

THE KEY ROLE OF *JUBAEA* PALM TREES IN THE HISTORY OF RAPA NUI: A PROVOCATIVE INTERPRETATION

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INTRODUCTION

This paper presents an estimate of the numbers of *Jubaea* palm trees on Rapa Nui prior to the last clearance of the palm forest: more than 16 million palm trees. The labor requirements for clearance were enormous (a few hundred people were probably employed in this task for six to eight centuries), as well as the acquired amount of wood and the potential volume of the palm's sap (approx. 1,600,000 liters per year?). Possible uses of the palm's sap are discussed.

This paper is based

- on facts about the spatial distribution of *Jubaea* palm trees before the last clearance of forest,
- on a scientifically sound calculation of the number of palm trees on Rapa Nui before the last clearance, and
- on assumptions of the dynamics of population density.

Our task is to stimulate discussion about the use of *Jubaea* palm trees and namely of the palm sap. Our methods were described by Mieth et al. (2002).

Palm trees have started growing again on Rapa Nui within the last decades: coco palms and occasionally a few trees of the Chilean Wine Palm *Jubaea chilensis*. All of those were planted during the 20th century. The Chilean Wine Palm thrives and prospers far better on Rapa Nui than in Chile's central regions. According to first observations, young plants can reach from two to five times the growth rate of biomass on Rapa Nui compared to the continent. This enormous growth is mainly based on the favorable climatic conditions (balanced high temperatures, nearly year-round rich precipitation, and high humidity) of Rapa Nui.

Using the analysis of pollen and other organic fragments, Flenley and others acquired the evidence that a related species, or even the Chilean Wine Palm *Jubaea chilensis* itself, was domiciled on Rapa Nui for many millennia, and that it became extinct through human impact several centuries ago (Bahn and Flenley 1992, Flenley 1993, Diamond 1995, Orliac and Orliac 1998, Grau 2001, Orliac 2000). This extinction might have been caused by consumption of most of the palm's nuts by the Polynesian rat (*Rattus exulans*), as Bahn and Flenley (1992) point out, or by the total clearance of the palm forest due to the human demand of timber or nuts.

RELICTS OF THE PALM FOREST

Remains of the last palm forest (palm root channels, burnt palm stumps, carbon of palm wood and palm nuts) have been preserved until today:

- the roots grew down until the un-weathered bedrock was reached (at some sites more than 6 meters),
- the width of the palm root cylinders and, accordingly,

the diameter of the *Jubaea* palm trunks (up to 1 meter and above),

- the horizontal distance between individual palm trees (from a few decimeters up to several meters),
- the spatial distribution of the palm trees, and
- the palm forest land usage previous to its final clearance.

The palm tree boles were apparently chopped off a few centimeters above the soil surface. The remaining trunks of the palm trees were subsequently burnt along with other unused leftovers of the plants (e.g. premature palm nuts, some with teeth marks of the Polynesian rat) and other wood or grass. The charcoal layer was frequently preserved in situ or merely displaced along the down-slope and mid-slope areas, e.g. on the Poike peninsula and on Rano Kau (Mieth and Bork, 2003; Mieth et al. 2003).

Burning of the palm trunks released substances in the whole depth along the roots, which agglutinated the soil particles on the root channel surface. According to field observations it is doubtless that only a single burn clearance took place for each site. Therefore the conglutination only occurred once and only among the last palm generation. Palm roots with upper remains of burnt palm trunks were identified to be of the same age. All of the palm root cylinders so far discovered in any area of Rapa Nui (except for the higher positions of Maunga Terevaka, outcrops of rock and steep cliff sections) represent the latest palm forest. Some palm root channels contain thin root fragments. Results of a radiocarbon dating at the research area of southwest Poike obtained a root fragment age of 250 to 300 years in reference to the charcoal of the burning time. Thus it appears that at the time of burning, the trunks of the palm trees were 250 to 300 years of age.

Remains of palm trunks are primarily situated on deposition sites. Several adjoining trunks were frequently burnt in situ together for the preparation of meals. We discovered *umu* on top of charcoal of trunks e.g. above the cliffs in the southwest and in the east of Poike peninsula (Mieth and Bork 2003, Mieth et al. 2003).

