

SITUATED LEARNING, PRAXIS, AND THE UNDERSTANDING OF BIOLOGICAL INVASIONS FROM SUN CORAL COLLECTORS ON THE BRAZILIAN COAST

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ABSTRACT

We investigated the management of biological invaders as a socio-scientific practice from situated learning and dialogues with the Vila do Abraão local community in Rio de Janeiro, Brazil, while aiming to amplify the learning processes on this theme. Historical-dialectical materialism was used as a theoretical-methodological perspective. When considering the learning process through social practice, we seek contributions from the philosophy of praxis and Paulo Freire, so the management participants constructed the concept of biological invasions and their meanings. The Marxist contributions of praxis and Paulo Freire were necessary for the theoretical synthesis of this work, pointing to the potential of the *catação* (picking; management) practice as a place of exchange between science and society through praxis, awareness, and action on reality.

KEYWORDS

biological invasion, awareness, non-formal education, social practice

APRENDIZAGEM SITUADA, PRÁXIS E SABERES SOBRE INVASÕES BIOLÓGICAS DE CATADORES DO CORAL-SOL NO LITORAL BRASILEIRO

RESUMO

A partir das proposições da aprendizagem situada e dos diálogos entre ciência e a comunidade local da Vila do Abraão — Rio de Janeiro, Brasil, foi investigada a conceituação do manejo de invasores biológicos enquanto prática sociocientífica que amplifica os processos de aprendizagem sobre questões que envolvem esta temática. O materialismo histórico-dialético foi utilizado como perspectiva teórico-metodológica. Ao considerar a aprendizagem por meio da prática social, buscamos as contribuições da filosofia da práxis e Paulo Freire. Assim, o conceito de invasões biológicas e suas significações foram construídos pelos participantes do manejo. As contribuições marxistas

da práxis e de Paulo Freire foram necessárias para o processo de síntese teórica deste trabalho, que aponta as potencialidades da prática de catação (manejo) como local de intercâmbio das relações entre ciência e sociedade através da práxis, conscientização e ação sobre a realidade.

PALAVRAS-CHAVE

bioinvasão, conscientização, educação não-formal, prática social

1. INTRODUCTION

Biological invasions as a topic have gained increasing attention due to the recurrent introduction of exotic species in Brazil and the world. This problem is considered the third most significant cause of biodiversity loss on the planet (International Union for Conservation of Nature, 2012). Furthermore, despite being perceived as something restricted to ecological realms, its impacts cause considerable damage to the economy and society (IUCN Species Survival Commission, 2000). The African snail in Brazil can be cited as an example when considering the direct impacts of extractivist cultures and their relationship with nature or public health. Nevertheless, how can society participate and become involved in the scientific enterprise, including those affected by bio invaders, and actively search for public policies?

We looked for examples of public involvement on this issue. We found the case of a biological invasion on the Brazilian coast by two species of sun coral native to the Pacific Ocean: *Tubastraea tagusensis* and *Tubastraea coccinea* (Oigman-Pszczol et al., 2017). As a biological invader, the sun coral significantly impacts local human communities and ultimately on consumers of marine resources in urban centers mainly due to the speed of its growth, proliferation, and impacts on the food chain (De Paula et al., 2014). In addition, other studies show that it is a threat to endemic species in Brazil, such as the brain coral (*Mussismilia hispida*; Creed, 2006).

The Sun Coral Project (SCP), supported by the non-governmental organization Brazilian Institute of Biodiversity, is a socio-environmental initiative to tackle the problem of biological invasions. Its main activities are intensive scientific research on the biology, ecology, and possible impacts of the sun coral in Brazil. It is composed mainly of researchers from universities in the state of Rio de Janeiro (especially the State University of Rio de Janeiro). Its leading research site is Ilha Grande Bay, located in Sul Fluminense, where the presence and impacts of coral are visible.

In close relationship with researchers in collecting sun coral, the SCP and residents conduct an activity dubbed “picking” (*catação*) to manage its abundance in the environment. That brings the local population closer to the scientific dimensions of data collection, interpretation, application of results, and debates in institutional spheres such as the Ministry of the Environment on Ilha Grande. The participation of Ilha Grande residents in invasive coral management activities represents a process of immersion in a scientific, social and environmental enterprise, which according to Gohn (2014),

operates within their own reality, presenting a possibility of learning in a “world of their own lives”, that is, in their daily lives.

According to Gohn (2014), “the sociocultural environment where one lives and the social class to which one belongs is part of the construction of an individual’s culture” (p. 39). Thus, education in non-schooled environments is seen as a forum and process of collective participation, sharing of experiences, elaboration of knowledge, and above all, political exercise (understood mainly by relationships), something associated with the ideal of participatory democracy. At this point, it is impossible to separate the ideas mentioned above from participatory and emancipatory ways for the collective construction of a multidimensional scientific culture. It is centered not only in the internal processes of an investigation but also in the entire historical and cultural apparatus that situates any scientific enterprise and in the circulation and appropriation of its knowledge.

