LUMEN ET VIRTUS

Analysis of the presence of protozoria in seawater as a learning tool for the discipline of microbiology

https://doi.org/10.56238/levv15n38-041

Manuella Macêdo Barbosa[1]

ABSTRACT

Beaches and seawater are potential sources of parasite infection because of the contamination of these natural resources by sewage and human feces. Thus, the general objective of this work was to identify, together with the students, the protozoan parasites present in seawater, as a tool to complement the theoretical knowledge of the Microbiology discipline. The students, through the knowledge discussed in the classroom, were able to identify, in seawater, collected in the Municipality of Caucaia, the presence of *Euglena*, Ameba and *Paramecium*. The characteristics of these protozoa, possible diseases that they could cause, as well as the benefits that some of them can bring to the environment were discussed with the students. The present project contributed to meaningful, dynamic and applied learning about the content of protozoa.

Keywords: Microorganisms, Protozoa, Contamination, Learning, Meaningful.

INTRODUCTION

The intense growth and technological development are increasingly compromising the quality of water resources, in their most diverse uses, for human consumption, leisure, fishing. The environmental impacts related to human pollutants (human waste, garbage, agricultural and industrial effluents) and the intensive use of soil for the Green Revolution agricultural model (chemical and biotechnology dependence, mechanization, irrigation, monoculture and land concentration) negatively affect the quantity and availability of water for human consumption and use (AUGUSTO *et al*., 2012; CORDEIRO *et al*., 2015).

Beaches and seawater are potential sources of infection of intestinal parasites because of the contamination of these natural resources by sewage and feces of animals and humans. The larvae can actively penetrate the skin of humans and animals when in contact with contaminated soil or water, thus representing a risk of infection for beachgoers, which can trigger diseases and an infection known as geographic bug (DULGHEROFF, 2023).

[1] Doctor in Chemical Engineering
Professor at the Federal Institute of Education, Science and Technology of Ceará – Caucaia Campus
Email: manuella.macedo@ifce.edu.br
ORCID: https://orcid.org/0000-0003-0533-7430

Waterborne diseases, especially those caused by intestinal protozoa, have emerged as one of the main public health problems in the last 25 years, despite the adoption of increasingly restrictive regulations and measures and advances in treatment technologies (SMITH *et al*., 2006; FRANCO, 2007). In Brazil, the concern with these pathogenic protozoa to humans and other animals led the Ministry of Health to publish Ordinance 1469, revised under No. 518/2004, which was later replaced by Ordinance No. 2,914/2011, this publication recommends that Water Treatment Plants research these agents in the water to be distributed to the population, with the aim of achieving a pattern of absence as a goal (NETO *et al*., 2011). However, in coastal areas, due to environmental contamination, this problem presents itself in an accentuated way, transmitting diseases to humans and animals, as these protozoa come into contact with the skin or even orally.

The problem of water contamination by protozoa, despite being an important public health problem in several countries, presents a scarce amount of research. Thus, studies should be carried out to disseminate knowledge on this subject and measures should be adopted to minimize the contamination of drinking water and seawater, by sewage and waste. Conservation and appropriate management measures should be taken to minimize risk factors for the health of the population. Thus, some measures will have to be adopted to try to minimize this impact and the contamination of the waters by protozoa, among them the following stand out: implementation of the Environmental Education discipline in schools; application of laws to enforce the mandatory treatment of agricultural and industrial effluents; effective and periodic garbage collection.

The teaching-learning process of Chemistry through practical investigative activities has been gaining space and importance (TOLLOMEOTTI, 2012). Teaching, exercised in the classroom, must be contextualized and take into account the daily life and reality of each region and community. Practices integrated with reality provide experiences lived by students, which will be taken to their professional performances, interfering in the way they can act as citizens or create solutions to the problems involved in the context they experience. Thus, the general objective of this work was to identify, together with the students, the protozoan parasites present in seawater, as a tool to complement the theoretical knowledge of the discipline of Basic Microbiology, with the students of the Medium/Technical Course in Chemistry of the Federal Institute of Education, Science and Technology of Ceará – Caucaia Campus.

The specific objectives were: to make students aware of the seriousness of the situation of water contamination by sewage, and the harm caused to health, in addition to making the student easily understand the structure of a protozoan, which is a eukaryotic microorganism.

