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The Evolutionary Ecology of Rotuman Political Integration

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On the basis of the constructs of evolutionary ecology, this article presents an explanation for political integration during the prehistoric–protohistoric period on Rotuma, Fiji. Archaeological, ethnohistorical, and environmental data are analyzed with a geographic information system (GIS) to define the natural and social constraints according to which specific behavioral strategies conferred benefits to the people who employed them. The analysis suggests that during the prehistoric–protohistoric period chiefs from the relatively less productive, eastern side of Rotuma dominated the political arena. The integration of the island into a single, loose polity provided the eastern chiefs with social and material benefits. Because of these benefits, the eastern chiefs sought to perpetuate the political structure. Individuals from other districts participated in the hegemonic political structure because they reaped long-term benefits, suffered minimal costs, and perceived relatively fewer advantages in obtaining pan-Rotuman positions. Given the specific environmental context of this relatively isolated island, the formation of an island-wide polity provided selective advantages to its members.

Traditional Polynesian societies exemplified a diverse array of political forms. Over the past decades anthropologists have tended to separate these societies into essentialist categories or stages and to theorize about how the societies have evolved from one type or stage to the next. Typically, these studies focused on the degree of social stratification or differentiation and the extent of political integration. In many of these studies an increase in social stratification correlates with an increase in the area ruled and the number of social units integrated into a single polity. Explanations for the elaboration of social stratification and political integration range from functional interpretations (Sahlins 1958; Service 1962), to hypotheses concerning the role of status rivalry (Goldman 1970), to phylogenetic models (Kirch 1984; Kirch and Green 1987), to models that stress external influences (Sand 1993; Friedman 1981; Spriggs 1986, 1988). As an alternative, the Darwinian selective advantage of particular social manifestations can be considered. As such, the aim of this paper is to delimit the prehistoric–protohistoric environmental and social constraints of Rotuma, Fiji, and to determine how the integration of the island into a single polity would have been advantageous to the participants.

ROTUMAN PREHISTORIC–PROTOHISTORIC SOCIOPOLITICAL STRUCTURE

Rotuma is situated at the juncture of Micronesia, Melanesia, and Polynesia and has been influenced from all three areas. The cultural origin of the island's original inhabitants is unknown, but other islands in West Polynesia were settled by people associated with lapita pottery ca. 3200 BP who originated farther west in island Melanesia (see Kirch 1984, 1988; Kirch and Hunt 1994). During the late prehistoric period Rotumans were significantly influenced by the Polynesian cultures of Tonga and Samoa. Today, Rotumans are considered physically and culturally Polynesian.

At the time of European contact in 1791 the relatively small (14 × 4.5 km) isolated island of Rotuma was divided into seven

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semiautonomous districts that were loosely integrated into a single polity (Figs. 1 and 2) (Howard 1985, 1986; Ladefoged 1993a, 1993b). In addition to individual district chiefs, the island-wide polity was led by three pan-Rotuman positions, the *fakpure*, *sau*, and *mua*. The *fakpure* was the secular ruler of the island, whereas the *sau* and *mua* were religious leaders who were dialectically opposed (Howard 1985, 1986, 1989). The *mua* was associated with the mythical founder of Rotuma, Raho, and the first indigenous people of the island. In Rotuman conceptions the *mua* represented the commoners as producers of an agricultural surplus that was used to support the chiefly elite. The *mua* was associated with fertility, the productive interior, and the west side of the island. He derived his power from the gods who resided in Limari, to the west of the island. In contrast, the *sau* was associated with the mythical figure Tokaniua and represented foreign usurpers of power. As such, the position had a performative aspect to it. As a representative of the chiefs, the *sau* was a consumer of commoner produce. The *sau* was associated with the sea and sky and the relatively unproductive eastern side of the island. In part, the position of *sau* derived its power from the foreign chiefs of Tonga.

There is some ambiguity concerning the role and relative position of the *sau* with respect to the *fakpure*. Hocart (1912) suggests that the position of *fakpure* did not exist before the war of Saukam in 1840 and that the entire island was ruled by the *sau* with individual districts maintaining a degree of autonomy. Brief remarks by Dillon (1829), Lesson (1838–1839), and Bennett (1831) in the early 1800s substantiate the view that the *sau* held preeminence over the *fakpure*. Bennett (1831) and Dillon (1829: 95) wrote that a council of chiefs selected the *sau* and made no mention of the *fakpure*. This omission could mean that the position

