The Logics of Island Life:

The Archaeology of Movement, Distance, and Settlement in the Neolithic Aegean and Ceramic Age Lesser Antilles

By

Thomas P. Leppard

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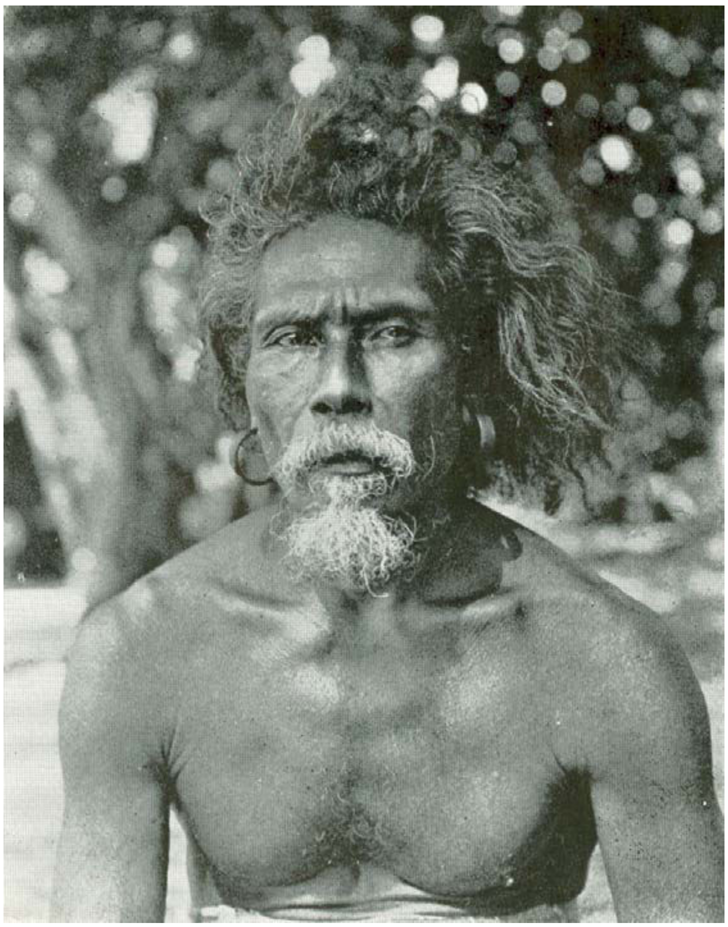

The islander.

Pa Fetauta, head of the House of Manoa, Kafika clan, Tikopia
(After Firth 1936: plate 2)

This dissertation by Thomas P. Leppard is accepted in its present form
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dissertation requirement for the degree of Doctor of Philosophy

Date_________________ _________________________________
John F. Cherry, Advisor

Recommended to the Graduate School

Date_________________ _________________________________
Peter Van Dommelen, Reader

Date_________________ _________________________________
Stephen D. Houston, Reader

Date_________________ _________________________________
Susan E. Alcock, Reader

Date_________________ _________________________________
Scott M. Fitzpatrick, Reader

Approved by the Graduate Council

Date_________________ _________________________________
Peter M. Weber, Dean of the Graduate School

THOMAS P. LEPPARD

Joukowsky Institute for Archaeology and the Ancient World
Brown University, Providence, Rhode Island 02912 USA
Email: Thomas_Leppard@brown.edu
Telephone: (401) 863-9423

EDUCATION

2007-13	Ph.D. in Archaeology, Joukowsky Institute for Archaeology and the Ancient World, Brown University.
2006-07	M.A. (Distinction) in Aegean Archaeology (Research Track), University of Sheffield
2002-06	M.A. Honours (1st class, second highest degree to be awarded in 2006 in Arts) in Ancient History and Archaeology, University of St Andrews

RESEARCH INTERESTS

- The archaeology of the Neolithic and Bronze Age Eastern Mediterranean
- The archaeology of the pre-Columbian Caribbean
- The archaeology and anthropology of islands
- GIS-led and quantitative approaches to regional analysis and survey archaeology
- The emergence of social complexity and theorization of its emergence

GRANTS, FELLOWSHIPS, AND AWARDS

2013	Office of International Affairs Summer Travel Award, Brown University.
2012-13	Dissertation Completion Award, Brown University. $67,841
2012	Office of International Affairs International Colloquium Grant, Brown University. Before *Mare Nostrum*: Current Issues in the Prehistory of the Mediterranean. (Co-authored with Clive Vella) $5,000
2012	Office of International Affairs Summer Travel Award, Brown University.
2012	Graduate School Research Award, Brown University. $1,600
2011	Office of International Affairs Summer Travel Award, Brown University.
2011	Graduate School Research Award, Brown University. $2,500
2010	National Geographic Society/Waitt Grants Program W86-10. Pasts and Present: Survey and Landscape Archaeology on Montserrat, West Indies. (Co-author; Co-PIs John F. Cherry & Krysta Ryzewski) $10,544
2007-12	Joukowsky Presidential Fellow, Joukowsky Institute for Archaeology and the Ancient World, Brown University. $273,000
2006-07	Research Preparation Masters Scheme Scholar, Arts and Humanities Research Council/Dept. of Archaeology, University of Sheffield. £13,700
2007	Petrie Watson Exhibition Fieldwork Award, Dept. of Archaeology, University of Sheffield
2006	Wiedemann Fund Conference Travel Award, Wiedemann Fund/Society for the Promotion of Hellenic Studies

2006	Bell Prize, Faculty of Arts, University of St Andrews
2006	Leventis Foundation Summer Travel Award, A.G. Leventis Foundation
2005	Lady Maxwell Prize, Dept. of Classics, University of St Andrews
2005	Adam Smith Thompson Travel Scholar, Dept. of Classics, University of St Andrews
2005	Society of Antiquaries Summer Travel Award, Tessa & Mortimer Wheeler Memorial Fund, Society of Antiquaries of London
2004	Hamish & Eileen Todd Prize, Dept. of Classics, University of St. Andrews

CURRENT RESEARCH

2013—	Southern Sardinia Archaeological Project (Sardinia, Italy) GIS Coordinator and Collaborating Archaeologist
2009—	Survey and Landscape Archaeology on Montserrat (Montserrat, West Indies) GIS Coordinator and Survey Team Leader (2011—); Collaborating Archaeologist (2009—)

COMPLETED RESEARCH

2008-09	Eastern Boeotia Archaeological Project (Boeotia, Greece) Survey Team Leader (2009); Field Assistant (2008)
2004-09	Sangro Valley Project (Abruzzo, Italy) Research Associate, Landscape Archaeology and GIS (2008-9); Survey Team Leader (2007-9); Site Supervisor (2005-6); Field Assistant (2004)
2008	Terra Incognita Survey Project (Molise, Italy) Survey Team Leader (2008)
2005	Kato Fana Archaeological Project (Chios, Greece) Field Assistant (2005)
2001	Fenland Archaeological Trust (Peterborough, UK) Field Assistant (2001)

PUBLICATIONS

Leppard, Thomas P. Under review. The Colonization of Islands and Coasts by Food-Producing Communities: the Mediterranean, Pacific, and Caribbean in Comparative Perspective. *Journal of Island and Coastal Archaeology*.

Leppard, Thomas P. In preparation 2014. Unique Challenges in Archipelagoes as Landscapes: Examples from the Mediterranean and Pacific islands. In Peter Siegel (ed). *Island Historical Ecology: Socionatural Landscapes across the Caribbean Sea*. Santa Fe: SAR Press.

Cherry, John F. and **Thomas P. Leppard.** Forthcoming 2013**.** A little history of Mediterranean island prehistory. In B. Knapp and P. Van Dommelen (eds.). *The Cambridge Prehistory of the Bronze Age – Iron Age Mediterranean*. Cambridge: CUP.

Cherry, John F., Krysta Ryzewski, and **Thomas P. Leppard**. 2012. Multi-period Landscape

Survey and Site Risk Assessment on Montserrat, West Indies. *Journal of Island and Coastal Archaeology* 7(2):282-302.

Cherry, John F., Krysta Ryzewski, **Thomas P. Leppard**, and Emanuela Bocancea. 2012. The earliest phase of settlement in the eastern Caribbean: new evidence from Montserrat. *Antiquity* 86. Available at http://www.antiquity.ac.uk/projgall/cherry333/.

ORGANIZED AND CHAIRED SYMPOSIA

2012 Before *Mare Nostrum*: Current Issues in the Prehistory of the Mediterranean (co-organized with Clive Vella, Alex Knodell, and Müge Durusu). Joukowsky Institute for Archaeology and the Ancient World, Brown University.

2012 Frogs Crossing the Pond: New Frontiers in Regional Archaeology (co-organized and co-chaired with Bradley M. Sekedat and Parker VanValkenburgh). Society for American Archaeology Annual Meeting. Memphis, Tennessee, April 18-22.

2008 New England Graduate Archaeology Workshop (co-organized with Claudia Moser). Joukowsky Institute for Archaeology and the Ancient World, Brown University.

PAPERS AND PRESENTATIONS

2013 Embedded 'Subsistence': Exploring the Social, Material, and Ecological Rhythms of Neolithic Foodways (with Chantel E. White). Theoretical Archaeology Group, Chicago, Illinois, May 9-11.

2013 New Prehistoric Sites on Montserrat, West Indies (with John F. Cherry, Krysta Ryzewski, and Emanuela Bocancea). Society for American Archaeology Annual Meeting. Honolulu, Hawaii, April 3-7.

2012 Quantifying insularity: regional archaeology and island prehistory in the Lesser Antilles. Society for American Archaeology Annual Meeting. Memphis, Tennessee, April 18-22.

2011 The Prehistory of Montserrat: a Synthesis and an Update (with John F. Cherry and Krysta Ryzewski). International Association of Caribbean Archaeologists Biennial Meeting in Martinique.

2011 Using a GIS framework in Caribbean landscape archaeology: Survey and Landscape Archaeology on Montserrat 2010 (with Luke J. Pecararo, John F. Cherry, Krysta Ryzewski and Elizabeth Murphy). Society for American Archaeology Annual Meeting. Sacramento, California, March 30-April 3.

2010 'Trust no cloud': Communities and community archaeology under the Soufrière Hills Volcano on Montserrat, West Indies (with John F. Cherry, Krysta Ryzewski and Elizabeth Murphy). American Anthropological Association Annual Meeting. New Orleans, Louisiana, November 17-21.

2010 Parallels and contrasts in Neolithic maritime expansions: the case of the Lapita, Saladoid and Cardial-Impressed phenomena. Brown University

2010 Archaeology versus the Volcano: Survey and Landscape Archaeology in Montserrat (with John F. Cherry, Krysta Ryzewski, and Elizabeth Murphy). Brown University

2010 The Emergence of Globalization? Islands, Sailing and Network Intensification in the Early Bronze Age Cyclades. Archaeological Institute of American Annual Meeting in Anaheim

2009 Metallurgy and Urbanization: A Synthetic Model of Cypriot State Formation in the Bronze Age. Archaeological Institute of America Annual Meeting in Philadelphia

2009 Quantitative Approaches to Regional Archaeology: An Introduction to GIS. Sangro Valley Project Field School

2008 Metallurgy, urbanization, and behavioral structures: a synthetic approach to increased social cohesion in the Cypriot LBA. American Schools of Oriental Research Annual Meeting in Boston

TEACHING EXPERIENCE AND GUEST LECTURES

2013 Teaching Assistant, Brown University, RI. *Animals in Archaeology*.

2013 Guest Lecturer, Joukowsky Institute for Archaeology and the Ancient World, Brown University, RI. *Archaeology's Dirty Little Secrets*.
Lecture Title: The Archaeology of Social Complexity on Montserrat.

2012 Guest Lecturer, Department of Sociology, Framingham State College, MA. *Introduction to Cultural Anthropology*.
Lecture title: The Archaeology and Ethnography of the Pacific.

2011 Guest Lecturer, Department of Sociology and Anthropology, North Carolina State University, NC. *Introduction to Archaeology*.
Lecture title: The First Civilizations of Europe: The Rise of Complex Societies in the Aegean, 3000-1200 BC.

2011 Teaching Assistant, Brown University, RI. *Art in Antiquity – An Introduction*.

2010 Guest Lecturer, Joukowsky Institute for Archaeology and the Ancient World, Brown University, RI. *Archaeologies of the Ancient Middle East.*
Lecture title: "After the Kingship descended from Heaven…" Uruk-Warka, the first cities, and the explanation of culture change.
Lecture title: You are what you eat? The development of domestication and sedentism in Southwest Asia

2009 Teaching Assistant, Brown University, RI. *Introduction to Egyptian Archaeology and Art*.

2008 Teaching Assistant, Brown University, RI. *Thirteen Things: Archaeology, material culture, science studies and design.*

ADMINISTRATIVE DUTIES AND PROFESSIONAL SERVICE

2012— Reviewer, *Journal of Island and Coastal Archaeology*.

2008 Graduate Student Representative, Joukowsky Institute for Archaeology and the Ancient World, Brown University

2006 Graduate Aegean Archaeology Representative, Graduate Liaison Committee, University of Sheffield

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CHAPTER ONE

INTRODUCTION

> Better drowned than duffers; if not duffers, won't drown.
>
> (telegram from Captain Walker to his children, prior to the maiden voyage of the *Swallow*).
>
> Arthur Ransome, *Swallows and Amazons*, 1930

The point of this telegram is that the Walker children have to adapt. Having written to their father, asking permission to take their boat, the *Swallow*, out into the wide lake below their summer home, he responds succinctly. In changing to fit the requirements of the lake and its islands, gleaning the necessary know-how of wind and water, they will thrive in this new world. A failure to do so will be terminal.

This telegram represents the kernel of the problem faced by the first colonists of islands; the problem of adapting to fit the environmental challenges posed by these small and circumscribed worlds. How did the first inhabitants of maritime archipelagoes transform from mainland duffers to knowledgeable islanders? How did they adapt and organize their lives in these small and potentially isolated fragments of land? To what extent can we extrapolate from non-human to human behaviors in islands — do biogeography and ecology shed any light on how and why humans organize themselves on islands? How greatly did voyaging technologies based on human muscle alone impinge upon where and how prehistoric islanders lived? Did prevailing technologies of subsistence, in the face of the inherent environmental heterogeneity of small islands, render certain logics of insular living self-selecting for prehistoric communities? How does a recognition of the imperative and centrality of movement alter our understandings of the formation and spread of these early societies? Finally, how does a comparison of the interrelationships between technologies of movement and modes of living in different archipelagoes shed light on the darker corners of early insular prehistory?

