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# La Passion-Clipperton Atoll in the Eastern North Pacific: Anthropogenic Traces Revealing Environmental and Societal Dynamics

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## Abstract

Clipperton or Passion Island is a French possession, located in the north-eastern Pacific Ocean. Uninhabited since 1945, the atoll is considered the most isolated in the world. In addition to a few plant and animal species that thrive there, the island has large colonies of seabirds, land crabs and recently rats, which are engaged in an interspecific struggle. In addition, Clipperton's EEZ provides a significant resource of fish and polymetallic nodules. A scientific expedition studied the remains present on the coral crown: from Mexican remains from phosphate mining, to those abandoned by the American army, to wrecks of fishing boats, to the numerous pieces of waste transported by marine currents. The problem of such remains is thus considered not only as a reverse side of production, but also as a research object combining historical, geographical, economic, geopolitical, landscape and symbolic dimensions. Indeed, the island of Clipperton, currently free of human settlement and occupation, is nevertheless subject to anthropic interactions. In addition to the fact that its location gives it a geostrategic interest for the French State, the island constitutes an *in situ* and *in vivo* laboratory, for long-term scientific study.

## Keywords

Clipperton Atoll, Anthropogenic Traces, Island Biodiversity, Marine Waste, Human Influence on Territories

## 1. Introduction: Present Remains Bear Witness to Past Human Activities

"*A star and sand. The star could be one of the brilliant objects that populate the Universe, the sand could be that of any planet. But the sand here is that of the Earth, and the spectacle makes sense because it is seen. The important thing is not the sand or the star, but the invisible, central human being who looks, wonders and admires. At the end of his questioning, he creates a model of the world, science, in an unfinished co-birth. In the course of his admiration, he casts a new eye on the world, art, in a constantly renewed rebirth*" [1].

Clipperton, a small French atoll lost in the North Pacific Ocean off the coast of Mexico, uninhabited, little-known and even forgotten, is of great scientific and geostrategic interest. Owned by France since 1931, with sovereign rights over the exploitation and use of its resources, the atoll has taken on a new importance, evolving with history. However, isolated, far from the mainland and decision-making centres, it remains unknown to many. Yet it has been referred to in documentaries, expedition reports and novels, and given many names that reveal its physical, biological, historical and even mystical characteristics, such as 'Treasure Island'[1] [2] [3], 'Island of Passion'[2] [4], 'Island of Guano'[3], 'Island of Birds'[4] [5] and 'Island of Solitude'[5]. Two book titles, 'Tragic Island' by Rossfelder [6] and 'Island of Fools' by Garcia Bergua [7] tell the real and tragic story of the 'Forgotten Ones of Clipperton', which has also earned it the nickname of the 'island of for-

[1]Legend has it that in 1704, the freebooter John Clipperton, a mutineer or deserter from the ship Saint-Georges, led by the privateer William Dampier, hid a treasure there. Although no written trace of his passage has been found, history retains the name of Clipperton Island. According to Juet, the Clipperton treasure was an invention of Captain Murtie. After damage caused by a violent storm, the English ship *Kinkora*, loaded with wood, ran aground on the island's coral reef on May 1897. Murtie and the entire crew took refuge on the island and built shelters from the wood in the cargo. A week later, the crew of the schooner *Twilight* passed by the island and saw signs of the shipwrecked crew. The captain of the *Twilight* asked for a large sum of money to take them on board. Murtie refused and, to keep his men busy, invented the legend that John Clipperton had hidden a treasure on the island. On 27 June 1897, they were all rescued by the British cruiser *HMS Comus*.

[2]The atoll was sighted by French navigators on Good Friday 3 April 1711, the day of the Lord's Passion. On 23 March 1708, four ships, the *Princesse*, the *Aurore*, the *Diligente* and the *Découverte*, fitted out in Le Havre and Dunkirk, left the port of Brest bound for the Peruvian coast. On 8 March 1711, Mathieu Martin de Chassiron (1674-1722) and Michel Dubocage (1676-1727), commanding the frigates *Princesse and Découverte* respectively, set sail for China. On their way, on 3 April 1711, they sighted an uninhabited island that they named 'Passion'. They were unable to land there due to the state of the sea, but Dubocage described it in his logbook and mapped it. On 13 July 1712, after an eight-month stopover, the two ships left China. On 23 August 1716, they returned to the port of Le Havre. On their return, they discovered that a few years earlier, in 1704, the buccaneer John Clipperton had set foot on the island, which took his name.

[3]In the 19th century, guano was harvested and used as a fertiliser because of the phosphate it contained. The island's nickname is not misplaced, given the permanent presence and smell of this decomposing organic matter and the droppings that, when released from the sky, bless our presence.

[4]Nickname given by a cadet on board the cruiser Jeanne d'Arc on 4 December 1935.

[5]Film directed by Jacques-Yves Cousteau and Jacques Ertaud, 1980, Coll. The Underwater Odyssey of the Cousteau Team, vol. 36, Cousteau Foundation in co-production with TF1, KCET Los Angeles USA and Bavaria Atelier Gmbh/Amaya.

getfulness'[6]. More recently, other adjectives have been used, such as 'crab island'[7] [8]-[10], 'island of extremes'[8] [4] or 'mysterious island'[9]. Although uninhabited and isolated, the atoll contains many remnants of past human occupation and present activities, particularly in the Exclusive Economic Zone (EEZ), as well as countless items of rubbish carried back by the ocean currents and bearing witness to human impact on the ecosystems (**Figure 1**).

**Figure 1.** Clipperton atoll, at sunset, seems to float on the ocean. Credit: Tchekemian (2023) [11].

[6]In 1906, the Mexican government installed a garrison of soldiers, women and children. Captain Ramón Arnaud, at the head of the group, was appointed Governor of the island. The Mexican navy supplied them approximately every four months. But from 1910, at the start of the Mexican revolution, the islanders were no longer supplied and became 'the forgotten people of Clipperton'. Many died of scurvy or shipwreck trying to reach the Mexican coast. At the end of May 1915, Captain Arnaud spotted a ship off the coast of Clipperton. Desperate for help, Arnaud and Lieutenant Cardona decided to launch a makeshift raft. Unfortunately, the men disappeared into the ocean, leaving women and children to their fate. All that remains is the lighthouse keeper, Victoriano Alvarez, who everyone thought had died of scurvy, and fifteen women and children. The only man on the island, Alvarez proclaimed himself 'King of Clipperton' and for more than two years of tyrannical rule, he sexually abused and killed his subjects. On 17 July 1917, in a final burst of courage, two women, Alicia Arnaud and Tirzah Randon, struck their torturer dead. Ironically, the following day, 18 July 1917, the American ship *Yorktown*, which had come to check that Clipperton Island was not harbouring a German submarine base, landed on the island to discover three women, an adolescent girl and seven surviving children, emaciated, scared and haggard, as well as the lifeless body of Victoriano Alvarez.

[7]On Clipperton, millions of land crabs form a large colony. This orange-coloured crab is omnivorous and opportunistic, feeding on vegetation, regurgitation, seabird eggs laid on the ground and animal remains. The Clipperton crab was previously named Gecarcinus planatus Stimpson. In 2015, the expedition identified this native Clipperton species as *Johngarthia planata*. Then, the study by Perger revealed that the Clipperton crab, like that found on Socorro Island (Revillagigedo archipelago), located 900 km from Clipperton in the eastern Pacific Ocean, belongs to a new species, *Johngarthia oceanica* sp. nov, different from *J. planata* because of the broad sub-rectangular lobe of the infraorbital margin (narrow, sub-triangular in *J. planata*) and a dark yellow to bright orange dorsal carapace, with or without black areas, of different extent (uniformly red to brown in *J. planata*). On Clipperton, the crab population, *J. oceanica* sp. nov. deserves special attention because of the threat posed by the development of the black rat (*Rattus rattus*), a species introduced in the early 2000s with a high reproductive capacity, whose colony competes with other species.

[8]Because of *the* '*extreme fragility of this exceptional environment*', and the extreme climatic conditions encountered (heat, bad weather, storms, cyclones).