An analysis of numerous natural soil profiles on Rapa Nui (directly above the cliff, along gully walls, and at the escarpments of the badlands) as well as an exploration of soil profiles made under the influence of humans and machines (such as the soil pit at the southwestern slope of Maunga Orito or soil profiles along roadsides) do often allow an exact reconstruction of the horizontal distance between palm trees (with an accuracy of a few centimeters). Therefore a well founded calculation can be made of the numbers of palm trees before the last clearance on single slopes and the whole island.

DISTRIBUTION AND DENSITY OF THE PALM TREES BEFORE SLASH AND BURN

The reconstruction of the last existing palm forest on Rapa Nui does not concern a single date, but instead a certain period of time: the latest palm trees were chopped down at different times at different sites and the remains were burnt down shortly after the clearance. The slash and burn took place (according to radiocarbon dating) around cal. AD 1280 on a concave downslope a few dozen meters above the cliff at the far east of Poike peninsula (near Cabo Cumming), around cal. AD 1550 a few hundred meters south, around cal. AD 1400 at the southwest of Poike above the cliff and a few decades later at the northwest upslope of Maunga Puakatiki (Mieth and Bork 2003, Mieth et al. 2003).

A reconstruction of the horizontal distances between the palm trees is possible where long term accumulation occurred (centuries of dominating accumulation) as well as sites where slight soil erosion took place, as indicated by detailed field work. To measure the horizontal distances, the upper or, at least, the middle parts of the palms root cylinders must have been preserved. The cylinders converge in greater depth in the majority of cases. Measurements of the horizontal distances of palms are therefore impossible where the upper and middle part of the palm root cylinders have eroded.

Soil profiles provide evidence that palm trees had grown all way up to the craters of Rano Kau in the southwest of the island and Maunga Puakatiki on Poike peninsula. Almost no palm root channels were found on Maunga Terevaka higher than 250 m above sea level. They are very rare or missing at sites of intensive soil erosion during the 20th century and sites with unweathered younger Pleistocene lava layers that are almost impossible for palm trees to inhabit. Our investigations of soil profiles showed that more than 70 percent of the island surface was covered by a dense, agriculturally-used palm forest.

Which mean horizontal distance did the palm trees have? Twenty-nine palm trees were found in a 100.5 meters long profile in the southwest of Poike peninsula (Mieth and Bork 2003). The horizontal distances between the palm trees varied greatly. An older palm tree was often surrounded by a group of younger ones. This spatial formation was probably not a result of human plantations but of natural growth, influenced by humans.

The mean horizontal distance of the palm remains found in the above mentioned 100.5 meter profile was 3.5 m. Distance measurements were also taken at:

- the far east and in the central areas of Poike peninsula,
- in heights of 300 to 350 m above the sea level beneath Maunga Puakatiki's crater,
- in the north next to Ovahe,
- at the southern coast (e.g. near to Motu Mariu and Vinapu),
- on Rano Kau and
- at several other sites in the mid-lands.

Horizontal distances among 90 palm trees were measured for the island and the arithmetic average was calculated. The mean horizontal palm tree distance was found to be 2.6 meters. The choice and the disposition of the sites accomplish the criterion of spatial representation. The arithmetic mean did not change significantly after recording distances for the first 60

palm trees, although sites recorded subsequently were quite unequal to the first. The variability of the distances (0.5 to 12 meters) within every research site – each covering an area of around 1000 m² – was far greater than the variability of distances between them (1.7 to 3.5 meters). Therefore it is assumed that the arithmetic mean of the sample is close to the real value.

ESTIMATION OF THE NUMBERS OF PALM TREES BEFORE THE SLASH AND BURN

Therefore, the calculation can be made. A mean horizontal distance of 2.6 m amounts to about 38 palm trees per 100 m profile or to about 1,400 palm trees per hectare. At least 116 km² (70%) of Rapa Nui's total area of 166 km² was covered by palm forest. If we multiply 11,600 hectares by the average of 1,400 palm trees per hectare we attain the figure 16.24 million palm trees on the whole island shortly before the fire clearance.