These broad questions derive from the observation in island archaeology that insular archipelagic space — fractal, environmentally diverse, and ecologically fragile — offers profoundly different challenges to human societies than terrestrial space (Broodbank 1993, 2000; Callaghan 2001, 2010; Evans 1973, 1977; Keegan 2010; Rainbird 2004; Torres and Ramos 2008). In an attempt to answer them, this dissertation will assess the extent to which insular prehistoric societies with comparable technologies of subsistence and movement and in archipelagic environments exhibited commonalities and differences with regard to the occupation of their respective landscapes. In particular, this dissertation seeks to establish whether there any parallels between the social and spatial organization — especially, but not only, settlement ecology — of different maritime prehistoric societies in archipelagoes. In doing so, it addresses wider debates within prehistoric island archaeology, contributing to the ongoing debate as regards the extent to which insular environments — and the means used to exist in those environments — imposed constraints upon the organization and developmental trajectories of prehistoric societies (Anderson 2004; Boomert and Bright 2007; Erlandson and Fitzpatrick 2006; Fitzpatrick *et al.* 2007; Rainbird 1999, 2007). It does this by suggesting the existence of commonalities in settlement dynamics deriving from the interaction between technologies of movement, subsistence strategies, and insular environments, but also of divergent strategies of living deriving from culturally- and environmentally-specific factors.

Chapter Two presents the underlying theoretical framework of this dissertation. Beginning by considering the comparative project in anthropological archaeology in general and island archaeology more specifically, it is suggested that comparing and contrasting broadly similar processes in two very different contexts will be inherently productive, revealing the extent to which we may, or may not, generalize about self-selecting logics of distribution in the human colonization of archipelagoes. The two cases chosen for comparison are the Neolithic settlement of the Cyclades, in the Aegean (5,000 – 3,200 BC) and the Early Ceramic occupation of the Leeward Islands, in the Caribbean (500 BC – AD 500): archipelagoes and communities separated in space, time, and specific behaviors, but united in geographic scale and organization, mode of subsistence, and prevailing technologies of movement. Having briefly introduced the case studies, and the problem of antecedent hunter-gatherer populations, I then outline the conceptual background for a comparative island archaeology, exploring the development of the discipline in general and its Mediterranean and Caribbean iterations in particular. Following this, the unique environmental conditions of small island are archipelagoes are considered, highlighting the necessity of adaptive behaviors in successfully exploiting these fragile niches.

The final part of Chapter Two moves to a discussion of the use of behavioral ecology and island biogeography in modeling long-term responses to island landscapes. Specifically, I suggest that ecological thinking provides optimal scenarios for subsistence and distribution, and that comparison of these to actual distributional and organizational choices made in both case studies will be instrumental in establishing whether underlying social logics were comparable to any degree. The notion of settlement ecology is proposed as providing a means to relate distribution, social structures, and modes of food-gathering in a mutually-dependent fashion.

Chapters Three and Four form a pair. In these, the datasets to be considered in the subsequent analyses — the settlements of both archipelagoes in the periods under question, and their cultural assemblages — are outlined in detail (see Figures 1.1 and 1.2 for the Cyclades and Leeward Islands respectively), along with the chronological frameworks employed throughout the dissertation. A specific goal of these chapters is to highlight the modes of subsistence prevalent within each archipelago, and how — if at all — these modes changed in the long-term. These changes are explored in the context of adaptive behaviors in Chapter Six.

The data presented in Chapters Three and Four form the basis for the spatial analysis in Chapter Five. In Chapter Five I begin to explore the degree of patterning within the distribution of sites of human settlement in the Neolithic Cyclades and Early Ceramic Leewards. Beginning with density analysis, it is argued that the distribution in both archipelagoes is not random, and that the underlying patterning should have a meaningful social correlation. The degree to which the distribution of settlement in both cases also corresponds to ethnographic settlement data is also considered. I then move on to consider how interconnectivity in both case studies might be modeled. Using the principles of gravity modeling, the basic 'attraction' or likely degree of information, material, and genetic flow between sites is outlined at a heuristic level; utilizing recent thinking in the study of complex adaptive networks, I then develop these simple gravity models into networks, with different degrees of attraction between sites. Doing so illustrates which sites were preferentially connected, and which were peripheral. As a subsidiary experiment, Proximal Point Analysis for the Leeward Islands is undertaken. Both this and the network analysis suggest that, over time and in both archipelagoes, certain sites became preferentially positioned, whereas others seem increasingly parochial. This seems to be associated, at least in the Cyclades, with emergence of a two-tier settlement hierarchy.

Chapter Six attempts to flesh-out the observations made in Chapter Five. It begins by considering classes of material which are very easily provenienced, allowing their movement around each archipelago to be readily traced: these are Melian obsidian in the Cyclades, and Long Island chert in the Leeward Islands. In the Leewards, uniting detailed and quantified information on the spread and use of Long Island chert suggests the existence of down-the-line networks of exchange in the Early Ceramic period, with certain sites acting as potential centers for the redistribution of this material. Such preliminary conclusions support the modeling undertaken in Chapter Five, suggesting that different regimes of value emerged from the exchange of this and potentially other desirable materials. Importantly, it also appears that changes in social and spatial organization were also implicated in developing systems of exchange in the mid first millennium AD. Similarly in the Cyclades differential access to obsidian appears to be an outcome of increasingly complex systems of distribution in the fourth millennium BC.

In the final part of Chapter Six, I explore the extent to which the initial distribution of settlement in both cases exhibited environmental or ecological patterning. It appears that, in both cases, there existed a preference for certain types of environmental niche which maximized choice in subsistence behaviors. The degree to which this corresponds with the considerations of human behavioral ecology and island biogeography are explored

In Chapter Seven, these various lines of inquiry are drawn together. I suggest that, in several major respects, the choices and decisions made in the long-term adaptation to the insular contexts under study represent locally and culturally unique adaptations. In at least the initial mode of landscape occupation, though, there seem to be underlying adaptive logics which encouraged certain types of distributional behavior and inhibited others. In particular, it seems that, despite obvious differences in subsistence organization, certain types of environmental niche were targeted by colonizing populations — I suggest that this may be a self-selecting strategy in insular adaptation held in common between both case studies. Long-term changes, I argue, represent aggregated individual choices made in response to perceived increases in stress. These individual choices had divergent effects in both the Cyclades and the Leewards, but the underlying reasons for these choices are found in the confluence of cross cultural variables: the demographic dynamics of food-producing communities and the circumscribed, environmentally heterogeneous, and ecologically fragile nature of islands.

I conclude Chapter Seven, and this dissertation, by outlining an approach to long-term change in island societies which seeks to unite several current approaches into a holistic framework, which situates individual choice within different spatial and temporal ecological rhythms. I suggest the notion of human activity as embedded within multi-scalar environmental and social processes (both derived from and productive of them) is a fruitful way of conceiving the dynamics of human societies in island contexts. Finally, I outline the directions for future research implied by the process of undertaking the research this dissertation represents.

Chapter Two

Comparative Island Archaeology

> You are three men of sin, whom Destiny,
> That hath to instrument this lower world
> And what is in't, the never-surfeited sea
> Hath caused to belch up you, and on this island
> Where man doth not inhabit - you 'mongst men
> Being most unfit to live.

Shakespeare, *The Tempest*, 3.3

Islands have strange effects on people, animals, and the imagination. There is a well-developed and well-studied Western trope that islands are alien, potentially hostile, liminal, and transformative (Baldacchino 2008; Boomert and Bright 2007; Broodbank 1999c, 2000:6-21; Irwin 1999; Keegan 1999; Rainbird 1999, 2007; Terrell 1999; van Dommelen 1999). Ariel, addressing the wrecked Italian mariners in the foregoing passage, encapsulates the power of Prospero's isle to deceive and to change. The castaways' new-found insularity, of course, does change them: Antonio and Sebastian become would-be regicides, contravening the mainland social order. Conversely, the coming of the continent also transforms the island itself: Caliban — monstrous, aboriginal, naïve — is corrupted by mainland drink and demagoguery into attempting to subvert the insular social order. Miranda, famously, is rendered incredulous by the brave new worlds; in doing so she becomes subject to that very insular condition, the overpowering need to leave. Her father himself surrenders his magic, simultaneously being set free from his cell. For everyone — the islanders, the mainlanders, and the island itself — the exchange is transformational, and the delicate if strange harmony that had prevailed on the isle before the shipwreck is forever lost.

The Tempest is one text in a Western continuum in which islands are framed as alien worlds. The trope is a device which allows a variety of cultural processes, including 'othering' (Fabian 1983), exploring the self as an enlightened and powerful subject, and framing notions of normal versus abnormal (Rainbird 1999, 2007). It is certainly true, as Rainbird and others have argued, that framing islands as only remote, introverted, passive objects of study is probably more informative regarding the development of Western culture than it is regarding islands and their ecological and cultural processes. That said, *The Tempest* also captures several fundamental and undeniable truths about the effect of insularity on communities of living organisms, of the breaking of that insularity, and of the seemingly paradoxical nature of the island in the abstract. Islands are species-poor, but encourage speciation; they are environmentally fragile, but also environmentally diverse (in sum; not equitably diverse); their separation physically inhibits genetic exchange between communities, yet also necessitates it (e.g., Grant and Grant 2010; Hanski 2010; Whittaker and Fernández-Palacios 2007:107-248). They *are* biogeographically transformative in a real and quantifiable sense, alternatively luring or trapping species, and then facilitating their development into new forms (as first described, famously, by Charles Darwin on the *Beagle's* voyage to the Galapagos). The challenges and opportunities posed by getting to islands, then successfully living and reproducing on them, results in new behaviors, new ecological dynamics, and ultimately new taxa. The fully-fledged discipline of island biogeography and comparative ecology provides reason to be confident about the extent to which accurate and substantive generalizing statements can made about these processes in animals and plants (Lomolino *et al.* 2010).

The human animal is a very special sort of animal, undoubtedly, yet subject to many of the same needs that non-human species also experience. Specifically, the food-quest and the need to maximize reproductive potential and success govern our behaviors as much as they govern those of other animals. This suggests that bodies of theory which have explanatory power in terms of the ecosystemic dynamics of non-human species on islands may also have some explanatory power in accounting for how humans interact with each other and with their environments on islands, especially (but not only) in prehistory. Tentative explorations of human colonization patterns on islands, armed with biogeographic theory (Cherry 1981, 1984; Keegan and Diamond 1987; Terrell 1977a, 1977b, 1986, 2006), seem to indicate that this optimism is not entirely misplaced. It has been established that colonization dynamics of islands by humans can be shown to fit broadly into wider patterns seen in island-colonizations by other animals, although there are exceptions to patterning (e.g, Keegan and Diamond 1987:52-57). What is not clear is whether we can make general statements about human behavior in the aftermath of colonization processes, as we can to some extent with other organisms. The purpose of this dissertation is to address whether culturally unrelated and genetically distant groups of humans, like other animals, pursue broadly comparable strategies of survival in island environments, and to establish whether or not differing human populations adopt similar settlement and subsistence behaviors in island environments. In essence, it questions whether there are optimal strategies for survival for comparable human populations in island environments. Answering this question will either suggest that, on the contrary, contextual and culture-specific factors are more important in determining the nature of insular adaptation, and that the notion of an archaeology tailored to investigate island-specific behaviors is unhelpful. Or, conversely, it may suggest broad parallels in processes of adaptation and cultural development, and that we can begin to make general statements about human insular ecodynamics.

The aim of this chapter is to introduce the key themes relevant for this study, and to discuss some of the underlying assumptions. It begins by arguing for the utility of the comparative project in anthropological archaeology as a means of assessing our capacity to generalize about past human behaviors, and outlining viable case studies which might be compared. It then provides historiographic background by charting the development of island archaeology, from the 1950s to its current incarnation, in seeking to explain how truly comparative studies of post-colonization dynamics have not yet been fully articulated. It will review the relevant literature, both from Mediterranean and Caribbean archaeology and anthropology but also, to a lesser extent, from island biogeography and comparative ecology. In particular, the development of island archaeology and its debt to biogeography and ecology will be discussed, highlighting how current research has emerged in the context of the reaction against work which was heavily informed by the natural sciences, and how — in this context — this research has largely yet to consider comparison of settlement and subsistence in post-colonization phases. Moving on from this contextualization I will consider the concept of insular adaptation within a broadly behavioral ecological framework, introduce the concept of insular generalism, and underscore how small-island environments present novel challenges for agro-pastoral groups in the aftermath of colonization events. This will intersect with a discussion of the physiography of the two study areas in question, which in turns provides an environmental context for the review of human settlement in both archipelagoes, comprising chapters Three and Four which follow. It also introduces further concepts, such as historical ecology, and the argument for the inherent usefulness of the comparative approach in anthropological archaeology.

2.1. Comparison in Anthropological Archaeology

If the task of archaeology is to reconstruct past human behavior from its material correlates and provide an account for the existence and the development of this behavior (Binford 1962; Clarke 1968), then a comparative approach will be central (e.g., Bird and O'Connell 2006). Human behavior, both past and present, is obviously unique with regard to geographic and temporal context; we might, however, reasonably expect that by observing behavioral similarities between unrelated groups of hominins we might be able to make substantive claims about patterning in this behavior. Lewthwaite, writing about the Neolithicization of the western Mediterranean, captures this well:

> All parts of the earth's surface and all prehistoric situations are obviously in the final analysis *unique*, but it is by examining the regularities that we are likely to reach non-trivial conclusions (Lewthwaite 1982:316, author's italics).

If two actors or sets of actors, in different geographic and temporal circumstances, adopt similar modes of action, then this may be read either as coincidence or as a result of the existence of preferable strategies of behavior in comparable circumstances. This allows for the potential to develop generalizing statements about human behavior in any given circumstances, permitting us to account more fully for why humans adopt certain courses of action cross-culturally. In making this approach effective, it is not satisfactory to simply note that two entities resemble each other (Cherry and Davis 2007:126). Rather, as observed by Yoffee, the purpose of comparison is to elucidate similarity and difference; comparison "…entails the examination of two or more entities with the view of discovering resemblances and differences between them" (Yoffee 2005:193-194). In doing so, the extent to which factors common to certain types and conditions of human existence encouraged certain behaviors can be assessed, in turn allowing the development of statements about the spatial and temporal extent of these behaviors.

