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Observations on Puluwat and Gaferut, Caroline Islands

by

William A. Niering

with

Historical and climatic information on Gaferut Island
by Marie-Hélène Sachet

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Introduction

Observations presented in this paper were made during the summer of 1954 in conjunction with the Kapingamarangi Expedition to the Caroline Islands**. On the return route to Guam, several other island groups were visited for purposes of comparison. Among these were Puluwat and Gaferut.

I. List of plants noted on Puluwat Islet, Puluwat Atoll

The following species were recorded during a one-hour visit to the islet on Sept. 3, 1954.

Allophylus timorensis Bl.
Occasional in undergrowth.

Artocarpus altilis (Park.) Fosb.
Scattered in interior. Coll. no. 765.

Asplenium nidus L.
Women observed carrying leaves, growing plants not seen.

Calophyllum inophyllum L.
Large trees along lagoon shore.

Canavalia sericea Gray
Frequent in forested and semi-open areas. Coll. no. 769.

Carica papaya L.
Frequent around houses.

Cassytha filiformis L.
Occasional on undergrowth

Cocos nucifera L.
Trees scattered forming open plantations, also young plantings.

Colocasia esculenta (L.) Schott
Important food species.

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Cordia subcordata Lam.
Large specimens along lagoon beach.

Crinum sp.
Profusely flowering along paths.

Cucurbita sp.
Large productive squash in living area.

Eleusine indica (L.) Gaertn.
Frequent in open disturbed sites. Coll. no. 771.

Euphorbia chamissonis Boiss.
Occasional along sandy lagoon beach. Coll. no. 770.

Ficus prolixa Forst.
Coll. no. 767.

F. tinctoria var. neo-ebudarum (Summ.) Fosb.
Coll. no. 766.

Guettarda speciosa L.
Occasional in interior.

Hedyotis biflora (L.) Lam.
Coll. no. 762.

Hibiscus tiliaceus L.
Occasional in understory.

Hymenocallis littoralis (Jacq.) Salisb.
Coll. no. 772.

Ixora sp.
Red flowered ornamental around houses.

Lepturus repens R. Br.
Occasional in disturbed sandy areas.

Messerschmidia argentea (L.f.) Johnst.
Mixed with Scaevola along ocean beach.

Morinda citrifolia L.
Occasional as understory tree.

Musa sp.
Frequent around houses.

Nephrolepis hirsutula (Forst.) Presl
Dominant fern in coconut plantations often forming a dense ground cover 2-3 feet high.

Pandanus tectorius Park.
Frequent, often more common oceanward.

Paspalum conjugatum Berg.
Occasional in open disturbed areas. Coll. no. 763.

Piper betle L.?
Coll. no. 768.

P. fragile Benth.?
Coll. no. 764.

Plumeria rubra L.
Occasional in living area.

Polypodium scolopendria Burm. f.
Frequent on trees, often associated with Nephrolepis.

Portulaca sp.
Yellow flowering form, frequent along and in paths.

Premna obtusifolia R. Br.
Dominant in undergrowth.

Scaevola sericea Vahl
Frequent as a border along beaches.

Stenotaphrum micranthum (Desv.) Hubb.
Frequent in recently cleared areas planted to coconut.

Thalassia hemprichii (Ehrb.) Aschers.
Frequent in shallow sandy lagoon waters.

Thuarea involuta (Forst.) R. & S.
Frequent in recently cleared areas planted to coconut.

Triumfetta procumbens Forst.
Occasional along ocean beach.

Vernonia cinerea (L.) Less.
Weed of open areas.

Wedelia biflora (L.) DC.
Frequent in undergrowth.

Mangrove
Present along south lagoon cove (genus not determined).

Page 4 is missing

II. Description of Gaferut Island

Gaferut Island, an isolated land mass in the northern Carolines, was observed during a brief stop on the morning of Sept. 4, 1954*. The island is approximately 1,500 feet long and 500 feet wide, situated on a somewhat crescent-shaped reef which extends 500-750 feet outward from mean tide level. Gaferut is at present uninhabited, but the Japanese mined phosphatic rock there around 1935. Remnants of their buildings, clearings and excavations can still be seen. About an acre in the interior, although now overgrown, shows evidence of being cleared. In at least four areas excavations were observed, the most extensive being a trench about 2 feet in depth and of considerable width. The other areas within the clearing were quite small.