The management activity promoted by the SCP consolidated an educational process without schooling and within a sociocultural context, where scientific culture emerges as one of its constituent elements. As such, it is possible to understand how knowledge about the biological invasion problem is appropriated and shared through practices developed within a socio-scientific universe. To this end, we question how a management practice becomes a constituent of social and situated learning processes when framed by the theoretical perspective of situated learning (Lave & Wenger, 1991).

Lave and Wenger (1991) place their analytical learning perspective in the Marxist tradition. For the authors, learning is integral to social practice and cannot be interpreted as a linear and individual process. From this perspective, it was necessary to create a dialogue with the Marxist understanding of the philosophy of praxis, which is based on the dialectical relationship between human beings and objective reality. Within this perspective, the world is an object to be transformed through conscious action in unity between theory and practice (Konder, 2018).

The investigation of the practice of managing the sun coral (or *catação*) brings us important parallels and connections with Paulo Freire’s liberating education and his synthesis of the Marxist idea of praxis in the educational universe. Freire (2018) contributes with significant reflections on the importance of what he describes as a non-banking participatory education that prioritizes respect for the cultural and historical context of the subjects through a process of cultural synthesis. That is understood by the relationship between knowledge of living on the island and participating in management as part of the scientific enterprise with the continuous dialogue between educators and learners for critical awareness of reality.

Thus, we intend to understand the learning dynamics and transformative potentials in non-formal education scenarios that consider popular participation with researchers for environmental restoration, learning, and praxis as dimensions of scientific culture. In this universe, our research objectives are: (a) to understand the learning process about biological invasions, systematizing the dimensions of socio-environmental issues brought by participants during management; (b) to conduct a process of synthesis supported by Marxist and Freirean contributions based on reflections on learning and represented in

the concepts of conscientization and praxis, and lastly; (c) to provide subsidies for the expansion of debates on social participation in scientific issues.

2. THEORETICAL FRAMEWORK

2.1. SITUATED LEARNING

Situated learning emerges in anthropology from ethnographic works developed in different historical-cultural contexts. Unlike other views on learning, especially the cognitivists, which are based on the individual, these works sought to understand learning in the sociability of subjects. Jean Lave (1996) considers that the learning processes involving the constitution and development of someone who learns are complex and encompass one who is situated in a given time and space. Consequently, “theories of situated activity do not separate action, thought, feeling, value and their collective cultural-historical forms from localized, interested, conflictual, and meaningful activity” (Lave, 1993, p. 7).

We take as an example Lave’s research from the 1970s on the Van and Gola tailors and their apprentices in Liberia (Lave, 1996; Lave & Wenger, 1991). In this perspective, Lave (1996) observed that what was learned was not simply a body of isolated techniques for shaping a garment but a series of social practices and cultural values inherent to the history of a learning community, including building one’s own life, growing up, becoming a master tailor, and recognizing the respect and truth in this occupation.

Social practice sustains the learning community in its cultural-historical structure, but it also modifies it. As such, learning manifests itself as a change in participation through practice within this community, which does not only involve the gain of individual motor or mental skills. It is also the understanding of multiple meanings of participation and belonging. Therefore, the learners appropriate themselves at the same time as they are part of constructing a vast cultural repertoire that involves knowledge, specific skills, and contextualized socio-political issues. Here, we speak of a repertoire belonging to and constituting a scientific culture, where knowledge shared by the SCP team is balanced with their own and promotes new forms of participation and learning, thus shaping the relationship between science and society.

2.2. PRAXIS AND CONSCIOUSNESS

To Marx (1890/1980), man¹ transform his history and make himself subject by creating the necessary conditions to exist socially. Thus, man is “acting on external nature and modifying it, at the same time modifying his own nature” (p. 202). In other words, man becomes a subject in a process of humanization, as Leontiev (2004) considers,

¹ We chose to use the term “man”, as in Marxist texts, because we understand that it carries its own historicity. We are aware, however, that it is also impregnated with an exclusion of gender issues.

which allows them to him his history and culture. This transformation is only possible through the mediation of practical activity, best represented by Marx (1890/1980) in the form of the concept of work in general, a human activity aimed at an end.

Nevertheless, in transforming an object, it is necessary to become aware of its usefulness, consider its constitution, and seek its end from the existing reality. Vásquez (2007), in this perspective, brings an important analysis of the common human consciousness and how it transforms the human into a “practical man”. The common conscience, as the author reports, is the one that limits man to an unreflective practical activity by which everyday actions are not based on complex thoughts and aim at nothing more than the utilitarian response to what the world demands.

Thus, the concept of theoretical activity appears with the concept of practical activity as determinants of human action when we refer to the transforming unit of praxis. Theoretical activity is distinguished from practical activity by taking as objects raw material and elements of the psychic and subjective plane such as perceptions, sensations, concepts, theories, and hypotheses that are transformed into the ideal plane (Vásquez, 2007). As such, “the immediate purpose of the theoretical activity is to elaborate or transform the ideal – and not the real – to obtain products and theories that explain a present reality, or models that ideally prefigure a future reality” (Vásquez, 2007, p. 233).