In which period did the slash and burn take place? The palm forest clearance began at Rano Kau around cal. AD 800 according to pollen analysis (Bahn and Flenley 1992, Flenley 1993) and ended ca cal. AD 1550 (radiocarbon dating of burnt palm nut fragments from an *umu* in the east of Poike peninsula: KIA20383, BP 317 ± 20, 2σ cal. AD 1492 to AD 1505, AD 1507 to AD 1600, AD 1616 to AD 1642). Our investigations at Poike peninsula provide proof of the younger period of the lumber activity. An assumption that more than 16 million palm trees were stubbed in a period of about 800 years is therefore likely. This would mean that an annual number of 20,000 palm trees was cut down and a daily average lumbering of 55 palm trees took place.

A medium sized trunk of a *Jubaea* palm may have had a height of (at least) 10 m and a diameter of (at least) 0.5 m. Therefore each palm tree may have had (at least) a volume of nearly 2 m³ of trunk wood. The total number of 16 million palm trees thus may have had (at least) a total volume of 32 million m³ of trunk wood.

THE EXPENDITURE OF HUMAN LABOR FOR THE PALM FOREST CLEARANCE

Numerous people probably worked permanently on the logging of the palm trees and other plants during the 800 year period. 165 people would have been needed for the clearance and the transport if only three persons together were able to cut down a palm tree, clear off its fronds, chop the trunk, and transport it for several kilometers to the final point of use (e.g. the *moai* workshop at Rano Raraku or the shipyards along the coast where the sea-going catamarans were built) in one working day. Presumably 6 to 10 people were needed for the clearance, the transportation and the use of one palm tree – which would mean that an average number of 330 to 550 people permanently worked on this task during eight centuries (fewer in the beginning than later during the main period of clearance in the 13th, 14th and 15th centuries). How many people were living in the time of the slash and burn between AD 800 and AD 1550? Perhaps not more than 1,000 inhabitants about cal. AD 800 and barely 8,000 about cal. AD 1500. Approximately every tenth resident would then have to participate in the work of clearing the palm forest and treating the wood for its later use. Fewer persons were presumably needed for crafting the *moai*.

THE SAP OF THE *JUBAEA* PALM: PROVISIONAL VOLUME ESTIMATION AND POSSIBLE USE

Rapa Nui's palm would have contained large amounts of sap in its trunks as is the case for *Jubaea chilensis* in central Chile today. The sap provides sugar and other nutritious substances. It is very unlikely that the Rapanui did not use the natural resource. The sap of the *Jubaea* palm was possibly a major resource for the inhabitants and an exceedingly important liquid. Charles Darwin reports in *The Voyage of the Beagle* from August 16th, 1834, for central Chile: "... when the trunk is lying on the ground, the crown of leaves is lopped off. The sap then immediately begins to flow from the upper end, and continues so doing for some months: it is, however, necessary that a thin slice should be shaved off from that end every morning, so as to expose a fresh surface." (Darwin 2001:229).

How much sap could be gained from a palm tree, on average? Darwin (2001:229) mentions an amount of 90 gallons (approximately 400 litres) in his report, which was extracted from a "good tree" in central Chile. Rundel (2002) describes that nowadays 300 to 400 litres of sap are extracted from one *Jubaea chilensis* tree over a period of 6 to 8 weeks and more in the central region of Chile. Also Grau (1998) and Orliac (2003) assume that the yield of palm sap can reach up to 400 litres per palm individual. A maximum sap extraction was probably not realized on Easter Island due to the high density of palm trees. Perhaps a not very fully developed tapping technique was used. Therefore perhaps less sap was gained than with current technology.

One can hypothesize an average tapping per palm tree of only about 50 to 150 liters of sap. Based on an assumption of 80 liters of sap per palm tree an annual mean of 1,600,000 liters of sap was available during eight centuries (20,000 cleared palm trees multiplied by 80 liters of sap for each). Probably the clearance of the palm forest was intensified from about cal. AD 800 until cal. AD 1300/1500. Then a more or less constant amount of sap may have been available per inhabitant living on Rapa Nui in this period. According to the assumptions made above, approximately two liters of palm sap per person per day would have been available during seven or eight centuries.