Geology and Soils

Geologically the island is composed of three types of material: phosphatic rock, coral rubble and sand. The higher interior portion is underlain by phosphatic rock which gives way to a marginal coral rubble border 100 feet or more in width on the east and southeast sides. Along the western shoreline high step-like beach ridges composed of rubble extend 6 feet or more above mean tide level. The sandy deposits form a conspicuous elongated bar extending in a northwesterly direction. Near the end of the sand bar is a very large coral boulder which was probably perched there during a severe storm. These various areas are readily discernable on the aerial photograph (Fig. 1).

The interior phosphatic rock is either exposed, except for blackish algal or fecal coverings, or overlain with a thin rubble soil or humus layer. Several inches of rubble mixed with organic matter are typical. However, in the largest clearing rubble is absent and the rock is overlain by a dark brown friable acid humus (pH 5) varying from 2 to 3 inches in depth. In one area within but near the edge of the clearing it was found to a depth of 6 to 8 inches. These variations in depth may be correlated with the disturbance. One sample from this area contained large quantities of small gastropod shells. Beneath the humus the underlying rock consisted of cemented coral fragments, sand and foraminiferal tests, whereas those from the trench consisted primarily of larger rubble. In both cases the material was similar in that it exhibited a brownish salt and pepper appearance and was relatively soft so that it could be easily broken with one's fingers. In the trench the rock was exposed for at least 2 feet in depth with no evidence of an unconsolidated layer beneath. The humus layer and underlying phosphatic rock have all the characteristics of the Jemo Series named and described by Fosberg (1954) and observed by other investigators (Hatheway 1953, Niering 1956, McKee 1956). Further discussion concerning the possible origin of the rock will follow in a later section.

* The author wishes to acknowledge the most helpful suggestions of Dr. F. Raymond Fosberg and Miss Marie-Hélène Sachet in preparation of this manuscript.

Vegetation and Associated Animal Life

The general vegetational aspect is that of a low, relatively open forest, 12 to 25 feet in height. The dominant tree which characterizes the island is Tournefortia argentea, rather than the coconut which is so typical of inhabited islands. Only two mature coconut trees (Cocos nucifera) 50 to 60 feet in height, probably planted within the last 10 years, were found. The only other woody plant observed was Caesalpinia sp., and it was unimportant. On the phosphatic rock of the interior which has been least disturbed the trees are relatively large and frequently form a continuous but open canopy, in contrast to the marginal rubble borders where the trees are smaller and more scattered. On this coarse marginal rubble the Tournefortia frequently exhibit a shrubby dome-like appearance with branches extending to the ground. In the rubble areas the trees reach 6 to 10 inches in diameter and in the interior sections attain diameters of 12 to 18 inches. The dominant ground cover is Fleurya ruderalis which forms a continuous layer 12 to 18 inches in height in the openings and decreases slightly in the semi-open situations. Several specimens of a cucurbit (Cucurbita sp.) also occurred locally.

Associated with the Tournefortia community is a large bird population including frigate birds (Fregata minor palmerstoni), red footed boobies (Sula sula rubripes), and white terns (Gygis alba candida). Of these the frigate birds are most abundant. Their nests and immature specimens were conspicuous in the trees. At all times the air was filled with the din of hundreds of birds in constant flight. From a kodachrome taken over the island an estimated 550 birds were counted. While walking through the interior one had to be careful of these large birds since one could easily have been hit as they lost altitude on the take-off. Under those trees with many nests the stench was very pronounced and the absence of Fleurya may be correlated with the concentration of guano. It was truly amazing to see such great numbers of birds but presumably this is not atypical of certain uninhabited islands. Pokak, an uninhabited atoll in the Marshalls, is quite similar not only in its large bird population but also in its sparse flora (Fosberg 1957). Here 9 species of vascular plants were found in contrast to 7 on Gaferut.

