estudio.

Las semillas viables fueron colocadas en un medio nutriente Knudson “C” esterilizado (autoclave por 20 minutos a 1 atm) dentro de frascos de cultivo (Knudson, 1046). Sin embargo, esto fue modificado cuando se le añadió agua de coco (100 ml/L) o banano (100 g/L), con 3.5 g. de agar (Himedia). Después de 30 días en el medio de cultivo, solo 3 especies (*H. purpura*, *S. gloriosa* y *S. cernua*) tuvieron éxito. Las semillas germinadas se mantuvieron en cámaras a 26 /= 3°C,bajo la luz 24 horas (lámpara fluorescente de 40 wats) seguida por 105 días.

Las semillas de todas las 6 especies y las plántulas de 3 especies germinadas (como se menciona antes) fueron previamente observadas bajo un microscopio estereoscopio, fijadas en glutaraldehído (1% en 0.1 M regulador de fosfato, pH 7.2, mantenido a 4C) (Karnovsky, 1965) y luego preservadas en 70% de etanol. Las muestras de semillas y plántulas fueron deshidratadas en diferentes etanoles, sumergidas en historesino (Guerrits, 1991), seccionadas (a lo ancho y largo) en un micrótomo rotador, y marcadas con toluidina azul (O’Brien, Feder y Maccully, 1965) y en toluidina azul/básica fuchsin (Junqueira, 1990). Se analizaron características anatómicas a través del microscopio óptico con un microscopio Leica ICC50, al utilizar un software Leica LAS EZ, versión 18.1.

Pruebas micro químicas específicas se llevaron a cabo para la detección de lípidos (usando tintas Sudan IV y Sudan Black) (Ruzin, 1999), almidón (prueba de yodo-potasio de yoduro), lignina (prueba de floroglucinol) y celulosa (prueba de cloriodido de zinc) (Berlyn y Miksche, 1976). Todas las 6 semillas de las especies estudiadas fueron montadas en tocones de aluminio, cubiertos con una capa de oro, y luego examinadas mediante de un microscopio de electrones para escanear (Shimadzu SS-550 Superscan,) para obtener imágenes digitales.

Resultados

Todas las especies analizadas presentaron unas semillas ex albuminosas, unitégmicas, fusiformes y diminutas, con un embrión elipsoidal inmaduro. Hay un espacio intercelular relativamente desarrollado entre la capa de la semilla y el embrión. La capa de la semilla translúcida y lignificada consiste usualmente en 1 capa de células algunas veces elongadas y angostas con bordes rectos y cónicos. Las células de la capa de las semillas muestran diferencias relativas al engrosamiento de la pared de las células. Todas las especies tienen una pared celular delgada externa periclinal y una pared celular anticlinal mucho más gruesa, la pared celular periclinal interna está engrosada en la mayoría de las especies estudiadas, excepto en *C. loddigessi* y *H. purpurata*, que tienen una célula periclinal con una pared interna delgada.

Discusión

La capa de las semillas de las especies estudiadas consiste en una capa de solo una célula. En las orquídeas, durante el desarrollo de las semillas ambas capas del integumento interno y la capa interna del integumento externo se degeneraron; en la semilla madura, la capa de la semilla consiste en una sola capa originada de la capa exterior del integumento externo (Barthlott, 1976; Sood y Rao, 1986). Aunque la capa ontogénica de la semilla no se había evaluado, la capa simple que compone la capa de la semilla de las especies Laeliinae debe tener su origen en la capa externa del integumento exterior ovular, y las otras capas (incluyendo el integumento interior) deben haber sido degeneradas durante el proceso embriológico, como lo descrito por *Phalaenopsis amabilis* (L.) Blume (Lee, Yeung, Lee, y Chung, 2008). Probablemente, la capa de la semilla reducida y membranosa de las semillas Laeliinae entre el tegumento y el embrión es una adaptación relacionada con las propiedades aerodinámicas y a la humectabilidad de la semilla, que ocurre en las orquídeas

(Arditti y Ghgani, 2000; Barthlott, 1976; Dahlgren, Clifford, y Yeo, 1985). Además, Boesewinkel y Bouman (1984) nombraron las semillas de las orquídeas como orquídeas balón, debido a los espacios aéreos en forma de vejiga hallados adentro. Kurzweil (1993) analizó la morfología de la semilla en más de 150 especies Orchidoideae del sur de África, y el autor encontró dos clases diferentes de semillas: (1) *clase Satyrium*, con semillas diminutas y fusiformes (común en la mayoría de las especies en ese estudio) y (2) *clase Disauniflora*, con semillas grandes como balones. La semilla madura de la especie Laeliinae analizada en nuestro estudio puede ser clasificada en *clase Satyrium*, de semillas fusiformes.

Los embriones de las especies estudiadas son similares unos a otros, y muestran las típicas características descritas anteriormente para la estructura general de las orquídeas; solo el suspensor puede sufrir alguna variación. Veyret (1974) registró algunos grupos de orquídeas con diferentes suspensores de acuerdo con las especies o clase; esta variación puede ocurrir aun dentro del mismo género. En las especies estudiadas, solo *H. purpurata* mostró un suspensor con 2-3 capas de células contra los usuales suspensores de 2 capas observado en el resto de las especies.

El brote en el rotocorn que ocurre en las plántulas Laeliinae es un fenómeno común en *Orchidaceae*. Veyret (1974) consideró que este fenómeno puede terminar en la formación de plántulas múltiples, y son producidas con una frecuencia variable de acuerdo con las especies y el medio usado para la multiplicación.

De acuerdo con Veyret (1974), se presentan 2 situaciones en los embriones de las orquídeas: con o sin cotiledones. *Cattleya* (Laeliinea) es un ejemplo de especies acotiledóneas (Carlson, 1943). Sin embargo, el primer órgano foliáceo de las plántulas de las orquídeas puede no ser fácil de definir, Velenovsky (1907) se refirió a él como una cotiledónea, mientras Carlson (1943) y Veyret (1974) lo consideraron propiamente como una hoja. Batygina et al. (2003) debatió el término "cotiledóneo" debido al hecho de que los órganos foliares de la mayoría de las orquídeas aparecen durante el desarrollo post-seminal, es decir, en la etapa protocorn; aunque, no sería correcto referirse a ellos como cotiledóneos u órganos como hojas; los autores han concluido que son las propias hojas nuevas, mientras que el embrión en sí mismo no tiene cotiledóneas. Sin embargo, vale la pena anotar que el análisis estructural de las hojas de las plántulas Laeliinae, en este trabajo, ha mostrado diferencias significativas, las cuales pueden elevar el debate concerniente a que la primera hoja de la plántula de la orquídea sea considerada o no cotiledónea. Dos criterios fuertes pueden ser usados legítimamente acerca de la existencia del cotiledón en las plántulas Laeliinae: (1) la hebra vascular sencilla de la primera hoja, también conocida por cotiledones de especies epífitas y monocotiledóneas (Boyd, 1932), mientras que las otras hojas muestran 3 hebras vasculares, y (2) la primera hoja como órgano de *S. gloriosa*, la cual es una estructura como una vaina con un ápice filoso que cubre parcialmente el protocorn.

La subfamilia *Epidendroideae,* la cual incluye Laeliinae, presenta raíces aéreas gruesas con vello multiseriado (Dahlgren et al., 1985), las cuales son una adaptación para el hábitat epífita. La primera raíz de las plántulas Laeliinae consiste de vello con 1-3 capas de células; se ha sugerido que el vello posee la capacidad de absorber y almacenar agua y minerales, evitando la pérdida de agua (Benzin, Ott y Friedman, 1982). La raíz de Laeliinae es triarca o tetrarca, lo cual es también similar en estructura a *Calopogon pulchellus (*Carlson, 1943), aunque en las monocotiledóneas, especialmente en sus raíces adventicias, el xilema es usualmente poliarca (Mauseth, 1988).

La semilla y la plántula en la especie Laeliinae posee algunas características, tales como la capa de la semilla, SUSPENSOR, la primera hoja en desarrollo y el número de grupos PROTOXYLEM en la raíz, lo cual puede ser interesante para la taxonomía del grupo.

Reconocimientos

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Patrón de reclutamiento de 2 holoturoideos asociados a una comunidad coralina del Pacífico central Mexicano

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Resumen

Los holoturoideos cumplen funciones como recicladores de nutrientes, bioturbadores y presas de otros taxones en diversos ecosistemas marinos; por lo que afectan directamente la distribución de los organismos asociados a ellos. Pese a su importancia funcional, poco se sabe acerca de sus patrones anuales de reclutamiento. Las Islas Marietas albergan una comunidad coralina con un rico ensamblaje de holoturoideos. Con el fin de identificar los patrones de reclutamiento anuales de las especies *Pentamera chierchia* y *Neothyiobne gibber*, de marzo 2011 a febrero 2012 se realizaron 6 muestreos bimensuales.

-Se evaluó la densidad (ind cm^2) para cada especies y micro sustrato asociado. Ambas presentaron las mayores densidades durante mayo-junio (*N. gibber* = 0.0903 ind cm^2, *P. chierchia* = 0.0396 idm cm^2); durante el resto del año la densidad fue [0.01 idm cm^2. Este es el primer registro de *P. chierchia* en el área de estudio. No hubo correlación entre densidad y micro-sustrato (s_-0.61, n =7, p-0.05) El estudio de las s estacionales del reclutamiento de holoturias y su relación con factores como reproducción y disponibilidad de sustrato puede proporcionar información sobre sus ciclos de ida, dando mayor entendimiento a los patrones ecológicos d estas especies que contribuye al mantenimiento de la biodiversidad regional.

Palabras clave: Equinodermos; Dendrochirotida; Holothuroidea; Invertebrados marinos; Reproducción

Abstract

Holothurians are nutrient recyclers, bioturbators, and prey for other taxa in diverse marine ecosystems; thus, they directly impact the distribution of organisms with which they are associated. However, little is known about annual changes in holothurian recruitment. Islas Marietas harbors a coral community with a rich assemblage of holothurians. From March 2011 to February 2012, bimonthly samplings were performed in order to identify the annual recruitment patterns of species *Pentamera chierchia* and Neothyone gibber. Density (ind cm^2) was assessed for each of the 2 species, as was the micro-substrate abutting them. Both species had highest densities in the May and June period (*N. gibber* = 0.0903 ind cm^2, *P. chierchia* =0.0396 ind cm^2); densities 0.01 ind cm^2 were documented over the remainder of the year. This is the first record of *P. chierchia* in the study are. Furthermore, no correlation between species density and substrate type was found (s=0.61, n=7, p[0.05) The study of the seasonal recruitment fluctuations of reef-associated holothurians and their relationship with factors such as reproduction and availability of coralline substrate may provide information on their life cycles, in order to initially understand some ecological patterns of these species that contribute to the maintenance of regional biodiversity.

Key words: Echinoderms; Dendrochirotida; Holothuroidea; Marine invertebrate; Reproduction

Introducción:

El reclutamiento es un proceso importante que determina, por último, la estructura de la población de la mayoría de las especies marinas invertebradas (Caley et al., 1996; Pawlik, 1992; Rodríguez, Ojeda, e Inestrosa, 1993). Los patrones de la reproducción y reclutamiento de los marinos invertebrados son regulados por factores abióticos, incluyendo la temperatura del agua salina, concentración de los nutrientes, y el pH, así como también por factores bióticos tales como en la disponibilidad del substrato coralino, la presencia de los depredadores, y la densidad de la población (Abelson y Deny, 1977; Broitman et al., 2008; Hadfield, 1986).

Las comunidades de corales son ecosistemas productivos que albergan a una biodiversidad de ambos, vertebrados e invertebrados (Glynn y Enochs, 2011; Sheppard, Davy, y Pilling, 2010). Los holoturoideos representan un grupo sobresaliente y diverso de los habitantes del arrecife de coral, y ellos dependen de los arrecifes para el alimento, abrigo y reproducción (Borrero-Pérez, Benavides-Serrato, y Díaz-Sanches, 2012; Miller y Pawson, 1984; Uthicke, 1999). La clase Holothuroidea está representada por 6 órdenes: Apodida, Elasipodida, Aspidchirotida, Molpadiida, Dendrochirotida y Dactylochirotida (Kerr, 2000; Pawson, 2007); todos ellos pueden reclutar y habitar una variedad de substratos, tales como lodo, arena, piedras, camas de algas, escombros de coral, coral muerto o coral vivo (Alvarado Y Solís-Marín, 2013; Solís-Marín, Arriaga-Ochoa, Laguarda-Figueras, Frontana-Uribe, y Durán-González, 2009). La orden de Dendrochirotida está particularmente bien representada en los ecosistemas del arrecife de coral, aunque estos organismos sedentarios, crípticos, pueden también encontrarse en áreas templadas (Bakus, 1973; Birkeland, 1989). Los holoturoideos son un componente esencial de la dieta de pescados, crustáceos, poliquetos y estrellas de mar (Birkeland, 1989; Francour, 1997; Jennings y Hunt, 2010).

El Parque Nacional de las Islas Marietas representa una de las comunidades de coral más importantes de la región en el Pacífico Central mexicano (CMP) (Cupul-Magaña, Aranda, Medina-Rosas, y Vizcaíno, 2000). La estructura béntica está caracterizada por la presencia de corales masivos y ramosos, con el género *Pocillopora* demostrando la mayor cobertura entre los escleractinos (Conanp, 2007; Reyes-Bonilla, Carriquiry, Leyte-Morales, y Cupul-Magaña, 2002). Hasta ahora, un total de 38 especies de holoturoideos se han encontrado en ecosistemas de arrecifes del Pacífico Oriental, y 13 de estas son dendrochirotida (Alvarado y Solís-Marín, 2013, Alvarado, Solís-Marín, y Ahearn, 2010; Bastida-Zavala et al., 2013; Deihmann, 1941, 1958; Maluf 1987; Ríos-Jara, Galván-Villa, y Solís-Zaragosa et al. 2013; Solís-Marín et al., 2009). En el IMNP, se han reportado 3 especies de dendrochirotidos: *Pseudocnus californicus*, *Cucumaria flamma*, y *Neothyone gibber* (Conanp, 2007; Nepote-González, 1998; Solís-Marín y Laguarda-Figueras, 1999).

A pesar de la importancia y prevalencia de los cohombros en el área de CMP, estudios más prioritarios se han enfocado solamente en descripciones taxonómicas (e.g. Caso, 1962 Conanp, 2007; Chávez-Dagostino, Nepote-González, Medina-Rosas, y Solís Marín, 2000; Deichmann, 1938, 1941; Nepote-González 1998; Solís-Marín et al., 2009; Théel, 1886) o en la ecología básica de especies valiosas comercialmente. (e.g. Herrero-Pérezrul y Reyes-Bonilla, 2008). Por el contrario, existe poca información acerca del ciclo reproductivo (Herrero-Pérezrul, Bonilla, García-Domínguez, y Centra-Buenrostro, 1999) y se han conducido estudios limitados de sus patrones de reclutamiento (e.g. Aguillón-Negreros, 2011). Este escaso conocimiento puede ser atribuido al bajo valor económico de la mayoría de las especies, o a su tamaño pequeño, comportamiento críptico, y densidades bajas (Alvarado y Solís-Marín, 2013). Desde luego, la información sobre el reclutamiento de invertebrados en el IMNP es limitada (Cruz-García, Cupul-Magaña, Hendrickx, y Rodríguez-Troncoso, 2013; Medina-Rosas, Carriquiry, y Cupul-Magaña, 2005) y está ausente en el caso de los holoturoideos; solo unos pocos reportes en la etapa temprana de la historia de vida de estos organismos en el Pacífico mexicano se puede encontrar (Aguillón-Negreros, 2011; Alvarado y Solís-Marín, 2013).

El estudio de los patrones de reclutamiento en los holoturoideos es importante para la comprensión de la estructura de la población en etapas adultas (Balch y Schibling, 2000; Caley et al. 1996); además, este proceso influye en las dinámicas de la población de otras especies que son ligadas ecológicamente a los cohombros (Bakus, 1973; Birkeland, 1989; Glynn y Enochs, 2011). Las comunidades de corales proveen óptimas condiciones bióticas y abióticas para el reclutamiento de muchas de las especies de cohombros (Alvarado y Solís-Marín, 2013). En este estudio, el reclutamiento de *Pentamera chierchia* y *N. gibber* fue monitoreado en un tiempo de un año en el IMNP, y también determinamos la influencia de factores tales como cambios estacionales en la temperatura de la superficie del mar y cobertura por grupos funcionales en el substrato béntico en el patrón de reclutamiento de ambas especies.

Materiales y métodos

Las Islas Marietas están localizadas en el final noreste de Bahía Banderas, México (20°41’56” -20°41’53”N, 105°35’02” 105°35’02” -105°34’59”W). Consta de 2 islas de origen volcánico; con una importante comunidad de coral compuesta por manchas de *Pocillopora*, *Porites* y *Pavona*, así como arena y áreas de suelos rocosos (Conanp, 2007). La región se caracteriza por un clima sub-tropical con vientos predominantes del sureste durante el día (García, 1998). La temperatura promedio de la superficie del mar (SSDT) es 26.4°C (mínimo anual = 23°C y máximo =30°C) y está influenciada por la Corriente de California (CC), la cual es fría, y el agua de baja salinidad es llevada desde noviembre a abril. Luego, la Corriente Costera de Costa Rica (CCR) lleva agua templada, de salinidad alta desde mayo a octubre. Como tal, Bahía Banderas es un área oceanográfica transicional importante (Conanp, 2007; Espino-Barr, Cabral-Solís, García-Boa, y Puente-Gómez, 2004; Ulloa-Ramírez et al., 2008; Wyrki, 1965).

El muestreo fue realizado como lo informaron Cruz-García et al., (201) y Sotelo-Casas, Cupul-Magaña y Rodriguez Trocoso (2014) desde marzo del 2011 a febrero del 2012 en una mancha de arrecife localizado en Isla Larga. En resumen, con el propósito de generar un substrato para el reclutamiento de holoturoideos, se usaron 144 fragmentos muertos de *Pocillopora* de más o menos 5 cm de largo. Para eliminar cualquier materia orgánica, todos los fragmentos fueron sumergidos en 10% de hipoclorito de sodio (en agua salada filtrada) por 24 horas; luego, los fragmentos fueron lavados con agua dulce por 8 horas y secados en un horno (Precisión científica) a 60°C por 24 horas. Antes de colocar los fragmentos, 2 estructuras de concreto semi esférica con 6 varillas de acero fueron colocadas en un suelo arenoso, localizadas a, más o menos, 5 metros de profundidad a la par de las colonias de coral *Pocillopora* saludables. Inicialmente, un total de 24 fragmentos fueron unidos a ambas estructuras; cada 2 meses los fragmentos fueron removidos y reemplazados por nuevos. Sobre la recolección, los fragmentos fueron colocados individualmente en bolsas plásticas in situ, llevados al laboratorio, y conservados a -20°C hasta el procesamiento. Cada fragmento fue examinado, y todos los holoturoideos fueron separados, identificados y contados usando un microscopio estereoscópico (Zeiss Stemi DR 1040) o un microscopio compuesto (LABO), siguiendo un criterio taxonómico descrito por Solís-Marín et al. (2009) y Prieto-Ríos (2010). El largo total de cada espécimen fue medido y se disecaron individuos para localizar sus estructuras reproductoras. Se foto-documentaron especímenes y espículas usando una cámara Olympus y finalmente conservados en etanol al 70%. Adicionalmente, el micro-substrato adherido a los fragmentos de coral fue separado y clasificado en 4 grupos funcionales: césped algal, algas crustáceos, briozoos y macroalgas, secados individualmente en un horno Precision Scientific a 60°C durante 24 horas, y pesadas usando una pesa analítica (Explorer Ohaus). Finalmente, el área de cada fragmento de coral fue determinada usando el método de papel de aluminio de Marsh (1970). La abundancia de cada especie fue expresada como el número de individuos por área (ind cm-2), y el promedio del porcentaje de masa de cada clase de micro-substrato fue calculado como: (peso seco de cada substrato/peso seco del substrato total)*100.

La temperatura de la superficie del mar (SST) fue registrada in situ cada 15-minutos durante los 12 meses del experimento con un HOBO© Pendant registrador de datos localizado a la par de las estructuras artificiales. La información de la temperatura fue expresada como índice de temperatura = error promedio (°C=SE). Se realizaron análisis estadísticos usando un software Sigmaplot (v. 11.0) para Windows. Toda la información fue probada para la normalidad y homogeneidad de la variable. Como todas las informaciones no fueron normalmente distribuidas (Shapiro-Wilk, a = 0.05), con una prueba de Kruskal-Wallis (no paramétrica, de una vía ANOVA) se calculó para determinar las diferencias entre los tiempos del muestreo de cada especie; para comparaciones por pares de densidades, se realizaron pruebas de Dunn post hoc (a = 0.05). Evaluamos la relación entre la densidad de reclutamiento de cada especie con la estación, la cobertura de micro-substrato, y la temperatura al usar correlaciones de Spearman (a = 0.05).

Resultados

Un total de 163 reclutamientos de cohombros se identificaron: 84 *N. gibber* y 79 *P. chierchia* Todos los organismos fueron clasificados como juveniles, basados en la falta de estructuras reproductoras. Para ambas especies, se documentaron densidades más altas entre mayo y junio (*N. gibber*=0.0903 ind cm^2; *P. chierchia* =0.0396 ind cm^2). El promedio anual fue 26.1 = 0.02°C. El promedio mínimo de la temperatura se registró durante marzo a abril (20.9 = 0.01°C) y la máxima se registró durante setiembre a octubre con valores de 30.5 = 0.01°C. La variación máxima entre el muestreo bimestral fue de marzo-abril a mayo-junio con un aumento de 6°C.

Los holoturoideos mostraron diferentes densidades de reclutamiento en el transcurso del año (Kruskal-Wallis [efecto-tiempo] para *P. chierchia* p <0.001, prueba de Dunn, p <0.05; Kruskal-Wallis [efecto tiempo] para *N. gibber* p <0.001, prueba de Dunn, p <0.05). El reclutamiento fue significativamente más alto en ambas especies durante los meses de mayo-junio que en el resto del año, coincidiendo con una importante alza de SST. Excepto por el pico de reclutamiento observado durante mayo-junio, ambas *P. chierchia* (de 0. 00092 a 0.000839 ind cm2) y *N. gibber* (de 0 a 0.0129 ind cm2) presentan bajas densidades de reclutamiento a través del año. Hubo una total ausencia de reclutamientos de N. *gibber* entre noviembre y febrero, coincidiendo con el tiempo en el que se registró el más bajo SST. A pesar de este patrón aparente, la prueba de Spearman reveló una correlación no significativa entre la temperatura y la densidad de cualquiera de las especies ($s<0.58$, $n=6$, $p>0.05$).

Se observó un cambio en el micro-substrato a través del año, con una correlación negativa entre la proporción de la capa de césped de algas y las algas crustáceos ($s=-0.96$, $n=6$, $p<0.001$). Hubo una disminución en la capa en el césped de algas durante la estación húmeda, la cual persistió hasta la estación temperada durante enero-febrero. Se encontraron macro-algas y substratos briozoos de marzo a junio; sin embargo, disminuyeron en el período del muestreo de julio-agosto y disminuyeron a cero de setiembre a febrero. No hubo una correlación significativa entre la densidad de los reclutamientos y el substrato ($s\leq0.61$, $n=6$, $p>0.05$).

Discusión

IMNP alberga una comunidad de coral rica en biodiversidad y estructura. La cobertura de substrato de este ecosistema no solo está compuesta de arrecifes de corales, sino también de algas, rocas y arena; todos estos substratos pueden permitir el asentamiento de invertebrados marinos (Birkeland, 2989; Cupul-Magaña et al., 2000; Chávez-Dagostino et al., 2000; Graham y Nash 2013). Los holoturoideos del arrecife de corales tienen la habilidad de colonizar diversos micro-hábitats en la estructura del arrecife, tales como grietas y hoyos, suelos suaves, conchas vacías y madrigueras de otros organismos (Birkeland, 1989; Glynn uy Enoch, 2011). Sin embargo, diferentes especies de holoturoideos demuestran una preferencia única por lugares de reclutamiento (Mercier, Battaglene, y Hamel, 2000; Williams y García-Sais, 2010), y los factores que promueven los procesos de reclutamiento no han sido previamente estudiados en el IMNP. Informes previos en el Pacífico mexicano encontraron que *P. chierchia* y *N. gibber* tienden a reclutar los substratos calcáreos, tales como rocas o coral muerto (Alvarado y Solís-Marín, 2013; Deichmann, 1941, 1958; Solís-Marín et al., 2009). Como tal, el área de estudio proveyó áreas dispersas para el reclutamiento de ambas especies, lo anterior no ha sido nunca documentado en el IMPN.