[9]*The Mysteries of Clipperton* is the title of the 2005 documentary by Brigitte Delahaie, Luc Marescot and Pascal Plisson, produced by Gedeon Programmes and Canal+, revealing the exploration of the atoll by a team of scientists led by Jean-Louis Etienne from December 2004 to April 2005.

Clipperton is the only French territory in the north-east Pacific, located in the Latin American and Caribbean zone. Located 10,200 km from mainland France, 5400 km from Tahiti and 4100 km from the Marquesas Islands in French Polynesia, in the South Pacific, it is also 5000 km from Hawaii, 2400 km from the Galapagos Islands and 1100 km south-west of the Pacific coast of Mexico (Figure 2). Uninhabited since 1945, Clipperton is considered to be the most isolated atoll in the world, according to the French Committee of the International Union for Conservation of Nature. The only land mass between the mainland and the Marquesas archipelago, it is a stopover for many seabirds. In fact, the atoll is the only possible egg-laying site in the middle of an ocean surface area of several million square kilometres, and is home to a large colony of boobies.


Figure 2. Location of Clipperton atoll and the Pacific EEZ, between the islands of French Polynesia and the coast of Mexico.

In April 2015, an international expedition[10] from Tahiti took us to Clipperton. This scientific mission received financial support from the French Development Agency and the Pacific Fund. In terms of logistics, we were able to count on the support of the French Navy, by boarding the surveillance frigate Le Prairial (F731), and on the French Army, since a detachment of six men from the Régiment d'Infanterie de Marine du Pacifique-Polynésie (RIMaP-P), 'Les Dragons', assisted us on a daily basis. The presence of the French army on the atoll was the

[10]This expedition, organised by geographers from the UMR EIO from[1] April to 6 May 2015 (five weeks), took place as follows: departure from the port of Pape'ete (Tahiti) on[1] April 2015, aboard the French Navy's '*Prairial*', with a stopover in Hiva Oa (Marquesas Islands) on 6 April, arriving in Clipperton on 14 April, a fourteen-day crossing; the stay on the atoll lasted fifteen days, from 14 to 29 April 2015; on the return journey, five days of crossing, from 30 April to 6 May 2015, were needed to reach southern Mexico, for a flight from Tapachula to Fa'a'a (Tahiti).

first military occupation of Clipperton since the last 'Bougainville mission'[11] in 1969.


**Figure 3.** Aerial view and description of the Clipperton peninsula. Source: Tchekemian (2023).

Clipperton Island is the highest point on the oceanic ridge of the same name. Born from an underwater volcano, the island can be defined as a coral peninsula atoll due to the presence of the Rocher (coordinates 10 17 540 north and 109 12 441 west), a remnant of the former volcanic island. The atoll, which is currently closed, is sub-circular in shape and 12 km in circumference. The diameter of the atoll varies between 3 km and 4 km, with the north-west-south-east axis being the largest. Its coral reef (3.7 $km^2$) partially surrounds a lagoon, currently closed, with a surface area of 7.2 $km^2$. There is no correlation between the water level in the lagoon and the sea level, but during rainy periods the water level in the lagoon varies rapidly[12]. The lagoon is between 45 m and 400 m wide, with a land area of 1.7 $km^2$. The total surface area of the atoll, including the lagoon, is 8.9 $km^2$. The soil is made up of dead coral aggregates and sand, often cemented with guano (**Figure 3**). Overall, the ground is no more than 4 m above sea level. With an altitude of 28.4 metres, Le Rocher is the highest point on Clipperton (**Figure 4**). A remnant of ancient volcanic activity, the Rocher is characteristic of presqu'atolls: a category of atoll surrounded by a lagoon in which the mountainous part has almost disappeared.

[11]In the 1960s, on the initiative of General de Gaulle, the decision was taken to occupy Clipperton atoll militarily. The Navy was tasked with these missions, known as 'Bougainville', which were carried out between 1966 and 1969. Their objectives were to monitor the island and the maritime zone, observe meteorological phenomena and study the rehabilitation of the airstrip built by the Americans in the 1940s. To achieve this, six months' worth of supplies and twenty-five tonnes of equipment were landed, including sanitation facilities, traditional Polynesian dwellings, drinking water treatment tanks and generators. The French army's missions followed one another, and the remains that were used to build the camp can still be found in the island's coconut grove, known as 'Bois de Bougainville'.

[12]In April 2015, after two tropical showers, a rise of 16 cm was recorded in just a few hours.

**Figure 4.** The Rock of the Clipperton peninsula, 28.4 m high. Source: Tchekemian (2023).

Conversely, the deepest point is between 33 and 34 metres below the lagoon's datum. Inappropriately named the 'Bottomless Hole', the cavity corresponds to an ancient volcanic chimney (**Figure 5**). The bathymetric cross-section shows the top of a rise at the centre of the hole, 18.5 m below the lagoon's datum (**Figure 6**). This upwelling in the centre of the hole makes it unlikely that it could be 'bottomless', because for it to form, it would have to rest on rock. The most likely hypothesis for this hole is that it is a plug made of sediment. The cavity is more likely to be an old volcano chimney. The climate, a tropical oceanic type, is harsh. The temperature of the air and water, at night and during the day, varies little throughout the year: between 25˚C and 30˚C. Annual rainfall varies between 3000 and 5000 mm. Humidity levels fluctuate between 85% and 95%. The prevailing winds are the south-easterly trade winds: they are violent, with sudden and frequent downpours and numerous cyclones, generally during the months of April to September. The best time to visit Clipperton is around March. However, the heavy swell on the coral belt makes sailing and disembarking difficult and dangerous. Rain is the only source of fresh drinking water on the island. The lagoon is made up of brackish water, with a high concentration[13] of colibacilli[14], and bacteria, including *Escherichia coli*, due to its closed nature and the guano transported by run-off water. This makes it part of a natural eutrophication process[15]: a pre-cious phenomenon that many scientists would like to observe.

[13]Sampling and analysis carried out by the French Navy during the 'Passion 2015' expedition.

[14]Colibacillus is a Gram-negative, rod-shaped bacterium (*Escherichia coli*) present in the intestinal flora of animals and humans, which under certain conditions can become pathogenic and cause infections.

[15]The eutrophication of an aquatic environment, whether freshwater or marine, refers to the eutrophic character (from the Greek prefix *eu*, good, useful, real, optimal; and the root *trophê*, food), a richness in nu-tritive elements (phosphorus and nitrogen, such as nitrates). Nowadays, this term has a negative meaning akin to dystrophy. However, eutrophication is an indicator of the limited self-purification capacity of aquatic environments. It is also one of the stages in the natural process that slowly transforms shallow lakes into marshes, then meadows...

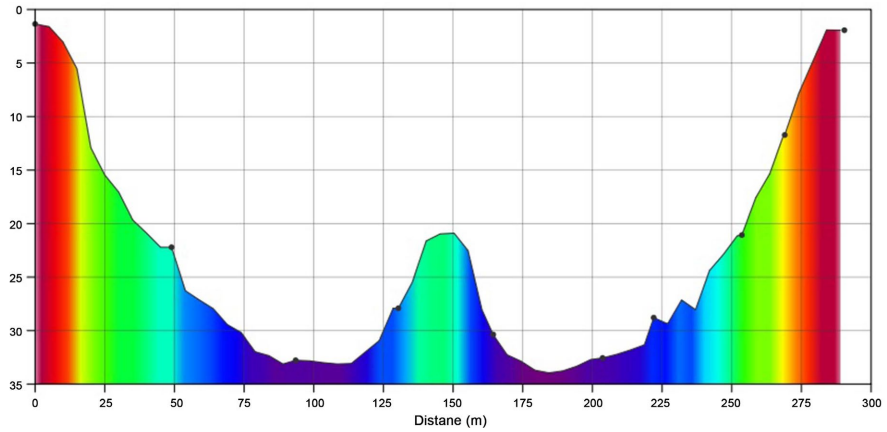


Figure 5. Bathymetric cross-section of the 'Bottomless Hole', from 33 to 34 m at the lowest points, in Clipperton lagoon (ordinate: depth in metres; abscissa: distance in metres). Source: Tchekemian (2023).