Conversely, of course, the resemblance may be superficial, with parallel behaviors resulting from very different and context-specific chains of causation. The comparative method demands that the entities selected for comparison bear some resemblance to each other in terms of the relevant variables. In archaeology, as a review of comparative studies in anthropological archaeology suggests (e.g., Earle and Kolb 2010; Adams 1966; Smith 2003), this is inevitably an inexact process. Where are the appropriate parameters for establishing that two or more phenomena are capable of comparison located? I propose that environmental context and mode of subsistence, and the symbiotic relationship between them, are of prime importance here. It has been argued, and is explored in further detail below, that the nature of small islands has transformative effects on colonizing biota, by virtue of their ecological composition. I suggest subsequently that this general pattern may also be extended to the cultural development of the human colonists of small islands. A good basis for comparison would be between two human communities, separated in time and space, but united by the challenges and affordances of small island living.

The distinction between hunter-gatherer subsistence strategies and food-producing (agropastoral or horticultural) strategies has an immense archaeological and anthropological literature associated with it, for good reason. It now seems clear that the adoption of agropastoral practices, or their replacement of hunter-gatherer subsistence strategies, has a number of socio-cultural consequences. This is observed cross-culturally: in a range of contexts, the presence of food-producing — as opposed to food-gathering — behaviors is implicated in demographic growth (Bellwood and Oxenham 2008; Bocquet-Appel 2002, 2008), the development of sedentism, and increasing socio-political complexity (e.g., Yoffee 2005). This suggests that comparison between two agropastoral communities separated in space and time, rather than between geographically-related hunter-gatherer and farming-herding groups, may allow us to elucidate real parallels between them. The appearance of agropastoral ways of life in small-island contexts, then, is of immediate interest: we might expect the cultural and behavioral dynamics associated with the agropastoral mode of production to be impacted by the peculiar environmental context that is supplied by the ecological heterogeneity and fragility of small islands.

Based on this reasoning, the two areas selected for comparison are the Leeward Islands of the Lesser Antilles, and the Cycladic islands of the Aegean, during the appearance of the first agropastoralists in both regions. The Neolithic of the southern Aegean (7th-4th millennium BC at Knossos and Ulucak, although restricted to the 5th and 4th in the Cyclades) and the Early Ceramic of the Lesser Antilles (1st millennia BC and AD) were spatially and temporally disparate phenomena, yet phenomena which nonetheless possess certain similarities. I deal with the physiography and archaeology of both groups in Chapters Three and Four respectively; it is important to note here, though, the further factors underlying the selection of these two island groups, and perhaps their limitations. Clearly, Old World and New World suites of domesticates vary in composition, nutritive potential, and mode of cultivation (e.g., Lane *et al.* 2008; Mickleburgh and Pagán-Jiménez 2012; Newsom and Wing 2004; Zohary and Hopf 2000). I discuss the comparison of horticulture and Neolithic agriculture further in Chapter Four; however, it is clear that there are substantive differences in the exploitation of Mediterraneanoid and Neotropic environments. The disciplinary history of Old and New World prehistory also reinforces this differentiation through terminology and trajectories of disciplinary development.

There are reasons to be optimistic that the comparison may be fruitful, though, despite these differences. On a fundamental level, both the Early Ceramic of the Leewards and the Late Neolithic of the Cyclades represent maritime colonization episodes involving the dissemination, cultivation, and exploitation of domesticated plant species, supplemented in both cases by maritime adaptations (e.g., Keegan *et al.* 2008), by pre-state, sedentary societies. In the Caribbean, exploited animal species were not domesticated in the sense that their survival and propagation were dependent on humans; alien species were, however, deliberately introduced to islands, where they formed essential components of Amerindian diets (Giovas *et al.* 2011). Whether we define this as exploitation of feral or crypto-domestic species is largely beside the point; these Neotropic mammals were deliberately targeted as containable and manageable sources of nutrition. In both instances, then, subsistence behaviors represent a fundamental separation from preceding regimes of landscape exploitation — the question of Archaic Caribbean horticulture is dealt with in Chapter Four — and one which provided the potential for very different demographic trajectories than in populations relying solely on non-domesticated resources. It is also apparent that the colonization of both island groups, and subsequent inter-community interaction, was conducted using parallel maritime technologies. In both archipelagoes, the sail was known only centuries after the first colonization by food-producing groups. This suggests that the challenges of communication and the maritime food-quest were met in both cases by the use of parallel technologies, the power of the human body and the paddled canoe or dugout vessel.

It is necessary to stress at this point out that neither the appearance of agropastoral lifeways in the Aegean, nor horticultural in the Caribbean, represents a situation in which enterprising mariners colonized true *terra incognita*. In both cases, there is substantial evidence for the presence of antecedent hunter-gatherer populations, whether Mesolithic in the Cyclades or Archaic in the Lesser Antilles. Detailed accounts of the evidence for and the behavior of such communities are provided in Chapters Three and Four, as regards the Aegean and Caribbean respectively. It is important to note prior to this, however, that the problem of antecedent populations complicates any comparative study of the development of food-producing societies in small-island contexts. In neither case, for example, is the exact nature of the relationship between two very different modes of subsistence and of living well-understood. The question of genetic or cultural relationships between hunter-gatherer populations is a problematic one in a general sense in prehistory, but especially so for that of the Mediterranean and Caribbean. A lack of chronometric resolution and the slow accumulation of new data are partly to blame, as is a general incapacity to model 'Captain Cook' moments in deep time, but it is still unavoidable that very little is known regarding the relationships between those practicing pre-Neolithic and Neolithic modes of production in these areas. This dissertation is not an attempt to clarify these murky waters, although clarification is needed. A necessary caveat to the subsequent discussion and analysis, however, is that cultural and social choices being made in the Neolithic and Early Ceramic may also have been influenced — in a very broad sense — by earlier islanders; their distribution, their insular knowledge, their genes, and perhaps by the animals and plants which they introduced. That said, as discussed in Chapters Three and Four, the data as they stand still do not fully substantiate the development of hunter-gatherer into food-producing communities *in situ*.

In exploring the choices made by first-farmers in the small-island archipelagoes of the Atlantic's two largest basins, it may become possible to note patterns in how these new islanders rose to the challenge of their isolated homes. In both cases, archaeologists have explored in detail the settlement and subsistence choices made by these first communities, yet — despite explicit calls for further comparison in island archaeology — there have been few attempts to seek inter-regional parallels and contrasts in insular cultural and behavioral development. This is perhaps a feature peculiar to the archaeological anthropology of islands, as elsewhere the validity and appropriate parameters of comparison have remained an object of focus, both within cultural anthropology and also archaeology (e.g., Sahlins 1999; van Dommelen 2011). Understanding the historiographic context of island archaeology, and its manifestation in both the Caribbean and Mediterranean, is vital in appreciating the contemporary research environments in both areas, and providing a basis for framing the current research.

2.2. Island Archaeology and Island Biogeography: Emergence and Development

In dealing with insular archaeology, it is vitally significant to begin by making a crucial distinction: archaeological research on islands has a long history, whereas "island archaeology" as a formalized field of study only emerged in several different locations during the second half of the twentieth century. This distinction is important, and reminiscent of Horden and Purcell's (2000:1-5) illustrative recognition that archaeology *in* the Mediterranean and *of* the Mediterranean are not one and the same. As those authors take the Mediterranean to be itself a conditioning factor in their study, so island archaeology can be defined as that archaeology which takes the condition of insularity to have bearing on the object of study. Prior to the development of an archaeology concerned especially with islands, the central research aims of this archaeology — colonization dynamics, modes of insular adaptation, historical ecology, and connectivity and exchange between insular populations — were not explicitly addressed in the literature. The condition of *being insular*, with all its attendant implications, was not taken to be a relevant factor in considering human cultural development. Despite a wider cultural recognition of islands as remote and potentially alien places (Rainbird 1999, 2007), early syntheses of archaeological regions containing significant islands or archipelagoes rarely treated their isolation as relevant factors in human behavior (e.g., Evans 1921, 1927). While this elides to some extent the very different concerns and trajectories of development in those parts of the world which would become the main interests of 'island archaeology,' there was no real archaeological interest in the relationship between insularity and cultural development that can be detected prior to the Second World War. This was not necessarily the case in Boasian anthropology, in which the appeal of islands as potential cultural isolates, worthy of study as closed systems, was anticipated (Mead 1928).

It is perhaps not coincidental that the beginning of a pronounced concern with the effects of islands on the development of cultures emerged during the dominance of the cultural-evolutionary school of anthropology, represented by Leslie White and Julian Steward, and their students. Steward had from an early stage placed great emphasis on the symbiotic relationship between subsistence base, environmental opportunities and limitations, and social structure (Steward 1955), and the decade after 1945 witnessed the first attempts to tailor fieldwork to address questions regarding this relationship (e.g., Willey 1952). Within this context, it is perhaps unsurprising that one of White's and Steward's students took the initial steps in proposing a relationship between island-living and behavioral development. This proposal is, despite its brevity, important, and fascinating in terms of the avenues of research at which it hints.

Marshall Sahlins published a paper in 1955, entitled *Esoteric Efflorescence in Easter Island*, which sought to account for the development of the practice of erecting *moai* on Rapa Nui/Easter Island. The *moai* diverge noticeably from any other cultural forms in the remainder of Polynesia, and it was this research issue which attracted Sahlins; it is worth considering his reasoning in detail, as its basic tenet remains foundational for much of island archaeology. Sahlins constructed a generalized Polynesian behavioral-cultural complex, in which social organization and economic organization are co-dependent and exist in an environmental niche typical for the insular tropical Pacific; this cultural-environmental relationship exists, in the paper, as an idealized norm (Sahlins 1955:1047-1049). Sahlins then imagined the appearance of this form of socio-economic organization in a very deviant — by Remote Oceanian standards — environment such as Rapa Nui. He suggested that the interaction between this established system and the novel environment created new cultural and behavioral forms, the 'esoteric efflorescence' of the paper's title. Importantly, it is the geographic and ecological properties of the island which are both limiting and enabling factors; its relative isolation militating against both the arrival of new colonists and the capacity of the population to return to the rest of Polynesia. As the geoecological conditions restricted cultural development away from the norm, they enabled the appearance of new forms (Sahlins 1955:1047, 1050). This is the key contribution of the paper — that the condition of insularity and its associated properties (in this case, relative environmental depauperation and distance from other communities) may have transformative effects on culture.

Sahlins' paper is best understood as a product of its decade, one in which the interrelationship between cultural evolution and environmental context was being explored at very abstract levels by Sahlins and his colleagues (e.g., Sahlins and Service 1960). Primarily, they were concerned with culture as an adaptive mechanism, with cultural elements subject to fitness-selection. It is very interesting then that subsequent research, first in the Pacific and then elsewhere, was heavily influenced by biogeography and ecology, areas of biology closely concerned with the relationship between the taxon cycle, evolutionary fitness, and environmental properties. Robert MacArthur and Edward Wilson published their theory of island biogeography in the 1960s (1963, 1967) in a research environment which was increasingly concerned with understanding the dynamics of whole ecosystems (Lomolino *et al.* 2010; Wilson 2010). This research was revolutionary, not in its recognition of the peculiar biotic dynamics of islands, but in its attempt to argue that general rules, related to the geography of islands, governed these dynamics which were in and of themselves quantifiable. Their work demonstrated the previously-anticipated existence of a series of formal relationships between area and configuration, species richness, and taxonomic dynamism, not least via the proof of the colonization/extinction equilibrium (Schoener 2010).

This work was followed by Wilson's subsequent experimental work on rates of re-colonization in the Florida Keys (Simberloff and Wilson 1969, 1971). This experimentation — involving the eradication of whole faunas on mangrove islets, and observation of their subsequent recolonization — seemed to verify the underlying theory.

The publication of MacArthur and Wilson's monograph in 1967 did much to establish biogeography as a coherent discipline, and the utility of islands as isolated areas of study within this discipline (e.g. Losos and Ricklefs 2010; Whittaker and Fernández-Palacios 2007). The exact formulation of the species-area relationship in particular has, inevitably, been subject to review, and the 1967 monograph of course no longer represents current trends in thought. However, the beginning of 'species-area number games' (Whittaker and Fernández-Palacios 2007:5) has spawned a diverse subfield of island biogeography — and also the study of habitat and other crypto-islands — much of which is now concerned with higher-level questions of metapopulation dynamics, the relationship between trophic structures and biogeographic reasoning, and the use of genetic data to inform large-scale biogeographic claims. Island archaeologists would benefit from exposure to this literature and its attempts to make general claims about biogeographic issues other than solely questions regarding colonization; it was, however, with its emphasis on colonization dynamics and islands as places to study ecodynamics as bounded systems that this research had a profound influence on the development of island archaeology, most notably in the Pacific and the Mediterranean, but also the Caribbean. It is for this reason that biogeography is of prime interest in the present discussion.

It is against the background of an increased interest in organism-environment symbiotic interaction that the (earlier) appearance of another vital publication is best understood, *Man's*

Place in the Island Ecosystem (Fosberg 1963a). In this volume, papers by Fosberg (1963b) and others (Vayda and Rappaport 1963) place great importance on islands as niches which are frequently remote and resource-poor (although certain resources may be present in abundance). Fosberg suggests that insular adaptation may result in "…archaic, bizarre, or possibly ill-adapted [cultural] forms" (1963b:5); this of course is reminiscent of Sahlins' esoteric efflorescence, but introduces the notion of maladaptation or over-specialization. This gives rise to his conclusion that potentially-maladapted insular cultures may be very fragile in the face of continental competition, or new colonization episodes. Here the assumptions underlying MacArthur and Wilson's colonization/extinction equilibrium loom large, despite the theory not yet having been explicitly formulated, as do notions of cultural fitness; both of these would continue to have a significant impact as island archaeology developed in its separate areal sub-fields.