Aunque, adultos de ambas especies fueron poco vistos durante a mayor parte del año debido a su naturaleza críptica durante el día, las 2 especies se consideran que tienen una distribución amplia y han sido reportadas desde varias localidades desde el Golfo de California a Perú (Deichmann, 1941; Prieto-Ríos, 2010; Solís-Marín et al., 2009). Las altas densidades de reclutamientos de *P. chierchia* y *N. gibber* en el IMNP pudiera ser una indicación del papel de las islas como un criadero de cohombros. La importancia de identificar y conservar los lugares de criaderos ha sido enfatizada en estudios previos en el Pacífico este (Aguillón-Negreros, 2011; Toral-Granda, 2005); y por lo tanto la Isla se convierte en un área prioritaria para la conservación de la biodiversidad en el CMP. Además, la presencia de *P. chiera* en el área de estudio llena una crítica brecha de distribución para esta especie a lo largo del CMP y representa un avance importante en el conocimiento de la biodiversidad en la región (Honey-Escandón, Solís-Marín, y Laguarda-Figueras, 2008; Salcedo-Martínez, Green, Gamboa-Contreras, y Gómez, 1988; Solís-Marín, Laguarda-Figueras, Durán-González, Ahearn, y Vega, 2005; Toral-Granda, 2005).

Las fluctuaciones anuales de la temperatura regulan ciertas actividades fisiológicas de los invertebrados, tales como reproducción y reclutamiento, los cuales son desencadenados y favorecidos durante los períodos cálidos (Cowen y Sponaugle, 2009; Somero, 2005). El tiempo de tales eventos es determinado por las condiciones oceanográficas locales (Broitman et al., 2008; Pineda, Reyns, y Starczak, 2009; Roughgarden, Gaines y Possingham, 1988). Algunas especies se caracterizan por un solo período de desove durante el verano, lo cual es también producido por los cambios SST (Herrero-Pérezrul et al., 1999). En el área de estudio, la densidad del reclutamiento de holoturoideos presentó cambios estacionales, con picos durante mayo-junio y valores bajos para ambas especies para el resto del año. Como la proporción de los reclutamientos depende del suministro de larvas, las altas densidades de reclutamientos observados en mayo-junio se pueden deber a un reciente evento de desove que ocurrió después del tiempo de muestreo de marzo-abril y mayo-junio, tal evento puede haber estado asociado con el fuerte aumento en SST entre marzo-abril y maho-junio. La falta de correlación entre SST y el reclutamiento ha sido previamente informado para equinoides, asteroides y holoturoideos (Miller, 1995), y asociado únicamente como un factor determinante para el desove durante la primavera y el subsecuente reclutamiento en el verano en especies tales como *Isostichopus fuscus* y *Holothuria* (*Selenkothuria*) *lubrica* distribuidas en el Pacífico mexicano (Herrero-Pérezrul et al., 1999; Skarbnik-López, Herrero-Pérezrul, Reyes-Bonilla, Domínguez, y Morales, 2010).

Aunque ambas clases de temperatura y substrato son importantes para el reclutamiento en la mayoría de los invertebrados, las corrientes oceánicas, señales químicas, profundidad, y complejidad del suelo, todos juegan papeles importantes (Abelson y Denny, 197; Allani y Melloni, 1999; Broitman et al., 2008). Además, factores bióticos, tales como depredación, preferencia del substrato, y provisiones de alimentos y factores endógenos, como la estrategia para el desarrollo de las larvas, duración de la etapa de competencia, y el movimiento (Allani y Melloni, 1999; Hadfield, 1986; Pawlik, 2992; Poulin, Boletzky, y Féral, 2001), tienen implicaciones importantes para el reclutamiento y pueden ser responsables por algunos de los patrones observados en el IMNP. Aquí, es importante considerar que los holoturoideos en este estudio se asentaron en estructuras esqueléticas de coral, sugiriendo que este es un substrato adecuado para el reclutamiento, independiente del micro-substrato que crece encima. La afinidad de los cohombros con este substrato puede asumirse como una respuesta positiva al refugio disponible, señales químicas positivas o complejidad estructural que puede ser beneficiosa para la supervivencia de las larvas. (Poulin et a.l, 2001). Además, la información muestra que la presencia de estos dendrochirótidas no dependió de un micro-substrato específico, posiblemente debido a sus hábitos de filtro de alimentación (Birkeland, 2989; Solís-Marín et al., 2009).

Después del reclutamiento y de la fase de crecimiento inicial, la mayoría de los cohombros migran del sitio del primer asentamiento a regiones más seguras, tales como substratos suaves, grietas, o madrigueras en las rocas u otros ambientes crípticos, donde hay suficiente comida y abrigo adecuado para esconderse de los depredadores (Alvarado, y Solís-Marín, 2013; Balch y Scheibling, 2000; Young y Chia, 1982). El comportamiento críptico puede explicar las bajas densidades de juveniles encontrados después de mayo-junio y la ausencia de holoturoideos adultos en nuestros muestreos.

La información sobre el reclutamiento descrita sobre *P. chierchia* y *N. gibber* provee una primera idea sobre el entendimiento de las dinámicas de reclutamiento de holoturoideos subtropicales y la no escogencia al azar por ciertas clases de hábitats, como ser observó en otros holoturoideos (Aguillón-Negreros, 20110; Wolff, Schuhbauer, y Castrejón 2013). La presencia de reclutamientos de holoturoideos asociada a la comunidad de coral da una evidencia indirecta de que estos organismos reconocen las condiciones del ambiente apropiado para reproducirse y asentarse dentro del lugar. Además, el proceso de reclutamiento mantiene no solo estas dos poblaciones de holoturoideos, sino a los organismos que dependen de ellos. La evaluación del patrón del reclutamiento de ambas especies representa un aumento del conocimiento de los cohombros en el área de estudio y evidencia del potencial del IMNP como una fuente de alimento, reproducción, refugio y cría de los invertebrados marinos en la región.

Reconocimientos

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Una nueva especie de alacrán del género Centruroides (*Scorpiones: Buthidae*) del estado de Michoacán, México

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Resumen

Se describe *Centruroides ruana* sp. nov. de Felipe carrillo Puerto, municipio de Buenavista en el estado de Michoacán, México. Se hace una comparación con las especies morfológica y geográficamente más cercanas: *C. balsasensis* Ponce-Saavedra y Francke, 2004, *C. infamatus* Koch, 1844 y *C. limpidus* (Karschm 1879). La descripción incluye el macho holotipo, 7 machos y 8 hembras paratipos. Se presenta un análisis morfométrico que también permitió diferenciar las 4 especies.

Palabras claves: Buthidae; Morfología; Métodos morfométricos; Taxonomía

Abstract

Centruroides ruana sp. Nov. is describe from Felipe Carrillo Puerto, from the Buenavista Municipality in the state of Michoacán, Mexico. The new species was compared with *C. balsasensis* Ponce-Saavedra & Francke, 2004, *C. infamatus* Koch, 1844, and *C. limpidus* (Karsch, (1879), which are both morphologically its closest relatives and geographically proximate. The description includes the male holotype, with 7 male and 8 female paratypes. A supplementary morphometric analysis is also presented allowing to distinguish the 4 species.

Introducción

La familia Buthidae es la más ostentosa en la orden Scorpiones. Actualmente incluye 91 genéros y 1.044 especies en todo el mundo (Ponce-Saavedra y Francke, 2013; Rein, 2015; Teruel, Kovarik, Baldazo-Monsivais, y *Hoferek*, 2015). En México, la familia está representada por 2 géneros: *Centruroides* Marx, 1890, con 42 especies de un total de 85 nativas del continente americano, y *Chaneke* Francke, Teruel y Santibañez-López, 2014, con 2 especies (Francke, Teruel, y Santibañez-López, 2014; Ponce-Saavedra y Francke, 2013; Rein, 2015; Teruel et al., 2015).

Centruroides existen continuamente a través del continente americano desde el centro de los Estados Unidos de América hasta el oeste de Sur América, incluyendo la mayoría de los archipiélagos asociados con los continentes, tales como las Indias Occidentales y los Galápagos. Es el género de escorpiones más común y más grande en México, y el único que tiene importancia médica debido a la toxicidad de muchas especies (Fet y Lowe, 2000). Contribuciones recientes (Ponce-Saavedra y Francke, 2013; Ponce-Saavedra, Martínez-Rodríguez, y Quijano-Ravell, 2015) registran 7 especies de *Centruroides* para el estado de Michoacán, con distribuciones geográficas bien definidas: (1) Cuenca Balsas (conocida localmente como *"tierra caliente"*, un término vernacular que literalmente significa "*hot lands*": *Centruroides balsasensis* Ponce-Saavedra y Francke, 2004, *Centruroides bertholdii* (Thorell, 1876), *Centruroides infamatus* (C. L. Koch, 1844), y *Centruroides limpidus* (Karsch, 1879). (2) Planicies costeras del Pacífico: *Centruroides nigrescens* (Pocok, 1898) y *Centruoroides tecomanus* Hoffman, 1923. (3) Cinturón Volcánico Transversal: *Centruroides ornatus* Pocok, 1902.

La Cuenca Balsas es una región de México biogeográfica única que se evidencia por los altos niveles de plantas y animales endémicos. En el caso de los escorpiones, 2 géneros son endémicos: *Kuarapu* Francke y Ponce-Saavedra, 2010 y *Balsateres* González-Santillán y Prendini, 2013. También, 6 especies son restringidas a esta cuenca: los diplocéntridos *Diplocentrus Churumuco* Francke y Ponce-Saavedra 2004 y *Kolotl poncei* (Francke y Quijano-Ravell, 2009); los vaejóvidos *Balsateres cisnerosi* (Ponce-Saaavedra y Sissom, 2004), *Konetontli kuarapu* (Francke y Ponce-Saavedra, 2006), y *Kuarupu purhepecha* Francke y Ponce-Saavedra, 2010, y los butidae *Centruroides balasensis* Ponce-Saavedra y Francke, 2004.

La nueva especie descrita aquí representa aún otro caso de un escorpión endémico de la Cuenca Balsas y aumenta el número de *Centruroides* que se sabe que existen en Michoacán y en la Cuenca Balsas de 8 a 5, respectivamente.

Materiales y métodos

Los escorpiones fueron recolectados durante el día por medio de un muestreo directo intenso, i.e., al volver rocas y otros objetos del suelo, limpiar la corteza y buscar dentro de grietas y aberturas. Todos los especímenes fueron conservados en alcohol de 96%. Fueron depositados en las siguientes colecciones: holotipo y algunos paratipos en la Colección Nacional de Arácnidos, Instituto de Biología, Universidad Nacional Autónoma de México, D.F., México (CNAN), y paratipos en la Colección Aracnológica del Laboratorio de Entomología “Biol. Sócrates Cisneros Paz”, Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Michoacán, México (CAFBUM).

Los especímenes fueron estudiados, medidos y fotografiados usando un estereomicroscopio Zeiss Stemi DV4, equipo con u micrómetro ocular de 0.1 mm. Se tomaron fotografías digitales de alta resolución usando luz blanca o UV y luego procesadas ligeramente con Adobe Photoshop CS5, solo para remover el fondo y optimizar el brillo y contrastar los parámetros para impresión. Se tomaron medidas y cuenta de dientes pectinales para analizar la variación morfométricas y merísticas de las especies. Todas las medidas se presentan en milímetros (mm). La descripción fue hecha de acuerdo a la nomenclatura y medidas de Stahnke (1970), excepto por la descripción de la carinación de las chelas de pedipalpo, la cual fue hecha de acuerdo a Acosta, Cándido, Buckup, y Brescovit (2008) y la carinación de segmentos metasomales, que Francke (1977) siguió.

Una comparación morfológica directa se hizo entre adultos de especies similares de muestras tomadas en diferentes localidades de México, incluyendo material procedente de localidades de los tipos *C. balsasensis* y especímenes de *C. limpidus*, de Arcelia, Guerrero, y *C. infamatus*, de León, Guanajuato y de Uruapan, Michoacán. Estas tres especies son morfológicamente lo más parecido a la nueva especie. Además, muestras de *C. tecomanus* de Faro de Brucerías (Brucerías Beacon), Aquila, Michoacán, también fueron incluidos en la comparación porque esta especie puede también confundir si el patrón de color del carapacho no es considerado.

Para determinar cuáles variables eran las mejores para diagnosticar la nueva especie, se realizó una comparación morfométrica basada en 54 variables: 28 medidas directamente, 25 calculados proporcionalmente, y cuentas de dientes pectinales. Algunas de estas proporciones han sido confirmadas en otros lugares como útiles en otras especies de *Centruroides* (Ponce-Saavedra y Francke, 2004, 2009, 2011a, 2011b; Ponce-Saavedra, Francke, Cano-Camacho, y Hernández-Calderón, 2009; Santibáñez-López y Ponce-Saavedra, 2009).

La matriz generada fue separada por sexo, tomando en cuenta el reconocido dimorfismo sexual en la mayoría de las especies del género (Hoffman, 1932; Ozkan, Adiguzel, y Kar, 2006; Ponce-Saavedra y Francke, 2011a,b). Se efectuó un Análisis de Correlación Múltiple en cada matriz, buscando tanto información redundante como atípica (correlación $\geq$80%). Además, se aplicó un Análisis de Componentes Principales (ACP) a la información de las matrices, con el objetivo de detectar las variables más informativas para caracterizar las especies, por ejemplo, un “filtro de reducción de ruido” (eliminación de variación inexplicable). Se usó un Análisis de Racimo (AR) y un análisis discriminante canónico para medir la adecuación de las variables seleccionadas para separar las especies. Todas las pruebas estadísticas se realizaron con un software JMP, versión 6.0 (2005).

Descripción

Family Buthidae C. L. Koch 1837

Genus Centruroides Marx, 1890

Diagnóstico

Este género puede distinguirse de otros miembros de Buthidae por la siguiente combinación de características: (a) dedos pedipales con 7-10 filas principales de los cuales están ligeramente superpuestos, oblicuos y flanqueados por dentículos dentículos supernumerarios internos y externos en cada lado (faltando en el primero y en el segundo en estado de desarrollo inmaduro); (b) ausencia del órgano estridular en el esternón III y pectinas; machos adultos con segmentos metasomales más largos y angostos que los femeninos (Armas, 2009).

Centruroides ruana sp. nov.

(Información morfométrica: Tablas 2 y 3; Figs. 1-3 y 6-8)

Diagnóstico

La especie se distingue por la combinación de las siguientes características: escorpiones de tamaño adulto moderadamente grandes (incluyendo telson) para el género *C. ruana* sp. nov. es un “escorpión rayado típico”, básicamente de amarillo a ocre, ventralmente más pálido con dos rayas dorsales negruzcas longitudinales en el mesosoma, separadas por una raya pálida ligeramente más ancha. El área media anterior del capacho pigmentado fuertemente en la mitad anterior, excepto en el surco medio anterior y dos áreas arriba del surco central lateral; la mitad posterior del área está ligeramente pigmentada, oscura en ambos lados del surco medio posterior y en la carina lateral posterior, la cual es más intensa; la superficie inter-carinal con gránulos densos y bien definidos. Los pedipalpos moderadamente elongados; mano ovalada pareja y moderadamente espesa. La placa basal de las pectinas en los machos es rectangular con la muesca anterior en forma de V, el margen anterior ligeramente cóncavo y lobulado, y el margen posterior recto, en las hembras el margen anterior es solo ligeramente mellado medialmente y con el margen posterior redondo. Las cuentas de los dientes pectinales 24-26 (modo 25; *n*=14 en machos) versus 22-25 (modo 23; *n*=14) en hembras. Metasoma con carina infra-mediana y supra-mediana, lateral, dorso-lateral bien desarrollada y aserrada; vesícula ligeramente elongada. Evidente dimorfismo sexual, hembras con pedipalpos más cortos, menos delgados y más fuertemente carinados, mano más voluminosa, metosoma más fuertemente carinada y con segmento en forma de V más corto, vesícula telson más corta y más redonda, con tubérculo subaculear más fuerte.

Descripción del macho holotipo (CNAN-T0874)

Coloración. Un típico "escorpión rayado" básicamente amarillo, más pálido ventralmente. El área media anterior del carapacho está fuertemente pigmentada, excepto por el surco medio y los 2 parches laterales que se extiende desde los lados del tubérculo ocular a través de los ojos laterales. El área media posterior es ligeramente pigmentada en ambos lados del surco medio y más oscuro en la carina lateral posterior. Un surco medio inmaculado, conectado a una área transversal desde el margen posterior a través de la carina lateral media. Los ojos del medio rodeados por un patrón de manchas sutiles, con un margen pigmentado fuertemente. Los márgenes laterales son pálidos inmaculados. El área alrededor de los ojos laterales es muy oscura, con una raya pigmentada remarcada por rayas pálidas en cada lado; la raya pigmentada se hace más ancha hacia su parte media posterior. El tubérculo ocular intensamente infuscado. El pedipalpo: el fémur dorsalmente infuscado difusamente, haciéndose más oscuro medial y distalmente. La rótula dorsalmente infuscada difusamente, más oscura sobre la carina; la garra ligeramente más oscura pero sin patrón definido, excepto por la carina fuertemente infuscada. *Las patas*: pigmentadas irregularmente, incluyendo el fémur, la rótula y la tibia. Las patas I y II más oscuras en el área distal de la rótula cerca de la articulación con la tibia y difusamente pigmentada a inmaculada en el resto. El fémur, la rótula y la tibia de las patas III-IV más oscuras y haciéndose más débiles en el metatarso. Mesosoma: dorsalmente con 2 rayas negruzcas longitudinalmente, separadas por una raya pálida ligeramente más ancha. Cada raya oscura está compuesta de una mancha cóncava y más grande bien definida sobre la postergita, la cual gradualmente se hace difusa como un patrón reticulado orientada transversalmente a través de la pretergita, donde ahí se fusiona con otra mancha más pequeña, convexa localizada justo en la orilla de los tergitas I-IV; las rayas más oscuras gradualmente se hacen difusas también a través de la tergita VII. La carena pigmentada longitudinal mediana en todas las tergitas. Las manchas de las bandas oscuras mesosomales consisten de manchas grandes en la postergita, cóncavas hacia la pretergita, la cual tiene una macha convexa más pequeña. Ambas manchas están interconectadas con pigmentación reticulada. En las pretergitas II-III, cada mancha negruzca se ve como una raya horizontal ligeramente inclinada hacia el centro de la tergita y se hace de alguna manera en forma cresciente en la postergita. Las manchas pigmentadas están rodeadas por puntos de tamaño pequeño a mediano. La esternita VII ligeramente pigmentada en la carina mediana. Metasoma: dorsalmente inmaculada, ventralmente fuertemente infundida sobre la carina ventral sub-mediana y ventrolateral en I-IV y difusamente manchado en el especio entre la carina sub-mediana ventral y ventrolateral en segmentos I-III, más débil en IV, e inmaculada en V. La vesícula amarillo-ocre; dorsalmente inmaculada; ventralmente y lateralmente con 1 raya mediana y 2 laterales infusionadas, separadas por bandas delgadas inmaculadas distalmente del área alrededor del tubérculo sub-ocular, donde el patrón manchado se hace difuso y con puntos amarillos. Aculeus (picadura) infusionada en todo, con distal medio oscurecida conspicuamente.

Carapacho. Margen anterior cóncavo, con borde crenulado débilmente. Áreas laterales débilmente granulado a liso, márgenes débilmente crenulados. El tubérculo ocular liso, rodeado por gránulos de tamaño pequeño a mediano en áreas pigmentadas, más desarrolladas detrás de los ojos laterales y medios. Margen posterior recto, con una hendidura o muesca mediana superficial, lateralmente con gránulos de tamaño mediano.

Pedipalpos. Moderadamente elongados (proporción largo/ancho del fémur y la rótula =0.92). Todas las carinas moderadamente a débil granuladas. Los espacios intercarinales finamente granulados en el fémur y la rótula coriáceo en la garra. La garra de los pedipalpos son granulados con gránulos bien definidos. La mano igualmente oval y moderadamente engrosada (con proporción de la garra ancho mano/ancho=1.09; proporción mano largo/ancho = 2.16). La carena de los dedos moderada y lisa; carina ventrointerna y ventroexterna fuerte y lisa. Dedos largos, delgados y curvos igualmente, con 8 filas principales de dentículos flanqueados por dentículos super-numerarios en cada lado, y con una sub-fila apical de 5 dentáculos.

Mesosoma. Tergitas con carinas longitudinales medianas fuertes, carinas sub-medianas laterales en VII fuertes y serradas. Todas las áreas pigmentadas están cubiertas por gránulos de tamaño pequeño a mediano, como en el carapacho. La esternita VII con carinas medianas ligeramente desarrolladas pero completas.

Pectinas. Conteo de dientes 24/24. Placa basal de pectinas en machos es rectangular con una muesca anterior en forma de V, el margen anterior ligeramente cóncavo y lobulado, y el margen posterior recto

Metasoma. Moderadamente elongada y no distalmente engrosada. Los segmentos I-IV con la siguiente carinación: laterales dorsales, supra-mediana laterales e infra-mediana laterales bien desarrolladas, denticuladas, la carina lateral dorsal se hace gradualmente más gruesa distalmente en cada segmento, laterales ventrales y sub-medianas ventrales bien desarrolladas, finamente serradas, pero haciéndose progresivamente más delgadas hacia el segmento IV.

4.2 Translation from Spanish into English

Algal Diversity from Extreme Environment: the Geothermal Spring Los Hervideros, México

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Abstract

In this work we describe the algal diversity, which is in Los Hervideros geothermal spring, in Michoacán, Mexico, and its spatial distribution related with the thermal gradient. This spring forms a part of Los Azufres system, which is affected by volcanic activity from the Transversal Neovolcanic Belt. The species identification was morphological and physical and chemical parameters were measured as temperature, specific conductivity and pH. The temperature recorded was between 22.2 to 85.2 °C. The specific conductivity is as high as 3,400 to 4,430 pS cm, with the pH is 7.5 to 8.0. The growth was dominated by the next Cyanophyceae species: *Arthrospira sp*, *Synechococcus sp* and *Synechocystis sp,* in temperatures from 22 to 76 °C, respectively. As far as the Bacillariophyceae, we registered: *Achnanthidium exiguum*, *Hulumphora veneta*, *Anomoeoneis costata*, *Diploneis elliptica* and *Punnularia viridis* in temperatures from 22 to 55 °C. We also registered one Chlorophyceae species, (*Oedogonium sp*. (30 to 35 °C). This spring is characterized by the presence of great changes of temperature in a few centimeters, which is reflected in a heterogeneous distribution of the algal species.

Keywords: Bacillariophyceae; Chlorophyceae; Cyanophyceae; Temperature; Tolerance; Hydrotheral

Resumen

El presente trabajo describe la diversidad algal del manantial geotermal Los Hervideros, Michoacán, México, así como su distribución en relación con el gradiente de temperatura. Este manantial forma parte del sistema hidrotermal Los Azufres, localizado en el mismo estado, el cual es afectado por la actividad volcánica de la Faja Neovolcánica Transmexicana. La identificación de las especies fue morfológica y se midieron parámetros fisicoquímicos como la temperatura, la conductividad específica y el pH. La temperatura del agua osciló entre los 22.2 y 85.2°C, presentó una conductividad específica de 3.400 a 4,430 pS m-1 y un pH de 7.5 a 8.0. Las especies que dominaron los crecimientos fueron de la clase Cyanophyceae, con los géneros: *Arthospira* sp., *Synechocccus* sp. *y Synechocystis* sp. en temperaturas de 22 a 76°C. En cuanto a las especies de Bacillariophyceae, se registraron: *Achnanthidium exiguum, Halamphora veneta, Anomeoneis costata, Diploneis elíptica* y *Pinnularia viridis* en temperaturas de 22 a 55°C. También se registró una especie de la clase Chlorophyceae, *Oedogonium* sp., en temperaturas de 30 a 35°C. Este manantial se caracteriza por presentar cambios drásticos de temperatura en trayectos cortos, que

pueden ser de menos de 1 m, lo cual se observó reflejado en una distribución heterogénea de las especies algales.

Introduction

The geothermal springs are those whose water temperature is increased due to the geological activity of the area. They are peculiar ecosystems in which the main restricting factor for life is temperature (Pantoja-Alor and Gómez-Caballero, 2000, 2004). Other characteristics as the pH or salinity may be associated with it to present even more extreme situations. In geothermic springs with a neutral pH and moderated salinities we can find a wide range of life manifestations in a wide interval of temperatures. Environments with really high temperatures are scarce on the Earth's surface, and the thermal slope in all of them is very wide, so that the temperature, from the point where water emanates, rapidly decreases;

therefore, the colonized spaces with high temperature are reduced (Margalef, 1983).

Temperature is a very important environmental factor that may considerably affect the development of organisms whether, accelerating metabolic reactions or making proteins, nucleic acids, and other cellular components to suffer harm and be irreversibly inactivated (Brock, 1978; Madigan, Marinko and Parker, 2001). In temperatures between 20 and 30 °C, the greatest diversity of aquatic species is present and it drastically decreases after 40°C. Above the 60°C it can only be found prokaryotes organisms are present and the only group that carry out the oxygenic photosynthesis under these conditions are the Cyanophyceae (Lengeler, Drew and Schleger, 1999).

Organisms that resist the highest temperatures are bacteria and archaea. Bacteria have been found alive and functioning in springs from 90 to 91 °C in Yellowstone, United States of America; from 97 to 98 °C in Iceland, and from 99.5 to 108 °C in New Zealand

(Margalef, 1983); meanwhile, archaea have been found in temperatures up to 113 °C (Madigan et al, 2001). Mann and Schlichting (1967) found optimum growths of cyanobacteria species in a range from 60 to 77 °C. Furthermore, they registered two *Phormidium bijahensis* Copelan species -actually *Leptolyngbya bijahensis* (Copeland) *Anagnostidis*- and *Synechococcus elongatus* var: *amphigranulatus* Copeland -synonym of *Synehococcus bigranulatus* Skuja- at 86.6 °C, that up to now, it would be the greatest temperature registered for this group.