In view of the presence of protozoa, responsible for various diseases, in water intended for consumption, leisure, recreation and fishing activity, as occurs in seawater, it is perceived the need to awaken in students a greater interest and motivation in learning the content about protozoa.

Addressing this theme through practices that involve everyday problems becomes an important learning tool, in addition to awakening, in the student, the interest in environmental problems and the maintenance of hygiene habits. Another factor that justifies the accomplishment of the present work is the fact that the student can act as a multiplier of this knowledge, transmitting it to the community in which he is inserted.

This research is characterized as an action-research, field and experimental. The methodological procedure used in this work initially consisted of teaching the theoretical class on protozoa. In a second moment, the students were asked to collect seawater samples. In the third moment, the students were taken to the General Microbiology Laboratory of the Federal Institute of Education, Science and Technology – Caucaia Campus and prepared slides with the water samples, to observe them under the optical microscope. The students were asked to try to identify the presence of protozoa and what type of protozoa were observed, and later, a debate was held about the diseases that these protozoa could cause, in addition to identifying ways to prevent water contamination.

The present work presents the following structure: 1. Introduction; 2. Development. 2.1 Theoretical Basis; 3. Methodological procedure; 4. Results and discussions; 5. Conclusions; 6. References.

DEVELOPMENT

THEORETICAL FOUNDATION

Protozoa, Water Quality and Experimentation in Chemistry Teaching

In developing countries, one of the main causes of disease is water contamination due to deficiencies in the sanitary sewage service. This deficiency causes part of the population's waste to be thrown directly into rivers, seas and lagoons, water reserves that play an important role in fishing, tourism, recreation, leisure and water supply (FALCHI, 2007). In addition to interfering in various social and economic aspects, water pollution and contamination can also lead to changes in the aquatic communities present in these reservoirs, such as plants, animals and microorganisms (MEDEIROS; ARAÚJO, 2018).

In view of the evident reduction in water quality, and based on the assumption that environmental problems are generally related to social problems, it is important and necessary that there is an insertion of the community in the debate on these issues. At the educational level, this can begin at school, through the survey of students' conceptions about the various aspects that involve this theme, considering that what people think about the environment interferes with their attitudes (MEDEIROS; ARAÚJO, 2018).

The importance of experimental activities in the teaching of Science, Chemistry and Microbiology is undoubtedly unquestionable, regardless of the place where these activities are

carried out, conditions that result in significant learning must be prioritized (MOREIRA; DINIZ, 2015), as proposed by the theory of Ausubel et al., laying the foundations for human understanding, building meanings and paths for the understanding of this content, added to its previous knowledge on the part of the student (TAVARES, 2003). This knowledge is kept to be used on other occasions and to serve as an anchor for new learning (DOS SANTOS; PERNA, 2018).

Teaching-learning, linked to microbiological practices, with the identification of protozoa in water, are relevant to understand the world in which we live, ensure a healthy life and act professionally, promoting environmental conservation and understanding the importance of hygiene habits. However, this content is little explored in high school, deserving greater attention and research on this theme, relating these microorganisms to the diseases they can cause (WILLE; SCHAWANK, 2022; JACOBUCCI; JACOBUCCI, 2009).

According to Medeiros and Araújo (2018), education is a product of the permanent dialogue between conceptions of knowledge, learning, teaching, society and the environment. Thus, one of the most favorable places to carry out these practices is the school space, as it is a teaching-learning environment that covers not only teachers and students, but also employees and even the students' families, thus allowing a greater number of people with different ages, behaviors and conceptions to be contemplated.

METHODOLOGICAL PROCEDURE

CHARACTERIZATION OF THE RESEARCH

This article is characterized as an action research, as it refers to a strategy for the organization of research in Education, by the teacher, who tends to use his research to improve the teaching and learning of students. It can be defined as the identification of planned action strategies that are subject to observation, reflection and change. In this research environment, the researcher collects information about his practices, and must be clear about the principles of his work, what he wants, what he is doing and why he is doing it (TRIPP, 2005; PEREIRA, 2013). Therefore, it is not only about data collection, since it depends on the involvement, interest and participation of the individuals present in the action (LORENSON; PEAR TREE; MARIANO, 2020).

The present work is also characterized as a field and experimental research, as the students were instructed to collect seawater, which was later taken to the Microbiology laboratory of the Federal Institute of Education, Science and Technology – Caucaia Campus, to be analyzed.