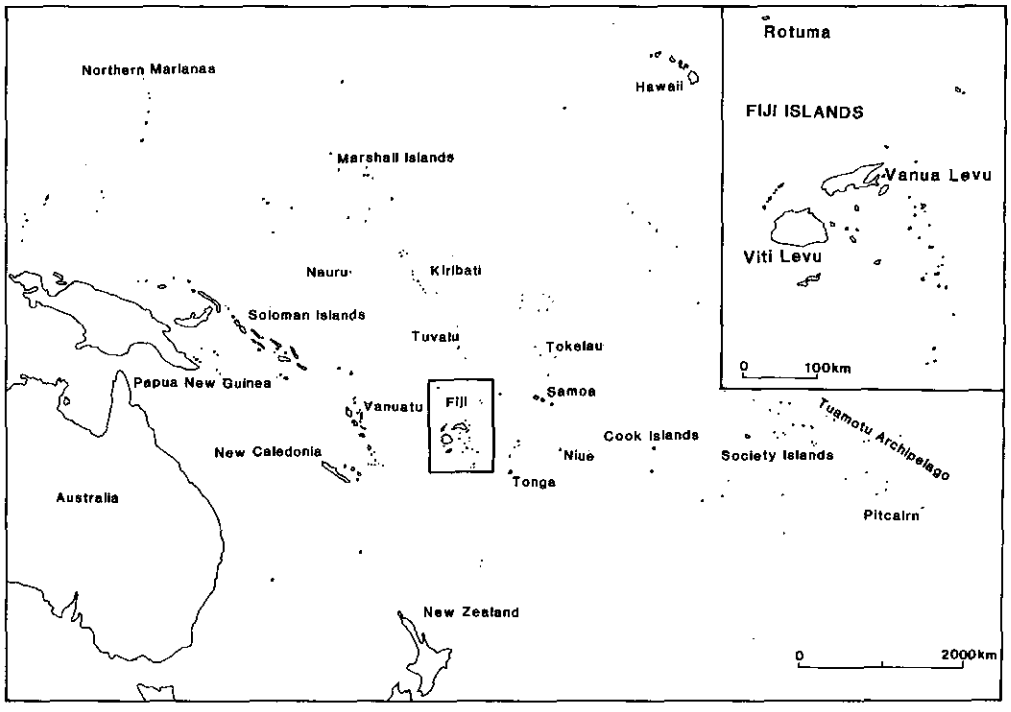

FIG. 1. The Pacific showing the location of Rotuma.

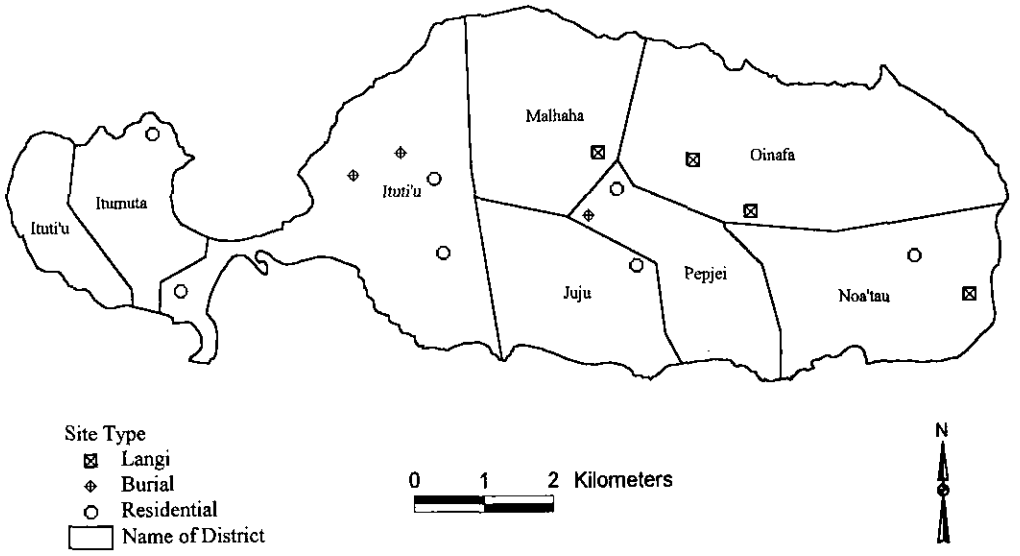

FIG. 2. The districts of Rotuma with the distribution of archaeological sites.

of *fakpure* did not exist or was of little importance or that the *fakpure* were unobtrusive during their visits. Similarly, Lesson (1838–1839) wrote that the island was ruled by the *sau* and never mentioned the *fakpure*. In 1895 Allen (1895) suggested that the *sau* chose the *fakpure*, indicating that the *sau* was preeminent. Further inconsistency is introduced by an occurrence of rebellion specified by Trouillet (n.d.). He notes an instance where a *fakpure* was "overcome by ambition and killed the *sau*." The old *fakpure* relinquished his former position and proceeded to proclaim himself *sau*. Trouillet's statement suggests that the position of *sau* held preeminence over the position of *fakpure* but that the latter might hold designs on the former. Furthermore, there is another instance in Trouillet's (n.d.) account where the position of *sau* and *fakpure* were filled by a single leader. This again emphasizes the somewhat flexible nature of the *sau*'s position. Finally, Gardiner (1898:462) lists the *fakpure* as one of the *sau*'s attendants and indicates that the *fakpure* was lower in rank. However, in other places Gardiner (1898:460) does propose that the *fakpure* outranked the *sau*. Regardless of the *sau*'s ranking in relation the *fakpure*, it is clear that in traditional Rotuman society the *sau* was a chiefly position that influenced the entire island (Howard 1964: 28).

According to some accounts, the position of *sau* was rotational with representatives of each district holding office in turn (Bennett 1831:473, Allen 1895; Gardiner 1898: 461; Macgregor 1932; Howard 1964:28, 1985:41). To Howard (1985:69), the rotational ideal of *saushíp* indicates that the position symbolized the unity of Rotuma in the absence of stable hegemonic political integration. The *sau* personified the polity and represented the entire island to the deities. Howard (1985, 1986) considers the *saushíp* an experiment designed to solve the problem of integration posed by a tradition of district autonomy. Despite the cultural ideal of a well-organized rotational political system, instability was occasionally manifest when commoners and lesser chiefs deposed unpopular pan-Rotuman chiefs and the leadership of the polity occasionally changed according to the fortunes of war (Howard 1985:69–70, 1986).

Howard argues that competition or war-

fare on Rotuma "was generally motivated by status rivalry rather than economic considerations, and was not a means of territorial aggrandizement" (Howard 1966:63). He also notes that "the fundamental causes of interdistrict strife resulted from breaches in etiquette between chiefs" (Howard 1964: 28). He suggests that "Imputed motives (for usurpation) include anger over slights, the incumbent chief's misconduct, and sheer ambition" (Howard 1986:11). Following Gardiner (1898:470–471), Howard (1966) proposes that the victors in war achieved little or no material gain. He suggests that chiefs of a district "were entitled to first fruits, and regularly received portions of food from feasts, and fish from communal fish drives, but under usual conditions these were not consequential" (Howard 1989:146). Ultimately, Howard (1985:68) concludes that:

> The relationship between the people and chiefs, is finally constructed as one of complementarity, with the people producing the food (and other goods and services) for the benefit of chiefs, who intercede with the gods, who provide abundance to the land.