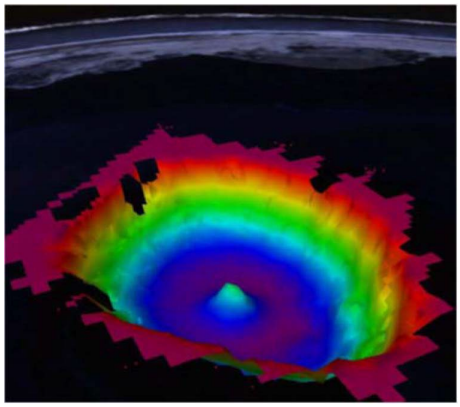

Figure 6. Three-dimensional view of the bathymetry of the 'Bottomless Hole' in Clipperton lagoon, with an 18.5 m rise at its centre. Source: Tchekemian (2023).

Now free of human settlement and occupation, Clipperton is nonetheless subject to ongoing and regular human interaction. The fieldwork has enabled us to geo-reference the remains on the atoll, measure them, determine their nature, understand their origin and function, and map them. The concept of remains encompasses both waste—material that has been discarded and thrown away, deemed to have no value—and remnants—ancient elements that have been destroyed or damaged and belong to a community. Until now, no exhaustive map had been produced. This work will make it possible to monitor the evolution of these remains, through a dynamic approach based on their deterioration, displacement, appearance and disappearance[16]. All the remains found on the atoll reflect human activities, such as phosphate mining in the early 19th century (Figure 7), reflecting the economic activity and territorial resources of the time (Figure 8), as well as the ambitions of certain countries (United States, Mexico).

[16]For example, during the field study, buried remains emerged from the foreshore with the tides and waves.

Figure 7. The French Republic stele and its mast above a mound of coral soup and guano, the remains of phosphate mining on Clipperton. Source: Tchekemian (2023).

Figure 8. Remains of a wagon on rails, dating from the end of the 19th century, when the Mexicans mined Clipperton's phosphate. Source: Tchekemian (2023).

- the stele of the French Republic and its mast (Figure 7), as well as the commemorative plaque affixed to the Rock (Figure 9), a vestige of the taking of possession of the island in 1935 by the training cruiser Jeanne d'Arc, are a reminder of sovereign power;


Figure 9. After any damage or theft (photo top left), a new plaque is affixed to the Rock, bearing the date and details of the French Navy ship that made the stopover. Source: Tchekemian (2023).

- a large number of remains from the American (wreck of the LST, amphibious gear, ammunition stocks—Figure 10) and French armies (equipment from the Bougainville missions—Figure 11), as well as wrecks from beached ships (Oco, Lily Mary—Figure 12, Figure 13);

Figure 10. Examples of US army remnants from 1944 on the atoll: ammunition stockpile (left), amphibious vehicle (centre), bulldozer (right). Source: Tchekemian (2023).

Figure 11. Remains of the Bougainville expeditions of the French army, between 1966 and 1969, on Clipperton atoll: pile of hardened cement bags, metal water tank and its support (top left), bread oven (top right), hut and metal tank (bottom left), concrete stele uncovered under the vegetation (bottom right) on which is engraved: BDC Blave-Groupe Bougainville 67-Sec AL Pac Detachement-RM-Avril 1967' (the name of the tank landing ship, the group, the section and the military regiment). Source: Tchekemian (2023).

Figure 12. Degradation, between 2008 and 2015, of the Costa Rican trawler, the Oco, which ran aground around 2005, south-west of the Clipperton Rock. Source: Tchekemian (2023).

Figure 13. Degradation, between 2008 and 2015, of the tuna vessel Lily Mary, grounded in 2000, on the north-east coast of the atoll. Source: Tchekemian (2023).

- but also the remains of Jean-Louis Etienne's scientific expedition in 2005 (Figure 14).

Figure 14. Remains of the camp from the expedition led by Jean-Louis Etienne in 2005, photographed in 2008, including the 'crazy people's bar', comprising, among other things, a sink, a gas cooker, jerrycans, cables and so on. In 2015, the facades, roof and other wooden elements were on the ground. Source: Tchekemian (2023).

Seen from the air, the atoll appears wild, devoid of human activity or presence (Figure 15), but on the ground, the remains are scattered all over, reflecting several stages of anthropisation and revealing current environmental crises. In this respect, the wreck of the Lily Mary, a tuna boat that ran aground in 2000, is particularly revealing, as it combines anthropogenic and environmental issues. As well as being a remnant, it raises the question of the introduction of an invasive animal species—the rat—and its consequences. Before 1997, the 'SurPacClip' expedition had not found any rodents; in 2001, however, their presence was confirmed by the members of the first 'Passion' expedition. This wreck is not isolated, and we can also mention the wreck of the Costa Rican trawler, the Oco (located to the south-west of the Rock), which ran aground in 2005, although information is lacking. The swell progressively dismantles these remains, which are still visible, alongside the large amount of rubbish transported by the currents and deposited on the beaches by the waves, particularly at high tide. Violent winds then scatter them across the island. The weight of plastic on the atoll's crown has been estimated[17] at 35 tonnes (Figure 16) and glass at 10 tonnes, not including the driftwood that washes up and adds to the metal remains already present (munitions,

[17]The land area of the island is 1.7 km$^2$, or 170 ha. The rock and its surroundings, covering an area of 40 ha, contain no waste. As a result, 130 ha of the coral crown is polluted by waste.

wrecks, boat engines, etc.).

Figure 15. Aerial photograph of the north coast of Clipperton atoll. Source: Tchekemian (2023).

Figure 16. Ground photograph of piles of rubbish on the north-west-south-east coast of Clipperton atoll (left) and piles of plastic debris eroded by the sea (right). Source: Tchekemian (2023).

Changes in demographics, lifestyles and consumption patterns, as well as preoccupations, have brought 'leftovers' into the category of the social sciences. The rise of garbology and rudology marks the first steps towards treating residues as tools for portraying societies. Using this concept allows us to examine the ways in which knowledge is constructed, in relation to systems for organising activities and representing the island. This study therefore makes a modest contribution to the debate now underway in geography as to whether the interest shown by the social sciences in remains as a research object, but also as a challenge for the organisation of territories, can be described as an epistemological turning point. The study of remains provides an opportunity to consider and debate the effects of the current economic and environmental crises.

The study of the remains provides us with information about the history of the island, its uses, activities, economies, leisure activities... and therefore about human appropriation, right up to territorial claims. Overall, it allows us to understand the forms of management, exchange, transformation and recovery of material elements left behind and destined to 'disappear'. The issue of leftovers is seen not only as a reverse side of production, but also as an object of research combining

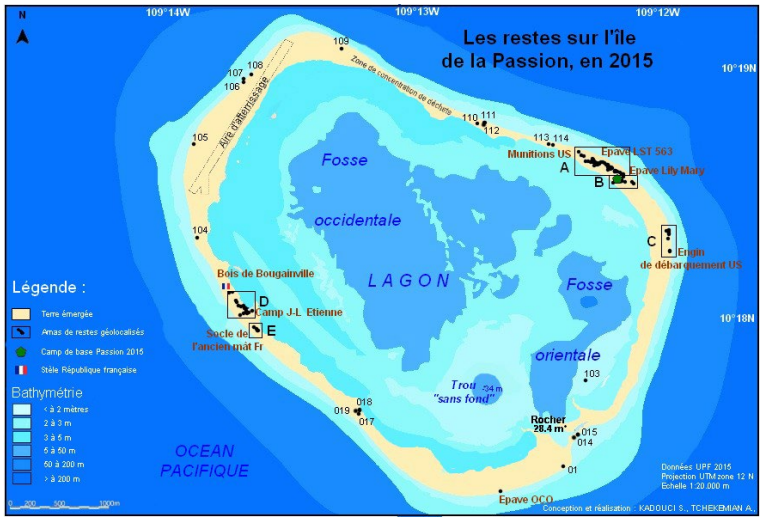


**Figure 17.** Georeferencing of remains on Clipperton atoll, geolocated in April 2015.

historical, symbolic, practical, geographical, economic, geopolitical, landscape and environmental, ecological and symbolic dimensions. Mapping and photographic illustrations of the geo-referenced remains on the atoll were used to establish the current situation. Methodologically, the whole of the land area between the ocean and the lagoon was surveyed, to grid the coral crown of the island.