Eukaryotes organisms do not resist very high temperatures and Brock (1978) considers that the maximum limit for these organisms fluctuates around the 60°C, being the fungus the ones that tolerate the highest temperature. Margalef (1983) mentions that the maximum limit for eukaryote algae is about the 40 °C; even though, there are species that surpass such temperature. As it is the case of the rodofite, *Cyanidium caldarium* (Tilden) Geitler, that can be found between the 56 and 60 °C in acid conditions (Brock, 1978, Tamsey and Brock, 1972). Brock (1978) considers that diatoms can be present up to 44 °C. There are some records of diatoms on 48 °C and up to 70 °C; meanwhile, some species of chlorophytes of the gender *Oedogonium Mongeotia, Spirogyra, Ulathrix, Closterium* and *Cosmarium* have been registered between 41 and 48 °C, which contrasts with the limits acknowledge by Bilgrami, Munshi, Yadava, and Bhowmick, (1985); Brock (1978); Mann and Schlichting, (1977).

There is a high number of geothermic zones in Mexico that are related to a great volcanic activity (Ferrusquía-Villafranca, 1998). Some of these springs have been studied due to the importance of the geothermic processes and their possibility of using them in the Generation of electricity. However, the knowledge regarding the biota that inhabits in these environments is scarce. Specifically, in Michoacán, geothermic and geochemical studies have been conducted in some regions, among them the spring of Los Hervideros, which is the one under study. This spring, when emerges to the surface, forms a current that presents a very pronounced gradient of temperature that is formed by the presence of two different aquatic systems and that converge their waters. From one of them, it emanates cold water, approximately 20 °C, and the other is mainly thermal, as the water comes up above the 90°C (Tovar-Aguado and García-Estrada, 1991). Due to the environmental characteristics of the Los Hervideros spring, this work carries out an analysis of the taxonomic diversity of the algae, taking into account the gradient of temperature, that allowed us to identify and established an interval of tolerance to the temperature for the studied species. For that purpose, we took Jiemba's proposal (2004) that classifies microorganisms based on the interval of temperature that they can tolerate as: psychrophiles (-7 to 18 °C), mesophyles (9 to 48 °C), thermophiles (39 to 73 °C), and extremophiles (65 to 110 °C).

Materials and Methods

Los Hervideros spring is located southwest from the Araró town, Michoacán. It is located in the 19°53´N, 100°48´W, 1879 meters above the sea level. The vegetation land is thorny forest, and the weather is dry or steppe climate with rain regime in the summer (BSw); the precipitation annual average is of 780.2 mm and an annual average environmental temperature of 18.6 °C (Inegi, 2009; fig. 1). The spring is formed by thermal water to a temperature up to 92 °C and a superficial shallow water table (1m) of cold water, approximately 20°C, that can be eventually mixed with the thermal water. Above the water level, there is a clayish layer formed by lacustrine deposits that act like a sealing layer, which makes the thermalism to manifest itself just where there is breakage of the layer (Tovar-Aguado and García- Estrada, 1991); therefore, the water comes up to the surface in form of hot deep pools with little output – an average of 10 to 201 min – and temperature from 92 to 22 °C, forming a current with a strongly marked temperature gradient.

This spring is saline, the main anions are the chlorides and bicarbonates, which present the following values: Cl^- = 1.290.2 ppm, HCO_3- = 158.5 ppm, SO_4- = 153.6 pμM and NO_3- = 0.2 ppm; while the principal cations are: Na^+ = 765.5 ppm, K^+ = 60.6 ppm, Ca^+ = 32.6 pμM + and Mg^+ = 0.5 pμM (Ramírez-Domínguez, Verma, Nieva, Quijano, and Moreno, 1988). Such area of thermal springs represents an important economic activity for the inhabitants of the near zones, as the water is used for recreational and therapeutic purposes in the spas.

Two collections were carried out, that is in April 2004 and in January 2005. It was determined the maximum of the water temperature by measuring it in the thermal emanation points. Samples of the visible algae growing in the site were taken. A total amount of 13 samples were collected. In each of the sample areas it was registered the temperature, the pH, and the specific conductivity with a Conductronic PC-18 conductivity measurer (Puebla, México). Temperature also was measured using a Mercury thermometer (-10 to 110 °C). The samples were taken to a laboratory in cold (4°C) to observe the material *in vivo* and to observe characteristics such as coloring and movement of the algae. In the laboratory, the samples were fixed with formalin at 4%. The cleaning of the diatoms for their identification was carried out with the acid oxidation technique (St. Clair and Rushforthe, 1976) and afterwards, the frustules were mounted with Naphrax resin. For the observation of the samples, an Olympus BX51 optical microscope was used (Tokyo, Japan) and the photographs were taken with an Olympus DP12 digital camera (Tokyo, Japan). The identification of the species was carried out with the following taxonomic schemes: Germain (1981) and Kramer and Lang-Bertalot (1968, 1988, 1999) to Bacillariophyceae;

Komare (2013) and Komarek and Anagnostidis (1998, 2005) to Cyanpohyceae, and Mrozinska (1985) to Chlorophyceae.

Results

The studied spring showed important variations in the water temperature due to the decay when moving away from the source and mixing with cold water. There were registered temperatures from the 92 °C in the emanation points of the spring and decreased up to 22 °C. A meaningful variation in the temperature in less than 1 m from the origin of the current was observed. Due to the emanation of hot water is present in different points, it was not registered a lineal slope, but rather a temperature mosaic. The pH of the water was circumneutral to lightly alkaline (7.5-8) and with a high specific conductivity, which agrees with the dominance of the chlorides and carbonates previously registered (Ramírez-Domínguez et al. 1988).

A total of 34 species were identified, out of which 21 (63%) belong to the Bacillariophyceae class, 12 (34 %) to the Cyanophyceae class, and 1 (3%) to the Chlorophyceae class. Four of them represent new registers for our country: *Chroococcus thermalis, Mastigocladus laminosus*, *S. bigranulatus* and *Luticola mutica*. Their descriptions are presented as follows.

Chroococcus thermalis

Synonym: *Chroococcus turgidus* var. *thermalis* (Meneghini) Rabenhorst et Hansgirg, 1932.

It was observed colonies formed by few cells (2 to 4 cells), enclosed in a hyaline mucilage from 2 to 4 .m of thickness, homogeneous; when there are more than 2 cells, it looks lamellated, that acquires the shape of the cells; in some occasions it is not visible. Generally mixed with other species, they are rarely solitary. The cells are of a shiny green bluish color, sometimes slightly opaque, with a granular content, from 11 to 16 p.m in diameter and from 5 to 14 p.m in length.

Ecological and Taxonomic Remarks,

This species is known in Europe, Japan and North America in temperatures up to 45 °C.

Mastigocladus laminiosus.

They present densely intermingled filaments, blue and green in color, from 4 to 8 p.m wide, with a fine pod and with real ramifications, type T or V. The branches are thinner than the main filament, in occasions attenuated. The trichomonas are cylindric, divaricated in straight angle and constricted in the old parts, but not in the branches. There are observed cells in form of a barrel in the main filament, cylindric in the branches and frequently longer than wider, and intercalary erythrocytes, spherical, ellipsoidal or cylindric of up to 6.5 in wide and up to p.m in diameter.

Ecological and Taxonomic Remarks

It is considered as cosmopolitan, since it has been registered in thermal springs in different parts of the world, generally between 37 to 55 °C. Synechococcus bigranulatus *Skuja*, 1933.

Synonyms: *S. elongatus* f thermalis Geitler, 1932; S. *elongatus* var. *amphigranulatus* Copeland, 1936; S. *elongatus* var. *vestitus* Copeland, 1936; S. *elongatus* f. *indefinitus* Emoto et Hirose, 1942; *Synechococcus amphigranulatus* (Copeland) Yoned, 1943.

There are observed different solitary cells or in group of two after de cellular division, cylindrical with rounded ends, straight o lightly curved, of blue green or green olive color; they present granules in the ends of the cell. The cell content is homogeneous, from 2 to 3 p.m in wide and from 4 to 8 p.m in length.

Ecological and Taxonomic Remarks

The Synechococcus gender includes species with a wide variety of forms and ecological requirement; therefore, it is surely heterogeneous. On one hand, it includes forms with life adaptations to high temperatures, and on the other hand, forms that live in other specialized environments, such as the marine planktonic. Copeland (1936) described several species and varieties of Yellowstone, that include *Synechococcus lividus* and its varieties, *Synechococcus vulcanus* and its varieties, and *Synechococcus elongatus* and its varieties. (*S. elongatus* var. *amphigranulatus* is a synonym of S. *bigranulatus)*. The species delimitation is problematic, because it is based on size, form, curvature, and the presence of granules and its position. Several of these characteristics are very variable and depend on the environmental conditions. Recently, Katoh, Itoh, Shen and Ikeuchi (2001) proposed the gender *Thermosynechococcus* with two species, *Therosynechococcus elongatus* and *Therosynechococcus vulcanus*, traditionally located in the *Synechococcus* gender. However, this gender is not recognized as a valid taxon, due to its diagnostic has not been published.

Luticola mutica (Kützing) D.G. Mann

Synonym: *Navicula mutica* Kützing

The small samples of this species present rhomboid shaped frustules; the bigger members present capitated forms, and the ones of an intermediate size are among these forms of frustules. They present lanceolate frustules that have from 11 to 20 p.m in length and 5 to 7 p.m in wide. The number of striae in 10 p.m goes from 16 to 25 and they are little radiated. The striae are interrupted in the central part, where there is an empty rectangle and it can only be appreciated a stigma located in a centered-sided position.

Ecological and Taxonomic Remarks

Previously, it was known as *N. mutica* Kützing, but today it is a synonym. It has been observed in humid and sub-aerial environments, among moss and salty, and in pH about 7. It is a species of continental and cosmopolitan environments. Different types of algae growings were presented, being the most conspicuous the microbial wall with different colorations. These were mainly built by cyanophytes such as *Arthrospira* sp, *Leptolyngbya* sp, *S. bigranulatus* and *Synecholystis* sp.

The group that share the higher tolerance to high temperatures was the cyanobacteria, followed by the diatoms and, last, the only chlorophyll species. Several species of cyanobacteria were presented in well-defined intervals of temperature. In temperatures under 35 °C, it was observed a *C. thermalis*, *Phormidium* sp., *Chroococcus* sp, *Phormidiu* sp. and *Nostoc* sp., *Synechococcus* sp. was mainly presented between 47 to 54 °C, while the *Arthrospira* sp., *Leiptolyngbya* sp., *M. laminosus, Pseudoanabaena thermalis, Pseudoanabaena* sp., and *Synechocystis* sp., were present mainly between the 54.7 and 73°C. Some species of cyanobacteria were also found up to the 76 °C, such as the *Leptolyngbya* sp., *Arthrospira* sp., *P thermalis*, *S bigranulatus* and *Synechocystis* sp. The higher number of diatoms species was shown to 47 °C, while, (21 spp); in the cyanobacteria, the higher number of species was present in the 54.5 °C, and the chlorophytes, represented by a species of the *Oedogonium* gender, was presented between the 30.5 and 35.5 °C, *Oedogonium* sp. and some species of cyanobacteria (*Chroococcus* sp., C. *thermalis*, *Phormidium* sp. and *Nostoc* sp.) correspond to meso-thermophilic forms; however, most of the diatoms are placed as thermophiles in the Jjemba's classification. Other species presented overlaps in the temperature intervals; several species of diatoms were placed as meso-thermophiles and some cyanobacteria as the thermo-extremophiles.

Discussion

The species diversity found in Los Hervideros turned out to be elevated in relation to the area, the number of samples, and the kind of environment considered extreme. From the total of species, 29 were in temperatures above 45°C; in other words, temperatures in which it is considered the proteins are denatured. The most diverse group of algae in temperatures above the 40 °C was the diatoms, with 21 species, followed by the cyanophytes with 8 species. However, the cyanophytes was the group that showed the most tolerance to high temperatures, being *S. bigranulatus, Synechocystis* sp. and *P. thermalis,* the species with more tolerance, as were present up to 76 °C. Only the cyanophytes were present above the 54 °C.

The diatoms were registered in temperatures up to 47 °C; that is why we can consider that the highest limit for the group is close to this figure. Brock (1978) considers, based on growing studies, that the highest limit for this group is of 42-44 °C, and that for some species like *A. exiguum* (like *Achnanthes exiguum*), the optimum temperature of growing is 40 °C. In the case of cyanophytes, it was observed that several species were found in defined intervals. *Arthrospira* sp. was abundant and even dominant in the microbial walls with temperatures between the 54 and 61 °C, and reduced the number in a considerable way above the 61 °C. *Laminosus* was present in temperatures close the 50°C (47.5 °C), that corresponds to previous data about the tolerance to the temperature between 45 and 62 °C (Brock, 1978; Komárek, 2013). This species has a cosmopolitan distribution, but it always grows in restricted ecological conditions. Above the 73 °C and up to 76 °C, there were recognized microbial walls dominated by *S. bigranulatus, Synechocystis* sp., *Letolyngbya sp.* and *P.*

thermalis, representing the superior limit of the oxygenic photosynthesis in the area under study. Several species of the gender *Synechococcus*, *Synechocystis*, *Leptolyngbya,* and *Pseudoanabaena,* have been described as characteristic of thermal environments and are considered the oxy-phototrophs organisms that tolerate the highest temperatures. Mainly, the *S. lividus* is considered, the cyanophytes with the highest tolerance and can represent the maximum limit in which the oxygenic photosynthesis is developed, that is around the 74 °C (Meeks and Castenholz, 1971). Some authors have documented the presence of cyanophytes in higher temperatures (Mann and Schliting, 1967; Sompong, Hawkins, Besley and Peerapornpisal, 2005); however, Brock (1978) considers that the presence records in higher temperatures can be due to possible errors in the measurement, to the record of another non-photosynthetic bacteria, or to the absence of an evaluation of the physiological conditions.

Regarding this study, temperatures were specifically measured were the growth was present. The physical integrity of the cells was verified through observation in the microscope of the form, coloring, and movement, recording the microbial walls dominated by cyanophytes in temperatures up to 76 °C. It is possible that in nature microbial walls dominated by cyanophytes in higher temperatures to the ones previously stablished are developed, which probably is related to the physiological ability and arrangement of the species in the microbial walls.

As particular cases, there were found species that we consider as rare, since there were not registered more than 5 samples in the analyzed preparations were not registered, such is the case of *Anomeoneis costata* (2 samples);

*Caloneis silicula, (*one sample); *Epithemia turgida* ((five samples); *Pinnularia* sp. (2 samples); *Nitzschia* aff. *Clausii* (3 samples) and *Cocconeis placentula* (5 samples). Despite the reduced number of samples, they could be determined regarding species and gender level.

Los Hervideros is a peculiar town, due to the elevated spatial heterogeneity that it presents, with sudden changes in the temperature related to a fast decay, and due the mix of 2 water systems with different temperatures that provokes a thermic gradient as a mosaic. Several species found belong to thermal environments like*, S. bigranulatus, M. laminosus, P. thermalis, C. thermalis, A. exiguum* and *Pinnularia joculata.*

Some of the populations under study did not correspond to the diagnostics of the species previously described, whether in morphometry or in ecology. In these cases, we prefer to write the epithet "sp." Particularly, the location of *Arthrospira* sp. is not clear. This could correspond to the populations identified as *Phormidium terebriformis* (sin. *Oscillatoria terebriformis*) registered in thermal springs of United States of America (Brock, 1978). However, *P. terebriformis* is found in stagnant cold waters or currents (Komárek and Anagostidis, 2005). In the case of the *Leptolyngbya* it has been described 80 species, even when the criteria of the specific delimitation are not clear. In summary, we can say that there are many taxonomic problems in the cyanophytes of these environments.

Thermal springs are ecosystems that present a wide variety of organisms with adaptations for the life in high temperatures and whose study will allow to understand important aspects on the evolution of life on Earth. Mexico, despite of counting with a huge amount of geothermic resources, is behind related to the knowledge of the biota that inhabits in such ecosystems. This is concerning if we consider that those resources face high risks of alteration in a short term due to the use for energy production or as a recreational bathing resort. It is urgent to carry out studies that complement the biodiversity that is found in those peculiar environments.

First Report of Agaricus Bisporus (Basidiomycota, Agariaceae) Wild in Tlaxcala and Veracruz, México

Gerardo Mata, Rosario Medel, Philippe Callac, Christophe Billete and Roberto Garibay-Orijel

Abstract

The fungus commonly known as white button mushroom, *Agarcius bisporus*, is the most commercially cultivated species among edible ones worldwide. In spite of its importance, its presence in wild stage had not been confirmed even when it has been included in lists of species from different states of Mexico. The aim of this study was to determine if this species grows wild in Mexico. Collections were made in the states of Tlaxcala and Veracruz, where 7 strains were isolated from wild specimen. Basidiomes of these strains were grown in commercial compost-based substrate. Wild specimens, deposited at XAL Herbarium, and those obtained in culture were studied macro and micro morphologically. IE 623 strain was used to obtain the DNA ITS ribosomal sequence. The revised specimens match morphologically with *A. bisporus* and have an average of 63.4% of bisporic basidia. The DNA sequence confirmed the

taxonomic identity and through similarity ad phylogenetic analysis, it was concluded that the strain derived from a wild specimen and not from a commercially cultivated strain. Native strains of *A. bisporus* from Mexico could provide important germplasm to improve its commercial cultivation.
Keywords: Wilde white button mushroom; Native germoplasm; Bisporic-basidia; Edible mushrooms

Resumen

El hongo conocido popularmente como champiñón, *Agaricus bisporus*, es la especie comestible más cultivada comercialmente en el mundo. A pesar de su importancia y de que se ha incluido en listados de diferentes estados de México, su presencia de forma silvestre no se había corroborado. El objetivo de este trabajo fue determinar si esta especie crece de manera silvestre en México. Se realizaron recolectas en los estados de Tlaxcala y Veracruz, y se aislaron 7 cepas a partir de ejemplares silvestres. Se obtuvieron basidiomes de dichas cepas cultivadas en un sustrato a base de composta. Los ejemplares silvestres que se depositaron en el Herbario XAL, y los obtenidos en cultivo, se estudiaron macro y micro-morfológicamente con *A. bisporus* y presentan en promedio 63.4% de basidios bispóricos. La secuencia de ADN corroboró la determinación taxonómica, y de acuerdo con los análisis de similitud y filogenéticos se concluyó que la cepa proviene de un ejemplar silvestre y no de una cepa comercial cultivada. Las cepas de *A. bisporus* silvestres en México podrían aportar germoplasma para mejorar su cultivo comercial.
Palabras clave: Champiñón silvestre; Germoplasma nativo Basidios bispóricos; Hongos comestibles.

Introduction

Nowadays, the species of the *Agaricusl L*. gender is very appreciated, not only for its nutritional properties but also for its organoleptic and medicine qualities. The fungus popularly known in Mexico as wild white button mushroom, *Agaricus bisporus* (J.E. Lange) Imbach, is the most famous of the gender and also the most produced worldwide among the cultivated species (Arrillaga, 2004). Its worldwide production was estimated in over 4 million tons a year 2009 (Sonnenberg et al., 2011). *Agaricus bisporus* differs from all the other species of the gender, as it presents two sterigma in most of its basidia (Parra, 2008); even though frequently it can be observed mono basidia, tri and also tetrasporic (Callac, Imbernon, Guinberteau, Desmerger and Theochari, 2003). Despite this morphology -2 spores per basidia-, it makes the species unmistakable; there are two wild varieties, besides the *A. bisporus* var. *bisporus*, that have shown to be mainly tetrasporic: *A bisporus* var. *burnettii* Kerrigan and Callac with distribution in North America and *A. bisporus* var. *eurotetrasporus* Calla and Guinb in Europe (Callac, Billette, Imbernon and Kerrigan, 1993; Callac et al., 2003).

In México, *A. bisporus* has been cited in several works as part of the inventory in different entities; however, none of them has given a complete description of the species and in very few it was specified the type of vegetation where it grew. It was registered in the Federal District, without making clear the kind of vegetation (Herrera and Guzmán, 1972) and of urban, suburban, and agricultural zones (Zarco, 1986); in Jalisco (Guzmán-Dávalos, Nieves and Guzmán, 1983; Sánchez-Jácome and Guzmán-Dávalos, 2011); in Morelos in gardens and disturbed zones (López, Mora, Montiel and Guzmán, 1985). *Agaricus bisporus* var. *albidus* (J.E. Lange) Singer and *A. bisporus* var. *bisporus* are known in Michocán (Conabio, 2005). Besides, some works have cited this species of commercial crops in Baja California (Ayala and Guzmán, 1984), Veracruz (López-Ramírez, 2011). Guzmán (1977) cited that *A. bisporus* var. *albidus* and *A. bisporus* var. *bisporus* are commercially cultivated, without specifying their location. On the other hand, Martínez-Carrera et al. (2001) cited the species in Tlaxcala, in La Malinche volcano; however, such authors did not mention in what herbarium it was deposited the studied and isolated material; therefore, there is not an accurate record. The objectives of this work were to demonstrate the presence of this species in a wild manner in México, verify the determination of the materials through the production of basidia obtained from isolated strain and by means of phylogenic analysis, as well as to describe its morphological characteristics of taxonomic value under experimental cultivation compost-based-conditions used for commercial production.

Materials and methods

There were carried out field trips in the states of Tlaxcala and Veracruz to collect fresh samples. Data from the location, substratum, and habitat of each collection site were taken. For the macroscopic study of the materials it was registered the data in fresh of pileus and stipe -form, color and size-, disposition and color of the sheets, position of the ring and the color that stains the context. Besides, microchemical reactions, Schäffer and KOH 5%, were carried out according to Parra (2008). The microscopic study of the samples was conducted under the routine of technics in mycology (Largent, Johnson and Watling, 1977), with a stereoscopic microscope (Car Zeiss, Stemi DV4) and a compound microscope (Carl Zeiss, Primo Star). The photographs were taken with a digital camera (Sony Cyber-shot). In order to determine the species, the works of Arrillaga (2004), Capelli (1984), Kerrigan (19186), and Parra (2008) were consulted. From some collected samples, strains in vegetative state were isolated, according to the methodology of Guzmán, Mata, Salmones, Soto-Velazco, and Guzmán-Dávalos, through the cultivation of glucose and agar added with extract of compost or through the cultivation of dextrose potato (PDA, Bioxon (Mata and Savoie, 2007).

In order to obtain the spores a 4 layer inoculum was prepared, according to the methodology of Mata and Savoie (2007), using sorghum seeds (*Sorghum vulgare* Pers.). Samples of commercial compost of 4 Kg were prepared. They were added a 5% inoculum, which was mixed uniformly and were placed in plastic bags. After 14 days of incubation at 25%, a layer of 5 cm of covering soil was added to induce the appearance of spores, and the bags were placed in an 18°C room with a relative humidity of 90% and a photo-period of 12/12 h (Mata, Calderón-Fuentes and Savoie, 2012). The samplings were harvested in different development states.

All the studied samplings, including the ones from the crop, are deposited in the mycological collection of the XAL Herbal of the Instituto de Ecología, A.C. In the samplings of the strains cultivated the percentage of the bisporic basidia was determine in relation to the mono, tri and tetrachoric, with a fragment of a mature sheet placed on an object holder for its direct observation under a microscope. It was determined the number of the spores per basidia, a total of 150 basidia each sampling, according to Imbernon, Callac, Gasqui, Kerrigan, and Velcko (1996); Kerrigan and Ross (1987) and Callac et al. (2003) and the average number of spores expressed as average spore number (ASN), according to the formula established by Callac et al. (1996).

Molecular Analysis

The sequences of the ITS region -transcript internal spacer- of the ribosomal DNA, that includes the ITS1, 5.8S and the ITS2, were obtained from the strain IE 623 isolated from the Mata 641 (XAL) sample. The DNA of the strain was extracted with the XNAP (Sigma-Aldrich) package. For this, approximately 1-2 mm^2 of aerial mycelium of the cultured strain in PDA was scrapped with a dissection needle. The mycelium was placed in an Eppendorf tube with 20 hpl of extraction solution and it was heated for 10 min at 65°C and 10 min at 95°C in a thermocycler (Bio-Rad, model T100). Later on, it was added 20 pl of dilution solution and it was incubated at room temperature for 30 min (Garibay-Orije, Morales- Marañón, Domínguez-Gutiérrez and Flores-García, 2013). The ITS region was amplified with the ITSIF and ITS4 primers (Garde and Bruns, 1993) under the conditions described by Izzo, Agbowo, and Bruns (2005). The PCR products were revised through the electrophoresis in agarose gels at 1% in TE shock absorbers. The good quality of amplicons was cleaned using a mix of 1po of ExoSAP-IT (USB-Affimetrix) with 1 pl of water by 3.5 pl of PCR product. The sequencing reaction was carried out with Big Dye Terminator 3.1 (Applied Biosystems) according to the manufacturer’s instructions. The sequences in both directions were obtained in an ABI 3100 sequencer (Applied Biosystems) in the Laboratory of Genomic Sequencing of

Biodiversity and Health of the Institute of Biology, UNAM. The sequences were edited and assembled in Geneious Pro R7 (Biomatters).