Associated with the coconut were azure-tailed skinks (Emoia cyanura cyanura) and coconut crabs (Birgus latro). The former were especially abundant in the trees; the latter were found under the fronds on the ground as well as within the nearby herbaceous cover. The largest crabs, one foot or longer, were in the cavities of the rock. Although ten nuts had sprouted under the trees they were partly chewed and the 1 to 2 foot shoots were badly damaged. Whether they will survive is questionable. Other animal life observed included hermit crabs and in the branches of the Tournefortia orb-weaving spiders were common.

In the large clearing toward the south end of the island dense growths of Ipomoea tuba cover most of the opening and are invading the surrounding Tournefortia and forming a complete covering over the trees. Several have already been killed as a result of this invasion. Infesting this viny growth was a caterpillar which develops into a whitish Lepidopteran. Leaves not damaged by this infestation were difficult to find. Another herb found locally in the clearing was Boerhavia diffusa, both the pink and white forms.

At the north end of the island most of the sand bar is devoid of vegetation. However, small Tournefortia are becoming conspicuously established at the south end of the bar. In this sector sea turtle activity was evidenced by the many excavations in the exposed beach sand. Also along the shore a flock of 12 to 15 turnstones (Arenaria interpres interpres) were seen as well as several plovers in flight.

Discussion

The origin of the phosphatic rock is of considerable interest in that it resembles the Jemo Series. The A (humus) and B (rock layer) horizons are comparable but the less consolidated C horizon was not found. Although the greatest depth reported elsewhere for the cemented B layer is 1½ feet, from Jemo Island, this may merely indicate that cementation on Gaferut has taken place to a greater depth. To be associated with the Jemo Series infers a dual biotic relationship only one component of which currently exists on Gaferut - namely, a large bird population. The other facet - a Pisonia forest, is wanting. Could there have been a Pisonia forest in the past - the soil forming processes operative for a long period resulting in the formation of the phosphatic rock and then the forest destroyed by a typhoon? (See section on climate below). Denudation of islands resulting from typhoons has also been reported from Ailinginae and Utirik Atolls in the northern Marshalls (Fosberg 1956) and most recently by Blumenstock (1958) and Fosberg (1961) on Jaluit Atoll in the Marshalls. The small very intensive typhoon which hit Jaluit completely removed the vegetation on the narrower parts of certain islets. Many trees were uprooted or snapped off and washed away. Large Pisonia trees were uprooted, and others still standing had many branches blown off and were greatly defoliated. During the height of the storm wave surges 6 feet in height and locally more than 8 feet swept over the islets accompanied by winds approaching 125 knots (Blumenstock 1958). From these observations it is not unreasonable to assume that a Pisonia forest could have been destroyed on Gaferut (see note on p.13). Surely the very soft nature of the wood would lend itself to tremendous storm damage. Although persisting root systems would tend to produce vigorous root suckers prolonged salt water inundation might well have killed any remaining root systems which were not completely washed away. A small isolated island such as this one would be particularly vulnerable to heavy damage since it would get the full impact of the storm regardless of the direction from which it came. That a severe storm has hit Gaferut is evidenced by a large coral boulder off the north end of the island. Wiens (1959) observed large blocks of this type on Jaluit which were washed 100-300 feet during the typhoon. In addition, the extensively developed marginal rubble border along the east and south sides of the island and the high beach ridges on the west may well have been laid down during such a storm. The fact that phosphatic rock formation does not appear to be occurring at present and has never been reported under Tournefortia suggests that it occurred under a different vegetation type presumably Pisonia grandis.

Although the idea that a severe storm may have destroyed the Pisonia forest is most tenable, its removal by man in clearing the land to facilitate the mining of phosphate is another possibility.

