FIELD-TRIP REPORT TO TETI'AROA ATOLL (22-24 AUGUST 2019): PLANT RECRUITMENT AFTER RAT ERADICATION ON MOTU REIONO

by

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In collaboration with the Tetiaroa Society

Background and objectives

A three days field-trip was conducted on the atoll of Teti'aroa (Society Islands, French Polynesia) between the 22 and 24 August 2019. It was organized in collaboration with the Tetiaroa Society (TS), a non-profit organization who funded the airplane tickets between Tahiti and Teti'aroa, and the accomodation at the TS Eco-station Research Facility. The main goal was to monitor permanent transects and quadrats set up on Motu Reiono in August 2018 (MEYER, 2018), just before a rat eradication operation (SAMANIEGO, 2019). The long-term objectives are to study the atoll forest dynamics (mainly plant seedling recruitment) during this habitat restoration program.

Material and methods

Study site

Motu Reiono (ca. 22 ha) is the southernmost *motu* (sandy islet) of Teti'aroa (**Fig. 1**). It was inhabited in the past by Polynesians, as evidenced by the presence of several archeological structures, including a temple (*marae Apara*), meeting houses (*fare pote'e*) and an archery platform (MOLLE *et al.* 2019). The motu was then temporary occupied during the European period with a coconut trees plantation, now abandoned. The native atoll forest is thus not pristine.

Figure 1. Satellite image showing Reiono motu with the barrier reef surrounding Teti'aroa atoll (Google Earth©, 2013)

Permanent transects and quadrats

Our experimental protocol was inspired by a study conducted in Palmyra atoll located in the North Pacific during another rat eradication project (WOLF *et al.*, 2018): we set up 25 m long x 2 m large transects (total area of 50 m²), marked on its median line and at both ends by iron posts, tagged with color flags indicating the transect number. Each transect was divided into fifty 1 x 1 m quadrats located on both side of the median line (**Fig. 2**). The « start post » (tagged « d » for « début » in French) was georeferenced with a GPS (Garmin Map 64s) and direction towards the « end post » (tagged « f » for « fin » in French) was assessed with a compass.

Figure 2. Description of the 25 m long transect with its median line starting by a post and with 25 one square meter quadrats on both side of the line (50 in total), numbered from 0-1 m to 24-25 m

Left side of the transect (from the start post)

0-1	**1-2**	**2-3**							**9-10**													**22-23**	**23-24**	**24-25**
0-1	**1-2**	**2-3**							**9-10**													**22-23**	**23-24**	**24-25**

Right side of the transect (from the start post)

In each of the 50 permanent quadrats, the total number of seedlings (< 30 cm in height) was counted for each plant species, as well as coconut seedlings (*i.e.* coconut with 1 to 3 young leaves). Resprouts (*i.e.* small stems with leaves) from roots were not counted, as well as coconuts without any leaves (*i.e.* young and full of water, or opened and empty, or dried and dead).

A total of 10 transect was set up on Reiono motu (*i.e.* a sampled area of 500 m² representing 5% of the total area) in at six main forest types identified in the motu (**Table 1**) :
- Dense *Pisonia grandis* forest found in the North;
- Dense *Pandanus tectorius* at the South end;
- Coconut (*Cocos nucifera*) open forest (*i.e.* abandoned plantation);
- *Pisonia grandis-Cocos nucifera* mixed forest;
- *Pandanus tectorius-Pisonia grandis-Coco nucifera* mixed forest;
- *Pisonia grandis-Coco nucifera-Guettarda speciosa* mixed forest.