A matrix of sequences was built with species of *Agaricus,* section Bivelares used in previous phylogenetic studies (Challen, Kerrigan, and Callac, 2003; Geml, Geiser, and Royse, 2004) and they were also included those sequences of GenBank that turned out to be similar to the sequence of the ITS region of the IE 623 strain through a search in Blast. The sequences were aligned in Muscle (Edgar, 2004) and the data matrix was analyzed through Neighbor-Joining methods, maximum verisimilitude and bayesian inference in Geneious Pro R7 (Biomatters). *Agaricus bitorquis* (AF432899) was used as external group (Geml et al., 2004). The trees of Neighbor-Joining were built with the model of genetic distance Tamura-Nei resampling with bootstrap through the 1,000 replicas. For the analysis of maximum verisimilitude, it was used the PhyML (Guindon et al., 2010) program to look for the topology of the trees with SPRs and HKY85 as a model of substitution;
bootstrap with 1,000 replicas was used to test the support of the branches. Bayesians analysis were also made in MrBayes (Huelsenbeck and Ronquist, 20019) using Gamma variation radio, the GTR substitute model with 4 chains of Monte Carlo over 1.100,000 generations sub-sampling each 400 generations and a temperature value of 0.2. The best models of substitution were chosen with Mr.ModelTest version 2 (Nylander, 2004). The values of length of the branches were storaged and the subsequent probabilities were calculated. The sequence of the strain IE 623 was compared with 63 sequences of the same species available

in GenBank. The sequences were aligned and the positions that presented heteroalellic in the ITS regions were determined.

Description

Morphological analysis

They were revised ten wild samples, of which a total of 7 strains were isolated and were placed in the Fungus Strain Repository of the Institute of Ecology with the clues: IE 623, IE 672, IE 674, IE 708, IE 746, IE 790, and IE 802. The samples obtained from the sampling saved in compost of the strains IE 623, IE 746, and IE 802 were revised. All the material checked match the morphological description of *A. bisporus* var. *bisporus* that is presented as follows.

Pileus of 50-90 mm of diameter, globose in youthful stages, convex to flat-convex, and finally flat, whitish in youthful stages, beige, ochraceous to finally of light brown color, with the center dark brown, with little threads separated towards the margin of brown color. Very close, wide free sheets with lamelulas intercalated, whitish when they are young that change to pink color and finally to dark brown, almost black, with vinous tones when they mature; whitish edge and lightly fimbriated. Thick context, whitish that stains of red-vinous when mistreated. Stipe of 50-55 x 12-17 mm from cylindric to claviform, sometimes slightly bulbous at the base, hollow, smooth, whitish, the inner part stains of red-vinous color when mistreated, often presents mycelial cords, which can have the aspect of short rhizophorms. Interferon and intermediate ring – in few occasions superior, membranous, thick, white. Basidiospores of (6-) 7-8 (-9) x 5.5-7 (-9) pm, broadly elliptical, brown, with thick wall of 0.6-0.8 µM of thick. Basidia of 18-26 (-30) x 6-8 pm, nailed, the majority bisporic -few trisporic or tetrasporic-, hyaline, of thick wall. Queilocistidios of 15-35 (-45) x 10-12 (-14) pm, nailed, hyalines, of thick wall, abundant. Macro-chemical reactions: negative Schäffer and KOH. Basidioma with weak odor, fungus, nice; sweet taste typically fungus, nice.

Taxonomic Summary

Habitat. Earthy, gregarious, under trees of the genus *Cupressus* in lands with potato crops or grassland.

Studied material. Tlaxcala, Cuapiaxtla Municipality, Ranch El Tejocote from 2 km of Cuapiaxtla, July 19th, 2001, *Mata* 641 (XAL), isolated strain IE 623; October 3rd, 2002, *Gándara* 317-A, 376 (XAL); October 3rd, 2002, *Ramírez-Guillén* 174 (XAL), isolated strain IE 673, 176 (XAL), isolated strain IE 674, 178 (XAL); October 10th, 2003, *Mata* 674 (XAL), isolated strain IE 708; September 18th, 2006, *Mata* 719 (XAL), isolated strain IE 746; August 29th, 2007, *Mata* 755 (XAL), isolated strain IE 790, Veracruz. Coatepec Municipality, Sports Unity Lic. Roberto Amorós Guiot, May 30th, 2008, *Mata* 785 (XAL), isolated strain IE 802.

Obtained samples in culture:

Mushroom cultivation plant from Institute of Ecology, A.C., Xalapa, Veracruz, June 28th, 2002, Mata 647 (of the strain IE 623, XAL); March 20th, 2002, Mata 724 (of the strain IE 746, XAL); June 14th, 2011, Mata 869 (of the strain IE 802, XAL).

Table 1 shows the proportion of bisporid basidios with respect to other types of basidios found in the analyzed samples. The sporomas of the studied strains showed variations between 44% and 82.5% (average = 64.3%) of bisporic basidios typic of the species, from 18.5% to 56% (average = 35.5%) of trisporics and of 0.5-2.5% (average = 0.8%) of tetrasporics. An ASN average of 2.65 was obtained.

Molecular Analysis

They were obtained four sequences of DNA in both ways of the strain IE 623 from different reseeding and culture mediums with among 620 to 710 pairs of bases. Among them, it existed a nucleotide similarity of 99.99% and its consensus sequence of 712 pairs of bases was registered in GenBank under the access number KM6777957. All the analysis brought similar results and a similar structure of the one registered by Challen et al. (2003) was recovered for *Agaricus* section *Bivelares*. In all the cases, the *A. bisporus* clado had a higher support -bootsrap of Neighbor Joining 99.4%, bootstrap of maximum verisimilitude 94.6%, Bayesian subsequent probabilities 1. In the three analysis, the strain IE 623 was placed inside the *A. bisporus* clado. Figure 3 shows the results of the analysis of maximum verisimilitude. Though inside of *A. bisporus* there is few structure and the clados that are formed have little support, the sequence of the IE 623 strain has a greater genetic similarity for wild strains than for cultured varieties.

They were found four positions -39, 510, 516, 552-, in the ones there were heteroallelios in *A. bisporus* var. *bisporus*. The strain IE 623 showed C, Y, C, and C in these positions respectively, and just one of the GenBank sequences (JF223230) has the same sequence, but this last one differs by A in position 522. The strain IE 623 has, therefore, a unique sequence. In the 4 positions of heteroallelic importance, the genotype “CYCC” of *A. bisporus* var. *bisporus* indicates that one of its nucleus has a genotype “CCCC” that appears with a greater frequency (8/58; 13% of the sequences); while the other nucleus, “CTCC” is less frequent (2/58; 3%) (table 2).

In the heteroallelic position 510 of the region ITS, the 63 sequences of the GenBank are C (18), T (41), or C/T=Y (4) (Table 3). However, these last 4 sequences differ from other positions of the strain IE 623, which corroborates that there is not an identical sequence to the sequence of such strain. Therefore, between the 2 nuclei of the heterocariotic strain IE 623, a nucleus that could be denominated A contains the nucleotide C; while the other nucleus called B, contains the nucleotide T. The sequences of these 2 nuclei, A and B, were compared to the 18 and 42 GenBank sequences, respectively containing C or T in the position 510. Between them it was found that 2 sequences were identical to nucleus A and 5 to nucleus B (table 4). Between the 2 sequences of type A, it was observed that one corresponds to a wild strain which comes from Alaska (EF460354; Geml, Laursen and Taylor, 2008); while among the 5 type B, one is an homocarion isolated through the method of protoplasts from a wild strain from France (AF465403; Callac et al., 2003), and the other is a wild strain from Denmark (AF432886; Challen et al., 2003); of the remaining 4 sequences of GenBank, there is no information in the data base or published about its origin.

Discussion

The studied material matches with *Agaricus bisporus* var. *bisporus* (Arrillaga, 2004; Cappelli, 2984; Parra, 2008) because the presence of the bisporic basidios is a distinctive character, as well as the measurement of the basidiospore greater than 6 μM of length and queilocistidios not greater to an average of 35 μM of length (Callac et al., 2993; Cappelli, 1984; Parra, 2008). Kerrigan (1986) mentioned that the microchemical reactions of Schäffer and KOH are negative in *A. bisporus* and that its main characteristic is the predominant presence of bisporic basidios. It has been classified in the *Bitorques* section (Kuhn and Rom. Ex Hein.) Bon et Cappelli group Bisporu Cappeli (Arrillaga, 2004; Cappelli, 1984) section a in the *Bivelares* (Kauffman) L.A. Parra subsection *Hortenses* (Kauffman) L.A. Parra (Kerrigan, Callac, and Parra, 2008; Parra, 2008) section. Arrillaga (2004) mentioned greater measurements of the diameter of the pileus, up to 100 mm with brownish brown flakes, which were not observed in the studied samples. The proportion of bisporic basidios and tetrasporic has been documented in other works for *A. bisporus var. bisporus*; Martínez-Carrerra et al. (2001) registered 67.5% of bisporic basidios and 27.5% of tetrasporic, while Callac et al. (2003) found 80% and 1.27% of bi and tetrasporic, respectively. Although, most of the strains have shown high percentages of bisporic basidios, in some cases this percentage has changed from 17% to 55% in wild strains (Callac et al., 1993, 2003). According to the results obtained by Kerrigan, Billete, Callac, and Velcko (1996) and Callac et al. (2003), both *A. bisporus* var. *burnettii* Kerrigan and Callac and the var. *eurotetrasporus* Callac and Ginb. have a high percentage of tetrasporic basidios, however the var. *bisporus* does not, as it that presents more bisporics than tetrasporics. In this work, similar results to the one registered by Kerrigan et al. (1996) and Callac et al. (2003) were obtained; even though, with a lower percentage of tetrasporic basidios. The ASN of the samples obtained from cultured strains (average = 2.65) corresponds with the samples considered as bisporic by Callac et al, (1996) (Calla, Theohari and Kerrigan, 2002); besides, the strain IE 623 presented an ASN of 2.53 (table 1). The number of spores per basidio is a determined characteristic mainly by a simple genetic locus called BSN, which is linked to the locus of matting MAT and to other loci of the chromosome I (Imbernon et al., 1996). *Agaricus* and other close genus of the tribe *Agaricea* Pa. are ancestrally considered tetrasporic; meaning, they produce basidios predominantly with 4 sterigmas (Kerrigan and Ross, 1987), which could mean the bisporic character of this species is the result of a process of an evolutive adaptation (Callac et al., 2003).

The commercial strains come from a limited number of traditional genotypes (Royse and May, 1982), and most of them are identical or very similar to the first hybrids Horst U1® and Host U3® obtained in the 1980s when crossing the *white* and *off white* (Fritsche, 1983) varieties. In contrast with the uniformity found among the cultured strains, the wild ones show a greater genetic diversity (Foulogne-Oriol, Spataro and Savoie, 2009). The sequence of the ITS region of the ribosomal DNA of the strain IE 623, supported the taxonomic determination of the sample *Mata* 641 -from which the strain was obtained-. The 3 analysis placed this sequence inside the clado of *A. bisporus* with high level of support. The analysis of nucleostide similarity shows that the IE 623 strain is genetically very similar to wild strains from different countries of the North Hemisphere, like United States of America, Denmark, and France – from the collected samples in China there is no certainty that they are wild-. In fact, the sequences of the closer commercial strains (HM149321, HM149322, FJ869182) are considerably different (0.5%). This shows that at least the IE 623 strain is wild, and it grows in a natural way in the state of Tlaxcala, and it is not about a cultured commercial strain that comes from mushrooms crops. The sequence for the IE 623 strain is typical of *A. bisporus*; however, it represents a unique disposition of the alleles known in this species so far.

According to Parra (2008), *A. bisporus* grows in Europe, mainly in places where there is cattle, very often under trees of the family Cupressaceae, rarely under other trees, and in dunes, The collected materials in Tlaxcala were also found under trees of the genus *Cupressus*, not so the materials from Veracruz. Although, the work of Martinez-Carrera et al. (2001) cited this species from Tlaxcala, it did not mention in which herbarium the material studied was deposited; so, this work corroborates the presence of *A. bisporus* in Tlaxcala and it first registers it in Veracruz, in both cases growing in a wild way. Although, the number of collected samples was low, the results suggest that the species could have a wider distribution in Mexico. Worldwide, *A. bisporus* has been registered in a wild way in North America (United States of America and Canada), South America (Argentine), Europe (Denmark, Spain, France, Greece), and Asia (Israel, China) (Albertó, 1996; Callac et al., 2002; Challen et al., 2003; Geml et al. 2008; Niveiro and Albertó, 2013; Parra, 2008; Wang et al., 2008). The germplasm found in Mexico could be an important source of genetic characteristics from which it could be done a work program aim to obtain better strains capable of developing under the local environment conditions. The capacity of resilience to plagues and diseases, the adequate growth in regional materials, as well as the ability to fructify in superior temperatures at 25°C are some of the desirable qualities in the mushroom strains (Largeteau, Callac, Navarro-Rodríguez and Savoie, 2011; Navarro and Savoie, 2014; Salmones, Ballesteros-Hernández, Zulueta and Mata, 2011). The challenge is to achieve that the Mexican germplasm is incorporated in a short time to the commercial production.

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First Record of the genus Nopachtus (Xenartha: Cingulata: Glyptodontidae) in Uruguay

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Abstract

Nopachtus Ameghino is a poorly known genus of glyptodontid. The genus includes 2 species recorded in Argentina: Nopachthus coagmentatus

Ameghino, from Brochero Formation (Montehermosian-Chapadmalalian, Early Pliocene-Late Pliocene) of Sierras de Córdoba/El Polvorín Formation (Upper Chapadmalalian, Pliocene) of Sierras Bayas de Olavarría, Buenos Aires province, and Nopachthus Cavrerai Zamorano, Scillato-Yané, Gonzále-Ruiz and Zurita, from Monte Hermoso Formation (Montehermosian, Early Pliocene) from SO of Buenos Aires province. The knowledge about the presence of Nopahtus outside Aregentina is due to Toriño and Rinderknecht (2005), who mention one osteoderm which possesses similar characters to those of Nopachtus and Panochthus intermedius Lydekker. Later Toriño and Perea (2008) resume this consideration. In this paper, the materials referred to Nopachtus in Uruguay are studied. There are 2 isolated osteoderms corresponding to the dorsal carapace: FC-CVF 1825 and CF-CBF 2759, both from Camacho Formation (Late Miocene) or Raigón Formation (Late Miocene-Middle Pleistocene) of the coast cliffs of San José Department, Uruguay. Due to the great similarity of these osteoderms to those of Nopachtus, and according to the comparative analysis conducted, both are assigned to the present genus, thus expanding the geographic distribution of this taxon to Uruguay.

Keywords: Glyptodobntid; Osteoder; Late Miocene; Geographic distribution

Resumen

Nopachtus Ameghino es un género de gliptodótido poco conocido. Cuenta con 2 especies registradas para Argentina: Nopachtus coagmentatus Ameghino, de la formación Brochero (Montehermosense-Chapadmalalense, Plioceno Temprano-Plioceno Tardío) de las sierras de Córdoba/formación El Polvorín (Chapadmalalense Superior, Plioceno) de las sierras de Bayas de Olavarría, provincia de Buenos Aires; y

Nopachtus cabrerai Zamorano, Scillato-Yané, González Ruiz y Zurita, de la formación Monte Hermoso (Montehermosense, Plioceno Temprano) del SO de la provincia de Buenos Aires. El conocimiento sobre la presencia de Nopachtus fuera de Argentina se debe a la mención de Toriño y Rinderknecht (2005) de un osteodermo que posee características semejantes a Nopachtus y a Panochthus Lydekker; posteriormente, Toriño y Perea (2008) retoman esta consideración. En la presente contribución se realiza un estudio de materiales referidos a Nopachtus en Uruguay. 2 osteodermos aislados correspondientes a la coraza dorsal:

FVCVF 1825 y FC-CVF 2759, ambos proceden de la formación Camacho (Mioceno Tardío) o formación Raigón (Mioceno Tardío-Pleistoceno Medio) de las barrancas costeras del departamento de San José, Uruguay. Dada la notoria semejanza de estos osteodermos con los de Nopachtus, y por comparaciones realizadas, se asignan al citado género, ampliándose así la distribución geográfica del taxón a Uruguay.

Palabras claves: Gliptodóntido; Osteodero; Mioceno Tardío; Distribución geográfica

Introduction

Nopachtus Ameghino is a poorly known genus of the *Glyptodontidae* family. It includes 2 registered species for Argentina: *Nopachtus coagmentatus Ameghino* -the species kind- and *Nopachthus cabrerai* Zamorano, Scillato-Yané, González-Ruiz and Zurita. *Nopachtus coagmentatus* was recognized by Amehgino (1888), based on a lateral carapace fragment and parts of the caudal tube, found in the sierras of Córdoba province in myio-pliocene sediments (Bocherense, sensu Castellanos, 1942) that outcropping near Villa Cura Brochero; recently known as Zamorano, Poiré and Scillato-Yañí (2015) ascribe to this species osteoderm of the dorsal carapace proceeding from the El Polvorín formation (floor/age Chapadmalalense Superior, Pliocene) of the Bayas de Olavarría sierras, Buenos Aires province. *Nopachtus cabrerai* was described by Zamorano, Scilato-Yañé, González-Ruiz, and Zurita (2011) base on the right half of a carapace originally identified by Castellanos (1942) as "*Nopachthus*" (sic) trouessarti (Moreno) (Moreno, 1888) (species actually included in the *Phlyctanopyga* Cabrera genus, see Zamorano et al., 2011), proceeding from the base of the gullies of Monte Hermoso formation Monte Hermoso (floor/age Montehermosense, Early Pliocene, see Zamorano, 2013).

According to the amended diagnosis established by Zamorano et al. (2011) and Zamorano (2012 a), *Nopachtus* is characterized for being a glyptodontide of medium to medium-high size, bigger than *Phlyctanopyga*, but smaller than *Panochthus Burmeister*, which osteoderms present a conspicuous central figure, flat in the front region of the carapace and a little convex in the rear part- although not so much as in *Phlyctaenopyga*- generally surrounded by two lines of peripheral little figures. The entire first line is formed by 9 to 12 little figures, and the second, not always complete, is formed by approximately twenty little figures, in some cases.

From the original proposal of Castellanos (1972) established base on presumed similarities in the ornamentation of the carapace, this genus has traditionally constituted a taxonomic group along with a *Panochthus* (constituted actually by 6 species; Zamorano 2012 a, 2012 b, Zamorano, Scillato-Yañé and Zurita, 2014) and *Propanochthus* Castellanos (with only one species: *Propanochthus bullifer* Burmeister), first known as subfamily (*Panochtinae, sensu* Castellanos, 1927) and then as a tribe (*Panochthini sensu* Simpson, 1945). This last one acquired a remarkable acceptance in the next decades, being included in the subfamily "*Hoplohorinae*" (e.g. Fernicola, 2008; Hoffstetter, 1958; Paulo-Couto, 1979; Scillato-Yañé, Carlini, Vizcaíno and Ortiz-

Jaureguizar, 1995; Zamorano, 2012 a, 2012 b; Zamorano et al., 2011; Zamorano and Brandoni, 2013).

Nonetheless, the monophyly of the tribe "*Panochthini*" has started to be questioned in recent phylogenetic analysis, in the same way it has been the one of the sub-family "*Hoplophorinae*" (e.g., Fernicola, 2008; Fernicola and Porpino, 2012; Porpino, Fernicola and Berqvist, 2010; Zamorano and Brandoni, 2013). According to Zamorano (2012 1, 2012 b) and Zamorano and Brandoni (2013), the "*Panochthini"* are not a natural group, being *Nopachthus* and *Propnochthus* genus more related to the representatives of the tribe "*Plohophorini,*" while *Panochthus* forms a clado along to *Hoplohorus* Lund (tribe "*Hoplophorini"* proposed by Zamorano, Zurita and Scillato-Yañé, 2013). Given the current systematic of the "Holophorinae" and their tribes are in revision, this work does not follow the system of traditional classification proposed by Hoffstetter (1958).

Regarding the presence of the *Nopachthus* genus out of Argentina, Toriño and Rinderknecht (2005) describe succinctly an osteoderm of dorsal carapace, collected in the shores of the Kiyú spa, department of San José, Uruguay, identified as belonging to a "*Panochthini,"* pointing out that has characteristics that resemble a *Nopachthus* and a *Panochthus intermedius* Lydekker. Later, Toriño and Perea (2008), within a commented list of glyptodontids of the Tertiary of Uruguay, resume this consideration, indicating the existence of more than one osteoderm, and delimiting the presumed similarity of the same to the first of the mentioned genus, although without giving further information. In the present contribution, a detailed study is made of the referred collected materials in Uruguay, getting to know, for the first time, for the country the presence of assigned osteoderms to the *Nopachthus* genus.

Materials and Methods

The described material is actually deposited in the paleontological collection of the Faculty of Sciences, Montevideo, Uruguay, and it was compared to samples present in the collections of the institutions that are detailed as follows. Abbreviations: FC-CVF, collection of vertebrate fossils. Faculty of Sciences, University of the Republic, Montevideo, Uruguay; MACNPV, National Collection of Paleo-vertebrates, Bernardino Rivadavia Natural Sciences Argentine Museum, Autonomus City of Buenos Aires, Argentine; MLP, Division of Paleontology Vertebrates, Faculty of Natural Sciences and Museum of La Plata, province of Buenos Aires, Argentine; Xen-45; collection of Avellaneda Cements, Olavarría, province of Buenos Aires, Argentine.

Description:

Magnorden Xenarthra Cope, 1889

Cingulata Illigker order, 1811

Glyptodontia Ameghino suborder, 1889

Glyptodontoidea Gray superfamily, 1869

Glyptodontidae Gray family, 1869

Nopachtus Amenghino genus, 1888

Sinomia. Nopachthus. Emmendatio illegitima pro *Nopachtus* Ameghino, 1988 (see Castellanos, 1925 and subsequence publications of the author; Mones, 1986: 237; ICZN, 1999; Art. 33).

Species type: *Nopachthus coagmentatus* Ameghino, 1988; original designation.

Floor/age Montehermonsense, Argentine.

New referred material

Two isolated osteoderms corresponding to the dorsal carapace (FC-CVF 1825 and FC

CVF 2759).

Estratigraphic and Geographic Origin

Ravines of San Gregory Point, Kiyú, Department of San José, Uruguay (34°41’ S; 56°49’ W). Collected by one of the authors (A.R.) in 2004, in the surf of the beach at the foot of the ravines. Camacho formation (Late Miocene) or Raigón Formation (Late Miocene-Medium Pleistocene).

Observations

The sample presents a pentagonal outline. In the outer face presents a central figure surrounded by a well-defined line of peripheral figures. The central figure has a subcircular outline, of flat surface and with one of its borders slightly higher regarding the level of the other figures. There are 12 peripheral figures that are in contact with the central figure, they present regular pentagonal or hexagonal outlines and they form a clearly differentiable ring. Additionally, it is observed a second line of peripheral figures smaller in size than the next line, of irregular forms, in an amount of 25. The rest is formed by some peripheral little figures of irregular distribution – some marginals, incomplete, probably shared with adjacent osteoderms. In almost all intersections of the grooves, more notorious foramina are appreciated more than in any other sample (FC-CVF 2759, see ahead). The inner face is gently concave, of flat surface and with presence of some foramina of irregular distribution, which have a greater size towards the central part of the plate.

Observations

The osteoderm is slightly rolled, its outline is practically quadrangular. As in FC-CVF 1825, the external view presents a central figure, with a proximal line of peripheral little figures or regular outlines in amount of 12, pentagonal or hexagonal, forming a defined ring around such figure. This last one, as in the previous described osteoderm, has a subcircular outline and of flat surface, also slightly higher than the rest of the little figures. The remining little figures observed are smaller than the ones that defined the adjacent ring to the central figure, and have polygonal forms: quadrangular, pentagonal, and hexagonal. An incomplete second line is recognized of these in an amount of 22. As it happens in FC-CVF 1825, it presents some incomplete marginal peripheral little figures, corresponding to peripheral lines shared with contiguous osteoderms. The foramina

observed in most of the sutures from the sample are less evident than in the previous. The inner face is pretty flat, and a in FC-CVF 1825, its surface is flat and presents some foramina.

Discussion

The comparative analysis of the studied material with taxa probably related to those registered in Argentine and Uruguay shows the following results: a correspondence of the material with *Propanochthus* (*P. bullifer*) is rapidly discarded, due to that in this taxon the central figure of the osteoderms of the carapace is surrounded by 3 or 5 lines of little peripheral figures (Castellanos, 1942; Zamorano, 2012 a; Zamorano, 2013).