Vásquez (2007) states that “today more than ever, men need to theoretically clarify their social practice and consciously regulate their actions as subjects of history” (p. 57). This process is related to awareness in Freire. According to his work (Freire, 1980), reality does not present itself as a knowable object through its critical consciousness at first. In the spontaneity of relations between man and the world, the natural position is not a criticism but naive. The ascension to what he calls maximum possible consciousness implies overcoming limiting situations, the spontaneous sphere of apprehension of reality “to reach a critical sphere where reality presents itself as a knowable object and in which man assumes an epistemological position” (Freire, 1980, p. 26). The more we become aware, the more we enter into the phenomenal essence of the object, and the more we become instrumental in transforming reality. This process does not exist outside of praxis (Freire, 1980).

3. THE THEORETICAL-METHODOLOGICAL POSSIBILITY OF HISTORICAL-DIALECTICAL MATERIALISM

The processes of learning and awareness were investigated from their consideration as objects determined by a series of essential integrative issues which allow their existence as a concrete reality. Thus, it cannot be investigated only from the empirical point of view and end up in abstractions/generalizations that do not construct a dialogue with the real world. We understand our investigation as a path that starts from concrete reality, is mediated by the abstract, and returns to concrete thought. In other words, “the concrete appears in thought as a result in the process of synthesis, not as a starting point” (Marx, 1859/2008, p. 258).

As a concrete reality, the social phenomenon is dialectical and tensioned by elements belonging to its essence. The path from appearance to essence (which reveals the concrete in thought) becomes the construction of the elementary praxis of research in itself. From this reasoning, Gimenes (2016) states that “the essence of an object does not immediately manifest itself to man. Therefore, research is a possibility of understanding between representation and reality. It is a process of reproduction in the thought of the dynamic structure of its object” (p. 85).

However, this process of overcoming is possible through identifying and abstracting the connective elements in the object’s body and composing its dynamic characteristics. At this moment, we sought the mediations and contradictions (Netto, 2011) as fundamental points for analyzing the handling/picking practice as a place of learning and awareness.

4. SUN CORAL MANAGEMENT PRACTICE: PICKING

Vila do Abraão is located in the municipality of Angra dos Reis, Rio de Janeiro, and is the stage for the SCP’s activities. Creed et al. (2017) bring a list of reasons that underlie the emergence of management activities in Vila do Abraão: a large number of coral populations in the region of Ilha Grande Bay, proximity to the village, availability of residents who have enough affinity with the sea in order to participate in activities, and the strong influence of tourism and subsequent high flow of visitors.

Run by the SCP within the Brazilian Institute of Biodiversity, the picking was the management aspect that involved the participation of residents between 2006 and 2012. When considering the origin of the coral picking, it is also necessary to highlight that this practice was born from a non-governmental organization’s socio-environmental initiative in partnership with researchers and residents in 2006. That was interrupted due to the end of the sponsorship previously given by Petrobras Ambiental in 2013. Therefore, this research focuses on a very early stage of this practice that could have developed over the following years if there were no external (but structuring) issues, such as economic viability.

This activity was carried out periodically by SCP members, who determined where and when the management would be carried out based on occurrence data. The methodology used in other management actions in Brazil is the manual removal of coral colonies using chisels. The collectors dived (freediving) in pairs with a box and did the work. In the end, colonies were removed, and all the work was accounted for and evaluated.

5. COLLECTORS AND INTERVIEWS

Coral collectors are subdivided into coordinators or novices. The coordinating collectors started their activities together with the construction of the SCP in 2006. As of 2009, the number of collectors increased and remained at around 20, many of them with limited or seasonal participation. Their ages, including coordinators (four people over time) and novices, ranged between 20 and 48 years, only half had completed high school, and 86% had their own residence (Creed et al., 2017). Most collectors, about 70%, received less than the minimum wage, and 79% did not have a steady job (Creed et al., 2017).

In 2016, through the intermediation of an SCP member who lives in Ilha Grande and still maintains friendly relations with some of the former collectors, we located five willing to participate in semi-structured face-to-face interviews, two being coordinators and three being novice pickers. It is important to emphasize that other collectors were located. However, some factors, such as shyness and the daily work on the island, influenced the possibility of conducting interviews since they were done in person on two trips to Ilha Grande with limited time and resources. We can mention, as an example, a local collector who was willing to participate; however, he operated a “taxi boat” service (maritime taxi), which made it impossible for him to have a fixed schedule. Therefore, interviews should take place at rest/night times, which also hindered them, as we understand that time off is invaluable in the world of work as we know it. Added to these findings, another limiting factor is the instability of the cellular and internet network on the island, which naturally hindered both telephone communication and the possibility of remote interviews.

The coordinating collectors C1 and C2 and the novices C3, C4, and C5 were interviewed about their dynamics and daily lives. All were over 18 years of age and agreed to participate in the research through an informed consent form. We emphasize that in the transcripts, we decided to keep the expressions of our own language with maximum fidelity, without adjustments and corrections in this sense. Thus, spoken words such as the vernaculars “pra”, “tava”, and “tô”, for example, were kept in writing.