From a methodological point of view, we are studying the nature of these remains, their dis-persion, their dynamics and their effects on the environment. The processing of this data is of major heuristic value in the human and social sciences, particularly in geography and regional planning. The fieldwork has made it possible to geo-reference the remains on the island, measure them, understand their origin and function, determine their nature, illustrate them with 255 photographs on the ground, and then map 118 corresponding remains (**Figure 17**); they correspond either to unified remains, in which case they are counted as one element; or to scattered remains of the same element, but over an area; in this case the pieces are considered as a whole, counted and car-tographed as one element, and the same applies to the waste, generally grouped together in heaps. Mapping and photographic illustrations of the geo-referenced remains on the atoll have made it possible to draw up an inventory. Methodologically, the whole of the land area between the ocean and the lagoon was surveyed, to grid the coral crown of the atoll.

## 2. Low Terrestrial Biodiversity, with Significant Interspecific Relationships

On Clipperton, the climate, the lack of water and the saline environment mean that only around fifteen plant species can be found, most of which are halophilic and xerophilic, none of which are endemic. Some appear and disappear over time, more or less sensitive to the sun, sea spray, swell, poor, dry, sandy soil, etc. Only

two species have been deliberately introduced by man: the coconut palm (*Cocos nucifera*) by the Americans in 1897 and tobacco (*Nicotiana glauca*) by the Mexicans in 1900. From the lagoon to the ocean, there are coconut palms (Figure 18), the only representatives of the tree layer, as well as groups of herbaceous plants: geniculate eleocharid (Eleocharis geniculata), wild okra (*Corchorus aestuans*), Curaçao heliotrope (*Heliotropium curassavicum*), goat's-foot and triloba ipomoea (*Ipomoea pes-caprae*, *I. triloba*—Figure 19), Queensland hemp (*Sida rhombifolia*) and purslane (*Portulaca oleracea*). In addition to this list, seven other plant species have been identified, including Eugene grass (*Achyranthes aspera*), sage (*Salvia occidentalis*), wild okra (*Corchorus aestuans*), rush (*Eleocharis mutata*), small white tamarind (*Phyllanthus amarus*), ciliated erragrostida (*Eragrostis ciliaris*) and thorny cenchrus (*Cenchrus echinatus*). Some more sensitive species, such as the Tahitian pūrau (*Hibiscus tiliaceus*), present in 2005 but not found again in 2015, are finding it difficult to maintain their presence on the island.

Figure 18. The coconut grove in the Bois de Bougainville, where certain isolated trees exposed to storms and strong winds have been topped. Source: Tchekemian (2023).

Figure 19. A carpet of plants formed by ipomoea, a creeping vine that covers the remains on the atoll. Source: Tchekemian (2023).

The floristic inventory carried out during this mission identified fifteen species of plants that make up the terrestrial flora (Figure 20), compared with twenty-four in 1958 and six in 1997 (Figure 21), although the number of individuals per species has increased compared with previous inventories. These plants have been transported by man, sea currents and spread by the wind and birds[18].

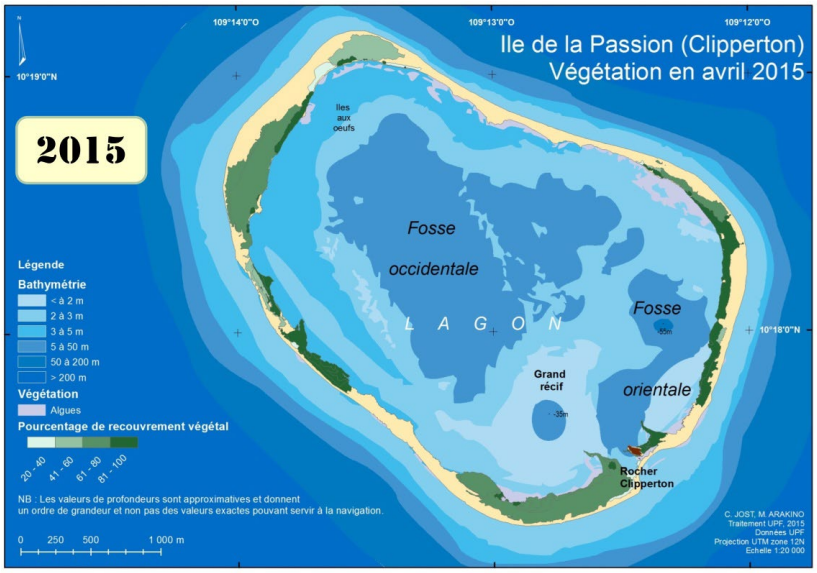


Figure 20. Mapping the vegetation cover of Clipperton atoll following the Passion 2015 expedition.

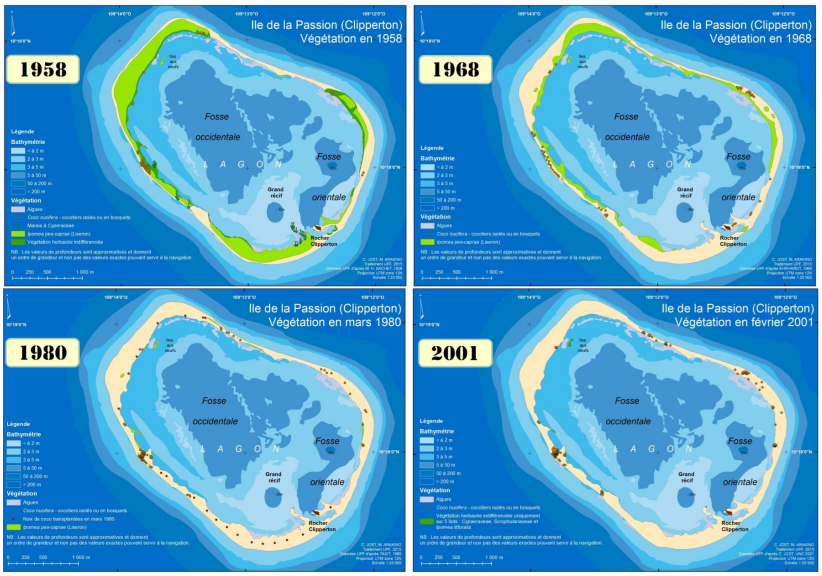


Figure 21. Mapping changes in the vegetation cover of Clipperton atoll between 1958 and 2001.

[18]For example, birds can transport seeds and spores through their plumage, legs and beaks (ectozoochory or epizoochory) and after ingestion (endozoochory) and ejection, enabling plants to spread: the term zoochory, from the ancient Greek *zôion* (ani-mal) and *khôrein* (to move), is used to describe the strategies used by animals to disperse seeds.

From 1958 onwards, following the elimination of pigs, the only predators, land crabs multiplied into millions of individuals [12]. This largely explains the disappearance of vegetation, since crabs feed on algae, coconut leaves and carrion. Since 2001, following the accidental introduction of the black rat (*Rattus rattus*), the crab population has declined considerably, and young plant shoots, which are eaten less, have been able to develop. Between 2001 and 2015, there was a rapid decline, particularly in creeping plants, to the detriment of ground-nesting birds such as masked boobies. In 2015, 46% of the atoll's crown was covered by vegetation, whereas in 2001 there were no representatives of the herbaceous or shrubby strata. Only 674 coconut trees were recorded, compared with 806 in 2015. In 2016, observations confirmed this revegetation dynamic. In 2018, 1,405 coconut trees were inventoried (865 in 2016 compared with 847 in 2015). The lianascent vegetation has also developed considerably, in particular the ipomoea meadows, which are extremely lively, despite the regular submergence of certain areas during heavy swells.