Deleterious effects of the existing bird population were not strikingly evident as has been observed by Hatheway (1955) on Canton Island, where he found dead and dying Tournefortia, presumably associated with the concentrated guano deposits; this is probably correlated with the drier climate of Canton Island in contrast to Gaferut. On Gaferut the larger trees heavily used by birds were not as vigorous in appearance as those in other areas but no dead trees were noted resulting from this factor. However, as mentioned above, the sparsity of herbaceous cover and seedling reproduction may be correlated with excessive guano. Periodic visits by natives may also play some role in reducing the bird population, but their present density would suggest that this influence is negligible.

In interpreting future trends within the existing vegetation it appears that Tournefortia will probably persist as the typical vegetation for some time since there are no other competitive species available which might replace it such as Pisonia or Ochrosia oppositifolia. Whether or not adequate reproduction will occur to replace mature trees in the future is questionable at this point. The two coconut palms that were presumably planted do not appear to be spreading. In fact, the poor vigor of the sprouted nuts as a result of coconut crab activity would suggest that the palm will probably not become an important part of the vegetation. This may well be a limiting factor in the establishment of coconut, even if introduced, on uninhabited islands or those where the coconut crab population is not kept in check. Since the crab is considered such a delicacy by the natives it presents no serious threat on inhabited islands. Another species, Ipomoea tuba, must also be considered since it has already engulfed and killed several Tournefortia. It is not impossible to visualize this very aggressive and drought-resistant species as eventually becoming dominant over an increasingly extensive portion of the interior.

Summary

1. Gaferut, an uninhabited island in the northern Carolines, is dominated by a low forest of Tournefortia argentea. Associated with this community is a large bird population, primarily frigate birds and red footed boobies.

2. The underlying phosphatic rock resembles that of the Jemo Series. Its presence suggests that formerly a Pisonia forest existed on the island and has since been destroyed perhaps by a typhoon. A large coral boulder perched on the reef is indicative of a severe storm in the past.

3. Tournefortia will probably persist as the dominant vegetation for some time. The coconut palms, presumably planted, do not appear to be spreading. Ipomoea tuba which has already killed several Tournefortia may become increasingly important in the future.