According to this interpretation, Rotuma exemplifies what Goldman (1970:20, 546) classified as an "open" society with a composite social system. The major district subdivisions of the island were political territories unstably integrated into a single polity, while the internal organization of the districts was structured on genealogical lines.

Although Howard has focused primarily on the postcontact history (Howard 1964, 1966, 1989) and cultural logic (Howard 1985, 1986), he makes suggestive comments regarding the precontact polity from a cultural ecological perspective. He (Howard 1985) relates the political structure of Rotuma to the demographic level and geographic dimensions of the island. Howard (1985:72–73) states:

> In Rotuma, . . . an isolated island of rather small size . . . and a medium-sized population, pragmatic constraints favored local autonomy and set limits on the degree to which chiefs could be differentiated from the people. Genealogies were shallow and distancing was difficult both physically, because of the small size of the island, and socially, because the population was too small to facilitate a distinct breeding population of chiefs, keeping kinship distance within boundaries. As a result Rotuman chiefs were not in a strong position to be either elevated in rank or mystified to a level approximating gods.

Howard's (1985) suggestion is that the elaboration of social stratification on Rotuma was to some extent constrained by the size and population of the island. According to this hypothesis, the principles of social differentiation based on genealogy would be extensively elaborated and a high degree of social stratification would occur on larger islands with substantial populations (Howard 1985:72).

EVOLUTIONARY ECOLOGY

While the explanations of Howard and other researchers provide useful insights into the variables that affected the social structure of Polynesian societies, the theoretical constructs of evolutionary ecology infused with a healthy dose of praxis theory provide a more robust explanation. Evolutionary ecology applies the principle of natural selection to the study of biological design within an ecological setting (Smith 1983; Winterhalder and Smith 1992:5). This perspective aims to delimit how evolutionary forces act on both genetic and cultural variation to produce the behaviors of individuals. The aggregate behavior of individuals in turn form societal norms, which are then explained as the consequence of evolutionary processes.

The application of Darwinian evolutionary theory in archaeological contexts assumes that natural selection involves a two-step process (Dunnell 1980, 1989; Rindos 1985). Variation is first randomly generated and then selection operates on this

variation to allow more advantageous variants to reproduce at a higher average rate. The process of differential reproduction leads to either the eventual replacement of the relatively less advantageous variants or their persistence at lower frequencies (Smith and Winterhalder 1992:26).

Richerson and Boyd (1984) note that natural selection may act on any system of inheritance where heritable variation affects an individual's phenotype and where the phenotypic differences affect an individual's chance of transmitting the variants to others. Cultural behaviors conform to these key properties. Variation in cultural behavior is transmitted from individual to individual through learning. Variation affects the observable appearance and behaviors of individuals, and behavioral differences between individuals can and do affect the probability that specific traits will be passed on. Cultural behavior can therefore evolve by the selective retention of nongenetic traits that enhance individual fitness (Leonard and Jones 1987).

Most evolutionary ecological models invoke methodological individualism as a fundamental premise (Smith and Winterhalder 1992:39–42). Methodological individualism assumes that cultural norms are the result of aggregate individual behavioral strategies (Mithen 1989:486; Boone 1983). As such, the rules and practices of social institutions result from both intentional and unintentional individual behavior. Methodological individualism provides an actor-based account for social phenomena, while recognizing that most evolutionary explanations will apply to collective behavioral strategies.

Optimization models implemented by evolutionary ecologists propose that people's behavioral strategies are based on the maximization of individual benefits (Durham 1976; Smith 1987; Smith and Winterhalder 1992:33). In these models, people behave rationally in the sense that they act as effectively as possible and do not commit logical errors in ordering their preferences (Smith and Winterhalder 1992:26). The notion of rational behavior excludes assumptions about how people assign values to choices; instead it assumes that people can logically execute these choices. Smith (1987:202) notes that all optimization models contain four features:

> (1) an *actor* that chooses or exhibits alternative states; (2) a *strategy set* (the range of options an actor chooses from or exhibits); (3) a *currency* (the cost-benefit measure that is maximized or minimized); and (4) a set of *constraints* (all those factors that determine the feasible strategy set and payoff to each option).

The "constraints" of optimization models include social and natural variables that constitute the context within which individuals exercise alternative behavioral strategies. These constraints are similar to what some archaeologists have referred to as the "context" or "landscape" (Butzer 1982; Green 1990; Savage 1990; Crumley and Marquardt 1987; Rossignol and Wandsnider 1992). Constraints include natural variables, such as the distribution of rainfall or soil types, and social variables, such as specific political structures, the presence of a militaristic threat, or the type and quantity of information available for making strategic decisions.

Not all members of society experience the same constraints when making strategic decisions. For instance, actors have variable cognitive abilities and depending upon social and economic status have differential access to information. These variabilities form distinctive social constraints for different members of society. Furthermore, the social constraints that actors experience when selecting between behavioral strategies may change through time. The constraints that an actor experiences can be altered by a variety of processes, including the aging of the individual, the actions of the individual, or importantly, the actions of other individuals. The dynamic nature of

social constraints means that individuals can employ behavioral strategies that affect or influence the constraints that other individuals experience. Actors select behavioral strategies that tend to decrease their own costs and increase their benefits at the expense of others partly by affecting the constraints that other people experience.