Largely simultaneously with the development of island biogeography as a field, Mediterranean archaeologists were becoming increasingly aware of the apparent properties of islands — the Mediterranean being blessed with a great many — as 'laboratories' for the study of cultural development, much like Wilson and Simberloff's mangrove islets functioned as laboratories for the study of virgin ecodynamics. John Evans and Colin Renfrew were both central figures in this development, and it cannot be coincidental that they had already conducted fieldwork together. Renfrew's prodigious output in the 1970s (e.g., 1972, 1973a, 1973b) was not necessarily concerned with islands *qua* islands, but rather with understanding cultural development as an outcome of systems-interactions at the largely local scale. The fact, however, that a proportion of this research addresses insular cultural development suggests an increasing awareness of the utility of islands as bounded areas for the study of similarly bounded systems — in this case, cultural, rather than biological systems. Examples include his pioneering work in the Cyclades (1972) and on the cultural parallels between Malta and Rapa Nui/Easter Island (1973a).

Evans, following his work on Malta and in the Aegean with Renfrew, produced two articles (1973, 1977) stressing how useful islands may be in charting cultural development. It is unclear whether Evans had been exposed to biogeographic theory; he makes no reference to it in either publication, although some of the central assumptions loom large. Fosberg's (1963a) influence is evident, however, and Evans makes explicit use of some of the theory offered by Vayda and Rappaport (1963), suggesting both that isolation, and the peculiar patterns of resource poverty and abundance that hold over (some) islands are crucial in determining behavior and cultural development (1977). For Evans, the bounded nature of the island system, as he saw it, rendered clearly-defined archaeological investigation possible: the research problem essentially manifested at the scale of the island, co-extensive with the system. Evans also, importantly, notes the utility of comparison. Following Renfrew's (1973:147-166) discussion of the emergence of chiefdoms on Rapa Nui/Easter Island and Malta, he raises the question of demographic growth in an insular context, considering whether the boundedness of islands could generate demographic resource-stress more quickly than in mainland contexts and with different results.

The combined work of Renfrew and Evans suggested that islands could usefully be understood as bounded systems with quantifiable natural and human variables in which the dynamic relationships between these variables might be studied, and generalizing conclusions about this dynamism produced. It is not immediately clear, however, how readily the banner of island biogeography was taken up with regard to insular cultural systems. The

Melos Project (Renfrew and Wagstaff 1982) was certainly cast in terms of systemic island dynamics (1982:1-8), and was remarkably successful in delineating the diachronic development of settlement and culture on the island. In the concluding synthetic chapters of this book, however, one loses sight of Melos' insularity as a conditioning factor (Renfrew 1982; Wagstaff and Cherry 1982); the authors trace cultural development on the island to expanding and contracting dendritic networks, seating cultural dynamism within systemic change brought about by periodic inclusion and exclusion. This perhaps makes most sense when considering the contemporary lack of comparative data for this project — it would seem hard to make generalizing statements about cultural dynamics in the Cyclades with only one dataset (this should be seen as the context for the further work on Kea [Cherry *et al.*1991]) — but the general tone about the capacity to generalize from the 'island laboratory' is somewhat pessimistic. It is illuminating to quote in full:

> The objective of using the archaeology of one single, limited unit… to illuminate the dynamics of culture change in a more general sense has proved a difficult one to fulfill. The lacunae in the evidence are now clearer than they were before. (Renfrew 1982:289).

This mode of thought, at least in the Aegean, has set the stage for the contemporary research climate, in which an individual island as a discrete unit is rarely taken as a unit of study by virtue of its status as a single entity (the exception being the Kea project [Cherry *et al.* 1991], discussed in Chapter Three). Biogeographical approaches have, however, retained their popularity in some aspects of research into the archaeology of Mediterranean islands, not least as regards patterns of colonization. Cherry (1981, 1984) utilized the principles of biogeographic modeling of island colonization to explore patterns in human colonization of the Mediterranean islands. Despite the gradual accretion of new and increasingly earlier data (Broodbank 2006; Dawson 2008, 2011), the expectations of biogeographic theory still seem largely to fit comfortably with the pattern of Holocene colonization in the basin, with larger and closer islands preferred to further and smaller islands. This understandable tendency of basin-wide comparative studies to limit themselves largely to colonization phases (e.g., Broodbank 2006; Zeder 2008; Broodbank 2013 is an exception made more obvious by the lack of studies of parallel scope) has, however, meant that post-colonization processes have only been explored in local or regional contexts, although some such studies have been enormously successful (e.g., Broodbank 2000). For example, settlement and subsistence dynamics in the Cyclades in the aftermath of their settlement by agropastoralists has not been considered in the light of distant and subsequent — but potentially parallel — processes in the western Mediterranean; this may relate to the development of regionalism in Mediterranean prehistoric scholarship, as much as developments within island archaeology and the perceived limitations of biogeographic theory in post-colonization contexts. It is certainly infrequently and only relatively recently that Mediterranean research has utilized approaches, theories, and occasionally material from the wider field of comparative island archaeology to illuminate cultural dynamics on islands, and this has been undertaken largely by a small subset of Anglophone archaeologists, notably Renfrew (1973, 1982), Cherry (1981, 1984, 1990), Broodbank (1999, 2000), Dawson (2009, 2011) Knapp (2008), and Held (1993), but also Phoca-Cosemetatou (2011) and Berlinghieri (2011). Despite the success of these studies, it is possible to identify elsewhere a lack of willingness to conduct explicit extra-regional comparison with other theaters (e.g., Sampson 2002:151-168). This is a missed opportunity, seeing as it is inherently unlikely that socio-cultural processes in the Mediterranean's prehistory were entirely exclusive to that area, or any given region within it.

Island archaeology in the Caribbean was not so receptive to developing ideas about insular cultural development as were the Mediterranean and — especially — the Pacific. The historiography of Caribbean archaeology is reviewed briefly in Chapter Four; suffice it to say that there was little interest in methods of comparison when the large-scale chrono-typological structures (e.g., Rouse 1985, 1986) which still characterize Caribbean archaeology were being built in the 1960s and 1970s, contemporary with but isolated from the first development of island archaeology. Rouse (1977), writing in the context of an issue of a journal dedicated solely to island archaeology, was certainly aware of the foundational literature of island biogeography and the burgeoning development of island archaeology itself (1977:8). For Rouse, however, the key issues were not the capacity of insularity to promote new behaviors or to foster certain kinds of socio-cultural process, but defining the cultural suites which transcended and linked islands. Perhaps perversely, in an edition of a journal in which Evans (1977) was laying out the future for Mediterranean island archaeology centered around the island as a unit of investigation, Rouse was describing the cultural series as the basic unit of analysis. This position — the sea as connector rather than insulator — has had a profound influence on the development of Caribbean archaeology (e.g., Boomert and Bright 2007), and is evident in the contemporary research climate, with connectivity and exchange a pronounced theme (e.g., Curet 2005; Fitzpatrick and Ross 2010; Hofman and van Duijvenbode 2011). There are certainly exceptions — Keegan and Diamond (1987) explicitly utilized biogeographic theory in their analysis of the Bahamian archipelago.

Here, however, the focus was again on the capacity of the theory to account for patterns in colonization, not in post-colonization spatial or subsistence organization.

The impact of biogeographic reasoning in the Mediterranean, and its essential absence in the Caribbean, has nonetheless resulted in a disinclination in both areas to compare and contrast diachronic socio-cultural processes on islands. In Mediterranean prehistoric scholarship, the study of comparative island dynamics is largely related to processes of colonization. Researchers have attempted to ascertain whether intra-regional patterning obtains, and whether these patterns are comparable from instance to instance. Following initial colonization, however, there seems to be a lack of willingness to continue the comparison and to establish whether there is post-colonization patterning in behaviors. This may be related to the wider tendency in Mediterranean archaeology to focus on the region at the expense of the wider area, and the separation of Mediterranean archaeology from more explicitly comparative anthropological archaeologies. In the Caribbean islands, the impact of insularity on cultural processes has largely been elided in contrast to stressing the connective power of the sea. The island archaeologies of both areas are, I suggest, impoverished as a consequence; if we really wish to establish whether we can make generalizations about human behavior on islands, it is important to compare and contrast behavior both during and after colonization, to ascertain whether the effect of insularity has an effect — or not — on diachronic human cultural development and ecodynamics. This dissertation attempts to foreground this research in suggesting that by observing the parallels in both processes we can make more concrete statements about the nature and causation of these processes themselves. To do so, though, requires some detailed consideration of the nature of the small-island archipelagoes under consideration, and their potentially transformative effects on colonizing communities of agropastoralists.

2.3. Ecological Heterogeneity in Small Island Archipelagoes

The behavior and evolutionary development of island biotas is notable not simply because islands are isolated: their ecological patchiness also contributes to this diversity. Archipelagoes are environments in which a combination of factors renders their surface highly heterogeneous, forming inherently complex spaces in which no one type of habitat is especially extensive. The one exception to this is the photic layer of the water column, which itself is transformed by varied daily, monthly, and annual tempos, as discussed shortly. Small island archipelagoes — those archipelagoes not dominated by a single large island, such as the Lesser Antilles, Macaronesia, the groups of Polynesia, and the Cyclades — are especially prone to geoecological patchiness. Often tectonically- or volcanically-derived, the constituent members of small island archipelagoes tend not to be dominated by long, homogenous mountain ranges — although they may represent the peaks of drowned mountains — and no great rivers or expansive plains occupy these circumscribed worlds. Forests or grasslands, or Mediterraneanoid *macchia*, are broken into patches by varied elevations and geomorphological dynamism. Tectonic activity, *sensu lato*, and its subsidiary geological phenomena are responsible for the existence of both the Cyclades and the Lesser Antilles, and correspondingly are responsible for their notable geological heterogeneity. This is further characteristic of small island groups, in contrast to fragments of continents drowned by sea-level rise — the British Isles, for instance, or Sundaland. The impact of the sea, both above and below the water, contributes to this patchiness, with seagrass reefs and tidal foreshores only half of the story; the meteorological impact of the ocean, and its intersection with seasonality and elevation, further renders small island archipelagoes fundamentally patchy.

Archipelagoes and their constituent islands nonetheless reproduce many continental topographies and ecologies in miniature, and the Leeward Islands and the Cyclades are excellent examples of this. A cursory glance at their environments from which the first agropastoral and horticulturalist colonists of both archipelagoes originated demonstrates just how miniaturized these new worlds were. Substantially fragmented compared to the Neotropic forest of Venezuela or the plain of Thessaly, these islands are many times smaller than the continental environments from which their first agropastoral colonists hailed. This miniaturization is broken up by the surrounding sea, itself not monolithic, but inherently diverse according to depth, season, climate, and time of day. According to strength of sunlight and the depth of the water, the sea may provide extraordinarily rich resources in the Caribbean — reefs and beds of sea-grass, homes to a myriad of species exploited by the first horticulturalists — or relatively impoverished and plankton-free expanses, as in the Mediterranean (Gallant 1985). Although the Aegean is not as fish-free as we might think, the Mediterranean in general is depauperate in terms of fish species as a relatively more oligotrophic — one low in microscopic plant life and thereby rich in dissolved oxygen — and more saline environment than the Atlantic as a whole (e.g., Ignatiades *et al.* 2002; Tselepides *et al.* 2000). Because of the relative lack of phytoplankton in the basin, the trophic base does not exist to support the great schools seen in, for example, the North Atlantic. This condition is exacerbated by the high rates of evaporation in the Mediterranean, and the constant inflow of colder, less-saline water from the Atlantic; this renders the Eastern

Mediterranean and the Aegean in particular very saline, compared to the Mediterranean in total (Hayes *et al.* 2005), making it relatively hostile to phytoplankton. This impoverishment — which can be overstated, considering the likely ratio of fish biomass to human population in the Neolithic — will have rendered the seasonal migration of large-bodied pelagic fish even more vital to coastal communities. The arrival of *Thunnus thynnus* and smaller species of tuna in both areas to spawn (Karakulak *et al.* 2004) would have transformed the sea-deserts that surround both archipelagoes, but especially in the Aegean, into teeming — and tantalizingly close — larders of protein and fat, which nonetheless require skill and cooperation to exploit. Their absence, or changing patterns of behavior over the long-term (Block *et al.* 2001; Ravier and Fromentin 2001), may have had serious consequences for villages grown accustomed to their bounty. Tides, or their absence at these latitudes, may account for beds of molluscs or the presence of large seagoing vertebrates — turtles and marine mammals — resources exploited in both archipelagoes.

The unique geometric and topographical arrangement of small island archipelagoes means that many, if not most, environmental niches are circumscribed along multiple axes, not only spatially but also temporally, by epoch, year, season, and day. The dependence of island ecologies and trophic regimes on intersections between climate, season, and elevation is in the ocean pertinent to strength of sunlight and, ultimately via phytoplanktonic biomass, to trophic pyramids; on land, these dynamics intersections are pertinent to rainfall and hydrology, and thereby to vegetation. This renders islands and their floras and faunas heterogeneous and ostensibly fragile, susceptible to changes and new patterns in these interrelationships. The further contributions of distance and the geometric configuration of archipelagoes – the subject of studies within island biogeography (Kalmar and Currie 2006;

MacArthur and Wilson 1967) — along with the mosaic-like quality of their constituent environments and the peculiar effects of insularity on originally continental taxa, render islands a great contributor to sum global biodiversity (Kreft *et al.* 2008; Lomolino 2010).