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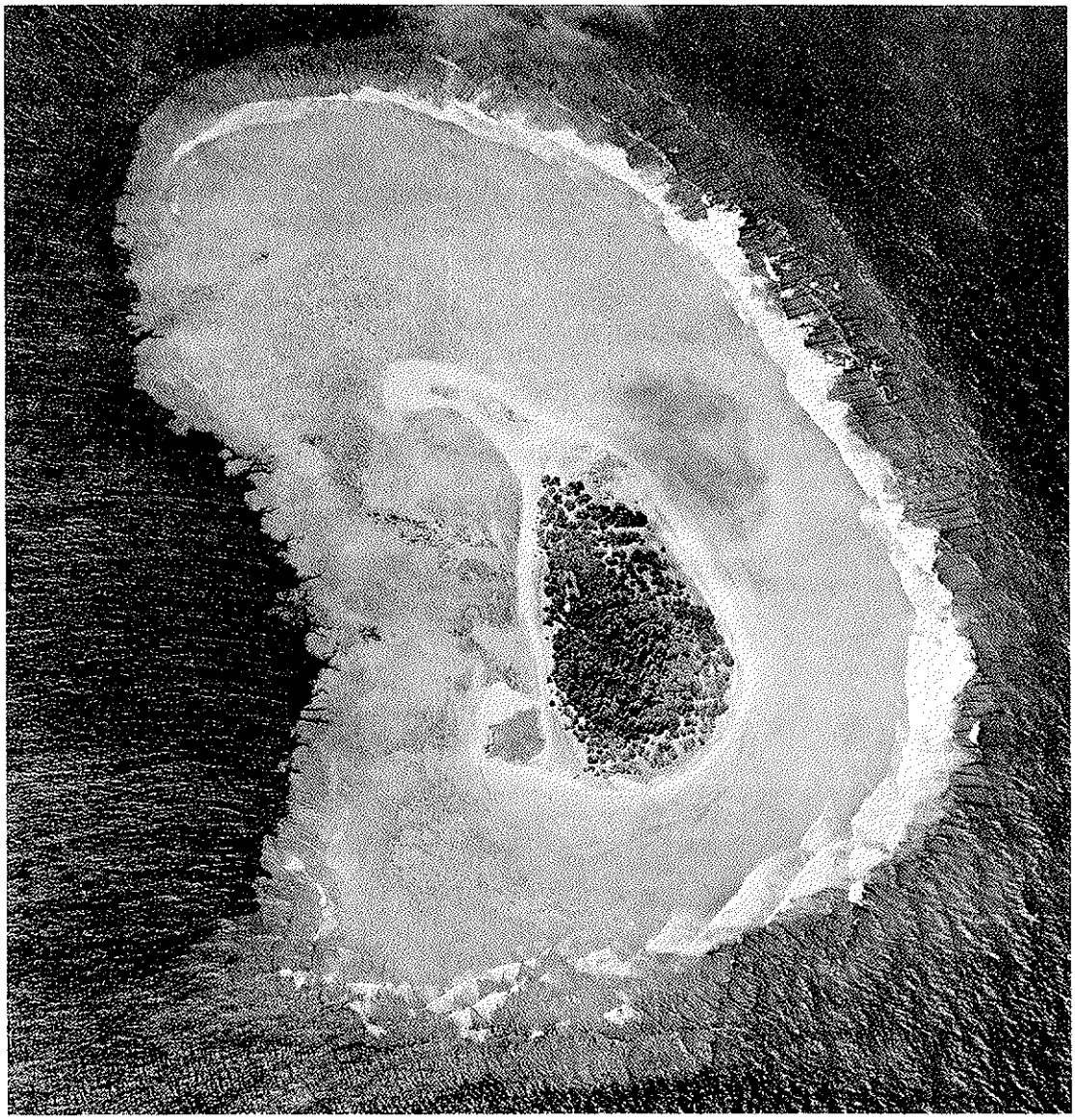
Fig. 1 Aerial view of Gaferut Island taken April 1944, 10 years prior to the present observations. Light gray vegetation dominant throughout is Tournefortia argentea. Rubble areas are evident, demarcated by the scattered specimens of Tournefortia, especially on the eastern and southern sides. On the phosphatic rock of the interior, Tournefortia forms a somewhat circular pattern around a uniform darker area which represents the section cleared for phosphate digging. In 1954 the cleared area was dominated by Ipomoea tuba. The sand bar building northwestward is devoid of vegetation. If the coconuts were present at the time the photo was taken, they were too small to be detected. There appears to have been relatively little change in the vegetational pattern in the 10 year period.

Photo courtesy of U. S. Navy.



Historical and climatic information on Gaferut Island

by

Marie-Helène Sachet

In view of the scarcity of information on Gaferut, it seemed worthwhile to utilize the library resources of Washington in order to supplement the valuable observations made by Dr. Niering.

History

The real native name of Gaferut is Faiau, Fallao (Spanish spelling), or Fayo (which means stone or rock in the Woleai language of nearby islands). The name Gaferut is never included in the old lists of islands of the Carolines, and, according to Smith (1951, p. 30), is never used by local people. Chamisso (1821, p. 115) relates how Carolinians from Woleai, Lamotrek and other atolls went every spring (April) to Guam, stopping on the way for several days at "Fayo, the desert island," and returning in May or June by the same route. Riesenberg and Kaneshiro(1960, p. 285) identify this stopping place as Gaferut. Chamisso also discusses some of the early descriptions of these central Caroline atolls and includes a chart modified from Cantova (1728), in which our Gaferut is obviously the island called Fauheu.

Of this island, Chamisso says also (p. 124) that it is uninhabited, without fruit trees or fresh water, which only collects in pits after rain, and that the inhabitants of near-by atolls visit it to collect turtles and birds. Farther on (p. 196) he says that the god of the desert island of Fajo is called Lage, and (p. 205) he writes:"On the desert island of Fajo, as at Bygar / Bikar in the Marshalls/, fresh water is conjured into the water pits. There is a species of black-bird /probably the frigate-bird, which was sacred on Sorol and Puluwat/ which is under divine protection on this island, and not permitted to be eaten." Chamisso had this information from his friend and informant, Kadu, a native of Woleai.