6. SOME CONTEXT ON VOICES OF THE ISLAND

For Lave (1993), structural contradictions are fundamental for establishing the relationships between meanings, the actions of subjects, and their contexts. Therefore, we consider it necessary to understand the context in which participation in practice occurs, as it is only in modulating dialectical relationships that any possibility of learning occurs. The way of life in Ilha Grande and the involvement of residents with environmental, social, economic, and political issues are some of the main aspects of the context in which management/picking is developed. Likewise, the historical processes of SCP’s genesis and the very presence of coral and other biological invaders also materialize in reality.

The main economic activity on the island is tourism, and most collectors live, in some way, from this activity. The common occupations for collectors are janitor, inn employees, divers, and tourist guides. It is important to highlight their stories as residents of a place of unique beauty when considering the way of life of the collectors. The relationship with the sea emerges as a cultural element that permeates practice, bringing unity between the context and the collection;

but because it is an island, the locals and the *caiçaras* already have great intimacy with the sea, surprisingly far above what one can apparently imagine. They are born on the island, canoe here and there, and play on the banks of the river. (C1)

In the following excerpt from collector C5's statement, we can also learn about the relationship with the sea and the perception of change in the environment after the arrival of the biological invader: "when we started diving as children, we had less of it, the quantity was smaller, but there was already a lot" (C5). Ilha Grande was already an environment modified by biological invaders; therefore, the experience of the *caiçara* population with these species is part of the context. In most cases, invasive species are not recognized as a problem, and their presence is taken for granted. The following speech exemplifies this aspect:

for the *caiçara* born here, the jackfruit has been here since the discovery of Brazil. So when you arrive, there already is a biological invasion; there is bamboo everywhere, so a person is born looking at it in a way that they do not consider a biological invasion. (C1)

Another important aspect is raised by the collector/coordinator C2 when referring to the complexity of the expropriation processes and the difficulty in communicating with novice collectors in a language that is close to the daily lives of these subjects:

Ilha Grande is experiencing a process of exclusion of these people, everyone who comes with preparation, with a much more competent way of setting up businesses, to take care of the place, to economically grow here, something people here do not have, they were excluded, and I think that when a project arrives and cannot speak the resident's language, this distance is only reinforced. (C2)

In the previous excerpt, collector/coordinator C2 refers to the scientific terms used by visiting researchers, revealing a contradiction regarding the construction of the practice within the context: the scientific and the popular. If the learning process is integrated into a context, it needs to be linked to the historical-cultural reality of the participants. In a way, sun coral picking becomes a form of approximation between concepts and reality, shaping the learning process.

Assuming that "people, actions, and the world are involved in all thoughts, expressions, knowledge and learning" (Lave & Wenger, 1991, p. 52), a brief construction of the context presented here was necessary. Furthermore, the reality of Ilha Grande is not only limited to the aspects raised here, and tensions are diverse. This multi-handed illustration was necessary in order to understand the learning and awareness processes that will be presented below.

7. REFLECTIONS ON SITUATED LEARNING AND PRAXIS IN SUN CORAL COLLECTION

For Marx and Engels (1932/2009), "the production of ideas, representations, and consciousness are in principle directly intertwined with the material activity and material exchange of men, the language of real life" (p. 31). In these assumptions, "one cannot understand what people feel and think without knowing how they live and what they do"

(Konder, 2018, p. 129). When collectors recognize themselves as such, they carry their history and the local culture, which is inseparable from social practice. The gathering does not exist without diving and a boat, more than that, it does not exist without island residents immersed in their own intersubjective insular reality and, as Freire (2013) refers to, “own community knowledge”. Here, we reinforce the situated character of learning and awareness of various issues in biological invasions.

8. MEDIATIONS OF THE LEARNING DIMENSIONS OF BIOLOGICAL INVASIONS

In this section, we work on dimensions created from the interviews’ analysis and the understanding of the existence of a contradiction that historically dichotomizes and is based on filters such as scientific neutrality, the knowledge of the natural sciences, and socio-political aspects. We assume this distinction as mediating dimensions for understanding the specific issues in biological invasions (biological, social, political) revealed in the interviews. However, it is important to emphasize that in the course of the analysis, this distinction is overcome in the statements of the collectors. This will be better explained in our synthesis of the processes of awareness and praxis.

8.1. LEARNING BIOLOGICAL AND ECOLOGICAL ASPECTS

Meireles et al. (2015) applied questionnaires, did interviews at Ilha Grande, and pointed out that most of the population that participated in the research (60%, $n = 125$) had already seen some invasive exotic species, 43.2% had already heard about the sun coral, and 40% knew how to recognize some type of problem/concept related to biological invasions. These data show a high degree of empirical knowledge regarding biological invasions on the island.

Participation in management strategies can bring people closer to aspects of the environmental reality in which they live, such as the conceptual elaboration of biological and ecological aspects. In the following excerpts, the collector/coordinator C₁ brings his understanding of biological competition and biological invasions:

you start to make a relationship with the other animals; the marmoset here is an invader with no predators and, like a sun coral, increases with each year. (...) So it’s the same thing at sea, you know? Same thing with sun coral. (...) The brain coral itself is directly impacted by the sun coral. Its procreation speed is much lower than the sun coral; they noticed it there, you know? (C₁)

We can also see a movement from the general to the particular (Davidov, 1999) when C₁ cites an example of another biological invasion on the island, the marmoset. Meireles et al. (2015) observe that the problem of the “marmoset that attacks birds” (p. 328) is well-known on the island.