The physiography of both the Leeward Islands and the Cyclades is considered in detail in Chapter Six, when the relationship between this physiography and human settlement is explored. It is worth noting here, however, the extent to which these island groups exemplify heterogeneous island environments. It has already been proposed that elements of Mediterranean geoecology are essentially fractal (Broodbank 2006; Horden and Purcell 2000), in that environmental diversity is seemingly scale-independent: as one focuses in on the Mediterranean, it retains is ecological patchiness, breaking down into tesserae of karst, coniferous upland, plain, coast, and sea. The Cyclades represent the microcosm of the microecologies (Broodbank 2000:68-92), founded upon a diverse geology derived from continuing tectonic processes in the Hellenic Arc (Stride *et al.* 1977). This combination of drowned karst and volcanic islets renders the individual islands of the Cyclades enormously geologically varied, from — famously — volcanic Thira and Melos with their sources of basalts and obsidians (e.g., Shelford *et al.* 1982) to the large limestone islands, remnants of drowned Cycladia — the drowned Pleistocene pocket-palaeocontinent of which Naxos is the resolute nub to the north of the volcanic arc (e.g., van de Maar and Jansen 1983). Metamorphic processes on the latter result in other geological riches, notably marbles, while several (but not all) of the islands of the 'western string' — Kea, Syros, Serifos, Sifnos, and the Melian sub-archipelago — possess small sources of metalliferous ores. The geological and pedological basis of the archipelago provided both attractive and repulsive factors for early colonists, with Melian obsidian one particularly desirable item (Perlès 1978; Renfrew and Aspinall 1989), the relatively poor soil-formations on many of the islands quite the opposite (the combination of low mean rainfall and poor soils as a relevant factor in timing and dynamics of expansion is addressed in Chapter Six). It should be noted, however, that the Cyclades — as well as other small island archipelagoes — tend to compensate for their poor soils by exhibiting very varied pedologies, resulting from underlying heterogeneous geologies, again encouraging the formation of micro-scale niches (Ibáñez *et al.* 2005, 2011). The complex interactions between macro-meteorological processes and Cycladic topography generate further diversity. Broodbank (2000:74) has noted that sheerness of relief is frequently positively associated with island size in the Cyclades, as elsewhere: consequently, Andros, Tinos, and Naxos benefit the most from orogenic rainfall, while Folegandros and the Erimonisia lie parched. This disparity, in combination with the variability in rainfall that the broader Aegean experiences on a number of temporal scales (Maheras *et al.* 2004), makes the prospect of continually successful and iterative farming practice in the long-term and under current late Holocene conditions highly improbable (Liakatas 1997). For demographically fragile farming communities in the fifth millennium, the temporal and geographic patchiness of the Cyclades would have provided substantive challenges.

Any attempt to define large blocks of contiguous types of landscape is frustrated by the peculiarly pointillist nature of the Cyclades; a diversity deriving ultimately from tectonic and climatic processes is similarly implicated in the Leeward Islands, the northernmost sub-archipelago of the Lesser Antilles, themselves the eastern division of the Caribbean islands as a whole. The subduction of the Atlantic plate under the Caribbean (Blume 1974; Defant *et al.* 2001; James 2005; Sigurdsson *et al.* 1980) has resulted in the formation of a classic volcanic arc, which is very much still active — witness the ongoing eruption of the Soufrière Hills volcano on Montserrat (Zellmer *et al.* 2003), or the eruption of Mt. Pelée on Martinique in 1902. Montserrat, Redonda, Nevis, St. Kitts, Saba, and Statia are all entirely volcanic, representing the inner Miocene subduction arc; Antigua, Barbuda, Barths, St. Martin and Anguilla are all pre-Miocene combinations of volcanics and uplifted sedimentary formations (Brasier and Donahue 1985; Christman 1953; Wadge 1994). This results in the classic division of 'high' (inner arc) and 'low' (outer arc) islands. The varied geology of the group results in very different soil formations and water retention, and of course mineral resources which were preferred by prehistoric populations. Antiguan chert, from the limestone northern half of the island, is the classic example, but there are also small sources of flint on St. Kitts (Knippenberg 2007:36-52); the basalts and andesites of the volcanic islands were utilized for ground stone implements prior to the appearance of Early Ceramic settlements in the region.

Prevailing annual climatic patterns would seem perhaps to militate against environmental heterogeneity in the Leewards, but this is not necessarily the case. The Trade Winds blow consistently from the east, but this consistency, combined with the exaggerated relief of the high islands, results in clearly demarcated zones of orogenic rainfall, as Beard's (1947) classic diagram (Figure 2.1) makes clear. Greater rainfall at higher altitudes encourages differential rainforest growth on both windward and leeward coasts of the typical Lesser Antillean island, with mist-shrouded elfin woodland dominating the volcanic peaks. On lower slopes true rainforest gives way to seasonal and dry-evergreen vegetation, especially on the windward coast. It seems likely that mangrove ecologies were abundant in the Leewards, especially in the low islands, prior to Contact and its deleterious effects on coastal ecologies.

The ocean surrounding the Leewards tends towards diversity as well (e.g., Keegan *et al.* 2008). The level of sunlight in the sub-tropical and tropical latitudes allows for the growth of coral; Caribbean fringing reefs consequently account for a great deal of sum total maritime biodiversity, and also for prey-species of both Archaic and horticulturalist populations. Intervening beds of seagrass are also central in maintaining taxonomic variety. The Leewards are, in general, blessed with shallow, productive seas, with the Saba bank, Anguilla bank, and the Barbuda bank providing productive fishing grounds; to the north, at the Anagada Passage, and to the south — the Guadeloupe Passage — the ocean floor plunges to abyssal depths.

Small islands promote ecological fragility in one final and noteworthy respect. Possessed of varied environments, it has long been known that the size of small islands relative to mainland point of origin for island taxa can have severe effects on population dynamics (Hanski 2010; MacArthur and Wilson 1963, 1967). Specifically, for higher taxa in trophic pyramids, small initial colonizing populations and scarcity of resources brought about by inherent ecological fragility can have catastrophic effects, a driving force behind island extinctions. This outcome of insular living also renders human populations on islands more vulnerable than equivalent mainland populations (Weiss and Smouse 1976; Williamson and Sabath 1982). In particular, the stability of population sizes seems to be reduced, with both increase and decrease seemingly much more random (Demetrius *et al.* 2004). It has long been recognized that, during the process of colonization, human populations are especially vulnerable (e.g., Broodbank and Strasser 1991; Stanley Price 1977); this is not the only phase during which human communities would have been fragile, however. In Chapters Six and Seven I discuss possible demographic reconstructions for both the Cyclades and the

Leewards Islands. As it seems likely that in both cases populations were best counted in the hundreds during and immediately after colonization, the probable lack of demographic resilience and perhaps cultural perception of this would be relevant factors throughout the periods under study, rendering buffering strategies and/or the maximization of adaptive fitness all the more pressing concerns. As will become clear, the transition from small and vulnerable demographic units to larger, more stable, but increasingly resource-stressful seems to have been a possible driver of changing organizational dynamics in both archipelagoes.

2.4. The Ethnography and Archaeology of Movement and Distance

Notions such as ecological liminality capture the fragility and heterogeneity of these archipelagoes, but not the extent to which both internal difference, and difference from terrestrial contexts, renders them highly productive spaces, albeit contingently so (Keegan *et al.* 2008). A diversity of terrestrial and maritime flora and fauna, not to mention a varied geology and its bounties (ores, marbles, obsidians), made, and make, archipelagoes attractive places to be. Yet the fundamental difference in distribution and nature of calorific resources on islands in contrast to mainlands required both specialized, maritime adaptations of subsistence strategies originally developed in continental environments, and novel, insular-specific regimes of exploitation. As resource patchworks, archipelagoes both imposed constraints on and provided novel opportunities for prehistoric peoples. Exploitation of these patchwork worlds was only conceivable with subsistence strategies which combined effective domestic production of food with heavy utilization of marine and coastal resources, as is explored below and discussed in detail in Chapters Three and Four. In both the Atlantic and Pacific, societies using this combination of essentially Neolithic food procurement with maritime hunting and gathering seem to have proved to be highly effective colonists (Cherry 1981, 1990; Keegan and Diamond 1987; Kennet *et al.* 2008). In the Mediterranean, early cereal farmers also exploiting maritime resources, such as tuna (Evans and Renfrew 1968), seem to have been most successful in exploiting island environments to the full. In both the Pacific and the Caribbean, horticulturalists, bringing domesticated plants and relying heavily on marine resources for tools as well as nutrition (Keegan *et al.* 2003; Wing 2001), proved to be effective island dwellers, drawing on the patchwork riches of their environments to full effect (Fitzpatrick and Keegan 2007; Fitzpatrick and Ross 2010; Keegan *et al.* 2008). In both cases, insular adaptation included the importation of both domestic and wild animals; in the Pacific, pig, dog, chicken, and perhaps Pacific rat are all implicated in the terrestrial isotopic signature evident amongst Lapita populations (Kennett *et al.* 2006; Nunn *et al.* 2007; Valentin *et al.* 2010). In the Caribbean, no truly domesticated species were utilized but, as will be seen in Chapter Four, large Neotropic rodents were introduced to the islands. These populations being corralled effectively by the sea, they were exploited as readily accessible herds by the horticulturalist populations, alongside commensal species such as dog and rice rat.

This apparent flexibility in adapting to island environments on the part of food-producing populations is in stark contrast to preceding hunter-gatherer populations in the Atlantic's two Middle Seas — in both instances eminently capable of reaching islands, and using them, but perhaps less adept at settling down in these small worlds. Indeed, in a prehistoric archaeology of distance and scale, the multi-scalar nature of the early insular Neolithics, in contrast to the relative inability of Mesolithic or Archaic peoples to miniaturize their lifeways (deriving from relative efficacy of respective methods of food acquisition per unit of territory), must figure prominently.

The execution of these strategies of intensive food procurement demanded, in turn, the capacity to move freely and extensively over interiors, along coasts, and between islands, exploiting the resources of each niche as they flourished and ebbed in turn. Movement, to acquire not only food but also raw materials, and, vitally, mates, was inevitable in an archipelagic context with a relatively low population density. Existence in these insular agropastoral environments was therefore premised upon what might best be understood as socio-technological complexes of movement. In the voyaging Neolithics (Broodbank 2006) of the Pacific and Atlantic, far more so than in comparable terrestrial Neolithic contexts, dynamism and its material and social baggage, admittedly frequently small-scale and relatively archaeologically ephemeral, was a constant of insular lifeways. It is for this reason that we should understand movement as a socio-technological complex, embracing physical and ideational zones of existence and with ramifications far beyond the simple arithmetic of distance and nutrition.

The physical elements of this complex were, in both the Neolithic and Aegean, centered on canoe technology, as far as this can be reconstructed. Scant archaeological evidence from organic vessels is complemented by ethnohistorical and ethnographic data from the contact-period Pacific and Caribbean (e.g., Anderson 2010; Fitzpatrick 2014; Irwin 2010), from experimental archaeology and inductive reasoning (e.g., Broodbank 2000:102-106), and archaeological and artistic representations (e.g., Televantou 2008). These lines of evidence suggest that, in both the Mediterranean and the Caribbean, early seagoing was dominated by canoes; certainly single-hulled dugouts in the Caribbean, although reed or skin-based vessels may have been more attractive in the mid-late Holocene Aegean, with fewer suitable tree species. The lack of evidence for stabilizing devices — such as outriggers or keels — in both instances, the limitations on beam and draft implied by a dugout mode of construction, and the similar absence of evidence for any additional propulsion technologies, has two implications.

First, we can establish with a degree of accuracy the likely parameters of these seagoing craft in terms of range and speed. While a number of factors contribute to oceangoing performance, not least oceanographic conditions (changeable in both inner seas according to season), a daily average of around 20km in a dugout <10m is accurate, bearing in mind that this distance could certainly have been exceeded in both cases. Taking this as a mean, however, considered with the dimensions implied by craft of no more than 20m (probably the exception rather than the rule [Fitzpatrick 2014]), allows a limited degree of logistical modeling, discussed in Chapter Five and Six. Such modeling indicates that while the island-dwellers of the Leewards and the Cyclades were inherently competent mariners, movement over long distances was not an easy feat, and by extension not an insignificant one. Second, able to roughly frame the capacities of seagoing technologies in both contexts, we can draw parallels between them. Social and cultural specifics notwithstanding, propulsion of canoe by sheer human muscle (with winds and currents aiding and abetting, or hindering) means that the conquest of distance in both archipelagoes was a comparable task.

The concept of seagoing as a socio-technological complex is not an attempt at deliberate obfuscation of existing terminology. Archaeologies of the sea, of ocean-going vessels, of technology, and of the discursive relationship between humans and their materials already exist. Framing the technical and material aspects of crossing the sea as constituent elements in social webs — webs relating to food-gathering, to forming kinship ties — reinforces how social formations, spatial organization, materials, and individual behaviors are mutually constitutive. Highlighting the conglomerate nature of movement in archipelagoes, incorporating materials, physical space and environmental conditions alongside knowledges of conceptual space and social traditions suggests how dominant movement, and a lack of movement, were as structuring principles in voyaging Neolithics. The overcoming of distance, and its corollary, the failure to overcome distance, were, inevitably, powerful forces in the constitution of the voyaging Neolithics. In order to explore how powerful, it is necessary to consider two examples of these Neolithics with shared modes of overcoming distance, to elucidate their parallels and contrasts. This — the archaeology of movement and distance in pre-sailing environments — is considered in detail in Chapter Five. Using ethnographic information and spatial modeling, I argue that there is a relationship between the distribution of colonizing agropastoral populations over time and their capacity to reach both each other and desirable resources. This relates, also, to the uneven distribution of resource-patches in both archipelagoes, patterning related to which is addressed in Chapter Six.

2.5. Behavioral and Historical Ecology in Island Archaeology

Islands are diverse, heterogeneous environments that can present unique challenges to agropastoral settlement. The dissertation aims to assess to what extent these challenges forced different agropastoral populations into adopting parallels strategies of distribution, interaction, and subsistence. To do this, a conceptual suite that seeks to integrate environmental affordances, patterning in subsistence behaviors, and their material correlates will be important. Human behavioral ecology, landscape learning, and historical ecology, provide such a framework and key pieces of terminology that clarify the central problems. The use of human behavioral ecology and island biogeography in conjunction also suggest possible self-selecting strategies of subsistence which will be considered in detail in subsequent chapters.