In the osteoderms analyzed here (FC-CVF 2759 and FC-CVF 1825), ascribed to *Nopachthus* sp., the second line, already mentioned, has 25 and 22 little figures, respectively; in other words, they have more than in the *Pseudohoplohorus absolutus*

Perea (2 little figures, only in some of the lateral zone plates, see Perea, 2005), *Plohophorus figuratus* Ameghino (16 to 17, according to Ameghino, 1889) and *Stromaphorus compressidens* (Moreno and Mercerat) (with a maximum of 21, see Cabrera, 1944, fig.18), but less than in the *Phlyctaenopyga ameghinti* Aeghibo, 1889 (that get to 27, see Zamorano et al., 2011). On the other hand, from the 6 species that integrate the *Panochthus* genus, only *P. intermedius* presents central figures in osteoderms in most of the dorsal carapace. However, in this last species, the central figures have a of rough surface and the little peripheral figures are proportionally smaller and have a larger amount of lines, unlike what happens in *Nopachthus* (Zamorano, 2012 a). In the rest of the *Nopachthus* species, just central figures are observed in the outer zone, although without reaching a notorious development as in the studied material. Nonetheless, due to its morphology the described plates do not correspond to the outer zone, but to the dorsal region.

Due to the notorious correspondence in the ornamentation of the studied plates regarding the samples of *Nopachthus* genus, and regarding the stablished comparisons in previous paragraphs, it is considered that the presented material gathers enough qualities to be assigned to the aforementioned genus, thus expanding the geographic distribution of this taxon to Uruguay. The osteoderms described here are not assigned to any of the 2 species of *Nopachthus*, since it is considered that the characteristics of the materials presented here only allow its attribution to a generic level. The central figures are slightly raised. In *Nopachthus*, such figures are higher in the rear region of the dorsal carapace, in *N. cabrerai a*re form real raised to frankly convexed, with respect to the ampoule, in *N. coagmentatus* are much less high. At the same time, it should be noted that, up to now, in the glyptodontid, it is not possible to identify the side of the carapace (right/left) the osteoderms belong to; this identification can be done in dasipidia (Scillato-Yañé, 1975, 1982; Zamorano et at., 2015) In regards to the osteoderms presented in this contribution, it can only be specified that, by taking into account that central figures are slightly raised than the rest of the little peripheral figures, and that in the latter, there are 2 full lines that surround the central figures, these osteoderms (FC-CVF 1825 and FC-CVF 2759) correspond to the central region or rear part of the dorsal carapace (Zamorano, 2012 a; Zamorano et al, 2011).

With regards to the probable stratigraphic origin of the studied material, it is currently recognized 2 lito-stratigraphic units for the ravines of the zones of the discoveries (Bossi, Ortiz and Perea, 2009; the Camacho formation (Late Miocene) of costal and marine origin, and the Raigón formation (Late Miocene-Middle Pleistocene) of pluvial continental origin. The first of them, has shown remains of several mammals of Huayqueriense affinity, including xenarthos, cardiaterinos rodents, notoungulated and lipotherms; as well as other affinities of Laventese, Montehermoson, Chapadmalalan and Marplatense (Perea, Rinderknecht, Ubilla, Bostelman and Martínez, 2013). On the other hand, the register of the Raigón formation covers a wide temporal lapse, incluidig taxons of montehermoson affinities, such as the notoungulado *Trigodon aff. T. gaudryi* and the tardigrade *Proscelidodon patrius* Ameghino (Mones, 1967; Perea et al., 2013). In addition, ensenadenses-bonaerenses, such as *Catonyx tarijensis* (Ameghino) (McDonald and Perea, 2002; Perea et al., 2013). According to these antecedents, it is estimated that the assigned material to *Nopachthus* in the present contribution can correspond to any of the 2 units. Future will allow to establish more precise taxa and stratigraphic considerations in relation to the presence of the genus in the country.

The study of these osteoderms of the dorsal carapace, diagnosed perfectly, assigned to *Nopachthus* sp., provide for the first time the register of the genus to Uruguay, and this new register is the most eastern oriented of the genus. This glyptodontid, so far exclusive to Argentine, increases the biodiversity of megafauna of Uruguay.

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Composition and Structure of Polychaete Communities (Annelida) Associated with Soft Bottom of the West Coat of Baja California Peninsula, Mexico

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Abstract

Polychaetes are one of the most important groups of the benthos from any point of view. The present study aims to characterize the species richness of polychaete fauna o the West Coast of Baja California, from the mouth of Magdalena Bay to Punta Colonet. Collections were made by the Oceanographic Cruise SIMSUP VIII. We compared the number of families and species collected both bathymetrically and latitudinally, we also performed a diversity analysis using several indexes such as alpha diversity. Pielou evenness, Simpson dominance and specific dominance. A total of 60 stations were revised, 30 of these were positive, finding 3,790 specimens grouped in 11 orders, 27 families, 62 genera and 99 species. Spionidae has the highest richness with 4 genera and 12 species (12.2% of global diversity and 42.7% of the relative abundance) for a total of 1,583 specimens *Paraprionospio pinnata* was the most abundant, frequent and dominant species (24.2% of all specimens). Of the total sample, 53.8% belong to the central one, 26.9% to the southern one and 19.2% to the northern one. The highest richness (85.9%) and abundance (62.8%) correspond to the central zone.

Keywords: Polychaetes; Diversity; Mexican Pacific

Resumen

Los poliquetos son uno de los grupos más importantes en el bento desde cualquier punto de vista. Con el presente estudio se tiene el propósito de caracterizar la riqueza específica de la fauna de poliquetos de la costa occidental de Baja California, de la boca de bahía Magadalena hasta punta Colonet, a través de recolectas realizadas por el crucero oceanográfico SISJP VIII. Se comparó latitudinal y batimétricamente el número de familias y especies encontradas en el estudio; asimismo, se realizó un análisis ecológico utilizando los índices de diversidad alfa, diversidad de Shannon-Wiener, dominancia de Simpson y equitatividad de Pielou. Se revisó un total de 60 estaciones; 30 de estas fueron positivas, las cuales resultaron en 3,709 organismos agrupados en 11 órdenes, 27 familias, 62 géneros y 99 especies. La familia Spionidae presenta la mayor riqueza con 4 géneros y 12 especies (12.2% de la diversidad global y 42.7% de la abundancia relativa) para un total de 1.583 ejemplares. *Paraprionospio pinnata* fue la especie más abundante, frecuente y dominante (24.4% del total de ejemplares). Del total de muestras, el 53.8% pertenecen a la zona centro, 25.9% a la sur y 19.2% a la norte. Se encontró la mayor riqueza (85.9% y abundancia (62.8%) en la zona centro.

Palabras claves: Poliquetos; Diversidad; Pacífico mexicano

Introduction

Soft bottoms are considered the benthic habitat more extensive on the continental platform, slopes, and watersheds. These are constituted by sandy and muddy sediments, which differ in the grain size, providing habitats, dissimilar for different species of organisms (Schiff, Allen, Zeng and Bay, 2000). The kind of sediment, including the size, porosity, organic content and organic products of the grains that these could have absorbed, it is closely related with the distribution of the organisms that constitute the communities. The polychaetes anelids are considered a dominant group in such communities due to their diversity, abundance, and ecological functionality, which allow them a high adaptability to the different habitats (Díaz-Castañeda and Harris, 2004). Likewise, polychaetes are part of the pioneer groups in the areas where is some environmental disturbance of any kind (Díaz-Castañeda and Almeda-Jauregui, 1999; Heilskov and Holmer 2001). These organisms are an essential part in the food chains; serving, as important markers of the conditions of the environment (Díaz-Castañeda, de León and Solana, 2005) and intervening directly in the process of sedimentation, providing a link between the medium fauna and macrofauna, allowing in this way, the good functioning of the medium (Cacabelos, Moreira and Troncoso, 2006). Considering the importance of the polychaetes in the structure of the aquatic ecosystems, several studies have been conducted of the continental platform in the west coast of the Baja California peninsula (De León-González, 1988, 1990, 1992, 1994 a,b, 1998; Fauchald, 1968, 1970, 1972, 1982 a,b;

Hartman, 1939 a,b, 1940, 1941 1944 a,b,c, 1950, 1956, 1957 and Hartman, 1961; Salazar-Vallejo, 1987; likewise De León-González, Hernández-Guevara and Rodríguez, 2006; De León-González and Díaz-Castañea, 1998; De León-González and Rodríguez-Valencia, 1996, De León-González and Solís-Weiss, 1998, 2000, 2001; Díaz-Castañeda, De León-González and Solana-Arellano, 2014; Díaz-Castañeda and De León-González, 2007; Díaz-Castañeda and Harris, 2004; Díaz-Castañeda and San Martín, 2001; Díaz-Castañeda et al., 2005). The present study determines the taxonomic composition of the polychaetes fauna, the spatial changes along the continental platform of the zone under study, as well as the spatial variations of the density and the faunistic affinities among the locations of the sampling, evaluating the algal diversity and determining their geographic variations.

Materials and Methods

In October 1995, within the frame of SIMSUP VIII *Sistemas Marinos de Surgencias y su relación con Pelágicos menores* (Marine Systems of Surgencies and its relation to minor Pelagics) project carried out in the west cost of the Baja California peninsula on board the oceanographic boat “El Puma” “the Cougart”, samples were collected from the soft bottoms in 60 stations through a Smith-McIntyre dredger (0.1m2). The stations were divided in north zone: from Colonet point up to San Antonio point; central zone: from Eugenia Point up to San Hipolito; and south zone: in the mouth of Magdalena Bay. In Table 1, it is showed the coordinates of the 30 positive stations concerning this work. Each transect was divided bathymetrically in 4 intervals of depth: of 0-49m, of 50-99 m, of 100-1499 m, and of 150-200, as it has been suggested by Hernández-Alcántara (2002), McConnaughey (1978), and Ross (1977). The quantification of the collected organisms was carried out by species and its register in the respective tables is presented in terms of density (orgs/0.1m^2), which is the sampling area of the Smith-McIntyre dredger used in the recollection of samples. The representation and analysis of the spatial distribution of the density and the number of species was carried out by maps of distribution. In order to do this, several indexes and statistic treatments were included such as: algal diversity, Pielou evenness, and Simpson dominance. With the purpose of analyzing the north-south variations of the polychaetes fauna and comparing the differences in the composition of the species along the peninsular shore, the Beta diversity was evaluated (Gray, 2000). The utilization of the Beta diversity in the west coast of the Baja California peninsula allowed to detect biotic changes in the north-south direction, through the index proposed by Wilson and Shmida (1984). To suitably select the representative species of a community, the dominant species were determined both, in the locations of sampling and in the different geographic regions, through the specific dominance.

Results

Global analysis of the richness and specific abundance

A total of 3.709 organisms included in 62 genus and 99 species were examined. The Spionidae family presented was the richest, constituted by 12 species and 4 genus: *Minuspio cirrifera, Minuspio perfinsi, Paraprionospio alata, Paraprionospio pinnata, Prionospio cristata, Prionospio dubia, Prionospio jubata, Prionospio malmgreni, Prinospio vermillionensis, Spiophanes bombyx, Spiohanes kroeyeri and Spiophanes wigleyi;* the same that integrate the 12.2% of the global diversity and the 42.7% of the relative abundance (1.583 organisms). The families Syllidae *(Exogone dispar, Opisthosyllis brunea, Opisthostyllis japonica, Syllis caeca, Syllis gracilis, Trypanosyllis aeolis and Trypanosyllis zebra*), Ampharetidae (*Amphicteis scaphobranchiata,* *Eclysippe trilobata*, *Lysippe labiate, Melinna oculate, Melinna tentaculate, Melinnampharte gracilis and Paralysippe annectens*), Cirratulidae (*Aphelochaeta monilaris, Aphelochaeta parvus, Caulleriella gracilis, Chaetozone corona, Chaetozona setos, Monticellina serratiseta and Monticellina tesselata*), and Maldanidae (*Clymenella complanate, Clymenella mucosa, Clymenura gracilis, Maldane sarsi, Praxillella gracilis, Praxillella pacifica and Rhiodine bitorquata*) grouped the 28.2% of the total species and 24.0% of abundance -889 organisms. The families that showed the least specific diversity were Capitellidae (*Capitella sp*.), Chaetopteridae (*Spiochatopterus costarum*), Flavelligeridae (*Pherusa neopapillata*), Scalibregmatidae (*Scalibregma inflatum*), Serupulidae (*Hydroides gracilis*), Sternapsidae (*Sternspssis fossor*), all with just one species, including the 7.7% (287) of abundance from the total of individuals.

Analysis of the specific richness in the south zone

From the samples obtained in this zone, 788 organisms were identified, representing 26 families and 61 species (61.6%), where 7 of these correspond to Spionidae (*M. cirrifera, M. perkinsi,, P. alata, P. pinnata, P. malmgreni, S, bombyx and S. kroeyeri*) constituting the 11.5% of the specific diversity and the 35.9% of relative abundance -283 organisms- Syllidae (*E. dispar, S. caeca, S. gracilis and T. aeolis,* Ampharetidae (*E. trilobata, M. tentaculate, M. grailis and P annectens*), Lumbrineridae (*Lumbrinerei crassidentata, Lumbrinereis erecta, Lumbrinereis latreilli and Ninoe longibranchiata*) and Sabellidae (*Euchone incolor, Megaloma pigmentum, Paradialychone ecaudata and Pseudopotamilla reniformis*) they are equivalent to the 26.2% of the richness of the zone and 17.9% of the relative abundance -141 organisms-. Likewise, Cirratulidae (*A. parvus, C. setosa and M. tesselata*), Goniadidae (*Glycinde polygnatha, Goniada brunnea and Goniada maculata*), Maldanidae (*M. sarsi, P.*

gracilis and P. pacifica), Orbiinidae (*Leitoscoloplos Kerguelensis, Leitoscoloplos pugettensis and Scoloplos treadwelli*), and Pilargidae (*Ancistrosyllis jonesi, Sigambra bassi and Sigamba tentaculate*) constitute the 24.6% in the number of species and 22.7% of the relative abundance -179 organisms-. Sternapsidae (*S. fossor),* Capitellidae *(Capitella* sp), Chaetopteridae (*S. costarum*), Dorvilleidae (*Schistomeringos annulate*), Eunicidae (*Eunice vittata*), Flabelligareidae (*P. neopapillata*), Hesionidae (*Hesione intertexta*), Magelonidae (*Magelona pacifica*), Pectineridae (*Amphictene auricoma*), Scalibregmatidae (*S. inflatum*), and Serpulidae (*H. gracilis*) correspond to the 17.9% of the specific richness and 13.1% of the number of organisms -103 organisms.

Analysis of the specific richness in the north zone

In the north zone a total of 592 organisms (6%) belonging to 23 families and 60 species were identified. The family Spionidae represented the 18.3% of the specific richness of the zone (*M. cirrifera, P. alata, P. pinnata, P. critata, P. dubia, P. jubata, P. malmgreni, P. vermillionensis, S. bombyx, S. kroeyeri* and *S. wigleyi*). Ampharetidae (*A. Scaphobranchiata, E. trilobata, L. labiate, M. oculate, M. gracilis* and *P. annetens*) and Maldanidae (*C. complanata, C. mucosa, C. gracilis, M. sarsi, P. pacifica* and *R. bitorquata*), concentrate the 20.0% of the richness and 11.3% of the abundance -67 organisms-. The family Cirratulidae includes 5 species (*A. monilaris, A. parvus, C. gracilis, C. setosa* and *M. tesselata*), which means the 8.3% of the richness and10.8% of the abundance -64 organisms- Sternapsidae (*S. fossor*), Dorvilleidae (*S. annulate*), Hesionidae (Podarkeopsis glabra), Magelonidae (*Magelona suculata*), Pectineridae (*Pectinaria californiensis*), Scalibregmatidae (*S. inflatum*), Cossuridae (*Cossura brunnea*), Goniadidae (*G. maculata*), and Serpulidae (*H. gracilis*) resulted with just one species in this zone, which represents the 14.94% of the richness and 17.1% of the abundance -101 organisms-.

Analysis of the specific richness of the central zone

A total of 2,329 organisms (62.8%) belonging to 25 families and 82 species (82.8%) were identified in this zone. The family Spionidae, as well as in the other zones, was the best represented with 9 species (*M. cirrifera, M. perkinsi, P. alata, P. pinnata, P. malmgreni, P. vermillionensis, S. bombyx, S. kroeyeri* and *S. wigleyi)* equivalent to the 11.0% of the total richness of the zone and 46.8% of the abundance - 1.089 organisms-. Syllidae *(E, dispar, O. brunnea, O. japonica, S. caeca, S gracilis, T. aeolis and T. zebra)* and Cirratulidae *(A. monilaris, A. parvu, C. gracilis, C. corona, C. setosa, M. serratiseta* and *M. tesselata)* are constituted by 7 species each, both equivalent to the 17.1% of the richness and 15.2% of the abundance -354 organisms-. *Maldanidae* with 6 species (*C. complanate, C. mucosa, C. gracilis, M. sarsi, P. pacifica* and *R. bitorquata),* which represents 7.3% of the richness and 7.5% of the abundance - 174 organisms-. The families Sternapsidae (*S. fossor*), Flavelligeridae (*P. neopaillata*), Scalibregmatidae (*S. inflatum*) and Serpulidae (*H. gracilis*) resulted with just one species in this area, which represents 4.9% of the total richness and 9,1% of the abundance -212 organisms.

Global estimate of indexes with specific biological importance

The results state that the Maldanidae family presented the most diversity of Shannon-Wiener with a value of 1.76, which at the same time contrasts as contrast with the obtention of a low dominance data (0.194) and corroborated by a high value of correspondent evenness to 0.9032. Other families where outstanding data of diversity and evenness are also observed are: *Cirratulidae*, *Skpionidae, Nephtyidae,* and

Sabellidae. In the same way, the families with low values of diversity and evenness, as well as a high dominance are *Dorvilleidae* and *Eunicidae*, as it is observed.

Estimate of indexes with biological importance in the south zone

In the south zone a total of 26 families were collected, from which *Spionidae* resulted the most diverse, with a total of 7 species, and presented a value of 1652, which states a high evenness (0.849) in the 7 stations where they were present and a minor dominance (0.214). In the case of *Sabellidae* family, it included a total of 4 species in 4 stations, evidencing that is the second family with higher values of diversity and evenness (1.316 and 0.949, respectively) and a minor dominance (0.286). Within the families that presented the least diversity are *Nereididae* with 2 species in 3 stations, with a value of 0.673 and an evenness equally low (0.52); however, this shows us that there is a high dominance between the present species (0.917). In the case of *Capitellidae, Chaetopteridae, Dorvilleidae, Eunicidae, Hesionidae, Magelonidae, Pectineridae, Scalibregmatidae, Serpulidae, and Sternapsidae*, there were obtained levels of diversity as well as of evenness equal to 0 and a dominance equal to 1, which indicates us that it only counts with just one species for each case.

Estimate of indexes with biological importance in the central area

In the central zone a total of 25 families were found, out of which *Cirratulidae* turned out the most diversed with a value of 1.537 and a total of 7 species in 9 stations; which indicates a high evenness (0.79) and a minor dominance (0.266). In the case of the *Maldanidae*, it presented a total of 6 species in 8 stations for this zone, showing that is the second family with higher values of diversity and evenness (1.421 and 0.793, respectively) and a minor dominance (0.284). Within the families that presented the least diversity is *Eunicidae* with 2 species in 5 stations, with a value of 1.732 and an equally low evenness (0.249); however, this shows that there is a high dominance between the present species (0.9201), since one of their 2 species presents a higher number of organisms in this zone. In the case of *Flabelligeridae, Scalibregmatidae, Serpulidae*, and *Sternapsidae*, there were obtained levels of diversity and evenness equal to 0 and a dominance equal to 1, which indicates us that it only counts with just one species of the organism per each case.

Estimate indexes with biological importance in the north area

In the north zone a total of 23 families were found out, of which *Maldanidae* turned out to be the most diverse with a value of 1.589 and a total of 6 species in 4 stations; this indicates a high evenness (0.886) and a minor dominance (0.218). In the case of *Spionidae* case, it had a total of 11 species in 5 stations for this area, showing that is the second family with higher values of diversity and evenness (1,466 and 0.611, respectively) and a minor dominance (0.341), because 3 of these species present a higher abundance regarding to the rest. Within the families that presented the least diversity are Eunicidae 2 species in 2 stations, with a value of 0.500 and a high evenness (0.721); however, this shows that there is a high dominance among the present species (0.680). In the case of *Cossuridae, Dorvilleidae, Goniadida, Hesionidae, Magelonidae, Pactineridae, Scalibregmatidae, Serpulidae, and Sternapsidae*, there were obtained levels of diversity and for evenness equal to 0 and an equal dominance to 1, which indicates that it just counts with one species of organism per each case.

Bathymetrical analysis based on the estimate of indexes of biological importance

Out of the 60 sampling stations during the SIMSJUP VIII cruise, in 30 it was obtained at least one sample of polychaete, where the 53.3% corresponds to the central zone, the 26.7% to the south, and the 20% to the north one. Likewise, the highest richness (85.9%) and abundance (62.8%) were the result of the collections done in the central zone. It should be noticed that these differences with respect to the other 2 zones could be attributed to the fact that the 56% of the sampled stations were carried out in this area. In the study performed by Rodríguez-Valencia (1994), equivalent to the central area and compared with the one of Hernández-Guevara (1994), corresponding to the north area, it was also superior in specific richness and abundance, as it happened in the present study. Bathymetrically, the 50-99 m interval for the total area and for the 3 zones presented the most richness and specific abundance, as well as the highest diversity estimated based on the Shannon-Wiener and Simpson index.

Discussion

Until mid1980s, the west coast of Baja California concentrated approximately 236 species of polychaetes (Salazar-Vallejo, De León-González and Salaices-Polanco, 1989). Barboza-López (2008) carried out the revision of the bases for the data of the records done between 1901 and 2004 in the continental platform of the west coast of Baja California, recording a total of 491 species; so, the elaborated listing in the present study corresponds to the 20.2% of such species (Annex 1). In short cycles studies, Rodríguez-Valencia (1994) identified a total of 20 families in the area corresponding San Juanico Bay, in the west coast of South Baja California, out of which the 85% of them are the same as the ones found in the present work. Likewise, Hernández-Guevara (1994) identified 23 families of polychaetes in the Sebastián Vizcaíno Bay, where the 88% are also present in this investigation. In the work of De León-González (1994a), an overlap of the 85% of the documented families in both studies, was obtained.

The 64.5% of the species of polychaetes identified in the present study belong to 10 families: *Spionidae, Maldanidae, Ampharetidae, Syllidae, Cirratlidae Nephtydae*, *Paraonidae, Pilargiidae, Lumbrineridae,* and *Nereididae*, which mostly, are dominant in their soft substrates. Rodríguez-Valencia (1994) obtained an estimate of the 62.2% in the 10 families with the highest richness, where 7 of them appear in both listings, and Hernández-Guevara (1994) obtained the 67.3% with 5 families sampled in both works. In the same area of study, Barboza-López (2008) registered that *Spionidae, Paraonidae, Ampharetidae, Cirratlidae, Nereidae*, and *Syllidae* contribute with the 32.8% of the species. Hernández-Alcántara (2002), in the Gulf of California, also pointed out within the first 10 families with the highest richness and number of organisms to *Spionidae, Lumrineridae, Nereididae, Paraonidae*, and *Cirratulidae*, the same that represent the 27.6% of the species.

Out of the 27 families, *Capitellidae, Sternapsidae, Serpulidae, Flabelligeridae, Chaetopteridae,* and *Scalibregmatidae* were represented by only one species; however, *Sternapsidae* presented 198 organisms and the rest, less than 20. Comparatively, other studies carried out by Rodríguez-Valencia (1994) had a total of 55% of similarity, which equals to 11 families with just one species. Hernández-Guevara (1994) showed a similarity of the 60%, equivalent to 15 families, which only presented one species. De León-González (1994a) documents for the area of Eugenia Point up to Cabo Falso Point a similarity of 39.4% or the equivalent to 13 families. Hernández-Alcántara (2002) equally records a *Sterbaosudae*, *Serpulidae*, and *Chaetopteridae,* as just one species for the Gulf of California.

One of the prevailing results of the analysis of the fauna-polychetes were the outstanding data of the richness and abundance that represents the *Spionidae* family, because it constitutes the 12.2% of the 99 identified species and the 42.7% of the 3,709 organisms. Similar information was documented by De León-González (1094a), counting 10.6 and 37.8% of richness and abundance, respectively. Likewise, Hernández-Guevara (1994) identified 5 species (10.9%) out of 171 organisms of this family (25.8%). In the same way, Rodríguez-Valencia (1994) examined 712 specimens (66.4%) belonging to 4 species. It should be noticed that the greater presence of this family is based on the habitat diversity that it occupies both, latitudinal and bathymetrically, in the continental platform, dominating widely the soft bottoms of shallow and deep waters, as it is pointed out by Hernández-Valdez (2008).