Specific societal norms can be analyzed in terms of the actors, strategies, currencies, and constraints that make up optimization models. For example, the extent and type of competition that exists between groups can be analyzed in terms of the natural and social constraints that actors experience when they make strategic behavioral choices. Specifically, researchers have suggested that in densely populated, circumscribed environments with highly concentrated predictable resources individuals will tend to engage in intergroup competition (Durham 1976; Dyson-Hudson and Smith 1978; Boone 1983, 1992).

Political integration is another societal norm that can be effectively analyzed using optimization models. Political integration is not an inevitable outcome made up of complementary roles which benefit all members of society. Rather, it is the result of individuals making strategic choices given their own particular constraints and opportunities (Brumfiel 1992, 1994). Natural variables constitute some of the constraints people experience and therefore must be considered in developmental models of political integration. Certain environmental settings with distinctive distributions of resources are more conducive to political integration than others. Social constraints and opportunities that individuals experience also affect whether or not they choose to employ behavioral strategies that may result in political integration.

When political integration occurs, most members (that is, virtually everybody except slaves and prisoners) of a polity have employed behavioral strategies that optimize their own benefits according to their perceptions of the constraints they experience. While membership in a single integrated polity may prove advantageous to all participants, the elite usually benefit disproportionately (Earle 1991:4–5; Brumfiel 1992). The elite should therefore employ behavioral strategies which change the constraints commoners experience so that commoners will choose behavioral strategies that include membership in the polity (Brumfiel 1994).

Earle (1991:5–6) suggests that the elite will attempt to dominate the economic, militaristic, and ideological conditions that commoners experience. In general, the elite affect economic conditions by controlling the subsistence resources that commoners rely upon. This can be done by controlling the distribution of land or irrigation rights. Elites can also use the threat and application of force to achieve polity affiliation. Commoners will react variously to this social constraint depending upon its strength and extent and then choose whether or not to be members of the polity. Elites can also use ideological means including mystification to create and naturalize social constraints that commoners experience. These ideological beliefs are not post-hoc justifications for people's behavior; rather such beliefs help to define the suite of social constraints that individuals experience. If the natural environmental constraints permit the elite to employ behavioral strategies which alter the economic, ideological, and militaristic constraints that commoners experience, a chiefdom may be maintained as a unified supradistrict polity.

THE ROTUMAN CONTEXT

The natural and social constraints of prehistoric–protohistoric Rotuma were created and defined by members of society so that most individuals perceived membership in a single island-wide polity as advantageous. These constraints are discussed to understand why and how political integra-

tion occurred. Recorded oral traditions, ethnohistorical accounts, and archaeological data are analyzed to reconstruct the social constraints, and a geographic information system (GIS) analysis is used to ascertain the environmental context within which people lived.

As stated earlier, various accounts suggest that the political system on Rotuma involved a rotating *saushíp* in which each district took turns appointing a *sau* who would to some extent rule over the entire island. However, a closer examination of the oral traditions and ethnohistorical accounts reveal inconsistencies with this hypothesis. Before examining these inconsistencies, several issues concerning the use of oral traditions need to be addressed.

Researchers in the Pacific have viewed recorded oral traditions as both a "chronological history" and a reflection of the structuring principles of a society. Kirch (1984:7) recognized that distortion exists in oral traditions but felt that actual events and people are represented in traditions pertaining to the last few hundred years prior to European contact. Kirch and Yen (1982:362–364) found that their interpretation of the archaeological record and some of the oral traditions of Tikopia corresponded closely, and concluded that for the most recent period oral traditions documented historical events. In a similar manner, Shutler and Evard (1991) suggest that Rotuman myths chronicle actual historical events.

Alternatively, it has been proposed that myths do not necessarily chronicle history but that they can be used to organize and interpret it (Sahlins 1981, 1985; Howard 1985, 1986). Howard (1986:22) proposes that Rotuman myths are not a "putative sequence of historical events" but should be regarded as "a statement about the cultural logic of priorities in the constitution and reconstitution of the social order." Hereniko (1991:186) generally concurs with Howard (1985, 1986), but feels that there is probably a degree of historical and chronological accuracy to some Rotuman myths. In my analysis of oral traditions I have followed the precedent set by Howard (1985, 1986) and Hereniko (1991) and have used Rotuman myths to delineate the structuring principles of late prehistoric–protohistoric Rotuman society. The following analysis does not presuppose that myths chronicle precise events, but that the relative occurrence of events in the myths, or the metaphorical associations of these myths, provides an indication of their importance and likely occurrence. Events that occur with frequency in myths are thought to have been important to Rotumans and reflect the extent to which the activity was practiced.

By analyzing oral traditions in this manner, Howard (1986) notes that different social status positions were consistently associated with particular regions of the island. This notion is somewhat inconsistent with the ideal of a rotating *saushíp*. Howard (1986:4–5) suggests that there was a "geographical code" on Rotuma and observes (see Fig. 2):

> That portion of the island to the west of the isthmus is called Fa'u, "back," and is strongly associated with the indigenous people. This contrasts with the remainder of the island, which is termed *mua*, "front". . . . The eastern segment is further divided into an end and middle section. The end section includes Oinafa and Noatau, which, being at the extreme eastern part of the island, is most closely associated with stranger-chiefs.

On the basis of oral traditions Howard (1986) suggests that the eastern districts of Noatau and Oinafa were associated with chiefs, and the western districts were associated with commoners.

If the eastern districts were associated with chiefs, it is possible that the *saushíp* did not rotate between districts, but was predominantly held by people living in the east. To assess the accuracy of this hypothesis recorded oral traditions and several

lists of *sau*, which indicate the *sau*'s home district, were analyzed (see Trouillet n.d.; Hocart 1912; Macgregor 1932; Churchward 1937a, 1937b, 1938, 1939; Evans n.d.). The temporal span of these lists extends from the mythical origins of the island when Raho poured sand from a basket to create Rotuma, until 1871, when the position of *sau* was abolished. The events documented in these lists were analyzed for the period from the mythical creation of the island until 1822, the point in time when European contact began to have a significant influence on Rotuman society (Lesson 1838–1839).