This dissertation does not adopt a strict behavioral ecological approach — there are reasons to suppose that adopting human behavioral ecology as a strict credo rather than as a tool in a wider set is inherently blinkering (Zeder 2012). Several of human behavioral ecology's key concepts, however, mesh well with the underlying assumptions of island archaeology. Human behavioral ecology in its archaeological application (e.g., Bird and O'Connell 2006; Broughton and O'Connell 1999; Gremillion and Piperno 2009; Kennet and Winterhalder 2006; Shennan 2008; Smith and Winterhalder 1992, 2003; Winterhalder 1996) deals primarily with adaptive behavior that increases an individual organism's fitness, defined as its capacity to survive and reproduce in a given environment. It does this on the assumption that humans — consciously or subconsciously — aim to maximize their fitness. This goal and strategies directed towards it are termed "constrained optimization" (Kennet and Winterhalder 2006b); constrained or conditional, as any given behavior is unlikely to be the most optimal of a whole set of behavioral choices. In particular, human behavioral ecology seeks to provide functional explanations concerned with the survival and reproductive implications of behavior (Bird and O'Donnell 2006:145-148), and to correlate archaeological data with these behaviors. The strong resemblance with the terminology of island biogeography is not coincidental, as both sub-disciplines deal essentially with adaptive behaviors, and the relatively advantageous or disadvantageous behavior of species. Considering the peculiar patterns exhibited by island ecosystems, we might also reasonably expect that the predictions provided by behavioral ecology will be different for island as for mainland contexts — that is, heterogeneous geoecological environments will provide different opportunities for constrained optimization than will mainland or continental contexts. This might constitute a body of theory with which to model potential human behaviors in island environments.

Human behavioral ecology has found most success in analyzing patterns of subsistence in prehistory, and accounting for them in terms of their relative fitness — it is this insight that is of importance here (e.g., Winterhalder and Smith 2000). Agropastoral and horticulturalist modes of production in both the Neolithic Cyclades and Early Ceramic Leewards are not indigenous developments, but imported subsistence practices, as I explain in Chapters Three and Four. In both instances, then, we might expect a degree of adaptation in subsistence (and settlement) behaviors associated with the novel environmental challenges experienced. Rockman's (2003; Meltzer 2003) notion of "landscape learning" is useful here, as developed by Phoca-Cosmetatou (2011:20-22), in its recognition that new occupants actively and purposively seek to acquire information about their new environments before, during, and after colonization processes. The notion of 'transported landscapes' as a means of organizing subsistence — wholesale movement of systems and material of subsistence from niche to homologous niche (Kirch 1997) is in part supported by the evidence in both the Caribbean and the Aegean. It is inherently unlikely, however, that human colonists will simply replicate mainland means of subsistence in the face of new and obvious challenges posed by new geoecological conditions (an example might be the arrival of typically low-latitude Polynesian modes of subsistence in temperate and pseudo-continental New Zealand). The extent to which this occurs in both archipelagoes is discussed at length in Chapters Three and Four. Behavioral ecology, however, can expand on this, suggesting how and why subsistence choices develop over time. This, in conjunction with the concept of insular generalism, discussed below, indicates that there are certain behaviors that we should expect in the appearance of agropastoral lifeways in islands.

Behavioral ecology is closely associated with optimal foraging theory (Bird and O'Connell 2006; Sih and Christensen 2001), which has largely dominated its application in archaeology and anthropology. This, in its various iterations, holds that cost-benefit considerations are taken into account during food-acquisition activities. In essence, upon encounter with a given prey item — which may be any source of nutrition — optimal foraging theory indicates that choices are made about a) whether to exploit this item based on the likelihood of subsequently encountering another prey-item of higher calorific potential, the consumption of which would confer greater fitness and b) the processing costs associated with transforming the prey-item into food. Under this reasoning, species will be preyed upon not based on their relative abundance, but rather upon a calculation of whether higher-ranked (i.e., preferred) types of prey — vegetable as well as faunal — will be encountered. This discussion has mostly focused on pre-agropastoral lifeways, and has found considerable success (e.g., Winterhalder 1996; Smith and Winterhalder 2003), primarily because of the direct extrapolation from behavioral ecology in non-food producing animal communities to non-food producing human communities. Keegan (1986), in a publication considerably ahead of its time, noted the utility of applying optimal foraging theory to horticulturalist communities, recognizing that horticulture itself is a mode of gathering in a human-managed context; encounters with domesticated species, while more intensively and routinely managed, are nonetheless encounters with nutrition opportunities that have associated handling costs. Recently, this reasoning has been extended to other pristine food-producing societies (communities exploiting both domestic and wild resources) without stretching the underlying assumptions too far (Kennet and Winterhalder 2006a).

Small islands are species-poor (MacArthur and Wilson 1963, 1967). Their inherent ecological patchiness, however, means that per unit of area they are likely to be more environmentally diverse than a corresponding mainland or continent. This means that an island colonist has a greater diversity of ecological niches, and by extension taxa, in their immediate environment which to exploit in contrast to their continental equivalent. An imagined given radius from a point of origin on an island provides access to terrestrial, montane, forest, coastal, reef, and pelagic ecologies; these niches are all species-poor in contrast to their mainland equivalents, yet, thrown together in such a dense and colorful patchwork, they in fact afford *greater diversity* in terms of subsistence choices. In the continental equivalent, overall taxonomic diversity is greater, but the absence of patchiness provides fewer opportunities to encounter varied prey-species. A random walk through the terrestrial radius may encounter two ecotones with ten species each; a random walk through the island radius may encounter five ecotones with five species each, affording greater selective opportunity. Added to this, we should consider the even greater diversity maintained by the introduction of whole suites of domesticates in both the Cyclades and the Leewards, with the importation of both cultigens and domestic animals (Keegan *et al.* 2008).

What does this mean in terms of optimal foraging — perhaps better, optimal subsistence — theory? The outcome of any given encounter with a prey item, be it wild, domestic, or crypto-domestic (like the cavids of South America) will be subject, in theory, to reasoning based on the likelihood of encountering preferred species whose cost-benefit ratio is more favorable as regards fitness. In the context of insular patchiness, the likelihood of further encounters is increased due to environmental micro-variation. As a consequence, less high-ranked prey items will be more frequently passed over when compared to their encounter in mainland contexts, in the expectation that ease of passing to a new patch will make available, with relatively little cost, a new suite of prey species with different cost-benefit ratios. For example, the relatively unattractiveness of a small Neotropic mammal with a high handling cost may render a neighboring patch (a reef) with high-protein, low handling cost prey species very attractive. In an Aegean context, the presence of schooling tuna in a nearby patch may temporarily adjust the relative attractiveness of a domesticated ovicaprid, considering the long-term impact of predation on flock-dynamics and the likelihood of the tuna being encountered in the future. The behavioral outcome of this increased selectivity in island contexts is that we should expect, all other things being equal, food-acquisition strategies in islands — especially among agropastoral and horticulturalist communities — to be both broader, but also more selective than their continental equivalents, with the reasonable assumption that more favorable prey may be readily encountered influencing the optimal foraging logic. This, at least, should operate until unstable human ecodynamics negatively impact the abundance of populations of (wild) prey species and the species per patch score decreases. Essentially, we would expect early agropastoralist and horticulturalist colonizers in both the Cyclades and the Leewards to exploit a wider range of species than their continental cousins, and to be choosier about food items within this range. This is one of the options outlined in early models for the colonization of the Neolithic Aegean (Cherry 1981), but might reasonably be expanded cross culturally.

The expectations of insular human behavioral ecology are in line with the findings of island biogeography as it regards fitness of, and adaptation in, some colonizing taxa. With regard to the island biogeography of avifauna and some plant species there seems to be — perhaps counter-intuitively — a tendency for newly-insular species to generalize in their subsistence behaviors (Clegg 2010:310-315; Scott *et al.* 2003). This should not be understood to run counter to the tendency to speciate: islands do encourage speciation for a series of reasons (e.g., Whittaker and Fernández-Palacios 2007:165-207), but *within* individual island units, the expectation is that certain given taxa will be more generalist than their mainland counterparts. This seems counter-intuitive, considering the intense ecological patchiness that we know occurs in small islands, but in fact it is not: effective exploitation of continental scale ranges in insular contexts demands an increased generalism in the face of diverse prey taxa.

Studies of this sort have certainly not been conducted on humans, and we should be wary about extrapolating from animal behaviors. It is at least interesting, though, that both behavioral ecology and island biogeography suggest that generalist behaviors represent more effective methods of island living than do limited subsistence behaviors. This indicates perhaps that more readily adaptive phenotypes will more effectively face the challenges of insular living; in Chapters Three and Four, I review the evidence for patterns of subsistence in both the Cyclades and the Leewards, and argue that it is possible to trace increased generalism — in contrast to mainland strategies — in subsistence behaviors, especially as regards coastal and maritime resources. This is, in and of itself, interesting but perhaps unsurprising; diversity in food resource-selection as a more effective means of island subsistence has an archaeological pedigree, and in the Aegean has been suggested to be a more effective means of island subsistence (e.g., Cherry 1981; Halstead 2008). The more interesting question is whether socio-spatial organization is affected by, or premised upon, the adoption of insular generalist strategies by agropastoral island communities. Here, we might usefully use the notion of settlement ecology: that is, does the spatial organization of these communities positively index a relationship to the subsistence ecology? This is addressed in Chapter Six — and touched upon in Chapter Five — in which the relationship between diachronic distribution of human populations and ecological and environmental variables is analyzed.

It is necessary to consider — briefly — a recent critique of human behavioral ecology approaches in archaeology, a critique which also has a bearing on island biogeography. Zeder (2012) has argued that the reliance on optimal foraging theory in human behavioral ecology is inherently problematic, chiefly because of its conception of human-environment dynamics as a one-way transaction. She suggests that human niche construction — also drawn from behavioral ecology approaches — is a more effective mode of understanding human ecological dynamics, recognizing as it does that humans actively alter their environments to maximize their own fitness. The benefits of a framework which recognizes human transformation of select environments is obviously beneficial in considering food-producing, rather than solely food-gathering, communities. In this study, Zeder's point is well taken; both groups of colonizing farmers and horticulturalists clearly actively transformed their environments, rather than passively adapting to the resources on offer. The introduction of crypto-domesticates to the Leeward Islands is one example, yet populations in both areas under consideration, through introducing alien vegetable species, transformed trophic and pedological dynamics. This is discussed further in Chapter Three, with regard to Phoca-Cosmetatou's (2011) discussion of 'transported landscapes' in the Cyclades, but the thinking permeates this dissertation: the notion of settlement ecology relies on recognizing the mutually constitutive relationships between people and the places in which they choose to live. The final analytical perspective, along with human behavioral ecology and island biogeography, that underlies the reasoning in this dissertation fully develops the mutual aspect of these relationships.

Historical ecology indicates that the relationship between humans and their environments is dynamic and symbiotic (Balée 1998; Crumley 1994). In this case of the appearance of humans in potentially fragile island contexts with potentially maladapted biotas, this dynamism is certainly more pronounced (e.g., Fitzpatrick and Keegan 2007; Fitzpatrick and Intoh 2009; Keegan and Hunt 1997; Kirch 1982; 2007b). The recognition of human impacts on islands is hardly a novel observation. That said, we must recognize that the viability of any human subsistence regime in the long term on islands is not necessarily a given — prehistoric societies were as capable of operating unsustainable modes of subsistence as are their modern equivalents (Rick *et al.* 2008). This is not a central theme of this dissertation, but there is an important outcome of such reasoning: human impacts on environments over time will impact biotic composition, which will in turn limit or enhance the viability of extant subsistence strategies. That is, the food-quest exists in a feedback relationship with island ecosystems. Diachronic developments in subsistence strategies should be understood not as passive responses to, for example, climate change or technological innovation, but as in symbiosis with changing faunal and floral composition whose dynamism is anthropogenic. These anthropogenic impacts may also be felt in soil exhaustion and slope failure, alongside other macro-scale geomorphological processes. In both the Cyclades and the Leewards, the composition of subsistence suites seems to change over time (e.g., Newsom and Wing 2004; Phoca-Cosmetatou 2008, 2011c), from reflecting an insular generalist strategy after initial colonization, towards increasing reliance on apparently less preferable prey items after several centuries of occupation. The data which support this conclusion are laid out fully in Chapters Three and Four, and the implications of this, and its potential effects on settlement ecology, are explored in Chapter Six.

It will be clear from the foregoing discussion that the position adopted in the succeeding chapters owes a great deal to the work of Karl Butzer (1982), in an early and clear exposition of settlement ecological theory. While the specific approaches used here – human behavioral ecology and historical ecology in particular – have been subject to increasing importance in the archaeological literature since Butzer's *Archaeology as Human Ecology*, in many respects this work prefigures the work undertaken in these ecological sub-disciplines. In particular, Butzer's recognition of the extent to which human and environmental systems overlap in a multi-scalar and mutually-constitutive fashion is prescient. In Chapter Seven I return to Butzer's work in a consideration of future frameworks of investigation of human adaptation to island environments.

2.6. Adaptive Duffers: Into the Archipelago

In this chapter I have reviewed the basis for comparison in anthropological archaeology, and the development of island archaeology, in several theaters, which has nonetheless shied-away from detailed comparison. I have suggested that islands have odd effects on plants and animals — insular biotas seem to behave, and develop over time, in manners different to continental equivalents. The reasons for this have been thoroughly explored, and relate to the peculiar geoecological properties of islands. Distance, separation, and the dense patchiness of microecological niches all contribute to the peculiarly insular adaptive behavior that is seen in non-human species. Island biogeography and ecology have advanced to the point that we can make substantive claims about the dynamics of animal and plant behavior on islands.

The challenges of island-living were and are experienced keenly by humans, as well as non-human species. In this vein, island archaeologists have carved out a sub-discipline centered on the concept that insularity is, in some sense, a conditioning factor in the development of human cultures on islands. The deep history of this branch of archaeology indicates its debt to biogeography and island ecology, particularly as regards its concern with adaptation and subsistence in island environments. Yet, island archaeologists seem only to retain interest in cross-cultural and inter-regional comparison when such comparison involves colonization dynamics. The processes whereby new-found islanders adapted to the fragile and sometimes environmentally liminal spaces they occupied have not been subject to cross-cultural comparison. It is such comparison, however, that will allow us to seek patterning in these processes. This, in turn, will either permit the formulation of general statements about how certain ways of living in island environments are inherently attractive and some inherently unattractive, or will suggest that in fact behavioral responses to insular living is largely context-dependent.

