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The Complexity of the Coastal Landscape: Assembly of Environmental Systems and Knowledge in Peña Blanca, Mexico

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Abstract

This work describes a complexity window in the Mexican Pacific, the Peña Blanca coastal landscape, which hosts a socio-environmental habitat resulting from the interaction of coastal features, their biophysical elements, and the regional climate (rains, drought, hurricanes, and storms). The cliffs on the coast of Colima, Mexico, are a habitat that allows the development of marine species adapted to constant and intense waves, sea breezes, splashes, and a rocky substrate, which become limits or edges that explain their spatial and temporal distribution. The so-called "chitons and hat snails" (*Chiton articulatus* and *Calyptraea spirata*) are recognized and identified as gastro-ecological elements and a regional food heritage resulting from the coastal complexity. Given their regional endemism, their populations, nutritional aspects, and interactions with the local community should be studied to establish inclusive and sustainable socio-ecological strategies for the maintenance of these marine species in the face of artisanal extractive processes and the current climate variability.

Keywords: Coastal socio-environmental complexity; Gastro-ecological landscapes; Univalves; regional food heritage; Conservation

Introduction

The Peña Blanca coastal system in Manzanillo, Colima, is located on the Central Pacific coast of Mexico (Figure 1). It is composed of multiple biophysical elements and coastal features, such as dunes and dune vegetation, beaches, coastal lagoons, marshes, cliffs, tidal pools, low deciduous forests, and mangroves, all of which are shaped under the influence of two climatic seasons (wet and drought) associated with hurricanes and tropical storms [1,2]. These environments are assembled into landscape scenes, which become habitats with particular characteristics derived from the interaction between ocean processes (coastal dynamics, sea breezes, tides, and splashes) and geomorphological features. They constitute a unique and complex socio-environmental system under a dynamic balance where the interaction of the coastal marine biophysical elements provides various goods and services, including a first line of defense against a potential rise in sea level, and socio-cultural inputs, natural richness, food sources, and emerging properties such as the beach + dunes coastal landscape [3].



Figure 1: Location of Peña Blanca Coast, Manzanillo, Mexico. Google Earth Images. Omar Cervantes Map Author.

As a result, micro-landscapes representing ecosystems are created, which must be studied and understood as coastal complexity scenes and spaces where constant and dynamic innovation alters and maintains a dynamic balance. In turn, this produces perfectly adapted species due to synchronized interactions that respond to spatial and temporal changes in the environmental conditions they are exposed to. These conditions have intensified and increased, facing a series of signals of an accelerated global environmental change that reflects climatic variability represented by stressors. The effects and potential changes from these stressors can be understood—and, therefore, identified, evaluated, and predicted-from the complexity concept perspective as a network of synchronized interactions that operate under an environmental order and hierarchy that explain its self-organization, functional processes, taxonomic scales, and a fundamental factor to understand them: the limits or borders that explain the distribution and spatial and temporal variation of their elements.

This defines particular or specialized spaces, segments, or substrates identified as socio-ecological or socio-environmental, which are the sociocultural foundation, basis, or support. The patterns that connect these spaces with the coastal community are based on knowledge and perspectives about the functioning or composition of these socio-ecological substrates. These substrates become potential inputs for maintenance, management, planning, or administration strategies of these spaces and the scenes they represent. This is the case of the coastal area known as Peña Blanca, characterized by various coastal features with particular functional elements and processes articulated and identified as food micro-landscapes, which, according to their composition, have been called gastro-ecological spaces. Peña Blanca includes rocky marine cliffs with peculiar features that house a geological and biological richness represented by native flora and fauna. Given its environmental and cultural relevance, Peña Blanca can be considered a natural, biocultural, and food heritage [4,5], which justifies its establishment as a geopark or geosite, given its didactic, recreational, ecological, and scientific value. Other coastal areas of the American continent share this status for promoting the economic and tourist development of the community while protecting these areas of socio-environmental interest [6], also supporting scientific tourism strategies based on coastal and food landscapes [2].

Analysis and Discussion

Cliffs and chitons

The Peña Blanca cliffs (Figure 2). are the habitat of marine organisms that are used based on local knowledge and traditions. Species worth highlighting are the polyplacophoran chitons *Chiton articulatus* and *Calyptraea spirata*, commonly known as sea cockroach and Chinese hat snail, respectively. Both are endemic to

the Mexican Pacific coast, with populations thriving on the coasts of Colima and, particularly, on the cliffs of the Peña Blanca beach. *C. spirata* is species of commercial importance exploited in the central Mexican Pacific region. Its meat and hat-shaped shell are highly appreciated as food and for other uses. This mollusk is directly exposed to intense waves in high-energy coastal rocky shores and cliffs, and its shell diameter is larger in areas with greater wave exposure and intensity. This chiton is collected manually on the beaches or by compressor-assisted diving during lobster and octopus fishing. It is an edible species that is valued and consumed by the local inhabitants in the Chamela Bay region, state of Jalisco [7,8] and Colima, and is also used as bait or for local sale. Its shells are highly appreciated as ornamental items and used for handcrafting. There is neither well-organized exploitation nor proper marketing. However, they are important in the family economy of the region as they provide food and income from the direct sale of meat and shells. Its demand and sale in restaurants, seafood markets, bars, and cocktail bars vary throughout the year because it depends on habits and traditions (Easter season, holidays, and end-of-year celebrations), as well as on weather conditions (tidal waves and storms) (Figure 3).