Forty-three of the 105 *sau* documented in the oral traditions were in power before 1822 and 62 *sau* reigned between 1822 and 1871 (Table 1). The *hanua*, or homeland, of the 43 *sau* that reigned during the prehistoric–protohistoric period was a locatable district or village in all but one case. During this period the greatest number of *sau* came from Noatau, the second highest number came from Itu'ti'u, and the third highest came from Oinafa.

To clarify these patterns, districts were grouped together to divide the island into northern, southern, eastern, and western portions. The groupings are based on oral traditions which suggest that during certain periods the island was divided into five districts (Trouillet n.d.). At one time the western districts of Itu'ti'u and Itu-'muta were part of a single district called Fau, and the southern districts of Pepjei and Juju were part of another district called Fag'uta. The oral traditions also note a strong alliance between the eastern districts of Oinafa and Noatau with no instances of warfare between these districts. However, the oral traditions do not indicate that they were ever united as a single district. For analytical purposes, Oinafa and Noatau are combined into a single group in the east, Itu'ti'u and Itu'muta are combined to form another group in the west, Pepjei and Juju are combined to form a third group in the south, and Malhaha is considered on its own in the north.

The distribution of the *sau*'s home district is presented in Table 2. It is evident that during the prehistoric–protohistoric period the greatest percentage of *sau* came from the eastern districts of Noatau and Oinafa. In contrast, far fewer *sau* came from the western districts of Itu'ti'u and Itu'muta and the southern districts of Juju and Pepjei, and the fewest number of *sau* came from the northern district of Malhaha. Therefore, the initial hypothesis that the *saushiр* was rotational is questionable. It is possible that the notion of rotational power was a cultural ideal, but in actuality the pan-Rotuman chiefs, as represented by the *sau*, typically originated from the eastern side of the island.

An analysis of interdistrict warfare as

TABLE 1
District Statistics

District	Area (ha)	Frequency of *Sau* before 1822	TPI	AATPI	NSAATPI
Malhaha	526.05	5	0.87	457.66	0.66
Pepjei	441.61	5	0.73	322.38	0.94
Juju	425.37	4	0.86	365.82	0.66
Oinafa	890.22	7	0.21	186.95	2.26
Noatau	594.73	11	0.27	160.58	4.14
Itu'ti'u	1049.69	9	0.83	871.24	0.62
Itu'muta	286.58	1	0.52	149.02	0.41

TABLE 2
District Group Statistics

District group	Area (ha)	Frequency of *Sau* before 1822	Participation in interdistrict warfare before 1822	TPI	AATPI	NSAATPI
Northern	526.05	5	7	0.87	458.40	0.66
Southern	866.98	9	8	0.80	690.64	0.79
Eastern	1484.95	18	11	0.23	345.40	3.15
Western	1336.7	10	10	0.76	1017.44	0.59

specified in oral traditions reveals an ambiguous, yet suggestive, pattern (see Table 2). A total of 16 interdistrict conflicts were documented in the oral traditions. The eastern districts participated in the greatest number of wars, 11 of 16 conflicts, or 69%. The western districts participated in 10 of 16 conflicts or 63%, the southern districts participated in 8 of 16 wars or 50%, and the northern districts participated in 7 of the 16 conflicts or 44%. Therefore, the people living in the eastern districts participated in interdistrict warfare slightly more often than other districts, and this practice might have contributed to the pattern of eastern chiefs occupying the pan-Rotuman position of *sau* more frequently than others.

The participation of eastern chiefs in strategies that affected the social constraints of others is also reflected in the archaeological record. A reconnaissance survey of 25 of 27 hills on Rotuma located and mapped 14 archaeological sites (see Fig. 2). These 14 sites are clearly only a small sample of all sites distributed throughout the island. However, the features recorded as elements of each site are probably representative of the features in the area. Most of the recorded features in these sites were platforms and terraces. These features were assigned to morphological classes on the basis of the type of material used for the fill, the type of material used for the rock facing, and whether or not a flat area had been created by cutting into the slope of the hill and depositing the sediment downslope (cf. Kirch 1988:45–46). Functional correlates of the six morphological classes of platforms and terraces were assigned on the basis of ethnohistorical, archaeological, and comparative West Polynesian data (see Ladefoged 1993a:203–207). The sites containing the different functional types of features were classified as (1) residential areas, (2) simple burial complexes, or (3) large *langi* burial complexes. The *langi* burial complexes are similar to the chiefly burial mounds of Tonga. They generally consist of large cut coral slab facings with an interior fill of calcareous sand.

The spatial distribution of sites on Rotuman hilltops is distinctive. It is possible to differentiate the types of archaeological features that the residents of the different districts were building on the hills in their districts. Large-scale burial monuments similar to chiefly Tongan *langi* are located exclusively in the eastern and northern districts. These monuments would have required the most energy and labor to construct, and it is likely that they were constructed by the leaders of the island, or their followers, in an effort to reaffirm chiefly status. The archaeological sites on the western mountains were quite different from the large-scale burial monuments in the east. On the western mountains there were several residential features and in two cases small burial platforms. While these monuments would have required considerable effort to construct, they are morphologically distinct and are not nearly as large and extensive as those in the east. It would thus appear that the people living in the

chiefly eastern districts where interdistrict warfare was common constructed a distinctive type of large-scale monumental architecture which was not constructed by the people in the western districts.