Two instances of island adaptation which seem suitable for comparison are the Neolithic occupation of the Cyclades, and the Early Ceramic occupation of the Leeward Islands. In both situations, several key variables are shared in common: most obviously, the colonization of a small-island archipelago from a neighboring mainland by an agropastoral, sedentary, pre-state society. Current island biogeographic theory and human behavioral ecology provide reason to be confident that there existed, for both of these communities despite their separation in time and space, optimal and sub-optimal strategies for survival in these new worlds. In the two subsequent chapters I explore the subsistence and settlement choices of both of these agropastoral colonizations, reviewing relevant sites and cultural characteristics, and establishing diachronic developments in subsistence behavior. Specifically, I argue that the patterns seen in subsistence development point to active insular adaptation in both circumstances. In Chapter Five and Six, I use a series of analytic techniques to draw out patterns in the distribution of human settlement in both study areas, and attempt to relate it to these adaptive processes.

CHAPTER THREE

CULTURAL SEQUENCE AND SUBSISTENCE PATTERNS IN THE NEOLITHIC SETTLEMENT OF THE CYCLADES

> The antiquities left in Seriphos do not point to any great artistic merit in the days of old; a few headless statues here and there, fragments of pillars, and one solitary sculpture of a symposium over a doorway were all the traces that we could see of the city where once dwelt the 'silent frogs.'
>
> James Theodore Bent, *The Cyclades, or, Life Among the Insular Greeks*, 1885

This chapter outlines the cultural sequence and associated spatial organization and subsistence behaviors of the first Neolithic colonists of the Aegean. Before assessing to what extent there is or is not any correspondence between the agropastoral and horticultural settlement in the study areas and relevant environmental and human variables, it is important to provide an account of the main cultural units and associated settlements in both the southern Aegean and the eastern Caribbean. This information is relevant in terms of both the initial distribution of sites and subsequent developments in settlement systems, the internal composition of these first agropastoral communities, and subsistence and technological choices made by the respective populations. In the concluding section of this chapter I argue that subsistence and distribution choices made in the fifth and fourth millennia in the Cyclades are indicative of behaviors which should be considered adaptive, and that the notion of 'transported landscapes' does not adequately capture the extent to which Neolithic colonists adapted their behaviors in the face of insular challenges. I also suggest that we can observe long-term changes in both subsistence behaviors and spatial organization from the Late to the Final Neolithic. The spatial aspects of these changes are considered in detail in Chapters Five and Six.

3.1. The Earlier Prehistory of the Cyclades and the Mesolithic Question

The earlier prehistory of the Cyclades has received a substantial amount of attention in recent years (e.g., Barber 1987; Brodie *et al.* 2008; Broodbank 1993, 1999a, 2000; Cherry 1981, 1982a, 1987; Cherry and Torrence 1982; Coleman 1977; Evans and Renfrew 1968; Galanidou 2011; Galanidou and Perlès 2003; Phoca-Cosmetatou 2008, 2012; Renfrew 1972; Sampson 2002, 2008a, 2008b; Torrence 1982, 1991; Whitelaw 1991). Overshadowed by earlier research into the Aegean's large, well-stratified Bronze Age sites which were foundational for Greek (and indeed Mediterranean) chronologies (e.g., Evans 1921, 1927), unequivocal evidence for substantial Neolithic occupation only began to emerge with a new program of prospection and excavation in the Aegean. This included the extensive survey of the Cyclades undertaken by Renfrew as part of his doctoral research (Renfrew 1965; 1972:63-224), and the excavations of the sites at Saliagos (Evans and Renfrew 1968) and Kefala on Kea (Coleman 1977). The latter two sites have proved foundational for Cycladic Neolithic archaeology, not least due to the full and comprehensive publication of the entire excavated assemblages. Such publication made clear the differences between the Late and Final Neolithic in the islands and the fifth and fourth millennia in Thessaly and Macedonia, but also provided a series of solid cultural and typological sequences to which unstratified material could be related.

The advent of intensive pedestrian survey in the Cyclades and neighboring southern Aegean islands (Cherry 1982; Cherry and Torrence 1982; Cherry *et al.* 1991; Broodbank 1999b) has added to the corpus of islands with Neolithic material, particularly on Kea and Melos. It is notable, however, that even following the first florescence of regional archaeology in the Cyclades, the 'island Neolithic' was still relatively inconspicuous in contrast to the rash of Early Bronze material and settlements (Cherry 1990; Broodbank 2000:117-174). To this initial list may now be added the sites on Mykonos, at Ftelia and Mavrispilia (Sampson 2002), both of which (typologically at least) seem to represent Saliagos-phase settlements; at least two sites on Naxos (at Grotta, and in the Zas cave, which provides the only complete stratigraphic record for the entirely of the Cycladic Neolithic); and probably the earliest material at Akrotiri on Thira. Finally, recent work on Andros suggests that the Final Neolithic is well-represented there, not least by the large site of Strofilas, whose Kefala-culture credentials now seem confirmed by radiometric dates (Liritzis 2010; Televantou 2008). Ten years ago, human occupation of the Cyclades during the fifth and fourth millennia was thought to be very sparse indeed. While density is obviously relative, these sites, and others whose credibility as undeniably sites of Neolithic settlement is yet to be established, suggest that human occupation of the islands was in fact not as thinly-spread as was imagined.

Before discussing the Cycladic Neolithic sites in detail, it is worthwhile to digress briefly on two subjects; the Mesolithic settlement of the Aegean, and the very early Neolithic of Crete, neither of which feature in the ensuing analysis but which are nonetheless important to any review of early island prehistory and settlement distribution in the Aegean. Three decades ago, Cherry (1981) could reasonably discount permanent or sizable Mesolithic occupation of the Cyclades, with any evidence for such an occupation doubtful, poorly-published, or both. Cherry did note (after Perlès 1979; Renfrew and Aspinall 1989) the presence of Melian obsidian in the 11th millennium BC levels at Franchthi in the Argolid. As Melos was not connected to the Greek mainland during the late Pleistocene and into the initial Holocene (Van Andel and Shackleton 1982; indeed, 'greater Melos' — Melos, Antimelos, Kimolos, and Poliagos — was probably separate from both the Greek mainland and a unified 'Cycladia' even at the Last Glacial Maximum [Van Andel and Shackleton 1982:44]), this provides concrete (if only proxy) evidence for Mesolithic traversal of sea-gaps of at least 20 km, and this assuming that an 'island hopping' rather than a direct departure-destination strategy was being employed. This itself is perhaps indicative of the capacity of Mesolithic mainland populations to traverse significant distance by sea. As Cherry pointed out, the discovery of the Melian obsidian flows only makes sense in the context of a wider exploration and subsequent knowledge of the islands (1981:45; Bintliff 1977:539; Broodbank 2006:209), and it is important to note that he did not dismiss the existence of an Aegean Mesolithic, only stressing the paucity of the data. Despite, however, the Melian obsidian at Mesolithic Franchthi, there was little reason to suppose a Mesolithic presence in the islands in any substantive or long-lived form.

Inevitably, new data generated in the 30 years since that paper's publication have caused a necessary re-assessment of its conclusions (although, admittedly, conclusive evidence of Mesolithic settlement in the southern Aegean is still very sparse). A recent review by Broodbank (2006) highlights the major new discoveries, perhaps the most important of which is the confirmation of the Mesolithic date of the site at Maroula on Kythnos (Cherry 1979; Laskaris *et al.* 2011; Sampson *et al.* 2010; Sampson 2008c). Maroula is seemingly a Mesolithic encampment, overlooking the north coast of the island. The site includes apparent intra-mural inhumation, complete with morphologically Mesolithic stone tools in Melian obsidian (figure 3.1), and also evidence for extensive fishing, as at the Cave of the Cyclops on Yioura (Sampson 2008a). The dating of these activities is bolstered by radiocarbon evidence (Sampson 2008c:16). Even more recent work at Plakias on the southern coast of Crete, undertaken since the publication of Broodbank's survey of the evidence, suggests further Mesolithic incursions into the islands. Initial targeted survey, followed by subsequent excavation, has recovered chipped quartz tools which, typologically, are described as Mesolithic (Strasser *et al.* 2010, 2011). If confirmed by radiometric dating, this material would presumably predate Knossos aceramic stratum X — the hitherto earliest settlement on the islands — by at least two millennia.

There is further evidence for broadly contemporary settlement on the island of Lemnos, in the northeast Aegean. The site at Ouriakos, on the southern coast of Lemnos (Efstratiou *et al.* 2013; Dawson 2011:39; Laskaris *et al.* 2011:2475), has exhibited anthropogenic deposits which provide AMS ^{14}C dates of 11,000-10,000 uncal. BP. These deposits are described as 'Late Palaeolithic' by the excavators; however, the radiometric dates parallel the site at Maroula, which is most effectively described as Mesolithic. The assemblage of chipped stone tools (Efstratiou *et al.* 2013: figure 8) includes micro-blades, micro-blade cores, and burins, which very clearly resemble the assemblage from Maroula in technological and morphometric terms. The coastal situation of the open air site again parallels its contemporary from Kythnos. The problem, then, is largely one of chronological terminology rather than understanding the relationship between these two sites; largely contemporary with very similar cultural material, both are implicated in terminal Pleistocene/initial Holocene hunting and fishing lifeways, whether these are described as Late/epi-Palaeolithic or Mesolithic.

This discussion leaves aside the question of Palaeolithic settlement of Crete. Based on the pedological context and the morphology of a portion of the lithic assemblage from the Plakias Survey, it has been argued that they represent the presence of pre-modern hominins on the island (Strasser *et al.* 2011). Prior claims for occupation of Crete by pre-modern hominins during the Pleistocene have been made before (Kopaka and Mantzanas 2009). This is not the place to review the tendentious issue of island-colonization by *Homo Erectus* and *H. Neanderthalis*. Until the Pleistocene provenience of these artifacts has been confirmed by a suite of radiometric dates, however, it seems premature to suppose that the Aegean islands were permanently settled by humans or near-humans prior to the Mesolithic at the earliest.

This discussion also deliberately leaves aside the inconclusive reports of Palaeolithic material from Agios Efstratios (Laskaris *et al.* 2011:2475) and the extensively-published evidence from the Cave of the Cyclops on Gioura (Sampson 2008a, 2011). This latter is certainly Mesolithic. Despite, however, the current insular nature of the Sporades, they, including Gioura, may well have been the easternmost extension of the Pelion peninsula in the late Pleistocene and into the initial Holocene (Van Andel and Shackleton 1982:449). This leaves four instances in which there is direct or proxy evidence for the existence of Mesolithic populations — of whatever size or duration — on Aegean islands: Kythnos, Melos, Lemnos, and Crete.

The remit of this study is confined to the earliest food-producing colonizing communities in both study areas. This extremely brief survey of the state-of-the-field of the island Mesolithic is relevant, however, as zooarchaeological studies at Maroula have suggested that the population here may have been practicing some form of food-production in the form of possible pig-domestication (Trantalidou 2008:25-27), alongside hunting and fishing as the main subsistence activities. This has potentially interesting parallels to Neolithic sites, especially Saliagos, where, despite obvious and clear evidence for the exploitation of domesticated cereals and ovicaprids, fishing — essentially maritime hunting-and-gathering — seems to have provided vital components of the diet. It is not the intention here to become involved in the debate surrounding the semantics and meaning of 'domestication', and the absence of any further evidence for Mesolithic food-production in the islands places the burden of proof squarely upon the Maroula data. Moreover, several millennia separate Kythnos's Mesolithic from the Cycladic Neolithic, and there is no reason to suppose the site at Maroula and the later Neolithic settlement of the Cyclades to be part of the same colonizing process or processes, or in any other way demographically or culturally related.

Consequently, the few Mesolithic sites in the southern Aegean (with only one in the Cyclades proper) have not been included in the study. Yet it seems worth bearing in mind the possibility that the subsistence strategies and social and spatial organization of island living Mesolithic communities in the Aegean may not have been enormously removed from that of their Neolithic successors, and that this may have been dictated by the limited and stark calorific opportunities afforded by inhabiting small islands. The paucity of Mesolithic sites when compared to their Neolithic successors certainly hints that a fully-Neolithic mode of production was a more effective strategy for effective settlement of the Aegean islands. This may have the interesting correlation that insularity, if it is in some sense a conditioning factor in cultural development, might affect hunter-gatherer-forager and agropastoralist in profoundly different ways; this is a topic for a later discussion.

Crete — a close (if large) neighbor of the Cyclades — should certainly be mentioned. Although not included in this study, it represents the earliest insular Neolithic settlement in the Aegean. Knossos stratum X — the earliest level at the tell, and the only aceramic deposit — dates from the seventh millennium BC (Isaakidou and Tomkins 2008; Warren *et al.* 1968), far older than any Neolithic site in the islands to its north and contemporaneous with the very first settlement of Thessaly. Probably the result of deliberate, targeted colonization from Anatolia (Broodbank and Strasser 1991), Knossos seems something of an outlier, culturally isolated from the wider Aegean world until the rash of settlement growth in the islands in the fourth millennium (Halstead 2008:230-233). For that reason, in addition to Crete's substantial geographic separation from the Cycladic archipelago and the different opportunities afforded by its biogeographic properties, the island is excluded from the study of Neolithic village communities in the southern-central Aegean.

Finally, it is important to make some notes about both the absolute and relative chronologies of the Neolithic settlement of the Aegean. The Bronze Age relative sequence was established very early, by relating the stratification at Phylakopi to the Knossos sequence, and as such the Neolithic material was clearly demonstrated to pre-third millennium. It was, however, only with the radiocarbon dates from Saliagos (Stuckenrath 1968)[1] that the Cycladic Neolithic could be placed absolutely with regard to its mainland and Cretan contemporaries. There are still far too few radiometric dates for the Cycladic

[1] Using modern calibration curves the Saliagos dates fall between 5,000 and 4,500 BC (e.g., Sampson 2002:155).

Neolithic as a whole, yet recent work at Strofilas on Andros (Liritzis 2010) and at the Early Cycladic site at Keros (Renfrew *et al.* 2012) bolster the existing framework as established by Barber (1987) and Broodbank (2000) (table 2). As such, it seems likely that the Saliagos to Kefala phase transition occurs in the second half of the fifth millennium; the development from the Kefala-phase Final Neolithic to Grotta-Pelos/Early Cycladic I seems to take place around 3,400-3,200 BC. This scheme is slightly complicated by the fact that some sites assigned by their excavators to the Saliagos-phase — notably Ftelia, but also perhaps Grotta and Koukounaries — may well extend into the fourth millennium, based on ceramic types, notably the presence of so-called crusted ware (see below). This long period of occupation for Saliagos-phase sites is not, however, necessarily a problem; there are reasons to suppose that they may indeed have been long-lived centers of population (Broodbank 2000:145-146), and their continuation into the fourth millennium means that there is no lacuna between Late and Final Neolithic settlement of the archipelago, the very different patterns of settlement and subsistence notwithstanding.