When we turn to the statements of novice collectors, we also observe a knowledge of the problems and ecological procedures related to invasions in their own ways of expression: “the sun coral, it would bring damage to our place because it was spreading, then other living beings didn’t stay there, they died since there was no space to grow” (C4);

it was obvious that they were occupying places that they took away, they pushed the brain coral to one side, and that slowly killed them. Certain types of corals are taking up space from the native coral, you know? So this is the idea of the invasion, in this case, of a being that came from another country that is not from here and starts eating the very foods of the fauna and flora from here they were taking it all, you see? (C3)

Visualizing the problem from the contact with the coral was a very important aspect of understanding the biological and ecological questions relating to invasions. The collecting activity itself entailed care in concepts appropriated by collectors, such as the method of sacrificing colonies and taking care at the time of removal so as not to release more larvae into the environment:

we have some instructions on how the sun coral should be taken out so that they do not multiply anymore, so we are very careful when removing it so as not to encourage breeding instead of controlling it (...) we would go with the chisel and take them out one by one, because the less adrenaline, the fewer spores they release. (C3)

The excerpt from C3’s speech reveals the importance of the unity between theory and practice in collecting the sun coral. For management to be properly developed, it is necessary to know the central configurations of the biology of the coral, which was present in the interviews with all collectors.

Finally, the practice of collecting also made it possible to decode biodiversity, especially with underwater life previously little noticed by collectors, despite being excellent divers:

like, in my case, I learned more about the species. I met many species there that I didn’t know, that we were very curious and asked “what was that there”, because we didn’t have that view down there, right? Because when we dived, we only went to the sun coral, after which we went to see other species there. (C5)

We see evidence of knowledge about their own place being established, reinforcing the idea of rapprochement with the environment. Conceiving a transforming character of the human condition without knowledge of one’s own reality is unlikely, and here this fact applies to biodiversity itself. Man modifies nature by knowing it, detaching himself from it as a merely functional part, and as such, he humanizes himself and produces history and culture (Leontiev, 2004).

8.2. LEARNING OF SOCIO-ENVIRONMENTAL AND POLITICAL ASPECTS

The awareness-raising processes are more evident when considering the construction of socio-environmental and political learning. The socio-environmental manifestations of biological invasions by the collectors appeared mainly in the meanings given to the management activity. The main meaning attributed is the coral's control and/or eradication because it is somehow bad for the island. This strong relationship with the island highlights the determination in the collectors' context. According to Lave and Wenger (1991), "a learning curriculum is essentially situated. It is not something that can be considered in isolation, manipulated in arbitrary didactic terms, or analyzed apart from social relations" (p. 97). Still on this point, from her reading of Paulo Freire's dialogical action, Andreola (1993) states that "knowledge encompasses the totality of human experience. The starting point is the concrete experience of the individual in his group or community. This experience is expressed through the verbal universe and the thematic universe of the group" (p. 33).

Based on these considerations, we can go through the forms of knowledge shared by collectors when we refer to issues beyond a reductionist vision of the natural sciences. An important aspect of the management that appears in the speeches of the collector/coordinator C1 and the collector C3 is the aesthetic approach of the sun coral. This approach is something that must be taken into account when we think of biological invasion as a socio-environmental issue because it reveals ethical and economic contradictions related to the presence of a species of great visual appeal:

certainly, we all worked at the time of picking with some heavy feeling (...) because it is a pity to remove it because it is beautiful, but the feeling goes beyond this because it is a living organism, any way you are eliminating a being, an organism, but the bigger feeling was that you gave an opportunity to those other organisms that were being harmed by the dominant presence of the sun coral, you know? (C1)

The aesthetic factor of the sun coral reappears in the following passage, this time in the statement from collector C3. This seems to be an important issue for understanding the socio-environmental dimension of the topic, as it is also related to economic activities and feelings:

in Lagoa Azul or Lagoa Verde, we were almost forbidden to take the sun corals there. Because tourists like to see the wall infested with sun coral, and the sun coral is beautiful. (...) The tourist thinks it's beautiful, but the tourist doesn't know to what extent it can harm the environment of the Island there, you know? They are not aware of this. Only those who are aware of this, at first, the *caiçaras*, can pass this on to tourists because, in this case, tourists want to photograph and take pictures of beautiful things, but they are unaware of it. And there would have to be greater environmental education, an environmental education project even bigger in the tourist information aspect. (C3)

From the readings of C₁ and C₃, we can recognize that the issue of biological invasions is surrounded by social problems of equal complexity and was mentioned from a clear process of critical development. Looking through the prism of Freire's (2018) methodology, we can conceive biological invasions as the generating theme, one that can build new conceptions in the dialogic and intersubjective path and that is ramified in the historical complexity where students are immersed.