Table 1. Location of the 10 transects and description of the Habita/forest types

Transect N°	Latitude S (°)	Longitude W (°)	Habitat/forest type
1	17.04395	149.54578	*Pisonia grandis* dense forest
2	17.04580	149.54466	*Pisonia grandis* dense forest
3	17.04664	149.54549	*Pisonia grandis-Cocos nucifera* mixed forest
4	17.04767	149.45438	*Cocos nucifera* open forest
5	17.04889	149.54497	*Pandanus tectorius-Pisonia grandis-Cocos* mixed forest
6	17.04638	149.54724	*Pisonia grandis-Cocos -Guettarda speciosa* mixed forest
7	17.04798	149.54678	*Pisonia grandis-Guettarda speciosa-Cocos* mixed forest
8	17.04918	149.54674	*Pandanus tectorius* dense forest
9	17.04860	149.54626	*Pisonia grandis-Guettarda speciosa-Cocos* mixed forest
10	17.04517	149.54648	*Pisonia grandis- Cocos* mixed forest

Transects were not installed in other habitat types located at the periphery of the motu (including dense shrublands of *Scaevola taccada* and *Suriana maritima*, low canopy forest of *Heliotropium foertherianum*, and the small and single stand of the tree *Cordia subcordata*) to avoid both forest

edge effects and the potential impacts of seawater (during strong swells) on seedling survival. We have also avoided *Pisonia* forests with an understorey dominated by the large terrestrial fern *Asplenium nidus* (« bird's net fern ») where it was difficult to set up quadrats.

Preliminary results

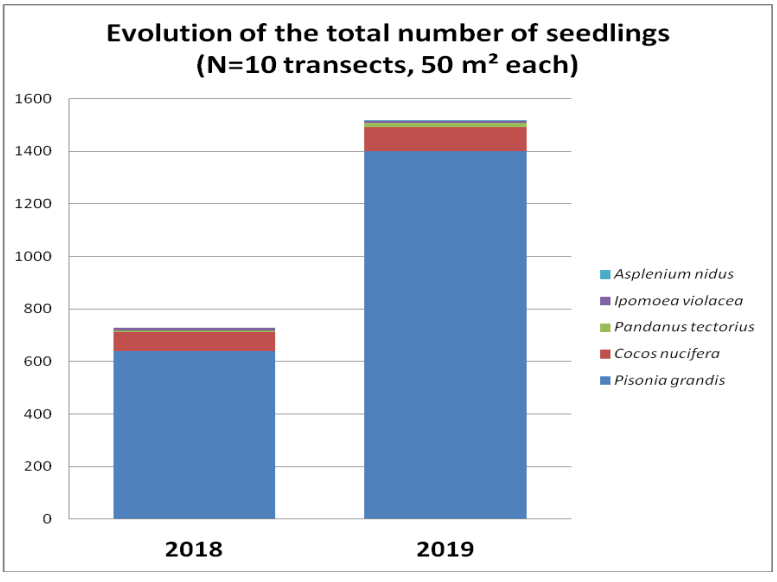
Seedling of only two native woody flowering plant species (the trees *Pisonia grandis* and *Pandanus tectorius*) and a native climbing vine (*Ipomoea violacea*) were noted in the 10 transects and the 500 quadrats in both our 2018 (August 8-11) and 2019 (August 22-24) surveys. No seedling of *Guettarda speciosa* were found, even in mixed forest with large *Guettarda* trees. A few native ferns (*Asplenium nidus*) appeared in 2019 (2 plants in two quadrats of transect N°4).

As expected, seedling recruitment differs according to habitat types, with more *Cocos* seedling found in coconut tree forest and *Pandanus* seedlings in *Pandanus* forest. However, it is noteworthy that the number of *Pisonia* seedlings is lower in *Pisonia* dense forest, probably because of high intra-specific competition for this fast-growing and probably shade-intolerant pioneer tree. The dramatic increase in *Pisonia* seedlings observed in 2019 in transect N°7 (raising from about 380 to more than 1050) can be explained by a treefall gap (a large *Pisonia* fallen tree).

Table 2. Evolution of the total number of seedlings between 2018 and 2019 in each transect.