A large amount of the sap was presumably used for nutrition. Due to the surplus of this resource we can hypothesize other uses, too. Perhaps a part of the sap was used as lubricant for the transport of the statues (*moai*) to the ceremonial platforms (*ahu*). By transporting them with the help of the sap it would have been possible to move the *moai* upstanding with a greatly reduced resistance along the roads which were build for this use. They also might have been pulled by sleds in different positions (upstanding or procumbent) to their final destination. How much sap was needed for transportation in this way?

The importance of the sweet potato as food for the Rapanui often has been discussed. But no attention was paid to the huge energy resource of the palm sap. Perhaps most of the palm sap was used as a sweet nutritious beverage.

RESEARCH QUESTIONS

Was palm sap important in Rapanui society? Did a lack of palm sap and thus of beverage due to the extinction of *Jubaea* palms cause a decline of Rapa Nui's population? What was the aver-

age sap volume that could be acquired from a palm tree? How was the sap prepared? Was it cooked like nowadays and processed to palm honey? Was sap needed for *moai* transport or for sealing of the sea-going catamarans? When did the first shortage of palm sap occur? Do we find remains of palm juice on the surfaces of *moai* roads or in villages?

These are questions upon which future Rapa Nui research should also focus.

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CALLIGAN'S LOST RONGORONGO, AND SOME SHIPWRECKS

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INTRODUCTION

Rongorongo, Easter Island's indigenous script, is represented by twenty-odd known wooden tablets and fragments. Their scarcity is one of the main barriers to the decipherment of the script. Almost all had been discovered and brought to public attention by the end of the nineteenth century¹. Despite many efforts, no more tablets have been found on the island since then, with the exception of a few fragments hidden in caves and rotted beyond recognition. If any more such artifacts exist, they would be among the few that were collected in the early days of Rapanui exploration and since have disappeared. The following is an account of my attempts to locate one of them, so far without success.

CROFT'S LETTER

On April 30th, 1874, a resident of Tahiti named Thomas Croft wrote a letter² to George Davidson, President of the California Academy of Sciences in San Francisco. The letter was a reply to earlier correspondence in which Davidson requested Croft to obtain for him actual specimens of *rongorongo*. Croft was not able to do so, but he did attach to his letter two sets of photographs of all the specimens available to him, namely those with Bishop Jaussen of Tahiti. His letter, an enthusiastic if amateurish collection of many facts and tidbits about *rongorongo*, is an important source for our knowledge of the subject.

In discussing tablets he had heard about but not seen, Croft writes:

Mr. Calligan, mate of an American vessel from your port, which vessel was lately wrecked on Easter Island, where he and his friends built a boat from the remains of the wreck, and came down in it to Tahiti, (and who now commands a small schooner sailing among the islands here) also managed to get one of the blocks, which, he has told me, (he is absent just at the present writing) he has sent to his wife, somewhere in California, I think. When he returns, I will

try to find out where, and inform you, so you may have an opportunity to see and probably obtain it, or at least obtain a photographic representation of its characters.

Later in his letter he mentions Calligan again:

Mr. Calligan, before spoken of in this letter, informs me that during his forced stay on Easter Island he kept a journal, noting down things which came under his observation, and that he has sent it to his friend, Mr. MacCrellich of the San Francisco *Alta California*, who will doubtless publish extracts from it. You will, thereby, perhaps, be able to learn much about the island, written upon the spot, with all the freshness of narrative that usually accompanies articles so written.

Nothing more was mentioned of Calligan's diary or his tablet.

Could they still exist? Imbelloni (1951) and others assumed that Calligan's tablet was destroyed in the great San Francisco earthquake and fire of 1906. Indeed, contemporary accounts (Hittell 1997, pp. 500-503) detail the materials rescued from the Academy building as the fire was reaching it. No anthropological specimens were among them. But did the tablet ever reach the Academy to begin with? In order to find out what happened to the tablet, it is best to start with Calligan's life and its consequences.

CAPTAIN CALLIGAN AND SOME SHIPWRECKS

Patrick John Calligan was born in Maine, possibly near Machias Bay, about 1837³. By 1867 he was living in San Francisco⁴, employed as Captain of the bark *Brontes*. The 1870 census lists him as married to Ellen, a 34-year-old native of Ireland, who could neither read nor write; no children are recorded. Calligan changed residence at least once⁵ during his years in San Francisco.