The low diversity of terrestrial animals is characterised by large, fragile colonies. The fauna is limited to the presence of one species of lizard, the Arundel skink (*Emoia cyanura arundelii*) [13], centipedes, followed by large colonies of land crabs and black rats. The latter is thought to have been unintentionally introduced to the island in the early 2000s, following the grounding of a tuna boat. Clipperton is also home to a large colony of masked boobies (*Sula dactylatra*), and (**Figure 22**, **Figure 23**) to a lesser extent brown boobies (*Sula leucogaster*), red-footed boobies (Sula sula) and a few frigate birds (*Fregata minor*), gygis (*Gygis alba*), American coots (*Fulica americana*), moorhens (*Gallinula chloropus*), as well as the red-tailed strawbird (Phaethon ru-bricauda) and four species of tern [14]. The atoll is also visited by other migratory birds from North America [15] [16]. Colonies of crabs and boobies have established themselves on the coral crown.

**Figure 22.** Masked booby (left) on the hull of a jet-ski floating in the lagoon, brown booby (middle) surrounded by Ipomoea, red-footed booby (right) at the foot of a coconut-tree, Clipperton. Source: Tchekemian (2023).

The number of land crabs is now declining, estimated at just 1 million in 2015 (compared with 11 million in 1967 and 1.25 million in 2005), a trend supported by the observation of lianascent flora, which is now very widespread (**Figure 24**).

Figure 23. Juvenile masked booby with a piece of plastic in its beak (left) and an American coot nest made from plastic waste. Source: Tchekemian (2023).

The masked booby population is also declining, from 100,000 in 2005 to 40,000 in 2016, a loss of 60% in 11 years. These birds are a sign of the vitality of the environment, which offers nesting sites. Their droppings help to enrich the soil and encourage plant growth. Both the crab and booby populations are continuing to decline, due to the low plant resources available to the crab, the rapid development of the rat (Figure 25), which is now the only predator on the atoll, and the pressure on fish resources exerted by the many fishing boats, forcing the seabirds to travel up to 132 nautical miles (244.5 km) every day to find food [14].

Figure 24. Clipperton land crab (*Johngarthia oceanica*) feeding on the skin of a young masked booby. Source: Tchekemian (2023).

Figure 25. Nest of black rats in a metal remnant, near the RF stele, including mulch, feathers, fish bones and crab carcasses. Source: Tchekemian (2023).

In the lagoon, which is currently closed, we note the absence of fish. In the ocean, however, the underwater fauna is very abundant, thanks to the zooplankton. In the intertidal zone and at depths of up to ten metres, we could regularly observe numerous tropical fish, including surgeonfish (*Acanthurus achilles*, *A. triostegus*, *A. nigricans*, *A. xanthopterus*) and nasons (*Naso annulatus*, *N. hexacanthus*, *N. lituratus*). Near the atoll, endemic marine species have been re-marked, including the Clipperton grouper (Epinephelus clippertonensis), Baldwin's warmouth (Stegastes de baldwini), Robertson's wrasse (*Thalassoma robertsoni*) and the Clipperton angelfish (*Holacanthus limbaughi*—**Figure 26**). All these species have already been recorded in Clipperton [17]. We also noted the presence of moray eels, lan-goustes and small sharks. The remains of dolphins and marine turtles were also found on the shore of the atoll (**Figure 27**). Perhaps these species had fallen victim to the fishing nets of the factory ships?

**Figure 26.** The Clipperton angelfish (*Holacanthus limbaughi*), an endemic and protected species (by decree dated 15 November 2016). Source: Tchekemian (2023).

**Figure 27.** Dolphin and sea turtle remains discovered on the shore of Clipperton Atoll in April 2015. Source: Tchekemian (2023).

The activity of numerous factory ships in and around Clipperton's EEZ also tells us about the abundance of tuna, bonito, marlin, swordfish and so on. However, we have no precise idea of the richness of the waters, nor of the attraction and retention that its oceanic isolation creates. Nonetheless, at the time of our expedition, no fisheries survey of the large pelagic fish had been carried out in the EEZ. However, the Clipperton atoll can be considered one of the world's rare sanctuaries (**Figure 28**). Clipperton is the only coral island in the North Pacific

Ocean that is occasionally inhabited, making it a unique ecosystem. What's more, its coral reef is a benchmark for monitoring corals, sharks and other pelagic species on a global scale [18].

**Figure 28.** The remarkable biodiversity of Clipperton's seabed. Source: Tchekemian (2023).

The biotic and abiotic elements that make up the island, as well as the way in which time passes, attest to the fact that this territory is far from being de-sertic or unoccupied. Clipperton's maritime and land areas contribute to the spatial and genetic connectivity of pelagic and mobile animal species. Twenty-seven of these species are on the International Union for Conservation of Nature's Red List, some of which are classified as highly threatened. In addition, thirteen species of seabird breed on the island, including four species of booby, and twenty-six others are occasional residents. Clipper-ton's barrier beach is home to one of the world's largest colonies of masked and brown boobies [19]. However, these bird colonies depend on the fishery resources present, in particular small fish and squid that are chased to the surface of the ocean by schools of tuna, themselves highly coveted by fishing boats.

Clipperton is therefore a territory of multiple dimensions and a complex set of ecosystems. Although the installation of a geodetic marker in 2001 has enabled data to be collected, it is still too early to determine whether Clipperton Island is rising or sinking. Rising sea levels could also be to blame. The geomorphological changes observed confirm that Clipperton is being eroded by the ocean. Despite rising sea levels, the coral reef remains one of the best preserved in the region, with a biomass of reef fish, specific marine species, a brackish water lagoon and a bird population of masked and brown boobies, whose colonies are said to be among the largest in the world. The island comprises a mosaic of different ecosystems, all interwoven within a small area: coconut groves, shrub steppe, dunes, beaches, etc. The density of both plant and animal life and the state of conservation of the environments make the whole area of major scientific interest. The peninsula also provides an opportunity to study atmospheric phenomena such as El Niño, the southern oscillation which is a consequence of global warming on coral reefs, impacting tectonic movements and variations in sea level.

The atoll appears to be a system in which both order and disorder are created in a self-organising process, leading us to question the relationship between rules and freedoms. It is not so much the multiplicity of elements, or even the diversity of their interrelationships, that characterises a system, but rather the potential un-

predictability of its operation, which forces us to interpret them in an intelligible way. The scientific objective is no longer to reduce the complex to the simple: it is to translate the complex into theory. The complexity of an area can therefore be seen first and foremost in its hierarchical organisational structures, and therefore in its complex internal structure. For example, in our case study, the presence of crabs, boobies and then rats creates organisational complexity, resulting in imbalances between species. In addition to the relationships between animal and plant species, the complexity of Clipperton is due to the abundance of remains of human activity. The many wrecks that have washed up on the reef around the island are a testament to the continuing difficulties experienced by those wishing to disembark there. Clipperton is constantly changing, like a vortex. Several senses are involved in defining the island's landscape: sight, hearing through the sound of the wind, the waves... touch through the unstable and loose layer of 'coral soup', but also smell through the island's particular perfume, a mixture of salts, sea spray and guanos. Wouldn't this olfactory landscape be similar to what the first navigators and explorers of the 18th century would have experienced? Clipperton is also of geostrategic interest to the French government in the North Pacific because of its location in a vast passage and fishing zone[19] [20], Clipperton also represents a geostrategic interest in the North Pacific for the French state.