The social constraints created by eastern chiefs who participated in interdistrict warfare and who constructed monumental architecture to support their political domination, have an interesting correlation with the natural constraints of the island. A GIS was used to calculate the agricultural productivity of different regions of Rotuma. A soil map of the island (Laffan and Smith 1986) was digitized to create a GIS soil coverage. The original map contained 56 polygons, which were classified into 23 soil mapping units. The 23 soil mapping units were reclassified to produce a new layer composed of four soil classes including (1) well-developed soils; (2) swamps; (3) beaches; and (4) relatively unweathered rock (Fig. 3). The four categories roughly correspond to the three Rotuman land divisions of "bush," "swamp," and "coast" specified in ethnohistorical accounts (Gardiner 1898:483). Contemporary Rotumans make a further distinction between bush land with fertile well-developed soil and bush land with rocky soils (Fuata Kamoe, Vafo'ou Jaire, personal communication 1991).

Figure 4 shows the percentage of each of the four soil types found throughout the island. Most of Rotuma, that is, 54% of the island, has well-developed soils, 37.4% of the island has rocky soils, 7.5% of the island has beach soils, and 1.1% of the island is swamp. The percentages of each soil class for district groups are also shown in the graph. It is apparent that the district group percentages differ from the island-wide soil percentages. The northern, southern, and western district groups have a much larger proportion of well-developed soil than the island as a whole. In contrast, the eastern districts contain a much lower proportion of well-developed soils and a higher proportion of rocky soil. This suggests that the four types of soils are not evenly distributed in the individual districts of the island. Some of the districts have much higher proportions of well-developed soils whereas other districts have much higher proportions of rocky soils.

The relative productive potential of each

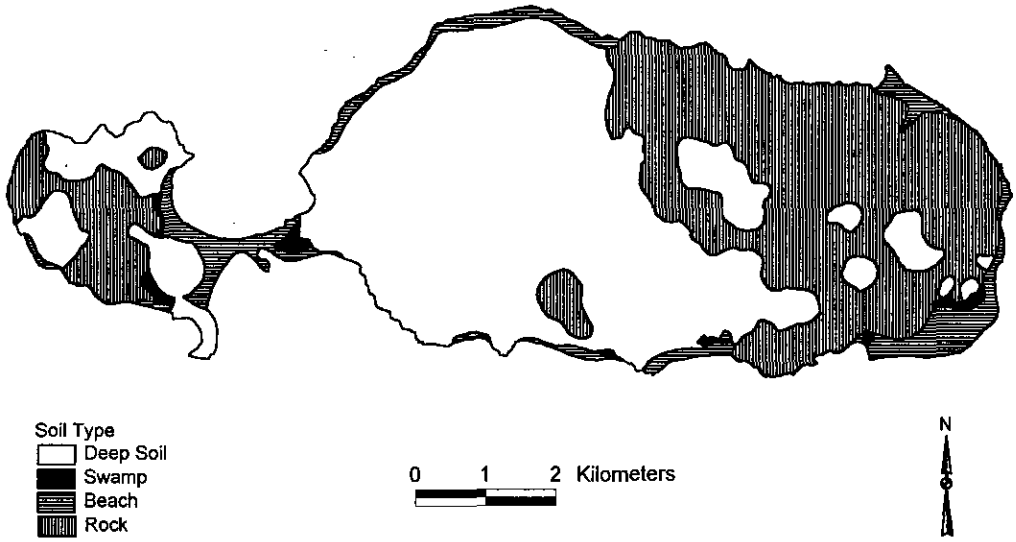

FIG. 3. The distribution of soils on Rotuma.

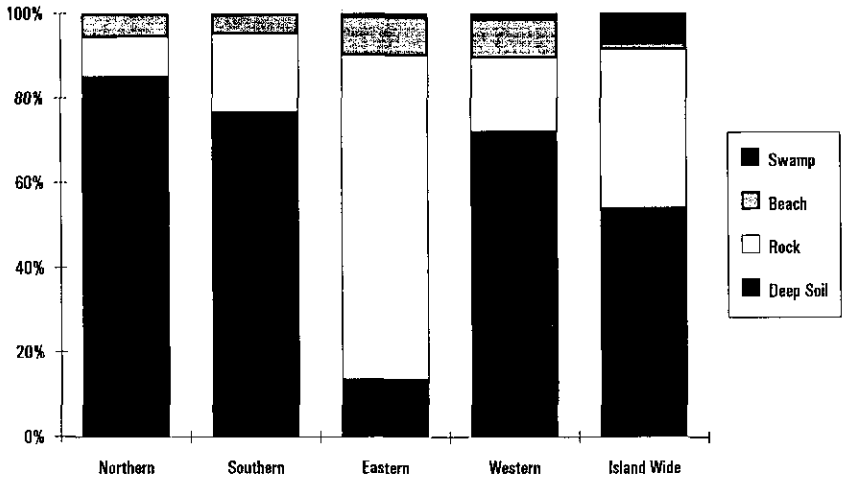

FIG. 4. District group soil percentages.

of the four soil types for growing the primary subsistence crops of taro, swamp taro, yam, coconut, and breadfruit, was estimated. Productivity ratings were assigned on a scale from 0 to 1. Although the productivity ratings are not precise measures, they provide a means for assessing the relative productivity of areas throughout the island. In areas of the island with well-developed soil, the productive potential for all types of crops with the exception of swamp taro would have been relatively high. Areas with well-developed soils have therefore been assigned a productivity rating of 1. The swampy areas of the island support a more limited range of crops and could have been used only for the cultivation of relatively slow-growing swamp taro. A productivity rating of 0.3 has been assigned to the swampy areas of the island because swamp taro takes roughly three times longer to mature than dryland taro (FAO 1989:40). The beaches of Rotuma were probably restricted to the cultivation of coconuts and breadfruit. Calcareous beach soils generally lack the nutrients of terrigenous soils and therefore have been assigned a productivity rating of 0.2. The rocky areas of the island are currently fallow. However, there is extensive archaeological evidence that yams were grown in these areas in the past (Ladefoged 1993a: 251–252). A productivity rating of 0.1 has been assigned to these areas on the basis of estimates of yam production per hectare in relation to estimates of dryland taro production per hectare. Under optimal conditions approximately 30,000 kg/ha of dryland taro can be produced (see Farrell and Ward 1962:217; Joralemon 1991:100; Landon 1984:270; Onwueme 1978:216; Purseglove 1972:64). In contrast, yam yields in the rocky areas of the island using artificial mulching would have been ca. 6500 kg/ha (see Coursey 1967:89–92; Landon 1984:270), or 22% of the yield of dryland taro under optimal conditions. Kirch (1991:120) notes that intensive dryland cultivation, such as artificial mulching, may take approximately twice the labor that regular dryland cultivation does. Dividing the relative crop yield in rocky areas (22%) by the amount of additional labor needed (2) results in the potential productivity of the rocky areas being approximately 10% of the optimal dryland zones. A relative productivity rating of 0.1 has therefore been assigned to the rocky areas.