What then was the real Gaferut? It was either an imaginary magic island, or perhaps a former islet of a reef now devoid of dry land (cf. legend of Ngaruangl in Gressitt 1953, p.2). According to Krämer (1937, foot-note p. 346) Gaferudj is a name for Sëpen, a former atoll near Yap; Müller (1917, p. 304) mentions that Sepin is a sunken magic island, culturally linked to Rumung (northernmost island of Yap). All this might explain why Senfft (1906, p. 284) was told that Gaferut was a devil's island and never visited by the Caroline people, who were afraid of it. The report then would apply to the real Gaferut, rather than to the island we now know under that name, and which Senfft visited (see below).

The confusion of names was recently clarified by Smith (1951, p.28) who calls our Gaferut Fayaew (in his own system of phonetic spelling), and adds (p. 29): "'Gaferut' in turn is a bastardization of a Yapese name, even though Yap has only very remote concerns for that island."

Fayaew belongs to the Faraulep people. When the name Gaferut was first applied (or misapplied) to the coral speck in 9°14'N, 145°23'E has not been ascertained. The island is also called Grimes (Gurimesu-to in Japanese) from Captain Grimes of the ship Jean (Findlay 1870, p. 766), who discovered an island in lat. 9°16'N., long. 145°43'E. He described it as high and well-wooded, of 6 miles in circumference, so there is possibly some confusion with some other island, perhaps Fais. Findlay adds:" It has since been announced as High Island, at lat. 9°11'N., long. 145°45'E. ..." These names are generally considered as synonyms of Gaferut.

One of the few references to Gaferut in the literature is an account of a visit by the German District Administrator of Yap, A. Senfft, in Dec. 1905. He described it (1906) as a flat sand bank, only locally reaching a height of 2 meters. The only vegetation noted was "a species of mangrove." Countless seabirds were nesting in the trees or on the flat ground. Coconut crabs were also observed, and tracks of large sea-turtles. Senfft also noted that a violent storm must have recently hit Gaferut, as most trees had broken branches and some very large ones were completely uprooted. Later, a German expedition exploring for phosphate deposits is said to have discovered phosphate on Gaferut (Aso 1946, p. 117). According to German sources (Sapper 1910) this expedition took place in 1907, not in 1903 as reported in the translation of Aso. As a result of their discoveries, the Germans started exploiting phosphate on Angaur, Peliliu and later Fais, but never on Gaferut. However, the Japanese did mine phosphate there, in spite of great transportation difficulties, starting about 1937.

In addition to the phosphate workers, other Japanese visited Gaferut, among them Yata Haneda, a mycologist interested in luminous fungi, who mentions Gaferut and its phosphate in an account of his 1937 travels in Micronesia (1939). The distinguished geologist Risaburō Tayama apparently also visited Gaferut, and he included a description of it, maps, sections and a photograph in his volumes on coral reefs of Micronesia (1952). He wrote (p. 262): "The table reef of Gaferut is a crude half circle with the convex side facing east. The length of the arc is 1.1 km. Gaferut is the only island on the reef. The shape of the island corresponds roughly to that of the reef. The northern half of the island is chiefly sandy and the southern half primarily gravelly. Recent limestone (Fig. 104) emergent at low tide, is best exposed toward the western end where it strikes northwest and dips 5 to 10 degrees to the southwest. Four recent limestone ridges may be discriminated near the southern coast. The inner ridges are of foraminiferal sandstone and the outer of coral conglomerate; they strike East-West and dip 5 degrees. The central part of the island is flat-topped and rises 5 meters above the reef-flat. The upper surface is level and built of coral limestone (Fig. 105). This limestone is altering to phosphate ore; it conformably overlies a brown clay; and the brown clay, in turn, conformably overlies a foraminiferal sandstone, and the sandstone, the coral gravel and foraminiferal sand bed.