Thus, this research is an approach in Education, of the action research, experimental and field type, carried out from an intervention, developed in the discipline of Microbiology, of the Medium/Integrated Technical Course in Chemistry, of the Caucaia Campus, involving 25 students from a fifth semester class.

TEACHING OF THEORETICAL KNOWLEDGE AND APPLICATION OF PRACTICE FOR THE IDENTIFICATION OF PROTOZOA IN WATER

The three pedagogical moments of the research were divided into: initial problematization and organization of knowledge, sample collection, microbiological analysis of seawater samples, preparation, observation of slides, discussion of results and consolidation of acquired knowledge.

At first, 08 hours of classes were taught on the structure of protozoa, places where they can be found, main types of protozoa, some protozoa that cause diseases and reproduction of these microorganisms. In the second moment, the students were asked to sanitize their hands, collect seawater in glass bottles, previously sanitized and bring the samples to the Microbiology laboratory. In the third moment, the students prepare slides, containing the sample of seawater and take it to the microscope. After visualizing the structures of the protozoa, the students tried to identify the types of protozoa that were being observed and the possible causes why they could be contaminating seawater, as well as possible solutions to minimize this environmental impact.

The intervention was carried out at the Microbiology Laboratory of the Federal Institute of Education, Science and Technology – Caucaia Campus, in which the 25 students, in groups, were able to visualize the protozoa with the help of an optical microscope.

RESULTS AND DISCUSSIONS

In Brazil, some of the main waterborne parasites are *Cryptosporidium spp*., *Giardia* spp., *Cyclospora cayetanensis* and *Toxoplasma gondii, which,* due to their high environmental persistence and resistance to chlorination, are a constant concern for water producing systems and food industries. The waters used for recreation, fishing and leisure activities also constitute a risk to the acquisition of these parasitic agents (FRANCO, 2007).

Diarrheal diseases, associated with lack of sanitation, inadequate hygiene, contamination of water resources and inadequate water supply, kill 2.2 million people/year. Waterborne diseases, particularly those caused by intestinal protozoa, have emerged as one of the main public health problems in recent years (FRANCO *et al*., 2012).

Based on the prominence that protozoan microorganisms occupy in the contamination of water resources and the dissemination of diarrheal diseases, third-year high school students were asked to make slides with samples of seawater, collected in the Municipality of Caucaia to observe under the optical microscope.

The formative character of experimentation stands out for its potential to promote the integration between theory and practice in teaching, although it is not the only strategy available to achieve this objective. In several documents with legal bases that regulate the offer of high school

courses integrated with professional training, it is possible to verify the inseparability between "*theory and practice"* (WILLE; SCHWANKE, 2022).

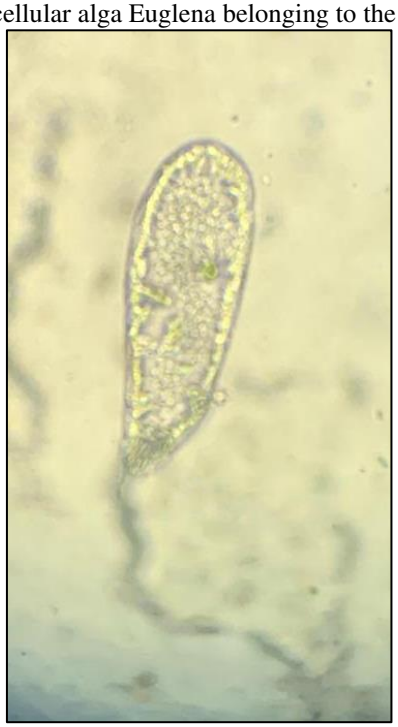
In the class of identification of protozoa in seawater, it was sought to explain to the students how their knowledge is applied in daily life, because the presence of protozoa in the water and the technique for their recognition were addressed in the classroom and experienced, in practice, by these students. Another important formative aspect that became evident with the realization of this work was that, when studying a content, it is possible to make an interdisciplinarity with another theme, as was done with this practice, when the contents of environmental education and preservation of water resources were related to the concepts of Microbiology. From this perspective, experimentation was applied to the learning of methodological processes for professional training, but it appears linked to work as an educational and interdisciplinary principle, contributing to the conception of integral human education.