P. pinnata is the most abundant, frequent, and dominant species among the polychaetes families obtained in this study and represents the 24.2% of the total number of organisms. In the studies done by De León-González (1994a), Donath-Hernández and Loya-Salinas (1989), Encalada-Fleites and Millán-Núñez (1990), and Rodríguez-Valencia (1994), *P. pinnata* was identified as the most abundant species

From the total of the identified species in the south zone, the *Spionidae* family was the most diverse, as it is mentioned in the work of De León-González (1994a), who mentions these sub-superficial sedimentary organisms as the highest abundant and with the highest richness of species in the continental platform of the west coast of Baja California, especially in soft substrates. The central zone comprised a total of 85 species of *Spionidae;* again, it is the best represented, followed by

Cirratulidae. In this area, *Eunicidae t*urned out to be the family with the least diversity of species. Rodríguez-Valencia (1994) mentions that this zone presents an accumulation of organic matter forming soft bottoms in its majority, making it homogeneous and achieving the enrichment of the substrate; favoring the development of a higher number of species with sedentary habits, which tend to disappear in deeper strata. In the north zone, a total of 60 species were identify out of which 11 belong to the *Spionidae* family. This presents the higher diversity, as well as in the study performed by Hernández-Guevara (1994) for the area of María Point to Eugenia Point, who mentions that the indicator of the magnitude in which the substrates are favorable to one species or the adaptation of the species to that substrate, is the density of organisms per unit of sampling.

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CHAPTER V

Data Analysis

According to Kalpesh (2013) the data analysis is a process used to inspect, clean, transform, and remodel data with a view to reach a certain conclusion for a given situation. In this chapter, the translator is going to analyze the documents in relation to the text analysis, text style, formality of the texts, difficulty, emotional tone, the text function, and the translation method.

5.1 Text analysis

The text analysis begins with the reading of the document to be translated. This text analysis gives the translator the necessary information to get acquaintance with the documents and the intention of the texts as well as the intention of the translator.

TEXT ANALYSIS	TRANSLATIONS FROM ENGLISH INTO SPANISH	TRANSLATIONS FROM SPANISH INTO ENGLISH
Text Style	Description	Description
Formality	Formal	Formal
Difficulty	Educated	Educated
Emotional Tone	Factual tone	Factual tone
Text Function	Informative	Informative
Translation Method	Sematic	Semantic

Table 1. Shows the text analysis of the articles from English into Spanish and vice versa
Source: Translator's own creation

5.2 Color Coding

The color coding is a valuable instrument that shows the importance of the translation techniques when translating the documents. These techniques provide the translation with the necessary naturalness and accuracy that helps the translation to express the intention of the text and the author.

In the table below, the translator shows all the colors used to highlight each translation technique.

Transposition
Omission – **bold-original**
Amplification
Explicitation
Modulation
Literal Translation
Equivalence
Compensation
Adaptation

Table 2. Shows the colors used to highlight the different translation techniques
Source: Translator's own creation

5.2.1 Paragraph Analysis

From English into Spanish

PARAGRAPH 1

Current estimates of fungal diversity-based o the plant-fungi ratio found in countries where both populations are sufficiently well studied the existence of 1.5 million species (Hawksworth, 1991, 2001; Muller & Schmit, 2007). The study of fungal diversity is important because fungi **are** decomposers of organic matter and comprise a major proportion of microbial biomass. Recently, global climate change and the better-known role of fungi in biogeochemical cycles have enforced the importance of studying fungal diversity (Chapin et al., 2000; Wardle & Giller, 1996).

Studies of fungal diversity have been limited by the lack of appropriate microbiological methods (Kimiura, 2006; Torsvik & Ovreas, 2002). The application of molecular approaches such as extracting. Cloning and amplifying DNA from environmental samples currently allows **us** to explore biodiversity without the need of culturing.

Las estimaciones actuales de la diversidad de hongos basados en la proporción de plantas-hongos encontrados en países donde ambas poblaciones están suficientemente bien estudiadas, sugieren la existencia de 1.5 millones de especies (Hawksworth, 1991, 2001; Müeller y Schmit, 2007). El estudio de la diversidad de hongos es importante porque los hongos descomponen la materia orgánica y comprenden una mayor proporción de biomasa microbiana. Recientemente, el cambio climático global y el mejor conocimiento del papel de los hongos en los ciclos biogeoquímicos han reforzado la importancia del estudio de la diversidad de hongos (Chapin et al., 2000; Wardle y Giller, 1996).

Los estudios de la diversidad de hongos han sido limitados por la falta de métodos microbiológicos apropiados (Kimura, 2006; Torvik y Ovreas, 2002). La aplicación de los enfoques moleculares tales como extracción, clonación y amplificación del ADN de las muestras ambientales nos permite explorar hoy día la biodiversidad sin la necesidad de cultivos.

PARAGRAPH 2

If terrestrial fungi are still largely under-described, aquatic fungi are even less known. Most of the cultivated aquatic species belong to the Chytridiomycota and Ascomycota phyla (Mueller & Schmit, 2007; Mueller, Bills, & Foster, 2004; Shearer et al.,

2007) and may fungal-related microbes belonging to the straminipiles (oomycets and hyphochytriomycetes in particular) have been describe (Mueller et al., 2004; Van der Auwera et al., 1995). In Mexico, an important effort to explore fungal diversity has been made (Guzmán, 1998). Exploration of aquatic fungal diversity has also been conducted by traditional methods isolating fungi from freshwater and marine environments (González & Chavarría, 2005; González, Hanlin, Herrera, & Ulloa, 2000; González, Hanlin, & Ulloa, 2001; Heredia, Reyes, Arias, Mena-Portalels, & Mercado Sierra, 2004). In marine environments, ascomycetes and mitosporic fungi were mainly found, although one basidiomycete was reported (González et al., 2001).

To explore the diversity of aquatic fungi in Mexico and **to** demonstrate the potential of a classification system based on a single molecular marker, **we** present an investigation of different water bodies (marine, brackish and fresh water) using a fragment of 18S rDNA sequences and the results of our phylogenetic clustering approach.

Si los hongos terrestres no están ampliamente descritos, los hongos acuáticos son aún menos conocidos. Muchas de las especies acuáticas cultivadas pertenecen a los filos Chytridiomycota y Ascomycota (Müeller y Schmit, 2007; Múeller, Bills y Foster, 2004; Shearer et al., 2007) y muchos de los microbios que están relacionados con los hongos han sido descritos y pertenecen a los stramenopiles (en particular a los oomycetos e hyphochytriomycetos) (Müeller et al., 2004; Auwere et al., 1995). En México, se ha hecho un esfuerzo importante para explorar la diversidad de hongos (Guzmán, 1998). Se ha realizado una exploración de la diversidad de hongos acuáticos con métodos tradicionales, aislando los hongos de agua dulce y de ambientes marinos (González y Chavarría, 2005; González, Hanlin, Herrera, y Ulloa, 2000; González, Hanlin y Ulloa, 2001; Heredia, Reye, Arias, Mena-Portales, y Mercado Sierra, 2004).

En ambientes marinos se encontraron principalmente hongos ascomicetos y mitospóricos, aunque se reportó un basidiomiceto (González et al., 2001).

Para explorar la diversidad de hongos acuáticos en México y para demostrar el potencial de un sistema de clasificación basado en un marcador molecular único, presentamos una investigación de diferentes cuerpos de agua (marina, salobre y agua dulce) al utilizar un fragmento de las secuencias de ADN 18S y los resultados de nuestro enfoque de agrupamiento filogenético.

PARAGRAPH 3

We decided to collect samples from water instead from organic matter to recover a wider selection of **the** fungal population in each site, not only of those directly involved in decay. Samples were collected from 0.5 m below the water surface using a clean and surface sterilized container. Typical sample volumes were 20 L. The whole sample was passe through 3 layer of sterile cheesecloth and afterwards filtered through 5 p.m PVDF membranes (Millipore). The biomass layer was scrapped with a spatula from the membranes, washed in 3-5 ml of the same water and centrifuged in 3 different Eppendorf tubes for replica analysis. Final biomass volumes were of 0.1-0.3 ml. Pallets were frozen at -20°C until extraction.

The whole peller was processed and total DNA extracted using the Ultra Clean Soil DNA Kit (MoBio, Carlsband, USA) in accordance to the manufacture's instruction s. Total DNA was analyzed for integrity by agarose gel electrophoresis.

Decidimos recolectar muestras del agua en lugar de materia orgánica para recuperar una selección más amplia de población de hongos en cada sitio, no solamente de aquellos directamente involucrados en el deterioro. Las muestras fueron recolectadas desde 0,5 m bajo la superficie del agua al usar un envase con una superficie limpia y esterilizada. Los volúmenes de las muestras típicas fueron de 20 litros. Toda la muestra se pasó a través de 3 capas de una estopilla esterilizada y después filtrada a través de membranas de 5 µM PVDF (Millipore). La capa de biomasa se desechó de las membranas con una espátula, se lavó con 3 a 5 ml de la misma agua y se pasó por la centrífuga en tres tubos Eppendorf diferentes para repetir el análisis. Los volúmenes finales de la biomasa fueron de 0.1 a 0,3 ml. Las bolitas pequeñas se congelaron a -20°C hasta su extracción.

Toda la bolita fue procesada y el total del ADN extraído al utilizar el equipo de Ultra Clean Soil DNA (MoBio, Carlsbad, USA) de acuerdo con las instrucciones del fabricante. El total del ADN fue analizado para la integridad con un gel de agarosa por electroforesis.

PARAGRAPH 4

Sequenced DNA files were provided in FASTA format and the name of each file was manually edited **in oder to** allow clear identification of each sequence in the future. An initial depuration was performed for each set of 384 sequences and very short or ambiguous **sequences** were removed. The rest of the sequences were submitted to individual identification against GenBank using the BLAST tool (Altschul et al., 1997). While most of the sequences matched entries from fungal origins those that clearly correspond to other phyla were removed. In samples from marine sources, the cutoff was less clear based on the poor number of well-characterized marine fungi so **we** decided **to** leave all ambiguous sequences in the set for further analysis. Approved set were automatically aligned using the Clustal W algorithm (Larkin et al., 2007) contained in Mega version 4 (Tamura, Dudley, Nei, & Kumar, 2007). Most of the sequence aligned in the first round, although optimization of the surrounding of variable regions required manual alignment.

Los archivos de la secuencia del ADN fueron proporcionados en formato FAST y el nombre de cada archivo fue editado manualmente para permitir una identificación clara de cada secuencia en el futuro. Una depuración inicial se llevó a cabo para cada conjunto de 384 secuencias y las muy cortas o ambiguas se eliminaron. El resto de las secuencias se sometieron para una identificación individual contra el Banco de Genes al usar la herramienta BLAST (Altschul et al., 1997). Mientras que la mayoría de las secuencias coincidió con las entradas de orígenes de los hongos, aquellas que claramente correspondían a otra fila se eliminaron. En muestras de fuentes marinas, la remoción fue menos clara basada en el poco número de hongos marinos bien caracterizados, así que decidimos dejar todas las secuencias ambiguas en el grupo para análisis posterior. Los conjuntos aprobados fueron automáticamente alineados usando el algoritmo Clustal W (Larin et al., 2007) contenido en la Mega versión 4 (Tamura, Dudley, Nei, y Kumar, 2007). La mayoría de la secuencia alineada en la primera ronda, aunque se requirió un alineamiento manual en el mejoramiento de los alrededores de regiones variables. Los fragmentos portadores del vector fueron removidos después del alineamiento.

PARAGRAPH 5

We tested the ability of our molecular marker, a fragment of the 18 rDNA gene containing regions V4-V8, to reconstruct a clustering profile with the taxonomic classification using our ensemble of reference sequences. Once the robustness of the cluster method was demonstrated, the environmental sequences from 10 of our 11 libraries (after removing the samples from Carpintero Lagoon for the reasons described above) were organized by site along with the fungal reference sequences as described in Section ´Materials ad methods´. Serial reconstructions of the 10 libraries were performed using the manually optimized multiple alignment from each site, which included the recovered reference sequences, until a robust and informative phylogram was obtained. Based on these phylograms **we** identified the most probable taxonomic classification of the environmental sequences by their clustering with reference sequences.

Probamos la habilidad de nuestro marcador molecular, un fragmento del gen rADN 18 que contiene regiones V4-V, para reconstruir un perfil del comportamiento consistente con la clasificación taxonómica al utilizar nuestro conjunto de secuencias referenciales. Una vez que la robustez del método de agrupamiento fue demostrada, las secuencias ambientales de 10 de nuestros 11 catálogos, (después de retirar las muestras de la Laguna Carpintero por las razones descritas arriba) fueron organizadas por localidad junto con las secuencias referenciales fúngicas, como se describe en la Sección “Materiales y métodos”. Se realizaron reconstrucciones seriales de los 10 catálogos al utilizar el alineamiento múltiple optimizado manualmente de cada sitio, el cual incluyó las secuencias referenciales recuperadas, hasta que se obtuvo un filograma informativo y robusto. Basados en estos filogramos, identificamos la clasificación taxonómica más probable de las secuencias ambientales por su agrupamiento con secuencias referenciales.

PARAGRAPH 6

Telorchis birabeni has a characteristic posterior part of body that constitutes a cupuliform formation, which opens to the excretory pore. According to Mañé-Garzón and Gil (1961a), the characteristic, unique among *Telorchis* species, justifies the description of a new genus for this species. A review of the species Telorchiidae of South America could contribute to the description of the new genus.

In both species (*T. platensis* and *T. birabeni*) **we** observed the presence of tegumental spines in higher numbers in the anterior region and decreasing from the acetabulum. The presence of spines in the tegument is characteristic of the *Telorchis* species; however, such spines may be lost if the host was frozen before being examined as suggested **by** Mascarenhas and Müller (2013). The host from which *T. platensis* and *T, birabeni* were collected were not frozen; therefore, helminths were fixed immediately after collection, allowing the preservation of the spines of the integument.

Telorchis birabeni tiene una parte posterior del cuerpo característica que constituye una formación cupuliforme, la cual abre un poro excretorio. De acuerdo con Mañé-Garzón y Gil (1961a), esta característica, única entre la especie *Telorchis*, justifica la descripción de un nuevo género para esta especie. Una revisión de las especies de *Telorchiidae* de Sur América podría contribuir a la descripción de un nuevo género.

En ambas especies (*T. platensis* y *T. birabeni*) observamos la presencia de espinas tegumentales en mayor número en la región anterior, y una disminución de los acetábulos. La presencia de espinas en el tegumento es característica de la especie *Telorchis*; sin embargo, dichas espinas se pueden perder si el huésped fue congelado antes de ser examinado, como lo sugirieron Mascarenhas y Müller (2013). Los huéspedes de los cuales los *T. platensis* y *T. birabeni* fueron recolectados no fueron congelados los helmintos fueron fijados inmediatamente después de la recolección, permitiendo la preservación de las espinas en el tegumento.

PARAGRAPH 7

Van den Berg et al. (2009) pointed out the main factors of diversification within Laeliinae remain a rich field for research, due to the great variation of morphological features, the large number of species, and generic and infrageneric groupings. In addition, both the seed, as well as the fruit structure have been neglected in the Orchidaceae (Dressler, 1993); Barthlott (1976) stated that seed structures are especially useful at the tribal and subtribal levels.

Reproductive structures of orchids have wide morphogenetic potential, conditioned by the high totipotency of their cells which contributes to a complex reproductive system (Batygina, Bragina, & Vasileyeva, 2003). Furthermore, those authors pointed out that data set, the advance of theoretical knowledge on reproductive structures, and the methods of plant micropropagation may be useful for conservation programs, in addition to benefit the introduction of secondary population under natural conditions.

Van den Berg et al., (2009), señaló que los factores principales de diversificación dentro de Laeliinae continúa siendo un campo rico para investigación, debido a la gran variedad de características morfológicas, el gran número de especies y los grupos infra-genéricos y genéricos. Además, tanto las semillas como la estructura de la fruta, han sido abandonadas en la Orchidaceae (Dressler, 1993); Barthlott (1076) dijo que las estructuras de las semillas son especialmente útiles a niveles de tribu y sub-tribu.

Las estructuras reproductivas de las orquídeas tienen un amplio potencial morfogenético, condicionado por el alto totipotencia de sus células, las cuales contribuyen a un sistema reproductivo complejo (Batygina, Bragina y Vasileyeva, 2003). Además, esos autores señalaron que el grupo de información el avance del conocimiento teórico sobre las estructuras reproductivas, y los métodos de micropropagación de las plantas pueden ser útiles para programas de conservación, además de beneficiar la introducción de poblaciones secundarias bajo condiciones naturales.

PARAGRAPH 8

The seed coat of the studied species consists of only 1 cell layer. In orchids, during seed development both layers of the inner integument and the inner layer of the outer integument degenerate; in the mature seed, the seed coat consists of only 1 layer originated from the outer layer of the outer integument (Barthlott, 1976; Sood & Rao, 1986). Although the seed coat ontogeny was not assessed, the single layer that compounds the seed coat of the Laeliinae species must have its origin from the external layer of the ovule outer integument, and the other layers (including the inner integument) must have been degenerated during the embryological process, as described for *Phalaenopsis amabilis* (L.) Blume (lee, Young, Lee, & Chung, 2008). **Most** likely, the reduced and membranous seed coat of Laeliinae seeds and the space between the tegument and the embryo is an adaptation related to the aerodynamic properties and to the wettability of seed, which occurs in orchids (Arditti & Ghani, 2000; Barthlott, 1976; Dahlgren, Clifford, & Yeo, 1985). Furthermore, Boesewinkel and Bouman (1984) named the orchid seeds as balloon seeds, due to the bladder-like air spaces found inside.

La capa de las semillas de las especies estudiadas consiste en una capa de sólo una célula. En las orquídeas, durante el desarrollo de las semillas, ambas capas del integumento interno y la capa interna del integumento externo se degeneraron en la semilla madura, la capa de la semilla consiste de una sola capa originada de la capa exterior del integumento externo (Barthlott, 1976; Sood y Rao, 1986). Aunque la capa ontogénica de la semilla no se había evaluado, la capa simple que compone la capa de la semilla de la especie Laeliinae debe tener su origen en la capa externa del integumento exterior ovular, y las otras capas, (incluyendo el integumento interior) deben haber sido degeneradas durante el proceso embriológico, como lo descrito para *Phalaenopsis amabilis* (L.) Blume (lee, Yeung, Lee, y Chung, 2008). Probablemente, la capa de la semilla reducida y membranosa de las semillas Laeliinae entre el tegumento y el embrión, es una adaptación relacionada con las propiedades aerodinámicas y a la humectabilidad de la semilla, que ocurre en las orquídeas (Arditti y Ghgani, 2000; Barthlott, 1976; Dahlgren, Clifford, y Yeo, 1985). Además, Boesewinkel y Bouman (1984) nombraron las semillas de las orquídeas como orquídeas balón, debido a los espacios aéreos en forma de vejiga hallados adentro.

PARAGRAPH 9

Embryos of the studied species are similar each other, and show the typical features previously described for orchids in general structure; only the suspensor may undergo some variation. Veyret (1974) recorded some groups of orchids with different suspensors according to species or type; this variation may occur even within the same genus. In the studied species, only *H. purpurata* showed a suspensor with 2-3 cell layers against the usual 2-layers suspensor observed on the rest of the species.

The budding on the protocorm that occurs in Laeliinae seedlings is a common phenomenon in Orchidaceae. Veytret (1974) considered that this phenomenon is able to end up on the formation of multiple seedlings, and are produced with variable frequency according to the species and the medium used for the multiplication.

Los embriones de las especies estudiadas son similares unos a otros, y muestran las características típicas descritas anteriormente para la estructura general de las orquídeas; solo el suspensor puede sufrir alguna variación. Veyret (1974) registró algunos grupos de orquídeas con diferentes suspensores de acuerdo con las especies o clase; esta variación puede ocurrir aun dentro del mismo género. En las especies estudiadas, solo *H. purpurata* mostró un suspensor con 2-3 capas de células contras los usuales suspensores de 2 capas observadas en el resto de las especies.

El brote en el protocorn que ocurre en las plántulas Laeliinae, es un fenómeno común en *Orchidaceae*. Veyret (1974) consideró que este fenómeno puede terminar en la formación de plántulas múltiples, y son producidas con una frecuencia variable de acuerdo con las especies y el medio usado para la multiplicación.

PARAGRAPH 10

According to Veyret (1974) 2 situations are presented in orchid's embryos; with or without cotyledons. *Cattleya* (Laeliinae) is an example of acotyledonous species (Carlson, 1943). However, the first foliaceous organ of orchid's seedling mayn ot be easy to define, for instance. Velenovsky (1907) has referred it as a cotyledon, whereas Carlson (1943) and Veyret (1974) considered **it** properly as a leaf. Batygina et al. (2003) discussed the term "Cotyledon" due to the fact that foliar organs of the majority of orchids appear during the post-seminal development, that is, at the protocorm stage; thus, **it** would be unsuitable to refer to them as cotyledons or leaf-like organs; the authors have concluded that they are t he shoot leaves proper, whereas the embryo itself has no cotyledons. Nevertheless, **it** is worthy to note that the structural analysis of Laeliinae seedling leaves, in this work, has showed significant differences, which are able to raise the debate concerning the first leaf of the orchid's seedling be considered or not a cotyledon.

De acuerdo con Veyret (1974), se presentan 2 situaciones en los embriones de las orquídeas: con o sin cotiledones. *Cattleya* (Leliinae) es un ejemplo de especies acotiledóneas (Carlson, 1943). Sin embargo, el primer órgano foliáceo de las plántulas de las orquídeas puede no ser fácil de definir. Venelovsky (1907) se refirió a ella como una cotiledónea, mientras que Carlson (1943) y Veyret (1974) lo consideraron propiamente como una hoja. Batygina et al. (2003) debatió el término "cotiledóneo" debido al hecho de que los órganos foliares de la mayoría de las orquídeas aparecen durante el desarrollo post-seminal, es decir, en la etapa protocorn; aunque no sería correcto referirse a ellos como cotiledóneos u órganos como hojas; los autores han concluido que son las propias hojas nuevas, mientras que el embrión en sí mismo no tiene cotiledóneas. Sin embargo, vale la pena anotar que el análisis estructural de las hojas de las plántulas Laeliinae, en este trabajo, ha mostrado diferencias significativas, las cuales pueden elevar la discusión concerniente a que la primera hoja de la plántula de la orquídea sea considerada o no una cotiledónea.

PARAGRAPH 11

Sampling was performed as reported by Cruz-García et al. (2013) and Sotelo-Casas, Cupul-Magaña, and Roríguez-Troncoso (2014) from March 2011 to February 2012 at one reef patch located at Larga Island. Briefly, in order to generate a substrate for holothurian recruitment, 144 dead *Pocillopora* fragments +- 5 cm lengths were used. To eliminate any organic matter, all fragments were submerged in 10% sodium hypochlorite (in filtered seawater) for 24 h; afterwards, the fragments were washed with freshwater for 8 h and dried in an oven (Precision Scientific) at 60°C for 24 h. Before placing fragments, 2 semi spherical concrete structures with 6 steel rods each were placed on a sandy bottom, located at +- 5 m depth next to the healthy *Pocillopora* coral colonies Initially, a total of 24 fragments were attached to both structures; every 2 months the fragments were removed and replaced by new **ones**. Upon collection, fragments were placed individually in plastic bags *in situ*, transported to the laboratory, and preserved at -20°C until **further** processing.

El muestreo fue realizado como lo informaron Cruz-García et al., (2013) y Sotelo-Casas, Cupul-Magaña, y Rodríguez Trocoso (2014) desde marzo del 2011 a febrero del 2013 en una mancha de arrecife localizada en Isla Larga. En resumen, con el propósito de generar un substrato para el reclutamiento de holoturoideos, se usaron 144 fragmentos muertos de *Pocillopora* de más o menos 5 cm de largo. Para eliminar cualquier materia orgánica, todos los fragmentos fueron sumergidos en 10% de hipoclorito de sodio (en agua salada filtrada) por 24 horas; luego los fragmentos fueron lavados con agua dulce por 8 horas secados en un horno (Precisión Científica) a 60°C por 24 horas. Antes de colocar los fragmentos, 2 estructuras de concreto semi esféricas con 6 varillas de acero fueron colocadas en un suelo arenoso, localizadas a más o menos 5 m de profundidad a la par de las colonias de coral *Pocillopora* saludables. Inicialmente, un total de 24 fragmentos fueron unidos a ambas estructuras; cada 2 meses los fragmentos fueron removidos y reemplazados por nuevos. Sobre la recolección, los fragmentos fueron colocados individualmente en bolsas plásticas in situ, llevados al laboratorio, y conservados a -20°C hasta el procesamiento.

PARAGRAPH 12

IMNP harbors a biodiverse and structure-rich coral community. The substrate coverage of this ecosystem is not only comprised of reef-building corals, but also of algae, rock, and sand; all such substrates could permit settlement by marine invertebrates (Birkeland, 1989; Cupul-Magaña et al. 2000; Chávez-Dagostino et al., 2000; Graham & Nash, 2013). Coral reef holothurians have the ability to colonize diverse microhabitats in the reef structure, such as crevices and holes, soft bottoms, empty shells, and burrows of other organisms (Bikerland, 1989; Glynn & Enoch, 2011), However, different species of holothurians demonstrate unique preferences for recruitment locations (Mercier, Battaglene, & Hamel, 2000; Williams & García-Sais, 2010), and the factors that promote the recruitment processes have not been previously studied at IMNP. Previus reports in the Mexican Pacific found that *P. chierchia* and *N, gibber* tend to recruit to calcareous substrates, such as rocks or dead coral (Alvarado & Solís-Marín, 2013; Deichmann, 1941, 1958; So9lís-Marín et al., 2009). As such, the study area provided widespread areas for recruitment of both species, the former of which had never been documented at IMNP.