"The reef-flat is extremely wide on the northwest side. The inner zone of the reef-flat is not exposed at low tide, and is dotted with shallow pools about 0.5 meters deep. Seaweeds are growing over the reef floor, and mushroom rocks, 2.5 to 3 meters high, are standing here and there."

Tayama's fig. 103 (p. 116) is a small-scale sketch map with bathymetric contours, and giving 2.7 m as the height of a rock on the NW reef. Fig. 104 (also 146) is a profile of the east coast, from the reef front to the bedded phosphatic rock of the interior, showing a mushroom rock, beach-rock ("recent limestone"), beach sand and gravel between the reef and the phosphate platform. The height of the latter is shown as 5 m above low tide. Fig. 105 is a "Columnar section of beds exposed in pit on Gaferut Island, Gaferut Table Reef," including:

"a. Surface soil-Blackish brown (20 cm)
b. Coral limestone-Phosphatic and include abundant Tridacna gigas (35 cm)
c. Brown clay (25 cm)
d. Foraminifera limestone-Somewhat phosphatic (65 cm)" lying on
"e. Foraminifera and coral sand."

An analysis of the "phosphatic reddish brown clay intercalated in the cay sandstone" is given on p. 265:

SiO_2	CaO	Fe_2O_3	Al_2O_3	P_2O_5
3.28	48.97	3.17	2.50	19.35%

Elsewhere (1942) Tayama had remarked on the amazingly high percentages of silica, iron and aluminum oxides.

In appendix I of the 1952 work is a photo (fig. 48, p. 95) of Gaferut Island. Concerning this F. R. Fosberg says (personal communication):"The presence of bedded phosphate rock on Gaferut suggests that a vegetation of Pisonia grandis may have existed on the island, and the presence of humus on the surface indicates that his must have been in the very recent past. The complete absence of Pisonia now, as indicated by Niering is indeed remarkable. Tayama's photo suggests that Pisonia may possibly have persisted until at least the date of the photo, as the much taller forest on the right side of the picture has the aspect of Pisonia, though the reproduction is so poor that this can be regarded only as an impression rather than a certainty."

There are almost no descriptions of Gaferut in the literature, other than the brief German and Japanese texts. The Sailing Directions (U. S. Hydrographic Office 1938) described it briefly as follows:"low, thickly covered with trees, and encircled by a reef. There are no coconut palms and no inhabitants, but natives from Faraulep Islands visit it to catch birds, which are numerous on it." In a later edition (1952), the information was amended to read:"Gaferut is low and covered with trees. Some of the coconut palms attain a height of 65 feet. There were no permanent inhabitants in 1935, but since that time phosphate mining has been reported. Numerous birds exist on the island, but no food or fresh water.

"The mean high-water interval at the island is 7h. 30m. Mean high-water spring tides rise 2½ feet."

Climate

The climate of Gaferut is a humid tropical one, with little seasonal change. There are no records from the island itself, but in this area of the ocean, temperatures vary little around the year, the mean average air temperature being about 82°F, with daily variations probably not exceeding 15°, and usually less. Atmospheric humidity is always high. It rains throughout the year, with probably higher rainfall in the summer. The total amount of rain must be in the neighborhood of 100 inches (less than Truk to the south and more than Guam to the north). At Lamotrek, somewhat to the south, the rainfall was 104 inches per year, based on 4 years of record.

The wind regime is probably the climatic component most affected by seasonality. The north-east trade winds are rather steady in the winter and spring, and northeast, north and east winds prevail. From June or July to October, the winds are more variable, with often a strong component from southwest, west or south.

Every year some tropical storms or typhoons originate in an area between Gaferut and Truk, and many of them, travelling northwestward toward Guam, must pass near Gaferut. A direct hit is probably not too frequent, but very strong winds and high waves must occur rather often. That Senfft observed the results of the passage of such a storm in 1905 is quite likely. Even Ophelia I, which was so damaging in Jaluit, passed not far from Gaferut toward the end of its destructive career, and so must have Ophelia II (Nov. 30, 1960) which devastated Ulithi. Such storms can occur any month in the year in this part of the Pacific although they are more frequent in the summer and fall.

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