This association brings us closer to praxis as a political manifestation of historical-dialectical materialism. Thus, shared knowledge directs us to the contradictions that need action to overcome. The collector/coordinator C₁ presents us with the ethical tension between "doing evil" and "doing good", as well as what C₃ states about the aesthetic contradiction represented by the beauty of the coral. Both are propositional; they point out what would be necessary: projects and environmental education.

Another important emerging aspect from the interviews is the awareness of the collectors about the importance of control. More than eradicating the sun coral, they demonstrate a broad view of the imposed problem. Collector C₄ brings his contribution on this point: "for us today after we began to understand that it was impossible due to the quantity" (C₄). Still, within this aspect, C₃ again highlights the importance of action based on her reflections:

well, I think that human beings and society, in general, could always unite more and get engaged to have more projects like Sun Coral because they are important projects that regulate the diversity of nature, right? On an island or anywhere, mainly on the island, because we are isolated here in the middle of the sea, so there is both the sun coral and even the little monkeys, I think that in all aspects of an invasive species, we can have a solution to the invasion, which is not even to eradicate it completely, but at least to control the invasion, understand? (C₃)

The role of collectors as amplifiers of the theme also appears in the interviews:

I worked as a tour guide for a long time, I always thought it was a topic that should be included in any activity, whatever the profile of the tourist I was leading. I always touched on this theme, so it's something very present on the island. You have a lot of invasive species present here, I mean, there are some, but some are very evident. (C₂)

Here, we can think of Freire's (2018) perspectives of dialogue, in which one learns and educates collectively, not from A to B, nor from B to A, but from A with B. All the collectors talk about the dialogues within the island, the heritage of collecting, and the importance of communicating with tourists. This is peculiar to the practice at the same time as it is liberating because it builds attentive, observant, and critical thoughts.

Finally, political/bureaucratic aspects of biological invasions also appear in collector/coordinator C₁'s statement. Its central participation certainly promoted greater involvement with other instances of the SCP, which made its participants perceive political

dimensions also related to the problem of biological invasions. In this case, the responsibility for the introduction itself is put at stake, as well as the responsibility for the control of invaders and the role of the government:

I think the companies could be forced to give a part of their profit for its implementation, be forced to reverse some part of it. There are so many compensations there to mitigate these problems, right? But we don't see anyone politically committed. It was a crazy difficulty for us to get a license from IBAMA [Brazilian Institute of Environment and Renewable Natural Resources], to be able to remove the coral and to be able to use the skeleton as a product. It is a complication in the law itself; it was made in a way that favors this type of thing, these impacts, but does not favor the mitigation of these impacts. (C1)

The central figure of collector/coordinator C1 carries all this historical and cultural burden, built on his practice experience. In his speech synthesis, we can observe the potentialities of this type of socio-environmental initiative when we refer to the construction of learning trajectories, processes of awareness, and praxis. The implications of these last two concepts will be discussed further in the next topic.

9. SYNTHESIS: CONSCIOUSNESS AND PRAXIS

We now synthesize the dimensions previously presented, assuming our references of praxis and awareness (*conscientization* in Freire). Thus, we can observe from the data that there is a direction toward overcoming the biological versus social dichotomy. In general, the scientific knowledge specific to biology and other social and political issues was not presented in a polarized way, an important characteristic to understand in the articulations between critical awareness through theoretical appropriation and action on reality. As such, we defend that the approach to scientific questions must be guided by the integral relationship between subjects and the world. Gramsci (1975/1999) discusses topics in the natural sciences in his *Cadernos do Cárcere* (Prison Notebooks), pointing out that the philosophy of praxis does not operate to establish, for example, the structure or properties of a material that is known objects of the exact sciences and technology — but instead investigate the material forces of production and the expressive social relations in particular historical moments.

By looking at the conscious manifestations of biological invasions from the practice of sun coral collecting integrally, we return to Freire (2018), who states: “if the moment is already that of action, it will become authentic praxis, especially if the knowledge resulting from it becomes the object of critical reflection. In this sense, praxis constitutes the reason for the new oppressed consciousness” (p. 73). We can now evaluate the statements from collectors C1 and C5:

so, when you see a *caiçara*, a guy didn't go to college. He works on the work he learned from his father, which was passed by his grandfather. For him, then he starts to get involved with a study, a work, a project that has a scientific nature proving the importance of all this, it's very good because the guy has a cultural gain, you know? This values him as a person and increases the self-esteem of a simple, humble person who has not had much access to education. This is the great thing about the project. So, you see this realization, and this guy's self-esteem increased because of the project; it was really cool for him to be able to go out and lead a tour and talk to people in his own way, in his humble way, but talking to people, that's very cool. (C1)

I have the knowledge, and today I can pass on to someone else that the species is invasive. Because when people get there and see that beautiful underwater garden, they think: it's beautiful, interesting, etc. But they don't know it's an invasive species, do they? So nowadays we pass it along, even more so now that most collectors work with tourism, with boats, so when passing them by, we say: look, this species is invasive, it's bad for other animals. So there's this vision of passing it along. (C5)

Gimenes (2016) states that theory transforms our awareness of facts and ideas about things but does not transform things themselves. Meanwhile, practice presupposes effective action on the world and thus transforms it from the articulation between both elements. Vásquez (2007) probes the relationship between cognitive activity and teleological activity: the first results in knowledge about a certain thing, being thus restricted to theoretical activity. The second treats knowledge as an attribute suitable for a practical, material, and objective purpose since "one does not know for the sake of knowing, but in the service of an end" (Vásquez, 2007, p. 225). At this point, we can consider the knowledge about biological invasions integrated into the management methodology as a teleological element. Within the community, this knowledge is suited to a clear end: the control, or utopianly, eradicating the sun coral.