The present study, in addition to contributing to the professional and integral training of the student, by addressing Microbiology themes, contributes to the awareness of the contamination of water resources and the adoption of hygiene measures in their daily lives, awakening, in the students, the importance of environmental education practices and measures for the preservation of water bodies.

Figures 01, 02 and 03 below show some of the protozoa detected by the students during the analysis of seawater.

Due to the theory, presented in the classroom, the students were able to identify, in Figure 01, a microorganism of the protist kingdom classified as *Euglena*. The characteristics of the *Euglenas* were reinforced with the students, based on the reference used in the classroom, which was the bibliography of Pelczar (1996).

Figure 01 – Unicellular alga Euglena belonging to the protist kingdom.



Source: The Author (2024).

Single-celled euglenoids are differentiated from other algae by the presence of chlorophylls a and b and the absence of a cell wall. There are more than 800 species, many of which are found in freshwater, especially in waters rich in organic matter. For this reason, euglenoids can grow either heterotrophs or autotrophs. Some biologists also consider the non-photosynthetic members of euglenoids to be protozoa because they can ingest particulate food through an esophagus (PELCZAR, 1996).

Euglenoids come in a variety of shapes and can range in size from 10 µm to more than 500 µm in length. Many species of *Euglena* are complex and contain numerous small chloroplasts. It has a nucleus and a long flagellum, which is usually held at the front of the cell. The film (cytoplasmic membrane plus exposed proteins) that surrounds the cell is flexible; It does not have a cell wall. Other cell organelles or inclusions comprise contractile vacuoles, mitochondria, paramilon (a polymer of glucose), and an eye spot or stigma (PELCZAR, 1996).

It was discussed with the students, to deepen the knowledge, that the different subphyla of the phylum *Euglenozoa* can be free-living, phototrophic, osmotrophic or phagotrophic organisms, as well as facultative or obligate parasites of plants, invertebrates or vertebrates. When pathogenic, these organisms are responsible for diseases of great medical and veterinary importance (MARTINS, 2008).

Figure 02 shows the second slide prepared by the students, with the presence of an amoeba. It was discussed with the students, in order to deepen their knowledge, that *Entamoeba histolytica* may also be present in seawater. It was then debated that the main form of contamination by this

protozoan includes the ingestion of water and food contaminated with cysts. E. *histolytica* trophozoites are capable of invading tissues, causing amoebic dysentery in humans.

It was reminded, with the students, that amebiasis is caused by the protozoan *Entamoeba histolytica* that eventually inhabits the large intestine of man, and can produce from asymptomatic colonization to severe invasive infections, with bloody diarrhea and even spread to other organs, with amoebic liver abscess being the most frequent form of extra-intestinal amebiasis (VELÁQUEZ *et al*., 1998; AMARAPURKAR; PANTEL, 2005).

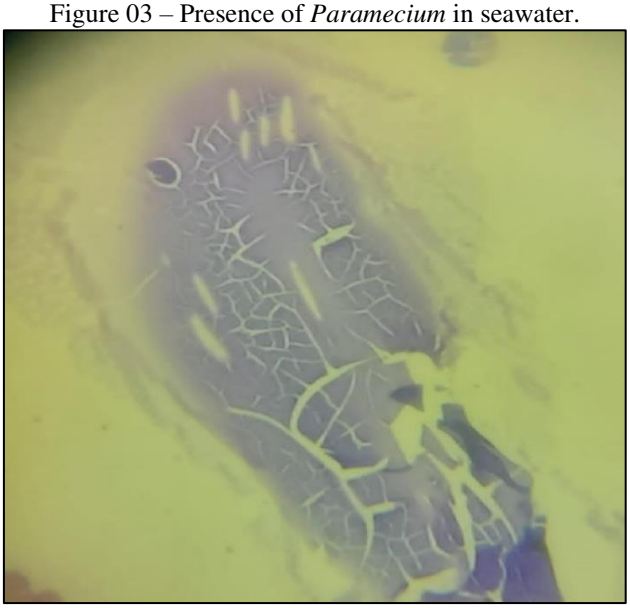
Figure 02 – Identification of amoeba in seawater.



Source: The Author (2024).