		2018	2019	2018	2019	2018	2019	2018	2019
N°	**Habitat/forest type**	*Pisonia*		*Cocos*		*Pandanus*		*Ipomoea*	
1	*Pisonia* dense forest	2	31	2	1	0	0	0	0
2	*Pisonia* dense forest	2	26	1	5	0	0	0	0
3	*Pisonia-Cocos* mixed forest	3	14	2	0	0	0	0	0
4	Coconut open forest	13	8	2	19	0	0	0	0
5	*Pandanus-Pisonia-Cocos* mixed forest	24	10	0	1	0	2	0	0
6	*Pisonia-Cocos-Guettarda* mixed forest	5	7	14	19	0	0	0	0
7	*Pisonia-Guettarda-Cocos* mixed forest	378	1053	14	12	0	0	0	0
8	*Pandanus* forest	2	16	1	2	6	14	0	0
9	*Pisonia-Guettarda-Cocos* mixed forest	201	221	3	6	0	0	4	3
10	*Pisonia- Cocos* mixed forest	10	14	33	26	0	0	7	5
	TOTAL	**640**	**1400**	**72**	**91**	**6**	**16**	**11**	**8**

Figure 3. Evolution of the total number of seedlings in the permanent transects between 2018 and 2019.



Conclusions and future prospects

Long-term monitoring is essential to study forest dynamics and understand ecosystem vulnerability and resilience, especially after natural or anthropogenic disturbances. The setup of 10 permanent transects on motu Reiono will allow to monitor both native and introduced plant species recruitment after the rat eradication campaign conducted in August 2018 (SAMANIEGO, 2019).

As documented in other vegetation studies conducted after rat eradication (see *e.g.* WOLF *et al.*, 2018), we observed an increase of seedlings of the native trees *Pisonia grandis* and *Pandanus tectorius* which fruits and/or seedlings are presumably eaten by rats. No significant difference was seen for the native vine *Ipomoea violacea* The native fern *Asplenium nidus* was newly observed in a few quadrats, but seedlings of *Guettarda speciosa* are still absent.

The number of non-native *Cocos* seedlings has slighly increase. This trend should be carefully monitored in the future as we have noted numerous young coconuts fallen in our transects which are no more eaten by rats. Rat eradication could possibly lead to an explosion of coconut trees which could be an unexpected and undesirable « surprise effect » (CAUT *et al.,* 2009). The progressive removal of coconut trees should be considered in future rat eradication projects on other islets of Teti'aroa, as previously done on motu Aie in 1982 (SACHET & FOSBERG, 1983) and planned on Palmyra atoll (HATHAWAY *et al.*, 2011).

A third monitoring should conducted next year between June and September 2020, *i.e.* during the dry and cool season in the Society Islands in order to avoid seasonal variability in seed germination and seedling recruitment by heavy rains during the warm and rainy season (between November and March).

We also recommend the installation of 10 new transects on motu Reiono to increase the sampling area according to the different habitat types, but also to the various substrates (sandy, limestone, soil) which may greatly influence seed germination and survival. This will require a longer field-trip, as it took us (two people) two full days to monitor 10 transects.

Acknowledgements

I deeply thank Frank MURPHY, Executive director of the Tetiaroa Society, for organizing the field-trips, and the TS rangers Moana LE ROHELLEC, Lusiano KOLOKILAGI and Tapuarii AA for their assistance on the field in 2018 and 2019. Mauruuru roa pauroa !

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Appendix 1: Photos of study sites and seedlings recruitment (credit: J.-Y. MEYER©)

Photo 1: *Pisonia grandis* dense forest (transect N°1, year 2018)

Photo 2: *Cocos nucifera* open forest with cocos seedlings (transect N°4, year 2018)

Photo 3: *Pandanus-Pisonia-Cocos* mixed forest (transect N°5, year 2019)

Photo 4: Treefall gap in *Pisonia-Guettarda-Cocos* mixed forest (transect N°7, year 2019)

Photo 5: *Pisonia grandis* seedlings in quadrats (transect N°7, year 2019)

Photo 6: *Cocos nucifera* seedling in quadrat (transect N°6, year 2019)

Photo 7: *Asplenium nidus* in quadrat (transect N°4, year 2019)

Photo 8: *Ipomoea violacea* seedling in quadrat (transect N°8, year 2018)