El IMNP alberga una comunidad de coral rica en biodiversidad y estructura. La cobertura de substrato de este ecosistema no solo está compuesta de arrecifes de corales, sino también de algas, rocas y arena; todos estos substratos podrían permitir el asentamiento de invertebrados marinos (Birkeland, 1989; Cupul-Magaña et al., 2000; Chávez-Dagostino et al., 2000; Graham y Nash, 2013). Los holoturoideos del arrecife de corales tienen la habilidad de colonizar diversos micro-hábitats en la estructura del arrecife, tales como grietas y hoyos, suelos suaves, conchas vacías y madrigueras de otros organismos (Birkeland, 1989; Glynn y Enoch, 2011). Sin embargo, diferentes especies de holoturoideos demuestran una preferencia única por los lugares de reclutamiento (Mercier, Battaglene, y Hamel, 2000; Williams y García-Sais, 2010), y los factores que promueven los procesos de reclutamiento no han sido previamente estudiados en el IMNP. Informes previos en el Pacífico mexicano encontraron que *P. chierchia* y *N. gibber* tienden a reclutar los substratos calcáreos, tales como rocas o coral muerto (Alvarado y Solís-Marín, 2013; Deichmann, 1941, 1958; Solís-Marín et al., 2009). Como tal, el área de estudio proveyó áreas dispersas para el reclutamiento de ambas especies, lo anterior no ha sido nunca documentado en el IMNP.

PARAGRAPH 13

Annual temperature fluctuations regulate certain physiological activities of invertebrates, such as reproduction and recruitment, which are triggered and favored dring the warm periods (Cowen & Sponaugle, 2009; Somero, 2005). The timing of such eents is determine by the local oceanographic conditions (]Broitman et al., 2008; Pineda, Reyns, & Starczak, 2009; Roughgarden, Gaines, & Possingham, 1988). Some species are characterized by a single spawning period during summer, which is also driven by SST changes (Herrero-Perezrul et al., 1999). In the study area, the recruitment density of holothurians presented seasonal changes, with peaks during May-June, and low values for both species for the rest of the year. As the rate of recruitment depends on larval supply, the high densities of recruitment depend on larval supply, the high densities of recruitment observed in May-June may be due to a recent spawning event that occurred after the March-April sampling time; such an event may have been associated with the strong increase in SST between March-April and May-June.

Las fluctuaciones anuales de la temperatura regulan ciertas actividades fisiológicas de los invertebrados, tales como reproducción y reclutamiento, los cuales son desencadenados y favorecidos durante los períodos cálidos (Cowen y Sponaugle, 2009; Somero, 2005). El tiempo de tales eventos es determinado por las condiciones oceanográficas locales (Broitan et al., 2008; Pineda, Reyns, y Starczak, 2009; Roughgarden, Gaines, y Possingham, 1988). Algunas especies se caracterizan por un solo período de desove durante el verano, lo cual es también producido por los cambios SST (Herrero-Pérezrul et al., 1999). En el área de estudio, la densidad del reclutamiento de holoturoideos presentó cambios estacionales, con picos durante mayo-junio y valores bajos para ambas especies para el resto del año. Como la proporción de los reclutamientos depende del suministro de larvas, las altas densidades de reclutamientos observados en mayo-junio se pueden deber a un reciente evento de desove que ocurrió después del tiempo de muestreo de marzo-abril y mayo-junio; tal evento puede haber estado asociado con el fuerte aumento en SST entre marzo-abril y mayo-junio.

PARAGRAPH 14

Although both temperature and substrate type are important for recruitment in most invertebrates, oceanic currents, chemical signals, depth, and bottom complexity all play important roles (Abelson & Denny, 1997; Allani & Melloni, 1999; Broitman et al., 2008).

In addition, biotic factors, such as predation, substrate preference, and food supply and endogenous factors, such as larval development strategy, duration of the competent stage, and motility (Allani & Melloni, 1999; Hadfield, 1986; Pawlik, 1992; Poulin, Boletzky, & Féral; 2001), have important implications for recruitment and may have accounted for some of the patterns observed at IMNP. Here, **it** is important to consider that the holothurians in this study settled on coral skeletal structures, suggesting this as an adequate substrate for recruitment, independent of the micro-substrate growing on top. The affinity of the sea cucumbers to this substratum can be assumed as a positive response to the available refuge, positive chemical signals or structural complexity that may be beneficial for larval survival (Poulin et al., 2001).

Aunque ambas clases de temperatura y substrato son importantes para el reclutamiento en la mayoría de los invertebrados, las corrientes oceánicas, señales químicas, profundidad y complejidad del suelo, todos juegan papeles importantes (Abelson y Denny, 1997; Allani y Melloni, 1999; Broitman et al., 2008). Además, factores bióticos, tales como depredación, preferencia del substrato, y provisiones de alimentos y factores endógenos, como la estrategia para el desarrollo de las larvas, duración de la etapa de competencia, y la movilidad (Allani y Melloni, 1999; Hadfield, 1986; Pawlik, 1992; Poulin, Boletzky, y Féral, 2001), tienen implicaciones importantes para el reclutamiento y pueden ser responsable por algunos de los patrones observados en el IMNP. Aquí, es importante considerar que los holoturoideos en este estudio se asentaron en estructuras esqueléticas de coral, sugiriendo que este es un substrato adecuado para el reclutamiento, independientemente del micro-substrato que crece encima. La afinidad de los cohombros con este substrato puede asumirse como una respuesta positiva al refugio disponible, señales químicas positivas o complejidad estructural que puede ser beneficiosa para la supervivencia de las larvas (Poulin et al., 2001).

PARAGRAPH 15

Legs: irregularly pigmented, including femur, patella and tibiae. Legs I and II darker on distal area of patella near the articulation with tibiae and diffusely pigmented to immaculate on the rest. Femur, patella and tibiae of legs III-IV darker and becoming weaker on metatarsus. Mesosoma: dorsally with 2 longitudinal blackish stripes, separated by a slightly wider pale stripe. Each dark stripe is composed of a well-defined, large and concave spot over the postergite, which gradually becomes diffuse as a transversely oriented reticulate pattern through the pretergite, where **it** then fuses into another smaller, convex spot located just on the edge of tergites I-VI; the dark stripes gradually become diffuse also through tercite VII. Median longitudinal arena pigmented on all tergites. The blotches of the mesosomal dark bands consist of large spots in the postergite, concave towards the pretergite, which has a smaller convex spot. Both spots are interconnected with reticulated pigmentation. On pretergites II-III, every blackish spot looks like a horizontal stripe slightly inclined to the center of the tergite and becomes somewhat crescent-shaped on postergite VII.

Las patas: pigmentadas irregularmente, incluyendo el fémur, la rótula y la tibia. Las patas I y II son más oscuras en el área distal de la rótula cerca de la articulación con la tibia y difusamente pigmentada a inmaculada en el resto. El fémur, la rótula y la tibia de las patas III-IV son más oscuras y haciéndose más débiles en el metatarso. Mesosoma: dorsalmente con 2 rayas negruzcas longitudinalmente, separadas por una raya pálida ligeramente más ancha. Cada raya oscura está compuesta de una mancha cóncava y grande bien definida sobre la postergita, la cual gradualmente se hace difusa como un patrón reticulado orientada transversalmente a través de la pretergita, donde luego se fusiona con otra mancha más pequeña, mancha convexa localizada justo en el borde de la tergita VII. La carena pigmentada longitudinal mediana en todas las tergitas. Las manchas de las bandas oscuras mesosomales consisten de manchas grandes en la postergita, cóncavas hacia la pretergita, la cual tiene una mancha convexa más pequeña. Ambas manchas están interconectadas con pigmentación reticulada. En las pretergitas II-III, cada mancha negruzca se ve como una raya horizontal ligeramente inclinada hacia el centro de la tergita y se hace de alguna manera, en forma creciente en la postergita.

From Spanish into English

PARAGRAPH 1

Los manantiales geotermales son aquellos cuya temperatura del agua se incrementa como consecuencia de la actividad geológica de la zona. Son ecosistemas peculiares en los que el factor limitante para la vida es **la** temperatura (Pantoja-Alor y Gómez-Caballero, 2000, 2004). Otras características como el pH o **la** salinidad pueden asociarse con esta para presentar situaciones aún más extremas. En manantiales geotermales con pH neutro y con salinidades moderadas podemos encontrar una amplia gama de manifestaciones de vida en un amplio intervalo de temperaturas. **Los** ambientes con temperaturas muy altas son escasos en la superficie de la Tierra y el gradiente térmico en todos ellos es muy amplio, de modo que la temperatura, a partir del punto donde emana el agua, decae rápidamente, por lo que los espacios colonizables con alta temperatura son reducidos (Margalef, 1983).

The geothermal springs are those whose water temperature is increased due to the geological activity of the area. They are peculiar ecosystems in which the main restricting factor for life is temperature (Pantoja-Alor and Gómez-Caballero, 2000, 2004). Other characteristics as the pH or salinity may be associated with it to the present even more extreme situations. In geothermic springs with a neutral pH and moderated salinities we can find a wide range of life manifestations in a wide interval of temperatures. Environments with really high temperatures are scarce on the Earth's surface, and the thermal slope in all of them is very wide, so that the temperature, from the point where water emanates, rapidly decreases; therefore, the colonized spaces with high temperatures are reduced (Margalef, 1983)

PARAGRAPH 2

En México existe un elevado número de zonas geotérmicas que están relacionadas con una gran actividad volcánica (Ferrusquía-Villafranca, 1998). Algunos de estos manantiales han sido estudiados por la importancia de los procesos geotérmicos y su posibilidad de empleo en la generación de electricidad. Sin embargo, el conocimiento de la biota que habita en estos ambientes es escaso. Específicamente de Michoacán, se han llevado a cabo estudios geotérmicos y geoquímicos, en varias regiones, dentro de las cuales se encuentra el manantial Los Hervideros, **localidad** del presente estudio. Este manantial, cuando emerge a la superficie, forma una corriente que presenta un gradiente de temperatura muy marcado que **se** forma por la presencia de 2 sistemas acuáticos diferentes y que confluyen sus aguas. De uno de ellos emana agua, aproximadamente a 20°C, y el otro es propiamente termal **en donde** el agua brota a más de 90°C (Tovar-Aguado y García-Estrada, 1991). Debido a las características ambientales **propias** del manantial Los Hervideros, en este trabajo se presenta un análisis de la diversidad taxonómica de las algas, tomando en cuenta el gradiente de temperatura, que nos permitió identificar y establecer intervalos de tolerancia a la temperatura para las especies observadas.

There is a high number of geothermic zones in Mexico that are related to a great volcanic activity (Ferrusquía-Villafranca, 1998). Some of these springs have been studied due to the importance of the geothermic processes and the possibility of using them in the generation of electricity. However, the knowledge regarding the biota that inhabits in these environments is scarce. Specifically, in Michoacán, geothermic and geochemical studies have been conducted in some regions, among them the spring of Los Hervideros, which is the one under study. This spring, when emerges to the surface, forms a current that presents a very pronounced gradient of temperature that is formed by the presence of two different aquatic systems and that converge their waters. From one of them, it emanates cold water, approximately 20°C, and the other is mainly thermal, as the water comes up above the 90°C (Tovar-Aguado and García- Estrada, 1991). Due to the environmental characteristics of the Los Hervideros spring, this work carries out an analysis of the taxonomic diversity of the algae, taking into account the gradient of temperature, that allowed us to identify and established an interval of tolerance to the temperature for the studied species.

PARAGRAPH 3

El género *Sybechococcus* incluye especies con una amplia variedad de formas y requerimiento ecológicos, por lo que seguramente es heterogéneo. Por una parte, incluye formas con adaptaciones a la vida a altas temperaturas y, por otra, formas que habitan otros tipos de ambientes especializados, como el planctónico marino. Copeland (1936) describió varias especies y variedades de Yellowstone, que incluyen *Synechococcus lividus* y sus variedades, *Synechococcus vulcanus* y sus variedades, así como *Synechococcs elongatus* y sus variedades (*S. elongatus* var. *Amphigranulatus* es sinónimo de *S, bigrabylatus*). La delimitación de especies es problemática, pues está basada en **el** tamaño, forma, curvatura y presencia de gránulos y su posición. Varias de estas característica son muy variables y dependen de las condiciones ambientales. Recientemente fue propuesto por Katoh, Itoh, Shen e Ikuhi (2001) en género *Thermosynechococcus* con 2 especies, *Thermosynehococcus elongatus* y *Thermonesychococcus vulcanus*, tradicionalmente ubicadas en el género *Synecococcus*. Sin embargo, este género no se reconoce como un taxón válido, pues su diagnóstico no ha sido publicado.

The *Synechococcus* gender includes species with a wide variety of forms and ecological requirement; therefore, it is surely heterogeneous. On one hand, it includes forms with life adaptations to high temperatures, and on the other hand, forms that live in other specialized environments, such as the marine planktonic. Copeland (1936) described several species and varieties of Yellowstone, that include *Synechococcus lividus* and its varieties, *Synechococcus vulcanus* and its varieties, and *Synechococus elongatus* and its varieties. (*S. elongatus* var. *amphigranulatus* is a synonym of *S. bigranulatus*). The species delimitation is problematic, because it is based on size, form, curvature, and the presence of granules and its position. Several of these characteristics are very variable and depend on the environment conditions. Recently, Katoh, Itoh, Shen, and Ikeuchi (2001) proposed the gender *Thermosynechococcus* with two species, *Therosynechococcus elongatus* and *Therosynechococcus vulcanus*, traditionally located in the *Synechococcus* gender. However, this gender is not recognized as a valid taxon, due to its diagnostic has not been published.

PARAGRAPH 4

Los ejemplares pequeños de esta especie presentan frústulos de forma romboidal; los miembros **más** grandes presentan formas capitadas y los de tamaño intermedio se encuentran entre estas formas de frústulos. Presentan frústulos lanceolados, que tienen una longitud de 11 a 20 µM y 5 a 7 µM de ancho; el número de estrías en 10 µM va de 16 a 25 y so un poco radiadas. Las estrías se interrumpen en la parte central, donde queda un rectángulo vacío y solo se puede apreciar un estigma ubicado en la posición centrolateral.

Comentario taxonómicos y ecológicos

Anteriormente fue conocida como *N mutica* Kützing, hoy día este es un sinónimo; se ha observado en ambientes húmedos, subaéreos, entre musgos y salobres, y en pH alrededor de 7. Es una especie de ambientes continentales y cosmopolita. Se presentaron diferentes tipos de crecimientos algales, siendo los más conspicuos los tapetes microbianos con diferentes coloraciones.

The small samples of this species present rhomboid shaped frustules; the bigger members present capitated forms, and the ones or an intermediate size are among these forms of frustules. They present lanceolate frustules that have from 11 to 20 µM in length and 5 to 7 µM in wide. The number of striae in 10 µM goes from 16 to 25 and they are little radiated. The striae are interrupted in the central part, where there is an empty rectangle and it can only be appreciated a stigma located in a centered-side position.

Ecological and Taxonomic Remarks

Previously, it was known as *N. mutica* Kützing but today it is a synonym. It has been observed in humid and sub-aerial environments, among moss and salty, and in pH about 7. It is a species of continental and cosmopolitan environments. Different types of algae growings were presented, being the most conspicuous the microbial wall with different colorations.

PARAGRAPH 5

Las diatomeas **se** registraron en temperaturas de hasta 47°C, por lo que podemos considerar que el límite máximo para el grupo es cercano a esta cifra. Brock (1978) considera, basándose en estudios de cultivo, que el límite máximo para est grupo es de 42-

44°C, y **que** para algunas especies como *A. exiguum* como *Achnanthes exiguum*), la temperatura óptima de crecimiento es de 40°C. En el caso de las cianofitas **se** observó que varias especies **se** mostraron en intervalos definidos. *Arthrospira* sp. fue abundante e incluso dominante en los tapetes microbianos con temperatura entre los 54 y los 61°C, reduciéndose de manera considerable por arriba de los 61°C. *M laminosus* se presentó en temperaturas cercanas a los 50°C (47.5°C), que corresponde con registros previos de tolerancia a la temperatura de entre 45 y 62°C (Brock, 1978; Komárek, 2013). Esta especie tiene una distribución cosmopolita, pero siempre creciendo en condiciones ecológicas restringidas. Por arriba de los 73°C y hasta los 76°C **se** reconocieron tapetes microbianos dominados por *S. bigranulatus, Synechocystis* sp*, Leptolyngbya* sp*. y P. thermalis,* representando el límite superior de la fotosíntesis oxigénica en el área de estudio.

The diatoms were registered in temperatures up to 47°C, that is why we can consider that the highest limit for the group is close to this figure. Brock (1978) considers, based on growing studies, that the highest limit for this group is of 42-44°C, and that for some species like *A. exiguum* (like *Achnanathes exigum*), the optimum temperature of growing is 40°C. In the case of cyanophytes, it was observed that several species were found in defined intervals. *Arthrospira* sp. was abundant and even dominant in the microbial walls with temperatures between the 54 and 61°C, and reduced the number in a considerable way above the 61°C. *Laminosus* was present in temperatures close the 50°C (47.5°C), that corresponds to previous data about the tolerance to the temperature between 45 and 62°C (Brock, 1978; Komárek, 2013). This species has a cosmopolitan distribution, but it always grows in restricted ecological conditions. Above the 73°C and up to 76°C, there were recognized microbial walls dominated by *S. bigranulatus*, *Synechocystis* sp., *Letolyngbya* sp *and P. thermalis*, representing the superior limit of the oxygenic photosynthesis in the area under study.

PARAGRAPH 6

Varias especies de los géneros *Synechococcus*, *Synechocystis*, *Leptolyngbya* y *Pseudoanabaena* han sido descritas como características de ambientes termales y son consideradas los organismos oxifotótrofos que toleran las temperaturas más elevadas. En particular, *S. lividus* es considerada la cianofita con mayor tolerancia y puede representar el límite máximo en el que se desarrolla la fotosíntesis oxigénica, que es alrededor de los 74°C (Mees y Castenholz, 1971). Algunos autores han documentado la presencia de cianofitas en temperaturas **más** elevadas (Mann y Schlichting, 1967; Sompong, Hawkins, Besley y Peerapornpisal, 2005), aunque Brock (1978) considera que los registros de presencia en temperaturas mayores pueden deberse a posibles errores en la medición, a un registro de otra bacteria no fotosintética o a la ausencia de una evaluación de las condiciones fisiológicas.

Several species of the gender *Synechococcus*, *Synechocystis*, *Leptolyngbya*, and *Pseudoanabaena*, have been described as characteristic of thermal environments and are considered the oxyphototrophs organisms that tolerate the highest temperatures. Mainly, the *S. lividus* is considered the cyanophytes with the highest tolerance and can represent the maximum limit in which the oxygenic photosynthesis is developed, that is around the 74°C (Meeks and Castenholz, 1971). Some authors have documented the presence of cyanophytes in higher temperatures (Mann and Schliting, 1967; Sompong, Hawkins, Besley and Peerapornpisal, 2005); however, Brock (1978) considers that the presence records in higher temperatures can be due to possible errors in measurement, to the record of another non photosynthetic bacteria, or to the absence of an evaluation of the physiological conditions

PARAGRAPH 7

En el caso **de** este estudio, **las** temperaturas fueron medidas puntualmente en donde se presentó el crecimiento. La integridad física de las células se verificó por la observación al microscopio de la forma, coloración y movimiento, registrando tapetes microbianos dominados por cianofitas en temperaturas **de** 76°C. Es posible que en la naturaleza se desarrollen tapetes microbianos dominados por cianofitas en temperaturas mayores a las previamente establecidas, **lo cual** *probablemente* **se** relaciona con la habilidad fisiológica y acomodo de las especies en los tapetes microbianos.

Como casos particulares, **se** encontraron especies que consideramos como raras, **ya que** no se registraron más de 5 ejemplares en las preparaciones analizadas, como es el caso de *Anomoeoneis costata* (2 ejemplares); *Valoneis silicula* (fig. 3I; un ejemplar); *Epithemia turgida* (fig 3J; 5 ejemplares); *Pinnularia* sp. (fig. 3K; 2 ejemplares); *Nitzschia* aff. *clausii* (fig. 3G; 3 ejemplares) y *Cocconei placentula* (fig. 4ª; 5 ejemplares). **A pesar del** numero reducido de ejemplares, pudieron ser determinados a nivel de género y especie.

Regarding this study, temperatures were specifically measured were the growth was present. The physical integrity of the cells was verified trough observation in the microscope of the form, coloring, and movement, recording the microbial walls dominated by cyanophytes in temperatures up to 76°C. It is possible that in nature microbial walls dominated by cyanophytes in higher temperatures to the ones previously stablished are developed, which probably is related to the physiological ability and arrangement of the species in the microbial walls.

As in particular cases, there were found species that we consider as rare, since there were not registered more than 5 samples in the analyzed preparations such is the case of *Anomeoneis costata* (2samples)*; Caloneis silicula*, (one sample)*; Epithemia rugida* (five samples)*; Pinnularia sp.* (2 samples)*; Nitzschia* aff. *Clausii* (3 samples) *and Cocconeis* *placentula* (5 samples). Despite the reduced number of samples, they could be determined regarding species and gender level.

PARAGRAPH 8

Las especies del género *Agaricus* L, son actualmente muy apreciadas, no solo por sus propiedades nutricionales, sino también por sus cualidades organolépticas y medicinales. El hongo conocido popularmente en México como champiñón, *Agaricus bisporus* (J.E. Lange) Imbach, es la especie más célebre del género y también la **de** mayor producción en el mundo entre las especies cultivadas (Arrillaga, 2004). Su producción mundial se estimó en más de 4 millones de toneladas en el año 2009 (Sonnenberg et al., 2011). *Agaricus bisporus* se diferencia de todas las especies del género por presentar 2 esterigmas en la mayoría de los basidios (Parra,, 2008), aunque con frecuencia se pueden observar basidios mono, tri e incluso tetraspóricos (Calla, Imbernon, Guinberteau, Desmerger y Theochari, 2003). A pesar de este **carácter** morfológico -2 espora por basidio- que hace inconfundible a la especie, existen 2 variedades silvestres, además de *A. bisporus* var. *Bisporus*, que han mostrado ser principalmente tetraspóricas: *A. bisporus* var. *burnettii* Kerrigan y Callac con distribución en América del Norte y *A. bisporus* var. *eurotetrasporus* Callac y Guinb preente en Europa (Calla, Billete, Imbernon y Kerrigan, 1993; Callac et al., 2003),

Nowadays, the species of the *Agaricus* L. gender very appreciated, not only for its nutritional properties but also for its organoleptic and medicine qualities. The fungus popularly known in Mexico as wild white button mushroom, *Agaricus bisporus* (J.E. Lange) Imbach, is the most famous of the gender and also the most produced worldwide among the cultivated species (Arrillaga, 2004). Its worldwide production was estimated in over 4 million tons a year 2009 (Sonnenberg et al., 2011). *Agaricus bisporus* differs from all the other species of the gender, as it presents two sterigmas in most of its basidia (Parra, 2008); even though, frequently it can be observed mono basidia, tri and also tetrasporic (Calla, Imbernon, Guinberteau, Desmerger and Theochari, 2003). Despite this morphology -2spores per basidia-, it makes the species unmistakable, there are two wild varieties, besides the *A. bisporus* var. *bisporus* that have shown to be mainly tetrasporic: *A. bisporus* var. *burnettii* Kerrigan and Callac with distribution in North America and *A. bisporus* var. *eurotetrasporus* Callac and Guinb in Europe (Calla, Billete, Imbernon and Kerrigan, 1993; Callac et al., 2003).

PARAGRAPH 9

Guzmán (1977) citó *A. bisporus* var. *albidus y A. bisporus* var. *bisporus* cultivados comercialmente sin precisar la localidad. Por otra parte, Martínez-Carrera et al., (2001) citaron la especie en Tlaxcala, en el volcán La Malinche; sin embargo, dichos autores no mencionaron en qué herbario fue depositado el material estudiado y aislado, por lo que no se tiene un registro certero. Los objetivos del presente trabajo fueron: demostrar la presencia de esta especie de manera silvestre en México, corroborar la determinación de los materiales a través de la producción de basidiomas obtenidos a partir de las cepas aisladas por medio de análisis filogenéticos, así como describir sus características morfológicas de valor taxonómico bajo condiciones experimentales de cultivo en compost utilizado para **la** producción comercial.

Guzmán (1977) cited that *A. bisporus* var *albidus* and *A. bisporus* var *bisporus* are commercially cultivated without specifying their location. On the other hand, Martínez-Carrera et al., (2001) cited the species in Tlaxcala, in La Malinche volcano; however, such authors did no mention in what herbarium it was deposited the studied and isolated material; therefore, there is not an accurate record. The objectives of this work were to demonstrate the presence of this species in a wild manner in Mexico, verify the determination of the materials through the production of basidia obtained from isolated strain and by means of phylogenetic analysis, as well a to describe its morphological characteristics of taxonomic value under experimental cultivation compost-based-conditions used for commercial production.