Belonging to the production process is inherent to non-alienated work. It is where scientific culture is inserted, such as knowledge of practice, practices, means of production, workforce, and the materialization of work in the commodity itself (Mészáros, 2016). C1 reinforces this idea when he mentions the importance of human contact with the issue of sun coral invasion in two moments: "the Sun Coral Project removes them, and it has a connection with a social part, it does not remove them with a chemical product, you do that with human work. This relationship is important, see?" (C1);

it is certainly different from when it used to be when you knew something but did not actually participate in an action when you saw the project start and grow, and despite not sitting on the university bench, you add up knowledge, you learn the names of other organisms, you learn how the chain works. Well, this is a spectacle; this is a gain for the project. (...) The

real gain is the cultural gain; it's what you learn in the involvement, from here, from those organisms, how that works, that's the cool thing. (C1)

The words of collector/coordinator C1 again bring us closer to Lave and Wenger's (1991) social learning theory. Collective participation in practice becomes not only a key mediation for the learning process for an integral construction of these collectors but also creates new ways of conceiving the relationship between science and society. On this subject, we agree with the vision of Gohn (2006) that community participation contributes to the transformation of reality, enabling environmental improvements, income generation, local development, and strengthening of social organizations. For the author, promoting citizen participation makes it possible to rescue self-esteem, but it also goes further by outlining life trajectories.

The socio-political and communal participation from collectively-built projects that lead to a social intervention – for example, a public square, contribute to transforming the reality of the public served. It leads to urban improvements, the generation of income for families, and the development and formation of artisan cooperatives. Projects that encourage the citizen participation of young people contribute to the recovery of self-esteem but can go much further by outlining projects and life trajectories. (Gohn, 2006, p. 37)

Participation is essential in order to establish awareness. For Freire (1981), awareness is a process of dialectical experience between “objectivity and subjectivity, reality and consciousness, practice and theory” (p. 117). Adding to the importance of local knowledge, here we perceive in C4 a dialectical movement between subjectivity and objectivity, theory and practice:

I worked with the sea; it was always my place, hence my experience of living with water. With time we know the places we could go, we see that the sea movement, and we go, and I managed to guide the guys about this and exchange a little experience in this area. (C4)

This activity for me, as I told you, was important because it was already in an area where I like, the sea. And it was a learning experience; we were understanding what the sun coral was and what damage it would bring to our place because where it landed, it spread, so other living beings didn't stay there, they died, and there was no room to grow there. (C4)

The two excerpts from C4's interview outline the necessary movements between context and knowledge and the importance of participation as a mediator between subject and reality. This collection characteristic probably underpinned the learning processes associated with the awareness unveiled here and dialogued with elemental forms of the philosophy of praxis.

10. CONCLUSION

The learning process on biological invasions appears as a phenomenon in which collection is a part of the collective effort and a place for promoting and constructing scientific culture. Thus, given some determinations and tensions that enter this debate, we brought the mediating dimensions of biological invasions that emerged in the interview process: biological/ecological, socio-environmental, and political. In the biological dimension, questions related to the biology of the sun coral, ecological dynamics, and biological diversity were presented in a way connected to the collection reports. The same occurred in the socio-environmental and political dimension, where we highlight social participation for overcoming this problem and becoming indicative of economic and political factors.

With the contributions of Marxist thought and Paulo Freire, we could know and discuss the potential of learning processes in and through practice. The main contributions of this synthesis process were the access to evidence that social participation in management practices allows the conceptual construction of biological invasions manifested from the particularities of the historical and social construction of the subjects (mainly local dynamics and language). Dialogic processes sometimes guide it; it has a non-alienating structure; it implies awareness-raising processes that exchange learning; it presents aspects of the unity of praxis and involves affective relationships.

Finally, we believe that our analysis can be added to a theoretical framework that seeks to understand aspects of the relationship between science and society based on the connections between cognitive and social processes of learning with action in reality. In addition, it contributes to the promotion of educational dimensions in multiple socio-environmental actions and social participation in science and technology topics, many of which are not yet understood through the prism of education, as is the case with the collection of the sun coral itself. Therefore, from a study on learning, we indicate the importance of participation in issues commonly solely appropriated by scientists but which have profound social impact.