The productivity ratings of the different types of soils throughout Rotuma can be

used to calculate a terrestrial productivity index for individual districts and for district groups. The terrestrial productivity indices calculated for areas in Rotuma are modified versions of the "composite index of agricultural productivity" that Kintigh (1985:105–107) used in his study of subsistence strategies in the Southwest United States (see also Hart 1968; Raitz and O'Malley 1985; Acury 1990; Hunt 1992). Kintigh (1985:106) assigned ratings to different soils on the basis of their potential for irrigated agriculture and then calculated an index for catchment areas around sites on the basis of the percentage of soil types within the catchment.

The terrestrial productivity indices, or TPI, for different areas on Rotuma were calculated using the following formula:

$$\begin{aligned}\text{TPI} = [((&\%\text{ of area that is well developed soil} \cdot 1.0) \\ &+ (\%\text{ of area that is swamp} \cdot 0.3) \\ &+ (\%\text{ of area that is beach} \cdot 0.2) \\ &+ (\%\text{ of area that is rock} \cdot 0.1))/100]\end{aligned}$$

The terrestrial productivity index for the entire island is 0.60. The terrestrial productivity indices for the districts of the island are given in Table 1. The district indices indicate that Malhaha, Juju, and Itu'ti'u have the highest productive potentials with indices of 0.87, 0.86, and 0.83, respectively. Pepjei and Itu'muta have moderate productive potential with indices of 0.73 and 0.52, respectively. Noatau and Oinafa have the lowest productive potentials with indices of 0.27 and 0.21, respectively. A Mann–Whitney test for equal averages indicates that when Noatau and Oinafa are grouped together they have terrestrial productivity indices significantly lower than those of the other five districts ($p = 0.047$, $T = 3$).

Terrestrial productivity indices are measures of potential productivity but they do not reflect how the size of a district or district group might compensate for low productive potential. To address this issue, area adjusted terrestrial productivity indices (AATPI) were calculated by multiplying the terrestrial productivity index by the area of the region in question (see Tables 1 and 2). These indices show a pattern similar to that of the terrestrial productivity indices and suggest that the most productive districts on the island are Itu'ti'u, Malhaha, Juju, and Pepjei, while the least productive districts are Oinafa, Noatau, and Itu'muta. When district groups are considered, the northern, southern, and western district groups have higher productive potential than the low productive potential found in the eastern district group.

To consider how the number of *sau* from an area corresponds with the productivity of that area a final index was calculated (see Tables 1 and 2). The index (NSAATPI) is a measure of how the number of *sau* from a productivity-adjusted area differs from the island-wide ratio of *sau* per productivity-adjusted area. The index incorporates the constant value of 0.0166, which is the total number of *sau* from Rotuma divided by the total area adjusted terrestrial productivity index for the entire island. The NSAATPI index is equal to $[(S/A)/0.0166]$, where S is the number of *sau* from an area, A is the area adjusted terrestrial productivity index for that area, and 0.0166 is the constant value for the entire island. The NSAATPI for the entire island would obviously be one, and any variation from that value gives an indication of how the actual number of *sau* from an area differs from the island-wide average. A larger NSAATPI value would indicate that a relatively higher number of *sau* came from a relatively less productive district. Conversely, a lower value indicates that relatively fewer *sau* came from a relatively more productive district. During the prehistoric–protohistoric period, Noatau and Oinafa have the highest indices. This suggests that relatively more *sau* came from the relatively less productive eastern districts in comparison to the other districts. The indices for Pepjei, Juju, Malhaha, and Itu'ti'u are all about the same, while that of Itu'muta is

the lowest. The ranking of the district group indices are similar, again suggesting that relatively more *sau* came from the less productive eastern districts (Fig. 5).

DISCUSSION

The environmental constraints on Rotuma are inversely related to the frequency of the number of *sau* from a district, the distribution of large-scale monumental architecture, and to a lesser extent the frequency of interdistrict warfare. This pattern would appear to be the result of individuals implementing behavioral strategies which maintained the island's loosely integrated polity. The selective costs and benefits associated with political integration varied for members of different social classes and for populations inhabiting different areas of the island.

The political integration of Rotuma with the eastern chiefs occupying the pan-Rotuman positions provided the chiefs from the less productive eastern districts with several advantages. The *sau* and his entourage from the eastern districts could have been sustained using nonlocal resources. By gaining access to the subsistence resources of the more productive districts, the Noatau and Oinafa *sau* were not only supporting a segment of their elite without using their own resources, they were also depleting the resources of potential rivals. This political structure meant that the Noatau and Oinafa *sau* reduced the ability of rival chiefs living in other districts to finance political insurrection and name their own *sau*. Furthermore, the Noatau and Oinafa *sau* obtained new avenues for displaying their supernaturally sanctioned fecundity. In the eastern districts the *sau*'s demonstrations of chiefly power were restricted by environmental conditions whereas in other more productive districts of the island they had greater opportunities to display proof of divine right. The cost of maintaining political integration for the eastern pan-polity chiefs included energy invested in attempts to control the economic, ideological, and militaristic constraints of the commoners and lesser chiefs.