In Figure 03, the students identified a *paramecium*. It was reminded, with the students, that the *paramecium* is a ciliated protozoan, which can be found in wells, dams, freshwater lagoons and seawater, where there is an adequate amount of food. Ciliated protozoa play an important role in the purification and regulation of the entire aquatic community and improve the quality of effluents in sewage treatment plants by removing most of the dispersed bacteria (CURDS *et al*., 1968; MADONI; ROMEO, 2006; MIRANDA; MARTINS, 2013). Despite all the benefits that these protozoa can bring to nature, it was reminded, with the students, that, among these protozoa, *Balantidium coli* causes dysentery and is the only human parasite (PELCZAR, 1996).

Figure 03 – Presence of *Paramecium* in seawater.



Source: The Author (2024).

It was found that, with the application of this practical activity, in addition to deepening the concept, definition, knowledge of the types of protozoa, way of life, locomotion and possible diseases that they can cause, it was also possible to work on other values and skills in the students. The present practical activity enabled the students to manipulate some equipment in the Microbiology laboratory, such as the microscope; applying, in practice, the contents seen in the classroom, from the preparation of microscope slides, to the identification of protozoa and contributed to develop cooperation among the class, through the development of group work.

Another important concept worked with the students was the importance of conserving water resources and the basic concepts of environmental education, such as maintaining daily hygiene and avoiding throwing garbage and waste into the waters. The approach to the presence of types of protozoa in water becomes relevant because it makes students aware of how the action of man, when disposing of residential and industrial waste, in an inappropriate way, can bring serious imbalances to the environment, directly reflecting on human health.

The relevance of this practical class as a training activity, addressing specific concepts of Microbiology and broader concepts about the preservation of water resources, highlights the role of the school in disseminating information about protozoa and the possible diseases they can cause, assuming its role as an agent of dissemination of knowledge to its students and the community in which they are inserted.

Other important and transversal factors that can be observed from this research are: the need to intensify actions and inspection of the Public Administration with respect to water and sewage treatment, basic sanitation, educational campaigns of a formative nature on Environmental Education and hygiene measures.

Practical class initiatives, such as the one carried out in this work, improve the teaching-learning processes, arouse the student's motivation and interest, contributing to their professional and integral training, in addition to placing them as protagonists, during the acquisition and consolidation of knowledge, making learning more dynamic, interesting and meaningful.

CONCLUSION

The realization of the practical class, carried out in the present work, contributes significantly and actively to the students' learning about the concept, definition, types and possible diseases that can be caused by some protozoa.

The students, through the characteristics of these microorganisms, worked on in the classroom, had the opportunity to prepare Microscopy slides and recognize the structure of protozoa, as well as work on factors and measures that contribute to the preservation of water resources.

The application of this methodology and intervention, with the students, made the class more dynamic, collaborative and motivating. Thus, it is understood that, in Chemistry Teaching, methodologies in this format make the class more dynamic and contribute to learning.

REFERENCES

Amarapurkar, D. N., Patel, N., & Amarapurkar, A. D. (2003). Amoebic liver abscess. Journal of Hepatology, 39, 291-296.

Augusto, L. G. S., Gurgel, I. G. D., Câmara Neto, H. F., Melo, C. H., & Costa, A. M. (2012). The global and national context regarding the challenges of adequate access to drinking water. Ciência & Saúde Coletiva, 17(6).

Cordeiro, L., Tavela, A. O., Leite, N. K., Exterkoetter, R., de Oliveira, L. J. G. G., Klein, D., Parisotto, C., de Sá, L. S. (2015). Parasitological assessment of groundwater in the Marombas River Region. In Proceedings of the XVIII Brazilian Congress of Groundwater (pp. [...]). São Paulo.

Curds, C. R., Cockburn, A., & Vandyke, J. M. (1968). An experimental study of the role of the ciliated protozoa in the activated sludge process. Water Pollution Control, 67, 312-329.

Dos Santos, G. R., & Perna, S. J. Q. (2018). Laboratory practices in the classroom: An experience report from Leônidas Monte public school – Abaetetuba, PA. In Proceedings of the VII National Meeting of Licenciatures (VII ENALIC), Fortaleza-CE (pp. [...]). Fortaleza.

Dulgheroff, A. C. B. (2024). Research project. Federal University of Paraíba. Available at: https://www.ufpb.br/ufpb/contents/noticias/pesquisadores-da-ufpb-identificam-parasitas-intestinais-em-10-trechos-de-praias-do-litoral-sul. Consulted on April 26, 2024.