PARAGRAPH 10

Para la obtención de esporomas se preparó inóculo de 4 cepas de acuerdo con la metodología de Mata y Savoie (2007), utilizando semillas de sorgo (*Sorghum vulgare* Pers.). Se prepararon muestras de 4 kg de compost comercial, a las que se les agregó un 5% **de** inoculo, se mezcló uniformemente y se colocaron en bolsas de plástico. Después de 14 días de incubación a 25°C, se añadió una capa de 5 cm de tierra de cobertura para inducir la aparición de **los** esporomas, y las bolsas se colocaron en un cuarto a 18°C con humedad relativa de 90% y un fotoperíodo de 12/12 (Mata, Calderón-Fuentes y Savoie, 2012). Los ejemplares se cosecharon en diferentes estadios de desarrollo.

Todos los ejemplares estudiados, incluyendo los **ejemplares** provenientes de cultivo, están depositados en la colección mitológica del Herbario XAL del Instituto de Ecología, A.C. En los ejemplares de las cepas cultivadas se determinó el porcentaje de basidios bispóricos en relación con los mono, tri y tetraspóricos, con un fragmento de una lámina madura colocado en un portaobjetos para su observación directa en el microscopio compuesto.

In order to obtain the spores a 4 layer inoculum was prepared, according to the methodology of Mata and Savoie (2007), using sorghum seeds (*Sorghum vulgare* Pers.). Samples of commercial compost of 4 kg were prepared. They were added a 5% inoculum, which was mixed uniformly and were placed in plastic bags. After 14 days of incubation at

25°C, a layer of 5 cm of covering soil was added to induce the appearance of spores, and the bags were placed in an 18°C room with a relative humidity of 90% and a photo-period of 12/12 (Mata, Calderón-Fuentes and Savoie, 2012). The samplings were harvested in different development states.

All the studied samplings, including the ones from the crop, are deposited in the mycological collection of the XAL Herbal of the Instituto de Ecología, A.C. In the samplings of the strains cultivated the percentage of the bisporic basidia was determined in relation to the mono, tri and tetrasporics, with a fragment of a mature sheet placed on an object holder for its direct observation under a microscope.

PARAGRAPH 11

Se construyó una matriz de secuencias con especies de *Agaricus* sección Bivelares utilizadas en estudios filogenéticos previos (Challen, Kerrigan y Callac, 2003; Geml, Geiser y Royse, 2004) y también se incluyeron aquellas secuencias **de** GenBank que resultaron similares a la secuencia de la región ITS de la cepa IE623 mediante una búsqueda en Blast. Las secuenias fueron alineadas en Muscle (Edgar, 2004) y la matriz de datos se analizó mediante los métodos Neighbor-Joining, máxima verosimilitud e inferencia bayesiana en Geneious Pro (Bio-matters). *Agaricus bitorquis* se usó como grupo externo (Geml et al., 2004). Los árboles de Neighbor-Joining fueron construidos con el modelo de distancia genética Tamura-Nei remuestreando con bootstrap a través de 1,000 réplicas. Para los análisis de máxima verosimilitud se utilizó el programa PhyML (Guindon et al., 2010) buscando la topología de los árboles con SPRs y HKY85 como modelo de sustitución; se utilizó Bootstrap con 1,000 réplicas para probar el soporte de las ramas.

A matrix of sequences was built with species of *Agaricus*, section Bivelares used in previous phylogenetic studies (Challen, Kerrigan, and Callac, 2003); Geml, Geiser, and

Royse, 2004) and they were also included those sequences of GenBank that turned out to be similar to the sequence of the ITS region of the IE623 strain through a search in Blast. The sequences were aligned in Muscle (Edgar, 2004) and the data matrix was analyzed through Neighbor-Joining methods, maximum verisimilitude and Bayesian inference in Geneious Pro R7 (Biomatters). *Agaricus bitorquis* was used as external group (Geml et al., 2004). The trees of Neighbor-Joining were built with the model of genetic distance Tamura-Nei resampling with bootstrap through the 1,000 replica. For the analysis of maximum verisimilitude it was used the PhyML (Guindon et al., 2010) program to look for the topology of the trees with SPRs and HKY85 as a model of substitution; bootstrap with 1,000 replica was used to test the support of the branches.

PARAGRAPH 12

Pileo de 50-90 mm de diámetro, globoso en etapas juveniles, convexo a plano-convexo y finalmente plano, blanquecino en etapas juveniles, beige, ocráceo a finalmente de color café claro, con el centro café oscuro, con fibrillas separadas hacia el margen de color café. Láminas libres, muy juntas, anchas, con lamélulas intercaladas, blanquecinas cuando son jóvenes, que cambian a color rosado y finalmente a café oscuro, casi negras, con tonos vináceos al madurar; arista blanquecina y ligeramente fimbriada. Contexto grueso, blanquecino que **se** mancha de **color** rojizo-vináceo al maltrato. Estípite de 50-55 x 12-17 mm de cilíndrico a claviforme, a veces ligeramente bulboso en la base, hueco, liso, blanquecino, la parte interna se mancha de color rojizo-vináceo al maltrato, con frecuencia presenta cordones miceliales, los cuales pueden tener aspecto de rizomorfos cortos.

Pileus of 50-90 mm of diameter, globose in youthful ages, convex to flat-convex, and finally flat, whitish in youthful stages, beige, ochraceous to finally of light brown color, with the center dark brown, with little threads separated towards the margin of brown color.

Very close, wide free sheets with lamelulas intercalated, whitish when they are young that change to pink color and finally to dark brown, almost black, with vinous tones when they mature; whitish edge and lightly fimbriated. Thick context, whitish that stains of red-vinous when mistreated. Stipe of 50-55 x 2-117 mm from cylindric to claviform, sometimes slightly bulbous at the base, hollow, smooth, whitish, the inner part stains of red-vinous color when mistreated, often presents mycelial cords, which can have the aspect of short rhizophorms.

PARAGRAPH 13

Se obtuvieron 4 secuencias de AND en ambos sentidos de la cepa IE 623 de diferentes resiembras y medios de cultivo con entre 620 y 710 pares de bases. Entre ellas existió una similitud nucleotídica de 99.99% y su secuencia consenso de 712 pares de bases quedó registrada en GenBank bajo el número de acceso KM677957. Todos los análisis dieron resultados similares y se recuperó para *Agaricus* sección *Bivelares*, una estructura similar a la registrada por Challen et al. (2003). En todos los casos, el clado de *A. bisporus* tuvo un soporte alto -bootstrap de Neighbor Joining 99.4%, Bootstrap de máxima verosimilitud 94.6%, probabilidades posteriores bayesianas- . En los 3 análisis la cepa IE 623 se ubicó dentro del clado de *A. bisporus*. **La** figura 3 muestra los resultados del análisis de máxima verosimilitud. Si bien dentro de *A. bisporus* hay poca estructura y los clados que se forman tienen poco soporte, la secuencia de la cepa IE 623 tiene una similitud genética mayor a cepas silvestres que a variedades cultivadas.

There were obtained four sequences of DNA in both ways of the strain IE 623 from different reseeding and culture mediums with among 620 to 710 pairs of bases. Among them it existed a nucleotide similarity of 99.99% and its consensus sequence of 712 pairs of bases was registered in GenBank under the access number KM6777957. All the analysis brought similar results and a similar structure of the one registered by Challen et al. (2003) was recovered for *Agaricus* section *Bivelares*. In all the cases, the *A. bisporus* clado had a higher support -bootstrap of Neighbor-Joining 99.4%, bootstrap of maximum verisimilitude 94.6%, Bayesian subsequent probabilities 1-. In the three analysis, the strain IE 623 was placed inside the *A. bisporus* clado. Figure 3 shows the results of the analysis of maximum verisimilitude. Though inside of *A. bisporus* there is few structure and the clados that are formed have little support, the sequence of the IE 623 strain has a greater genetic similarity for wild strains than for culture varieties.

PARAGRAPH 14

La proporción de basidios bispóricos y tetraspóricos se ha documentado en otros trabajos para *A. bisporus* var. *bisporus;* Martínez-Carrera et al., (2001) registraron 67.5% de basidios bispóricos y 27.5% de tetraspóricos, mientras **que** Callac et al. (2003) encontraron 80% y 1.27% de bi y tetraspóricos, respectivamente. Si bien la mayoría de las cepas han mostrado altos porcentajes de basidios bispóricos, en algunos casos este porcentaje ha variado de 17% a 55% en cepas silvestres (Callac et al, 1993, 2003). De acuerdo con los resultados obtenidos por Kerrigan, Billete, Callac y Velcko (1996) y Callact et al. (2003) tanto *A. bisporus* var. *burnettii* Kerrigan y Callac como la var. *eurotetrasporus* Callac y Ginb. Poseen un porcentaje alto de basidios tetraspópricos, no así la var. *bisporus*, que presenta más bispóricos que tetraspóricos. En este trabajo se obtuvieron resultados similares a los registrados por Kerrigan et al. (1996) y Callac et al. (2003), aunque con menor porcentaje de basidios tetraspóricos.

The proportion of bisporic and tetrasporic basidios has been documented in other works for *A. bisporus var. bisporus*; Martínes-Carrera et al. (201) registered 67.5% of bisporic basidios and 27.5% of tetrasporic, while Callac et al. (2003) found 80% and 1.27%

of bi and tetrasporic, respectively. Although, most of the strains have shown high percentages of bisporic basidios, in some cases the percentage has changed from 17% to 55% in wild strains (Callac et al., 1993, 2003). According to the results obtained by Kerrigan, Billete, Callac, and Velcko (1996) and Callac et al. (2003), both *A. bisporus* var. *burnettii* Kerrigan and Callac and the var. *eurotetrasporus* Callac and Ginb. have a high percentage of tetrasporic basidios, however the var. *bisporus* does not, as it that presents more bisporic than tetrasporics. In this work, similar results to the one registered by Kerrigan et al. (1996) and Callac et al. (2003) were obtained, even though, with a lower percentage of tetrasporic basidios.

PARAGRAPH 15

En lo referente a la presencia del género *Nopachtus* fuera de Argentina, Toriño y Rinderknecht (2005) describen sucintamente un osteodermo de coraza dorsal, recolectado en las costas del balneario Kiyú, departamento de San José, Uruguay (fig. 1), **al que** identifican como perteneciente a un "*Panochthini*," señalando que posee características que **lo** asemejan a *Nopachtus* y a *Panochthus intermedius* Lydekker. Posteriormente, Toriño y Perea (2008), en el marco de una lista comentada de gliptodóntido del Terciario de Uruguay, retoman esta consideración, indicando la existencia de más de un osteodermo, y acotando la presunta similitud de los mismos al primero de los géneros mencionados, aunque sin brindar mayor información. En la presente contribución se realiza un estudio detallado de los referidos materiales recolectados en Uruguay, dándose a conocer por primera vez para el país la presencia de osteodermos asignables al género *Nopachtus.*

Regarding the presence of the *Nopachtus* genus out of Argentina, Toriño and Rinderknecht (2005) describe succinctly an osteoderm of dorsal carapace, collected in the shores of the Kiyú spa, department of San José, Uruguay, identified as belonging to a

"Panochthini," pointing out that has characteristics that resemble a *Nopachthus* and a *Panochthus intermedius* Lydekker. Later, Toriño and Perea (2008), **within** a commented list of glyptodontids of the Tertiary of Uruguay, resume this consideration, indicating the existence of more than one osteorderm, and delimiting the presumed similarity of the same to the first of the mentioned genus, although without giving further information. In the present contribution, a detailed study is made of the referred collected materials in Uruguay, getting to know, for the first time, for the country the presence of assigned osteoderms to the *Nopachtus* genus.

5.3 Glossaries

5.3.1 Glosario Inglés - Español

SOURCE LANGUAGE	TARGET LANGUAGE	GRAMMAR CATEGORY	SHORT DEFINITION
Acetabulum	Acetábulo	Noun	Cavidad donde encaja un hueso
Algal turf	Césped de algas	Noun phrase	Hierba menuda donde crecen algas
Aliquots	Alícuotas	Noun	La alícuota es una parte que se toma de un volumen o una masa iniciales, para ser usada en una prueba de laboratorio.
Ápex	Ápice	Noun	Extremo superior o punta de alguna cosa
Budding	Brote	Noun	Botón de una planta
Buffer	Amortiguador	Noun	Que amortigua
Bulky	Abultado	Adjective	Grueso, grande, de mucho bulto
Crevices	Grietas	Noun	Hendeduras
Cycler	Secuencial	Adjejctive	Relativo a la secuencia
Cheesecloth	Estopa	Noun	Tela gruesa que se fabrica con la hilaza
Digenean	Digénos	Noun	Que pertenece o concierne a ambos sexos
Gap	Brecha	Noun	Abertura o rotura irregular en una superficie
Helminths	Helmintos	Noun	Nombre de los parásitos intestinales
Holdfast	Apéndice	Noun	Parte del cuerpo de los animales
Mangrove	Manglar	Noun	Sitio poblado de mangles
Mean	Porcentaje	Noun	Proporción

Monocots	Monocotiledón eos	Noun	Que tienen un solo cotiledón
Notch	Muesca	Noun	Hueco hecho en una cosa para encajar
Phyla	Fila	Adjective	Hierbas perennes
Robustness	Robustez	Adjective	Fuerza
Settlement	Asentamiento	Noun	Lugar donde se establece algo o alguien
Sheath	Vaina	Noun	Funda de ciertas cosas, cáscara tierna de las leguminosas
Spawning	Desove	Noun	Acción de desovar los animales
Steel rods	Varillas de acero	Noun phrase	Vara larga y delgada hecha de acero
Velamen	Vello	Noun	Pelo corto y suave que nace en algunas partes

5.3.2 Spanish-English Glossary

Source Language	Target Language	Grammatical Category	Short Definition
Anélidos	Annelids	Noun	External layer of the invertebrate's body that segregates the cuticular exo-squeleton
Atribuyen	Attribute	Verb	To concede characteristics
Barracas	Gully	Noun	A place built with wood
Basidios	Basidium	Adjective	Stem cells of the spores of certain fungus
Bispóricos	Bisporic	Adjective	Two spores
Bonaerense	From Buenos Aires	Adjective	A person from Buenos Aires, Argentina
Coraza	Breastplate	Noun	Envelop that protects the body of certain animals
Cuencas	Basin	Noun	Territory whose waters flow into a same river, lake or sea.
Cuarto menguante	Fourth waning	Noun phrase	Moon phase
Dasipodidos	Dasypodidae	Adjective	Mammal family of the order of the Cingulata
Escamas	Flakes	Noun	Membrane that covers the skin of certain animals
Estratigráfica	Stratigraphics	Adjective	Overlaped layers
Faunística	Related to the Fauna	Adjective	Set of animals from a determined area
Forámenes	Formina	Noun	It is a hole that permits way between two anatomic structures

Germoplasma	Germplasm	Adjective	Conjunto de genes que se transmite en la reproducción a la descendencia por medio de gametos o células reproductoras
Gliptodonte	Gliptodontus	Noun	Prehistoric mammal of big size
Homocarion	Homokaryon	Noun	Cells with two or more identic nucleus as a result of fusion
Herbarios	Herbal	Noun	Collection of dry plants that are used as a matrial for the study of Botanic
Heteroalelismo	Heteroallelism	Adjective	That have diferent alleles
Heterocarionte	Heterocarion	Noun	It is a multi-nucleus cell that contains nucleus genetically different
Lamélula	Laminated	Noun	Short sheet that does not get to the foot, it is intercalated between the sheets
Monofilia	Monophyllous	Adjective	That has only one leaf
Nucleotídico	Nucleotide	Adjective	It is part of the DNA code
Ornamentación	Ornamentation	Noun	Action and effect to ornamentate
Osteordermos	Osteorderms	Noun	Bony plate that animals in their skin or flakes
Pendiente	Slope	Noun	Inclination
Queilocistidios	Chelocistide	Noun	Scientific name for the turtle’s family
Resaca	Bakwash	Noun	Movement of the sea waves when withdraw from shore
Sedimentívoros	Sedimentivores	Noun	They feed from sediment
Sedimentos	Sediment	Noun	Matter that precipitates to the bottom of a liquid

CHAPTER VI

Conclusions and Recommendations

To conclude this work, valuable information was obtained through the evaluation and analysis, of the instruments used such as text analysis, color coding, and glossaries in both languages (English and Spanish). The conclusions and recommendations given by the translator contain meaningful information which can help future translators (students) when carrying out a research paper such as the present one. Therefore, the investigator will detail the conclusions obtained through the data collection instruments, and in addition, will provide several recommendations that are beneficial when doing a paper like this one.

6.1 Purpose of the conclusion

The conclusions are relevant for the translator because they ensure the goals proposed at the beginning of the translation, which were to render several documents in the field of Biology, in order to make them available for professors and students at U.N.A.. The use of different translation techniques, the evaluation of the effect of the translation techniques applied in the documents, help the author achieve communicative texts.

The conclusions contain a reflection of the text analysis done by the translator when applying the different translation techniques and methods. These important tools that reflect the coherence in terminology and style throughout the text. The conclusions helped the translator to tie everything together up nicely in the end. Therefore, the purpose of the conclusion is to accomplish the objective of communicating the reader the value of the texts that were presented throughout the translation, in order to answer the research question as well as demonstrating the importance of the results obtained after the investigation concluded (Osorio, 2017).

6.2 Conclusions

The translation of several articles taken from Revista Mexicana de Biodiversidad and their analyses are some of the purposes of this paper in order to identify with the color-coding technique, examples of the different translation methods, text analysis, and translation procedures used, such as transposition, omission, explicitation, and modulation. Consequently, it was fundamental for the researcher to read and analyze the documents from the author's point of view to have a general understanding and increase the clarity and accuracy of the texts to avoid possible translation mistakes.

6.2.1 To translate some articles from Revista Mexicana de Biodiversidad from English into Spanish and vice versa

The first objective of this paper was to translate various documents, and in order to do so, the researcher had to carry out a thorough analysis. Newmark (1988) states that understanding the text requires both, a general and a close reading. The purpose of the reading is to find out the intention of the texts, which can not be separated from understanding them. In the process of translation, an intense analysis must be made in order to have a full understanding of the message; consequently, the specific aspects have to be taken into account when translating, such as, text style, stylistic scale, text function, translation methods, and a useful glossary. The translator must take into account several sources to ensure the cohesion of ideas such as theme and rheme, anaphoric references, enumerations, opposition or dialectic, conjunctions, initial negatives, and punctuation.

The steps followed in this work started with the translation process by analyzing the entire text. In this analysis, the translator found the intention of the text and relevant words regarding the documents. Furthermore, having a general view of the texts and then analyzing particular words were important aspects in order to find out what the documents were about, and at the same time, finding out the intention and writing style of the authors, as well as helping the translator to get acquainted with the source message. The analysis of the text was based on the function of the text (informative, expressive, or vocative) and on the style (narrative, description, discussion or dialogue).

Having this information, the translator was able to identify the scale of formality, the scale of difficulty and the scale of emotional tone. The translation method used by the translator was the semantic one because the purpose of the texts was to inform the readers about the discoveries made in the field of Biology. Some other aspects taken into account were connotation and denotation, word choices, and nuances and so on. The analysis of the texts was illustrated in the text analysis chart in Chapter V.

6.2.2 To apply several translation techniques to the documents in order to achieve communicative texts

Once the documents were analyzed following what Newmark (1988) stated, it was important to take into account the six translation techniques that were essential to facilitate the process of rendering the source message to the target language in the documents. The color-coding instrument included transposition, omission, modulation, amplification, explicitation, and literal translation, and the six techniques were illustrated in the several articles provided by UNA. For example, the transposition technique helped the translator to figure out the grammar changes that had to be done form the source language to the target language. Modulation was very helpful to provide naturalness to the text, as well as to help the translator to see the translation from other perspective without changing or altering the meaning from the source language.

Likewise, amplification was very useful, as it helped the translator to clarify the message by adding more terms in the target language. This was more common when the translation was from English into Spanish because Spanish tends to use more words. Omission was more frequent when the translation was from Spanish into English because English tends to be more direct and shorter. Omission also allowed the translator to simplify the message by using less morphemes and lexemes in the target text.

Explicitation was equally useful for the translator because it allowed him to make clearer in the target language what was implicit in the content of the source one. Finally, literal translation helped the translator to provide naturalness to the format and the content which was very important for the translation of these documents. Literal translation is equally important since the production from Spanish into English and from English into Spanish due to the technicality of the texts was necessary in order to offer a precise correspondence of structure and meaning.

There is no doubt that the use of these techniques in the translation process of the articles was critical in order to get an accurate and transparent translation of the source language into the target one. The double-checked of the words used in a dictionary, monolingual or bilingual, was also helpful in order to avoid the use of false cognates that could lead to a wrong comprehension of the message in the target language.

6.2.3 To evaluate the effect of the translation techniques applied on the documents

The effect of the translation techniques was very important because it helped the translator to observe how these techniques affected each target text. In the documents translated from Spanish into English; transposition, omission, amplification, and modulation were most commonly used. In this translation, amplification was widely used, since the use of articles and prepositions is more common in Spanish than in English; on the contrary, amplification was poorly used in the translation from Spanish into English for the reasons mentioned above.

From English into Spanish, transposition, omission, amplification, and modulation were most commonly used because of the difference in the grammar structure when translating into Spanish. Transposition was the most common technique used for the use of adjectives and adjectival nouns in English. Modulation was equally used in both translations, mostly in relation to verbal forms, that is, the use of the passive voice in English translated into active voice in Spanish, and vice versa from Spanish into English. In the target texts, the translation techniques less common or scarcely used were adaptation, compensation, and equivalence due to the type of texts they were.

6.2.4 To create a glossary with the most important terminology found in the documents

In addition to the text analysis and the translation techniques, it was crucial for the outcome of this translation to create a glossary for each translation, from English into Spanish and from Spanish into English. The glossary illustrated the definitions and provided further information regarding the terms in the content that allowed the translator to save time and effort when looking up complicated terminology in a dictionary, besides keeping the coherence and consistency of the target text too.

The glossaries created were very useful, as they helped the translator to save time when looking up a word. They also provided assistance to the translator in order to have a guide of the complex and unique terminology of a specific field, and ensure a consistent style and voice, an accurate rendering of the original text, and a level of quality throughout the translation.

6.3 Restatement of the Problem Statement

The research question is the guide for readers to get an idea of what the thesis is about. The research question is the door to learn something new, in this case specifically about translation and every single step throughout its process. The research question is the methodological point of departure of a translation research. It is the fundamental core of a research project and it focuses the study, determines the methodology, and guides all stages of inquiry, analysis, and procedures of a translation.

The present research pretended to reproduce various texts related to Biology, in order to make them available to students who do not speak any of the languages of the translations, which was achieved successfully by the translator. First, because the evaluation of the translation procedures and methods used to translate several documents from English into Spanish and from Spanish into English for the U.N.A. was achieved. Second, because the translator applied various translation techniques to the documents in order to achieve a communicative text. Third, the evaluation of the effect of the translation techniques applied on the documents was completed. Fourth, the creation of two glossaries, one from English into Spanish and the other one from Spanish into English, with the most relevant terminology found in both texts. Both glossaries wer very helpful for the translator.

6.4 Recommendations

The current translation was able to achieve and to asses the importance of the above-mentioned methods, procedures, and techniques when translating the documents from the Revista Mexicana de Biodiversidad. Based on the previous chapters, and on what the researcher found during the translation process, as well as on the positive results obtained from this investigation, there are some advisable aspects that future translators must take into account.

It is necessary to implement the text analysis proposed by Newmark, so translators can get familiar with the source text; therefore, it will help them to transmit the message in an accurate way in the target language, it means that a general reading must be carried out to find the intention of the text, which cannot be separated from its understanding, as they go together. Translators should keep in mind what translation methods and techniques should be applied in order to render a natural and accurate translation. Newmark (1988), states that there are eight type of translation methods which give the translator the opportunity to choose the one that best represents the target text and the audience to which they are directed. Translators should keep in mind these translation procedures in order to apply them correctly in the texts. The translation procedures are used by the translator to solve problems that emerge when carrying out the translation process with a particular objective in mind.

To create a glossary is basic, not only to save time to the translator, but also to provide consistency in the use of the terms. Glossaries are developed to understand difficult terminology, and to provide assistance to the translator, so he/she can have a guide of the complex and unique terminology of a specific field. The idea is to create a glossary that contains the most difficult words.

The translator must keep in mind that when a glossary is elaborated, it is important to include information about the use, the kind of chronological indication, the geographical use of the word, the sociological background, and the grammatical connotations, such as gender, number, the kind of verbs, and nouns, and so forth. It is common to find just one equivalent for each term, but it turns out more convenient to include several equivalents for some of the terms due to the existent varieties in different countries, regions, or registers. When an equivalent is included, it is preferable if it has the same category. In most cases, it is about nouns, compound nouns or nominal syntagmas. If there is no equivalent of the same grammar category, it is recommendable to add an example of its use so it would be clearer how to use the term in a similar context.

To have at hand good dictionaries from different fields in order to write good translations no matter how much work it takes is an excellent idea for the translator. These specialized dictionaries contain the necessary information to illustrate the translation throughout the translation process.

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Tribunal Examinador

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