## 3. Clipperton, a French Presence in the Pacific: Scientific and Strategic Interests

Much of the waste found on Clipperton is the result of globalisation. Rubbish of varying sizes, particularly plastic, is harmful to Clipperton's environment. Over a strip 400 m wide, there are large areas of piles. This waste is transported by ocean currents and deposited by waves along the coastline. Then, depending on its relief, weight and climatic events, it moves across the atoll, buries itself and slowly degrades. This is only the tip of the iceberg, as items that are too heavy or submerged (such as cans) cover the ocean floor, while more fragile items (such as cigarette butts) are scattered in micro-particles. Sea currents are variable around Clipperton and play an important role in ocean circulation as a whole, as well as in the transport of living organisms over sometimes considerable distances. In this part of the Pacific, there are three main currents whose position and intensity vary according to the season. Plastic waste dumped in the sea begins a long drift. Under the effect of the Earth's rotation, ocean currents create ocean gyres, caused by the Corio-lis force. Rubbish often drifts for decades in the ocean and clumps together. The largest patch of ocean rubbish, floating between Hawaii and California, is known as the North Pacific Garbage Vortex (**Figure 29**). It is made up mainly of plastic waste, packaging, fishing tackle, etc.

[19]Annual fishing catches in the Clipperton EEZ are estimated at 50,000 tonnes of tuna, bonito, marlin, swordfish, etc., and some large pelagic fish caught at the same time. In 2015, at least 23 vessels (flying Mexican, Costa Rican, Guatemalan, Chinese and American flags) fished illegally in the Clipperton EEZ for 125 days.

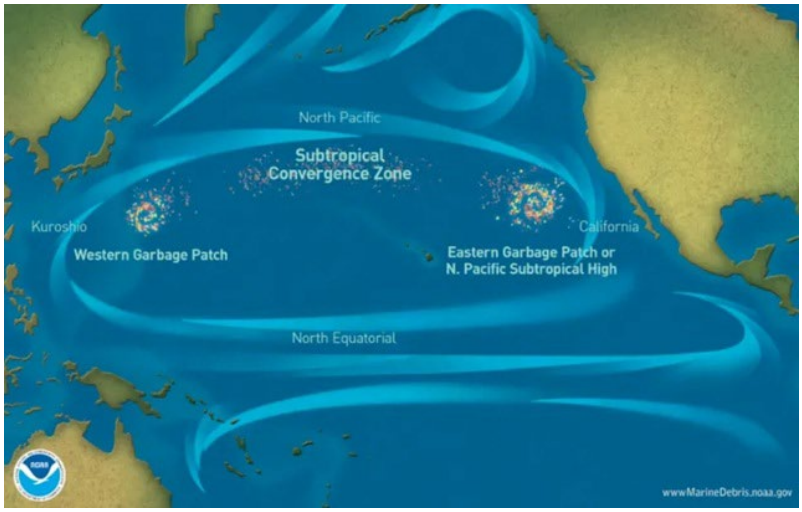


**Figure 29.** Waste patches in the North Pacific subtropical convergence zone.

The seventh continent is thought to be made up of more than 1.8 billion plastic lumps, or 80,000 tonnes, floating in the Pacific Ocean. It covers an area of 3.4 million km$^2$, and the size of the plates can be as much as 30 m deep. At Clipperton, the weight of waste on the atoll's rim was estimated in 2015 at 35 tonnes of plastic and 10 tonnes of glass, not including pieces of wood and metal debris carried by the ocean. That same year, a rubbish collection was organised with the help of all the scientists. Despite the quantity of rubbish collected, it is important to point out that it is not collected on a regular basis. The waste was loaded onto the surveillance frigate and stored in the ship's hold until the next port of call.

Clipperton is not located in French Polynesia's territorial waters, but the environmental regulations that apply there are those of the French State. In May 2002, the entire EEZ of French Polynesia was classified as a 'marine mammal sanctuary', home to more than twenty species, preserved and protected, roaming freely. The atoll offers France an EEZ of around 436,000 km$^2$, which represents as yet untapped potential for the development of international research into topics of global interest (climate change, waste and biodiversity, etc.). The EEZ is also a major fisheries resource, enabling France to meet its international commitments on marine protected areas (**Figure 30**). In 2006, a biotope protection order was issued, creating a Marine Protected Area (MPA) within the twelve nautical miles around the island (*i.e.* 0.4% of the EEZ), with the aim of preserving the biological balance of the natural environments necessary for the preservation of animal species. In November 2016, the French Ministry of the Environment created an MPA around Clipperton—a 'clearly defined geographical area, recognised, dedicated and managed by effective legal and other means, to achieve the long-term protection of nature, ecosystem services and associated cultural values'. Delimited by law, the MPA makes it possible to protect the whole of its environment, which includes the intertidal zone, its water column, its fauna and flora, as well as its historical and cultural features.

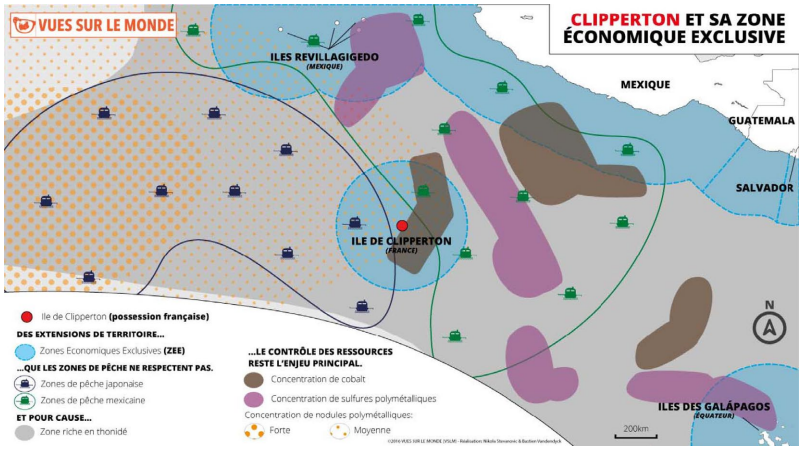


**Figure 30.** Fishery and mineral resources in the Clipperton EEZ. Source: Tchekemian (2023).

The Polynesian government is responsible for regulating environmental protection and marine resources. In French Polynesia, only 2% of the territory is protected land. One of the new fundamental principles is that of the Environment Code, which prohibits the removal of sand and shellfish, as well as the capture and marketing of the species present, which is therefore an illegal activity. Certain fish and shellfish have been given pride of place in coin and stamp series. The tensions between France, Mexico and the United States over the use and possession of Clipperton are illustrated by the official production and circulation of stamps between 1889 and 2011, enabling them to influence collective representations and lay claim to this territory and their sovereignty. The famous dispute between France and Mexico in 1898 is firmly rooted in the history of international law.

Like other maritime areas, Clipperton is governed by international law, in particular the Law of the Sea. Signed in Montego Bay[20] in 1982 and ratified by France in 1996, the United Nations Convention on the Law of the Sea defines the different statuses of maritime areas. There are different categories of areas over which states can exercise sovereignty and jurisdiction. Beyond the limits of national jurisdictions, there is the 'Area'[21], considered to be part of the common heritage of mankind. It is important to note that Clipperton has been a French overseas possession since 1931, the date on which French sovereignty over Mexico was confirmed by international arbitration under the King of Italy. A decree in 1936 attached it to the Government of the French Oceania Establishments. The atoll was then placed under the jurisdiction of French Polynesia in 1986. Since February 2007, it has been under the authority of the Minister for Overseas Territories, an administrative authority that he delegates to the High Commission of the Republic in French Polynesia, even though the atoll is not part of this archipelago. Today, Clipperton

[20]The United Nations Convention on the Law of the Sea (UNCLOS), signed in Montego Bay, Jamaica, on 10 December 1982, entered into force on 16 November 1994, following ratification or accession by 60 States. The Convention contains 320 articles defining the general principles for the exploitation of the sea.
[21]No State, natural person or legal entity may appropriate any part of the Area or its resources, which are managed by the International Seabed Authority, based in Kingston, Jamaica.

is part of the public domain of the French Republic and is listed on the French State's list of public property. As an uninhabited territory, the atoll is subject to the same legislation as the French Southern and Antarctic Territories (TAAF). In executive terms, it has only one budget line in the government's public accounts. Listed as a French commune, Clipperton has the status of an overseas collectivity. Then, following a bill tabled in the National Assembly[22] [21] in 2016, the Senate decided to rename the island 'La Passion-Clipperton', to list, by amendment, the powers of the Minister for Overseas France responsible for its administration and to confirm that the island is subject to the principle of legislative identity[23] (art. 263) [22]. Henceforth, by decree no. 2023-1182 of 13 December 2023 relating to the administration of the atoll, requests for authorisations to anchor, disembark and stay must be addressed to the Ministry of Foreign Affairs, which will forward them to the Ministry responsible for Overseas France. As a result, requests for authorisations will no longer go through the French Polynesian High Commission, which will no longer have jurisdiction in the matter.