Falchi, R. L. R. (2006). Contamination by potentially pathogenic protozoa in water from different points of Laguna dos Patos, Rio Grande, RS (93 pages). Master's thesis, Federal University of Pelotas, Pelotas.

Franco, R. M. B. (2007). Waterborne protozoa: Relevance to public health. Revista Panamericana de Infectología, 9(1), 36-43.

Franco, R. M. B., Hachich, E. M., Sato, M. I. Z., Naveira, R. M. L., Silva, E. C., Campos, M. M. C., Neto, R. C., Cerqueira, D. A., Branco, N., & Leal, D. A. G. (2012). Evaluation of methodologies for detecting Cryptosporidium spp. and Giardia spp. in water intended for human consumption to meet the demands of Environmental Health Surveillance in Brazil. Epidemiologia e Serviços de Saúde, 21(2), 233-242.

Jacobucci, D. F. C., & Jacobucci, G. B. (2009). Opening the test tube: What do we know about scientific dissemination and microbiology education research in Brazil? International School for Advanced Studies Journal of Science Communication, 8(2), 1-8.

Lorençon, G. A., Pereira, G. A., & Mariano, M. N. (2020). The use of games in the teaching and learning process of the periodic table: Evaluation of an intervention during a chemistry teaching internship. Research, Society and Development, 9(8), 1-23.

Madoni, P., & Romeo, M. G. (2006). Acute toxicity of heavy metals towards freshwater ciliated protists. Environmental Pollution, 141(1), 1-7.

Martins, A. V. C. (2008). Molecular and morphological characterization of Brazilian isolates of the genus Euglena (43 pages). Master's thesis, University of São Paulo, São Paulo.

Medeiros, M. L. Q., & Araújo, M. F. F. (2024). Protozoa, quality of water in reservoirs, and waterborne diseases as perceived by teachers and students of a public basic education school. Revista Educação Ambiental em Ação, 21(86). Available at: revistaea.org_pf.php_idartigo=1621.pdf. Consulted on April 29, 2024.

Miranda, M. M. P., & Martins, N. F. (2013). Optimization of Paramecium caudatum cultivation for toxicity testing studies. Revista Verde Agroecologia e Desenvolvimento Sustentável, 7(4), 50-55.

Moreira, M. L., & Diniz, R. E. S. (2015). Biology laboratory in high school: Infrastructure and other relevant aspects. In Moreira, M. L., & Diniz, R. E. S. Teaching Core. São Paulo: UNESP.

Neto, R. C., Dos Santos, L. U., Sato, M. I. Z., & Franco, R. M. B. (2011). Analytical quality control of methods used for detecting pathogenic protozoa in water samples. Arquivos do Instituto Biológico, 78(1), 169-174.

Pelczar Jr., M. J., Reid, R., & Chan, E. C. S. (1996). Microbiology: Concepts and Applications (2nd ed.). São Paulo: Makron Books.

Pereira, A. L. L. (2013). The use of games as a motivational and learning resource (132 pages). Master's thesis, Faculty of Letters, University of Porto. Available at: https://repositorio-aberto.up.pt/bitstream/10216/71590/2/28409.pdf. Consulted on May 10, 2024.

Smith, A., Reacher, M., Smerdon, W., Adak, G. K., Nichols, G., & Chalmers, R. M. (2006). Outbreaks of waterborne infectious intestinal disease in England and Wales. Epidemiology and Infection, 134, 1141-1149.

Tavares, R. (2003). Meaningful learning and science teaching. Ciências & Cognição, 13(1), 9.

Tripp, D. (2005). Action research: A methodological introduction. Educação e Pesquisa, 31(3), 443-466.

Velázquez, C., Shibayama-Salas, M., Agirre-García, J., Tsutsumi, V., & Calderón, J. (1998). Role of neutrophils in innate resistance to Entamoeba histolytica liver infection in mice. Parasite Immunology, 20(6), 255-262.

Wille, C. N., & Schwanke, C. (2022). When the essential is invisible to the eye: The importance of experimentation in microbiology education in integrated high school. Scientia Tec: Revista Educação, Ciência e Tecnologia do IFRS, 9(2), 111-137.