Figure 2: Coast of Peña Blanca. Cliffs, Island, beach and dunes. Photo credits Omar Cervantes.



Figure 3: Coast of Peña Blanca. Gastro-ecological spaces. Gorros and Quitones. Fisherman. Gastronomic preparation of univalve mollusks. Photo credits Itzel Sosa-Argáez.

Coasts and ethnography

The above has been documented from the complex-systems theory, emphasized in ethnography, the regional food heritage (PAR, for its acronym in Spanish), and coastal and food landscapes [2]. Thus, *C. spirata* is exploited with no restrictions for subsistence and self- consumption, and its fishing quotas are currently

not regulated by the General Law of Sustainable Fisheries and Aquaculture, the National Fisheries Charter, the General Law of Ecological Balance and Environmental Protection (LGEEPA), NOM-059-SEMARNAT-2010, or any other applicable legal instruments. This has led to a disorganized extraction process that follows tidal patterns (astronomical and storm), climatic seasons (absence of storms and hurricanes), and the uses and customs of the human communities living near this coastal site. One aspect worth mentioning is the empirical conservation and maintenance of this product without following the health and hygiene protocols for bivalve mollusks; as a result, the periods of safe consumption are short-lasting and pose risks to consumers. Therefore, there is a potential scenario of changes in the natural populations of these organisms, with social, economic, nutritional, and health effects on the communities that use them. We investigated and defined the Knowledge System around this species and the micro-landscape that harbors it, and also gathered information on the perception and local knowledge of the actors who extract and market the product in an artisanal way (known as gorreros). As a result, we recorded local knowledge about the food culture that may be useful for the care and conservation of this and other food-relevant species with incipient exploitation for being used basically as a means of subsistence and self-consumption. All of the above allows for visualizing and recognizing the close links and connection patterns between ecosystems and human societies (Complex Socio-Ecological Systems) represented as coastal and food landscapes. Through socio-political and ecological entities, these landscapes potentially allow encompassing sustainability, governance, policy, and ethics for biodiversity conservation in the face of global environmental change and climate variability resulting in changes on the adaptation of these complex socio-ecological systems [9].

Knowledge systems and regional food heritage

Knowledge Systems, understood as popular knowledge transmitted from generation to generation, and the Regional Food Heritage (PAR) of coastal communities near Peña Blanca have been developed by at least two generations of women and men who give them a traditional imprint, that is, they are subjected to constant evolution and renewal. Considering time as one of the variables, tradition is a phenomenon that undergoes visible and authentic changes [10]. Chitons are collected from cliffs and dishes are prepared by combining them with inland ingredients. It is worth mentioning that traditional should not be confused with ancient, i.e., assuming that everything traditional is necessarily many years old, which is not always the case. Tradition is defined by the cultural practices of a community that prepares food in a unique way of their own, which is then incorporated into the customs and uses that are part of the complex Peña Blanca socio-ecological system (Sosa-Argáez, Pérez M. 2021). We carried out semi-structured interviews with the local fishers, called gorreros, who, at low tide, engage in the collection and subsequent trade of Chiton articulatus (sea cockroach) and Calyptraea spirata (hat snail). They provided local knowledge about the food culture phenomenon that may be potentially useful for the care and protection of these species.

Thus, and given the above, sea cockroaches and hat snails are part of a non-material heritage, which is essential for the transfer of social identity and memory, understood as a living culture of those who produce it and provide ethnographic information and explanations [11]. This PAR results from an assemblage and interactions between the environment and local communities, where local and acquired knowledge is transformed into flavors, colors, and textures, giving identity and constructing Cultural and Food Landscapes [12]. The PAR is the intrinsic relationship between nature and man through culture, which changes by incorporating new knowledge. Through direct interviews with coastal fishers and cooks applying the ethnographic method, we recorded seven ways of chiton processing and consumption, which reflect the traditional regional cuisines of the Manzanillo coast.

Conclusion

That is why the registration of these species and the techniques and food preparation (Table 1) resulting from the creativity of the local communities and municipalities surrounding the Peña Blanca coastal region should be promoted as elements of the Regional Food Heritage (PAR) of the state of Colima. To note, one limitation to understanding this Knowledge System is the lack of studies assessing the nutritional characteristics of both species, which supported this pioneering study and future research in the state of Colima. All of the above underpins that knowledge systems and PAR are expressions of culture as a set of knowledge, techniques, traditions, and symbols related to the ways of producing, preserving, transforming, cooking, sharing, and consuming food. It is essential to recognize the importance of the transmission of knowledge through PAR registration as a repository of traditions and customs whereby women and men preserve family and local traditions. Besides, we should seek answers to establish safe forms of consumption, considering minimum sizes for collection, closed season, and other aspects. These should involve the participation of actors that set out public policies for the conservation of these species through regulations addressing human consumption and promoting the preservation of the species for present and future generations.

Table	1:	Local	food	preparation	using	hat	snails	and
chiton	s.							

Univalves	Local Food Preparation		
	Ceviche		
	Tahitiana		
Hat Caril (Calmburgan Cainata) 8	Breading		
Hat Shall (<i>Calyptraeu Spirata</i>) &	Aguachile		
Sea Cockroach (Chilon Articulatus)	Seafood salad		
	Cocktail		
	Consumed with rice		

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