Clipperton's position enabled France to join the Inter American Tropical Tuna Commission (IATTC) in 2003 and to play an active role in its work. In 1983, an EEZ with a radius of 200 nautical miles (435,612 km$^2$) was created around the island. In the early 2000s, tuna fishing in the EEZ was estimated at around 10,800 tonnes of illegal catches per year. The EEZ therefore allows France, as the coastal state, to exercise its sovereign rights in terms of resource exploration and use. Clipperton has therefore been the subject of renewed interest over the last fifteen years. France has reaffirmed its sovereignty by regularly sending military and scientific[24] missions there. These exploitable economic resources are located within 200 nautical miles (370 km) of the island, right in the heart of the tuna fishery in the tropical Pacific Ocean, and 2000 km from French exploration licences for polymetallic nodules and mining products[25] [23]. These oceanic mineral re-

[22]Draft law n˚4102 by deputy Philippe FOLLIOT.

[23]Legislative identity means that the laws and regulations of metropolitan France are the same as those of the overseas collectivities concerned. Laws and regulations apply as of right in the territory of these collectivities, subject to the adaptations desired by the legislator or the regulatory authority. It can be defined as 'the system of automatic applicability of ordinary law as derived from national laws and regulations; in this system, ordinary law is therefore the principle, and the existence of a specific or derogatory law is the exception'.

[24]In September 2017, the B crew of the Bâtiment multi-missions (B2M) Bougainville completed the first part of its 'Passion 2017' mission, which consisted firstly of exercising France's sovereignty over the island, and secondly of the pyrotechnical clearance of a stockpile of munitions abandoned by the Americans after the Second World War. This work followed on from the first operations carried out by the B2M d'Entrecasteaux in June 2016 and the B2M Bougainville in November 2016. After six days' work, almost 20,000 munitions were neutralised and destroyed, while preserving the wildlife. In addition, the crew organised several waste collection events. Finally, with the support of the Centre Maritime Commun de Polynésie française (CMC-PF), the Bougain-ville patrolled the Clipperton EEZ for around ten days. These surveillance operations confirmed that the situation established by the CMC-PF on the basis of electronic data (AIS and VMS) was in line with reality.

[25]'*Around the island, tuna fishing in the* 200 *nautical mile economic zone* (*an average of* 10,800 *tonnes of illegal foreign catches per year over the last thirteen years*) *and in international waters, on the one hand, and research campaigns on exploration permits for polymetallic nodules* (*which could be converted into exploitation permits*) *awarded by the* '*preparatory commission of the international seabed authority*', *on the other hand, would constitute the two other sectors of activity to be planned*'.

sources, estimated in 2012 at 410 million tonnes[26], are present in the geological zone between the Clarion and Clipperton fractures, covering an area of 6 million km$^2$ in the north-east Pacific, between the Hawaiian archipelago and the west coast of Mexico (Figure 31). However, exploitation is currently more expensive than profitable, with numerous environmental impacts [24].

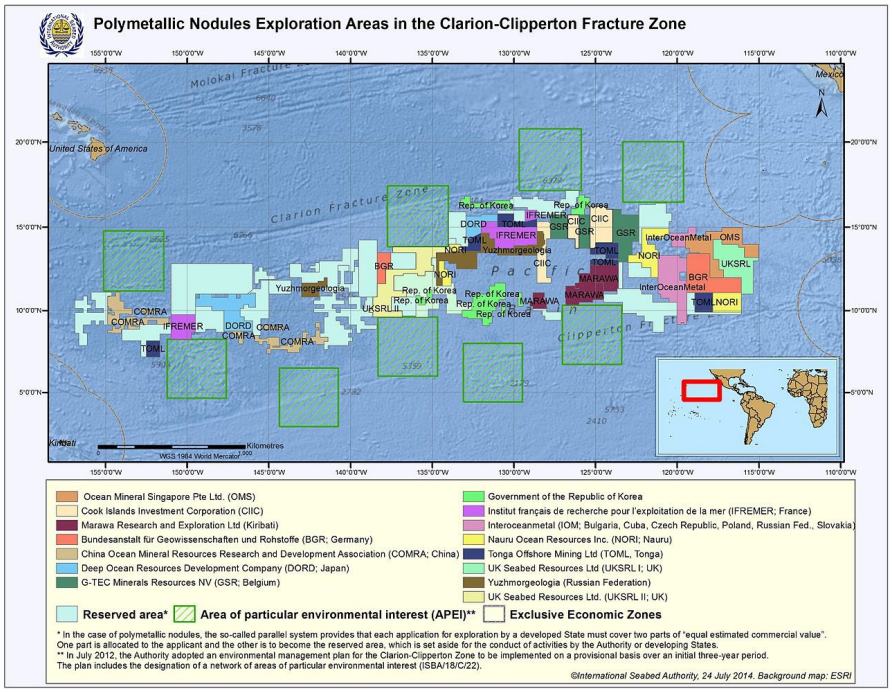


Figure 31. Map of mining licences granted by the International Seabed Authority (ISA) for the exploration of polymetallic nodule deposits in the Clarion-Clipperton fracture zone of the eastern North Pacific. Source: Tchekemian (2023).

The study of the remains tells us about the activities, past and present, practised on the island and in the Clipperton EEZ: for example, illegal fishing in one of the world's richest tuna reserves, leisure activities including shark diving, sport fishing, shore visits, and the suspicion that the island may serve as a "mailbox" for the parallel drug-trafficking economy, since drug parcels are frequently discovered on the beach. Clipperton is therefore a territory in the sense of the concept used in geography: that is to say, a space bounded by boundaries and controlled by an authority [25], a space shaped by human intervention, a space experienced and practised by individuals or social groups [26], a delimited space [25], disputed and controlled [27], with an "appropriation of power from a distance" [28], particularly in the case of parallel powers linked to drug trafficking [29] [30]. For example, fisheries surveillance and anti-narcotics missions are one of the priorities of the armed forces in French Polynesia: while Clipperton accounts for 4.09% of French maritime space, French Polynesia's share is 46.22% [31].

[26] *Cf.* Nautilus Minerals (Vancouver) press release, 24 September 2012, No. 23, entitled 'Nau-tilus releases NI 43-101 Resource Report for Polymetallic Nodules', 2 p.

Clipperton Island is of great scientific interest for meteorological and geostrategic surveillance in the North Pacific, as it is located on a major shipping lane. In addition, it enables observations to be made of the ocean, the deep ocean and its biodiversity, in the face of global climatic events. The island is also a good place to study connections[27] with all the ecosystems of the eastern Pacific, such as seabirds and sharks, as well as understanding[28] [32] interspecific[29] competitions between plants and animals.

Although this peninsula atoll is isolated, it is one of the keys to the Pacific, as an essential link between Panama and the Hawaiian Islands. Despite France's definitive sovereignty over the atoll since 1931, it is still the subject of claims, as it represents a geostrategic asset due to its proximity to the American continent. The island also has the advantage of being very close to the Equator, making it an ideal position from which to track satellite movements. The resources of the polymetallic nodule deposits represent a significant challenge. Its significant fishery resources are estimated at nearly 50,000 tonnes a year. However, the absence of any means of control over the area means that practices that contravene international maritime law cannot be eradicated. Clipperton's location in a vast fishing zone and passageway in the North Pacific could make it an ideal site for a military and scientific base.