The chiefs from the other districts might not have been motivated to employ similar strategies to those used by the eastern Noatau and Oinafa chiefs. The GIS analysis suggests that the eastern districts were not as productive as the western districts. While Noatau and Oinafa could have undoubtedly supported extradistrict elite, there were far fewer resources in these districts to control than in the other districts. The chiefs from the other districts could ex-

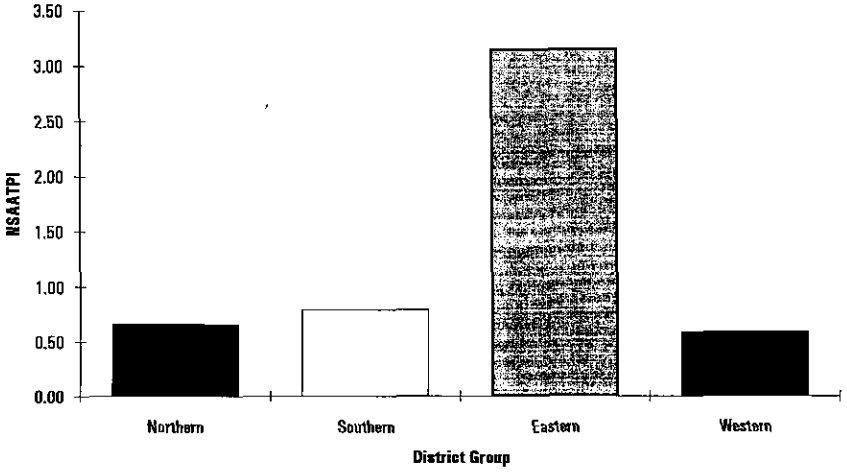

FIG. 5. NSAATPI for district groups.

press their supernaturally sanctioned fecundity, and control a relatively large percentage of the overall resources of the island, by simply ruling their own districts. There was not the same impetus to integrate the eastern districts into an island-wide polity. The people and chiefs of the noneastern districts had the added advantage that the political system was inherently unstable due to the weak resource base underlying the ruling Noatau and Oinafa *sau*. To some extent the success of an eastern *sau* was contingent upon the resources distributed throughout the island. If an eastern *sau* became too oppressive, the other districts might have been able to successfully overthrow him because of his own weak domestic resource base.

The costs and benefits associated with political integration were also different for the commoners living in different regions of the island. Political integration would have benefitted the common people living in the less productive eastern districts if they were granted agricultural use rights in adjacent districts. The poor soil conditions in the eastern districts meant that it would have been cost effective for the populations from the eastern districts to walk to agricultural plots located in more productive adjacent districts. The amount of time it took to walk to the more productive land would have been compensated for by the lower marginal costs of growing crops in a more productive area. This strategy would have disadvantages for the people living in the more productive areas only if highly productive land were limited in these districts. If there was a relative abundance of productive land then granting use rights to people from outside districts would not have been disadvantageous. The costs of political integration for commoners might have included increased tributary demands to support the pan-Rotuman elite. Furthermore, with political integration the social distance between the commoners and the pan-Rotuman elite probably increased, with likely material ramifications.

In addition to these costs and benefits that were specific to certain social classes, there were further important benefits for all members of society. The mortality rate of continuously warring autonomous districts would have probably been higher than the incidence of warfare-related mortality in an island-wide polity. Furthermore, political integration would have provided a measure of social insurance against periodic natural disasters. If separate regions of the island were differentially affected by natural disaster, such as a hurricane or drought, then subsistence resources could have been redistributed throughout the island to provide assistance. Even if the whole island was affected by a natural disaster, the subsistence crops grown in one area were probably more resistant to the disaster than those grown in another. Yams predominated in the rocky eastern districts, whereas dryland taro was abundant throughout the rest of the island. Yams are more tolerant of drought conditions than dryland taro. Under drought conditions, the eastern portions of the island which were reliant on yams for subsistence would have been less affected and might have provided assistance to other parts of the island. The swamp taro grown in the eastern district of Noatau and the western districts of Itu'ti'u and Itu'muta could have provided a similar buffer against temporary food shortages. Swamp taro is unique among Rotuman cultigens since it can be "stored" in the ground for years and used when necessary. The buffering and storage would have provided a selective advantage to members of an integrated polity. Environmental variation would not have had to have been extreme, and social buffering via resource sharing would not have had to occur all that frequently for political integration to have conferred significant benefits to its members.

Political integration does not occur simply because environmental conditions make it a viable option. Instead, it must confer some benefits to the members who

participate in it. On the small isolated island of Rotuma the question becomes whether a population of ca. 3000 to 4000 people, and possibly considerably more, would have survived as successfully with a political system at the village or district level of organization, or whether an island-wide political organization afforded them significant advantages.

People living throughout Rotuma would have benefitted from the social buffering that political integration provided against natural disasters. Furthermore, political integration may have allowed some of the commoners to reduce the marginal costs associated with their subsistence activities. Perhaps more important, however, were the advantages that political integration conferred upon a select group of people, the eastern pan-polity rulers. Although political integration provided some benefits to all members of society it was the eastern pan-Rotuman chiefs who seemed to have benefitted the most. The integration of Rotuma into a single polity was maintained because the environmental constraints were such that the costs of complying for the lesser chiefs and commoners living throughout the island were minimal and there were potential long-term benefits. Concomitantly, the social and material benefits for the eastern pan-polity elite were significant, and it was they who actively sought to promote the creation and maintenance of the political system.

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