Translation: Beverly Victoria Young Mokross

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REFERENCES

- Andreola, B. A. (1993). O processo do conhecimento em Paulo Freire. *Educação e Realidade*, 18(1), 32–45.
<http://hdl.handle.net/10183/232001>

- Creed, J. C. (2006). Two invasive alien *azooxanthellate* corals, *Tubastraea coccinea* and *Tubastraea tagusensis*, dominate the native *zooxanthellate* *Mussismilia hispida* in Brazil. *Coral Reefs*, 25(3), 350. <https://doi.org/10.1007/s00338-006-0105-x>
- Creed, J. C., Junqueira, A. de O. R., Fleury, B. G., Mantelatto, M. C., & Oigman-Pszczol, S. S. (2017). The *Sun-Coral Project*: The first social-environmental initiative to manage the biological invasion of *Tubastraea* spp. in Brazil. *Management of Biological Invasions*, 8(2), 181–195. <https://doi.org/10.3391/mbi.2017.8.2.06>
- Davidov, V. V. (1999). O que é a atividade de estudo. *Escola Inicial*, (7), 1–9.
- De Paula, A. F., Pires, D. O., & Creed, J. C. (2014). Reproductive strategies of two invasive sun corals (*Tubastraea* spp.) in the southwestern Atlantic. *Journal of the Marine Biological Association of the United Kingdom*, 94(3), 481–492. <https://doi.org/10.1017/S0025315413001446>
- Freire, P. (1980). *Conscientização: Teoria e prática da libertação – Uma introdução ao pensamento de Paulo Freire* (3rd ed.). Cortez & Moraes.
- Freire, P. (1981). *Ação cultural para liberdade*. Paz e Terra.
- Freire, P. (2013). *Pedagogia da autonomia*. Paz e Terra.
- Freire, P. (2018). *A pedagogia do oprimido*. Paz e Terra.
- Gimenes, C. I. (2016). O programa institucional de bolsa de iniciação à docência (PIBID) e a formação de professores de ciências naturais: Possibilidade para a práxis na formação inicial? [Doctoral dissertation, Universidade de São Paulo]. Biblioteca Digital USP. <https://www.teses.usp.br/teses/disponiveis/48/48134/tde-22122016-110603/pt-br.php>
- Gohn, M. G. (2006). Educação não-formal, participação da sociedade civil e estruturas colegiadas nas escolas. *Ensaio: Avaliação de Políticas Públicas Educacionais*, 14(50), 27–38. <https://doi.org/10.1590/S0104-40362006000100003>
- Gohn, M. G. (2014) Educação não formal: Aprendizagens e saberes em processos participativos. *Investigar em Educação*, 2(1), 35–50. <http://pages.ie.uminho.pt/inved/index.php/ie/article/view/4/4>
- Gramsci, A. (1999). *Cadernos do cárcere* (Vol. 1; C. N. Coutinho, Trans.). Civilização Brasileira. (Original work published 1975)
- International Union for Conservation of Nature. (2012). *Biological invasions: A growing threat to biodiversity, human health and food security*. Policy recommendations for the Rio+20 process. IUCN.
- IUCN Species Survival Commission. (2000) *Guias para La prevención de pérdidas de diversidad biológica ocasionadas por espécies exóticas invasoras*. IUCN Invasive Species Specialist Group. <https://portals.iucn.org/library/node/12678>
- Konder, L. (2018). *O futuro da filosofia da práxis*. Expressão Popular.
- Lave, J. (1993). The practice of learning. In J. Lave & S. Chaiklyn (Eds.), *Understanding of practice: Perspectives on activity and context* (pp. 3–32). University of Cambridge Press. <https://doi.org/10.1017/CBO9780511625510.002>
- Lave, J. (1996). Teaching, as learning, in practice. *Mind, Culture, and Activity*, 3(3), 149–164. https://doi.org/10.1207/s15327884mca0303_2
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

- Leontiev, A. N. (2004). *O desenvolvimento do psiquismo*. Centauro Editora.
- Marx, K. (1980). *O capital: Crítica da economia política. Livro 1: O processo de produção do capital* (R. Sant'Anna, Trans.). Editora Civilização Brasileira. (Original work published 1890)
- Marx, K. (2008). *Contribuição à crítica da economia política* (F. Fernandes, Trans.). Expressão Popular. (Original work published 1859)
- Marx, K., & Engels, F. (2009). *A ideologia alemã* (Á. Pina, Trans.). Expressão Popular. (Original work published 1932)
- Meireles, M., Souza Pimentel, D. D., & Creed, J. (2015). A educação ambiental no controle da bioinvasão marinha por coral-sol (*Tubastraea spp.*, *Anthozoa*, *Dendrophylliidae*) em Angra dos Reis (Rio de Janeiro, Brasil). *AmbientalMENTEsustentable*, (20), 323–343. <http://hdl.handle.net/2183/22207>
- Netto, J. P. (2011). *Introdução ao estudo do método de Marx*. Expressão Popular.
- Oigman-Pszczol, S., Creed, J., Fleury, B., Mantelatto, M. C., Capel, K. C. C., Meireles, C., Cabral, D., Masi, B., & Junqueira, A. (2017). O controle da invasão do coral-sol no Brasil não é uma causa perdida. *Ciência e Cultura*, 1(69), 56–59. <https://doi.org/10.21800/2317-66602017000100019>
- Vásquez, A. S. (2007). *Filosofia da práxis*. Expressão Popular.

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