## 4. Conclusion: Cooperation between Scientists and the Military

"*In the little piece of the Universe that is our planet, our cradle, our do-maine, what wonders! We are truly at home, surrounded by shapes, sounds and colours, created by the same forces at work locally, the same forces that created us. We could be content to admire, to let ourselves be lulled. But we can't be satisfied with seeing and hearing. We want to know and understand. Reality gradually provides us with some answers to our 'hows'. To our 'why' questions, we need to provide our own answers. Does this Universe make sense? Let's hope we never have an answer other than 'the meaning we give it'*" [1].

Evolving on an atoll with no regular human presence, the land and sea animals are nonetheless ingesting anthropogenic pollution. The environmental impact of plastic waste is very real, reflecting in spectacular fashion the aporias and wastefulness of the globalised system of exchange and production. The rubbish washed up on Clipperton bears witness to the illegal presence of factory ships in the EEZ. Although the relative surveillance of Clipperton, far from official decision-making

[27]In 2016, the masked booby colony is in decline (around 40,000 individuals), as it is dependent on the fish and squid populations that are driven to the surface by schools of tuna. As a result of the pressure exerted on fish resources by the many fishing boats, seabirds are travelling ever greater distances to find food.

[28]GAUSE's work in 1934 showed that, in a stable environment, two species that use the same type of resource cannot coexist: the most suitable one eliminates the other—this is the principle of competitive exclusion.

[29]For example, a vigorous liana plant, Ipomoea triloba, covers the ground, limiting the development of other plant species and preventing the masked boobies from nesting on the ground.

centres, facilitates illegal practices, its remoteness and lack of infrastructure put off French tuna fishermen. However, many boats take advantage of this isolation to tap into its fish stocks, which are considered to be among the richest in the world. The French government regularly renews the fish-sharing agreement, subject to conditions. But this does not prevent the massive pre-harvesting of tuna and other fish, which undermines the balance of reef, ocean and land ecosystems.

In addition to the problems of over-fishing, there is also the threat of tourist exploitation. However, the biotope protection order put in place around Clipperton has made it possible to limit access authorisations. Clipperton is thus a laboratory for the consequences of human activity on the environment. The ocean plays a major role in the global climate system. What's more, its deep seabed harbours an unsuspected wealth of life that is so coveted that controlled management is essential. More than half of the ocean, including the high seas, has no rules of governance, unlike mineral extraction, which is subject to mining permits issued by the UN-affiliated International Seabed Authority. Since September 2018, after 10 years of discussions, a third round of negotiations is due to culminate in the adoption of a high seas treaty, under the aegis of the UN. Negotiations are focusing in particular on the sharing of marine genetic resources and the carrying out of environmental impact assessments prior to development projects. With almost 70% of its marine area in the Pacific, thanks to its overseas territories, France is a coastal state bordering almost all the world's oceans. This global governance could be put in place as long as the notion of ownership is set aside and the focus of negotiations shifts to rights of use. Yet on a global scale, only 1% of the ocean is currently zoned for protection.

Protecting the area is therefore a major challenge. Sophisticated systems have been put in place to monitor the activities of boats in real time, including illegal activities. Illegal fishing is estimated to cost the world between 10 and 23 billion euros a year, or 20% of global catches. What's more, only 10% of the seabed is known with any accuracy. Despite progress, only 3% of the oceans benefit from strong protection measures. A rate of 30% to 40% would be necessary to benefit both fishermen and species. As well as providing food, energy, medical and cosmetic resources, the ocean is a major climate regulator. It absorbs 90% of the excess heat resulting from the atmospheric concentration of greenhouse gases. The acidification of the ocean by absorbing part of the atmospheric carbon dioxide also disrupts the entire marine food chain. Global warming is changing the marine ecosystem: invasive species are proliferating, microplastic pollution is potentially pathogenic... While the utilitarian vision of the sea dominates, a concerted, ecosystem-based approach must be adopted to regulate and limit the pollution dumped.

France's EEZs in the Pacific, however, remain rooted in new marine rivalries. Because of the extent of its marine areas, France shares maritime boundaries with thirty-one States. What's more, over the last thirty years, the maritime world has seen a huge expansion in the transport of goods. Its vastness makes it particularly

difficult to control and secure. In addition to the risk of collisions, conflicts over sovereignty and rivalries over the exploitation of offshore resources are also generating increasing tension. Aware of these issues, governments are asserting their power at sea, particularly in EEZs, and developing their military fleets. Controlling an EEZ of 9 million $km^2$ in the Indo-Pacific, France can lay claim to the status of regional player in the Indo-Pacific zone. This region, one of the most densely populated in the world, accounts for a third of international trade. Yet the risk of conflict is very high. In this complex environment, France plays a major role in security and stability, alongside its partners. The 'Indo-Pacific Axis' strategy enables France to exercise its maritime and air traffic rights in the region, and to combat illegal trafficking. In the global competition for resources, France has two major assets: the EEZ of French Polynesia and that of Clipperton. In the face of multiple threats, Clipperton has active surveillance resources, thanks to the armed forces present in French Polynesia and the satellite system that has been developed.

Finally, a permanent installation on the island of Clipperton would enable France to strengthen its means of asserting its sovereignty in the Pacific, on the model of the base present in the Indian Ocean. A scientific and military base would monitor fisheries and prevent illegal landings. The complementarity between scientists and the military observed during this mission is an incentive to strengthen this type of cooperation and encourages a permanent presence on the island. This would make it possible to observe changes in the oceanic island environment throughout the year, to continue the historical study of the remains, and also to compile, observe and anticipate environmental crises. This French property, which has revealed all its richness to us, is at the heart of contemporary environmental and geostrategic issues. Clipperton raises questions about the complex relationship between man and his environment: the island is an appropriate, humanised and civilised territory in which the oecumene is in harmony with the eema.

In fact, this photo of the desert island brings to mind my reading of Tournier's Vendredi ou les limbes du Pacifique. As a child, I was also surprised that Robinson Crusoe saw 'his' island as deserted and that the landscape seemed to him to be 'without a living soul', to use the expression. I thought I was reading a metaphor for absolute solitude, for a man on the margins of society on the verge of madness. But I now understand that the castaway defines himself first and foremost as the sole subject of a world of objects, over which he acquires a right of possession: without the presence of others, however, he cannot achieve an awareness of himself and the world. Yet there is nothing desert-like, arid or infertile about the landscape, and Robinson discovers there the luxuriance of life, both plant and animal. Inhabited and animated by elements of nature, the place no longer seems so deserted: to use a contemporary vocabulary, Robinson is constantly interacting with biodiversity. The island is also at the crossroads of periodic population movements. So the story would have been quite different if Robinson had been stranded on a place devoid of the slightest living thing! While the fiction of Robinson on

Figure 32. Remains of a talking doll, plastic waste deposited by marine currents on Clipperton atoll. Source: Tchekemian (2023).

his tropical island and the true story of the forgotten people of Tromelin may have fuelled the 'robinsonnade' genre to form geographical myths, they are at odds in their approach to the desert island (empty of humans or life). This leads us to question, more generally, the place of interactions between human beings and living things (plants and animals). This approach is in line with the current renewal of geography and provides a new way of linking the social sciences and the natural sciences, an approach that I believe was initiated by the inspirational scientist Nicole Mathieu. And as Nathalie Blanc, another great researcher, explains, this dimension of intimate space and time was little taken into account by geography. And the issue of sustainable development, which reintroduces a strong temporal dimension, is forcing geography to think in new ways. But the island environment can also reveal authoritarian, even tyrannical, characteristics. The story of the slaves on Juan de Nova and those shipwrecked on the Ba-tavia is a cautionary tale. In Clipperton, the memory of the atrocities committed by the Mexican, Victoriano Alvarez, self-proclaimed king of the island from 1907 onwards, remains vivid: during my stay, I couldn't help thinking of the ordeal endured by the women and children subjected to this executioner. A geographical determinism could explain these abuses: the isolation, the anonymity of the ocean void, the absence of control and structures. The island would then become a precipitate of the ills of our society: precarious, Eden would give way to the hell of the earthly condition (Figure 32). Beyond these fantasies, the field study and data analysis raise new questions.

## Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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