3.2. The Late Neolithic Site at Saliagos: Subsistence Behaviors and Insular Adaptation

The site at Saliagos (Evans and Renfrew 1968), excavated in the 1960s, is notable as the first definite site of Neolithic settlement to be excavated in the Cyclades. It lies on what is now a small island between Paros and Antiparos, but what sea-level reconstruction suggests was a headland jutting into a deep bay when the two islands were joined as 'Greater Paros' in the mid-Holocene (Morrison 1968). Extensive excavations in the thin topsoil across the site provided a series of radiocarbon dates from the fifth millennium (Stuckenrath 1968), contemporary with the relatively well-known Late Neolithic of Thessaly and Macedonia. The pottery from the site, however, diverges markedly from the well-known series in northern Greece (Andreou *et al.* 2001), with matt, light-on-dark wares predominating, white paint being applied to the vessels in a range of geometric patterns after firing (figures 3.2 and 3.3; Evans and Renfrew 1968:34-46). Other decoration included applied plastic additions to coarse vessels to form 'crusted ware' (figures 3.4 and 3.5); in both coarse and relatively fine vessels, open shapes (straight-sided and flaring bowls) were the most numerous.

The data which relate to subsistence activity at the site are of particular interest. Analysis of plant materials suggested the presence of the full Neolithic suite of cereals, including two-hulled barley (*Hordeum distichum*), Emmer wheat (*Triticum dicoccum*), and possibly Einkorn (*T. monococcum*) (J. Renfrew 1968), along with domesticated caprines, pigs, and cattle which, morphologically, appeared to be closer to domesticated size than that of wild *Bos primigenius* (J. Renfrew *et al.* 1968). This combination of subsistence choices is extremely reminiscent of other Late Neolithic subsistence choices in the Aegean basin, albeit terrestrial ones. What is particularly notable by contrast to this is the presence of fish-bones from a variety of families, of which most prevalent (97 per cent of all fish-bones recovered) were Scombridae, the family which includes the tunas and mackerels. As the authors note (J. Renfrew *et al.* 1968:119), these fish are pelagic, open-water species — although varieties of tuna often school inshore to spawn — and their catch implies the presence of a series of complex fishing technologies.[2] This may seem not, in and of itself, enormously interesting. The presence of pelagic species, however, has implications for understanding the extent to which the community at Saliagos adapted to its insular surroundings, and for the

[2] There was also at least one cetacean vertebra recovered from the site (J. Renfrew 1968:119), although it is entirely unclear whether this is evidence of the hunting of marine mammals — perhaps inherently unlikely considering the difficulty of the task — or a single instance of the butchering of a beached whale.

development of its material culture. To account for this, it is necessary to digress briefly, and consider the importance of barbed and barbed-and-tanged points at this and other Late Neolithic sites in the Cyclades.

Considering the evidence for fishing at Saliagos, and the absence of evidence for hunting of wild fauna, it is interesting to note one of the dominant (by number) types of chipped stone tool discovered at the site: tanged, and sometimes tanged-and-barbed, points, the vast majority in Melian obsidian (see figures 3.6 and 3.7; Evans and Renfrew 1968:46-61; Cann *et al.* 1968). These comprised 27 per cent (n= 347; Evans and Renfrew 1968: table 14) of all obsidian artifacts with secondary working. In marked contrast to the parallel-blade technology (comprising only 8.2 per cent at Saliagos, n= 104) of the subsequent Final Neolithic and Early Bronze elsewhere, and indeed of the lithic industries of the Greek mainland in the Late Neolithic, these points were ubiquitous at Saliagos.

The Aegean islands, like islands across the globe, are depauperate in terms of their flora and fauna (e.g., Palombo 2008; Sondaar 1977; Sondaar *et al.* 1966), and especially so in terms of large-bodied mammalian herbivores (and by extension mammalian carnivores). This, combined with the reliance on Neolithic domesticates as opposed to wild species at Saliagos, means that it seems unlikely that these points — whether they were attached to projectile or thrusting weapons — were used wholly, or indeed largely, in dispatching wild terrestrial prey. Projectile or thrusting weapons make little sense in the context of the organized slaughter of part of a domesticated herd. Inflicting maximum damage and pronounced blood-loss, with retention of the weapon in the body of the target, is not a priority with docile, potentially secondary-product bearing herds. Again, the report highlights the size and number of the fish identified during the excavation. With a minimum number of individual tuna of 65 (J. Renfrew *et al.* 1968:119), and these individuals up to two meters in length, catching the animals at sea would require an effective method of locating, corralling them inshore, and killing them. There is very little evidence to suggest what sorts of fishing technologies were being used. The delicate, organic remains of nets and lines would have survived very poorly, if at all; the best indicator for the use of nets is the presence of net-weights (Rose 1994:134-136), which have not been noted at Saliagos-phase sites. Considering the probable nature of Aegean Neolithic vessels as discussed in Chapter Two, however, alongside basic physics, and ethnographic analogy, it is possible to establish certain points about the nature of fishing for large pelagic species in the fifth and fourth millennia. Dug-out or reed based vessels cross-culturally tend towards having a high length to beam ratio, making them unstable (Fitzpatrick 2014). There is no evidence in the Neolithic Aegean for stabilizing technologies such as outriggers or keels (e.g., Broodbank 2010:252-254). Attempting to bring a live fish the size of an adult tuna would be to risk capsize (although from a human behavioral ecology perspective it is conceivable that the calorific reward would transform the risk into a socially acceptable one). It is important to establish, then, how these fish were caught, let alone located.

John Bintliff (1977:117-122) argued at length that large-scale fishing expeditions from the mainland were heavily implicated in the initial settlement of the Aegean islands. In particular, and relying heavily on the data from Saliagos and Franchthi, Bintliff understood the seasonal hunting of tuna schools to have lured mainland fishing expeditions into and through the islands, in a process of “transmerance” (1977:120). While the extent to which seasonal bounties of migratory fish (Bintliff focuses, as had Evans and Renfrew, on tuna, yet it is becoming increasingly clear that other taxa were more nutritionally significant) can probably be overstated (e.g., Gallant 1985), Bintliff's key observations in this argument are still valid. First, that the first Neolithic sites in the Aegean islands seem to have preferences for coastal locations alongside deep bays or straits; second, that Saliagos points (the barbed-and-tanged points found at Late Neolithic sites) are found at these coastal sites.

It seems possible that the tanged points were, then, implicated in the fishing of pelagic species. Specifically, the most parsimonious suggestion is that they were originally attached to fish spears or harpoons. This practice is recorded ethnographically elsewhere in the Mediterranean during the migrations of tuna (Bintliff 1977:540; Renfrew and Evans 1968:79-80; van Ginkel 2010). There is clear ethnographic evidence for catching Atlantic Bluefin from Sicily. During *la Mattanza* — 'the slaughter' — in the Egadi archipelago of western Sicily, adult Bluefin are trapped (Maggio 2000; van Ginkel 2005, 2010) in elaborate near-shore nets, constructed in anticipation of the tuna schooling in shallow water. The practice of corralling these large fish and then harpooning and dragging them onto to boats to be dispatched by severing the major ventral artery or letting them suffocate is, in the absence of modern fishing technology, a very effective means of hunting tuna. This practice is attested across the Mediterranean during the Medieval period (Maggio 2000). The preference for spearing, rather than simply netting, species of tuna also finds parallels in the Pacific, where there is ethnographic evidence for large-scale expeditions to seamounts which result in the harpooning of the larger species (Gillett 1987).

During *la Mattanza* steel hooks are used; without the benefit of metal tools, the barbs on the Saliagos points would make them more readily lodge in the body of the fish, allowing for it to be pulled onboard while simultaneously causing massive blood loss. The use of these points in large-scale seasonal fish-hunts seems, then, the simplest explanation of their ubiquity and design. This is supported by the absence of such points from the Zas I levels on Naxos; contemporary with Late Neolithic Saliagos but as far from the sea as possible within the Cyclades (Galanidou 2002:322), harpoon or spear-fishing is an inherently unlikely activity to have occurred on Mount Zas. The hunting of fish with arrows, another possibility for the Saliagos points, is also attested in the ethnographic literature (Codrington 1891:317-319: Radcliffe-Brown 1933:417-444).

It seems the best explanation of Saliagos' distinctive chipped stone technology is to understand it as related to the maritime subsistence practices taking place at the site. It is also clear that Saliagos deviates strongly from its Mesolithic predecessors in terms of chipped stone industry and morphology, yet is not an obvious extension of the Thessalian or Macedonian Late Neolithic. The amount of fish being consumed at the site is exceptional compared to either context. Despite a MNI of 65 fish being consumed over a period measured in centuries hardly suggests dependence, it is vital to remember that taphonomic processes and excavation biases inevitably reduce zooarchaeological material — especially fragile fish-bone — to a fraction of that initially present, and that portions of Saliagos island itself (other fish processing areas?) are now submerged. It could also be conjectured that these fish were the remnants of the last catch, or catches, prior to the site's abandonment; it is ultimately impossible to choose between these alternatives.

The reliance on caprines and pigs — presumably well-suited to the insular mid-Holocene Aegean (contrast the consumption of and presumed greater reliance on beef at Late Neolithic Makriyalos [Halstead *et al.* 1999]) — alongside cereals typical of the Near Eastern Neolithic package, as well as evidence for the exploitation of calorie-rich but potentially challenging maritime prey, suggests a subsistence strategy uniquely suited to a semiarid island environment. What is clear is that from these data emerges mode of subsistence which effectively utilizes all calorific sources, terrestrial and maritime (and also coastal), in order to support a settlement with an estimated population of 70-150 individuals (Broodbank 2000:145-146) over an extended period of time. Such diversification, and the apparent spread of Saliagos-phase settlements across a significant portion of the archipelago, suggests that this adaptive strategy was largely successful. The apparent replication of this mode of subsistence at other Late Neolithic sites in the Cyclades, albeit at sites for which the same type of detailed data does not exist, reinforces the notion that Saliagos-phase settlements effectively combined terrestrial and marine resource-exploitation.

3.3. The Late Neolithic in the Wider Cyclades

Two well-known sites on the island of Mykonos, in the north-central Cyclades, betray strong cultural similarities to the site at Saliagos (see table 1). Separated by only two kilometers, Ftelia and Mavrispilia (first noted by Belmont and Renfrew [1964]) are both situated on the western flank of the bay of Panormos. Following the excavation of Ftelia, the larger site, both may now be placed within the Late Neolithic (Sampson 2002:153-157). As the relationship between the two sites is unclear, aside from the fact that they seem to be contemporary and that Ftelia is apparently the larger, they will, for the purposes of the ensuing analysis, be considered as components of a larger settlement cluster on the southwest shores of the bay (cf. Sampson 2002:169).

Ftelia and Mavrispilia are notable for their surface concentrations of chipped stone and ceramics, with the former closely paralleling the excavated assemblage from Saliagos, in that tanged and tanged-and-barbed points predominate (Belmont and Renfrew 1964:396, 399, figure 5). White-painted ceramics were also evident on the surface at both sites. The Ftelia ceramic assemblage contains forms, however — such as red 'crusted' ware vessels and straight-sided, perforated vessels described as 'cheese pots' — which find some parallels at fourth millennium sites. Consequently, and in the absence of radiometric dates, it seems safest to conclude that the settlement of this part of Mykonos extends into the fourth millennium. Excavation at Ftelia, directed by Adamantios Sampson (Sampson 2002, 2008b; Phoca-Cosmetatou 2008), has revealed a substantial settlement site with several successive phases of occupation, again arguing for a lengthy period of use. The presence of a large, rectilinear structure in the first phase of settlement is notable (Sampson 2002; 2008b:29-30), although the extent to which this structure finds affinities in the Dimini 'megaron' as Sampson suggests is surely overstated (2008b:9). Of additional interest is the presence of two apparent granaries, and a large, well-built circular structure. Of more immediate concern here, however, are the data that relate to subsistence choices and strategies.

It is very unfortunate that no wet-sieving was undertaken during the excavation of Ftelia (Phoca-Cosmetatou 2008:38; Mylona, pers.comm. 2012), as this has almost certainly resulted in a bias against the recovery of marine vertebrate zooarchaeological material. Similarly adversely affected was the recovery of invertebrate remains; only 1,026 fragments of molluscs were recovered (Karali 2002:203) in contrast to 21,886 at Saliagos (Shackleton 1968:124), although considering the presence of coastal shellfish at both the latter and the Final Neolithic site of Kefala, it seems acceptable to assume that molluscs played a similar role in the diet at Ftelia. Aside from this, and despite the excavator's comments (Sampson

2002:152-153), there are further reasons to suppose that marine and coastal exploitation were significant components of the subsistence strategies employed by the community.

Firstly and most obviously, the presence of tanged and tanged-and-barbed obsidian points at Ftelia and Mavrispilia is paralleled at Saliagos (Galanidou 2002), with tanged points constituting 58.8 per cent of the excavated chipped stone assemblage from the main site. It has been suggested, both previously in this dissertation and elsewhere (Bintliff 1977:540; Renfrew and Evans 1968:79-80), that these points are implicated in fishing practices, although this certainly does not exclude use in hunting terrestrial game. At Ftelia, domesticates comprised 99.9 per cent (see figure 3.8; Phoca-Cosmetatou 2008:38-39) of the faunal assemblage (n= 3740, by NISP, not total count or MNI). This suggests an absence of terrestrial hunting — as at Saliagos, it seems to make little sense to dispatch domesticated herds with a projectile or thrusting weapon. In the absence of other viable candidates, hunting of large bodied pelagic fish presents a viable explanation for the presence of these points.

Secondly, it is interesting to note the strong similarities between the extent to which certain types of domesticate were being relied upon at Ftelia and Saliagos, compared to patterns evident at Final Neolithic Kefala (to be discussed below). As figure 3.8 illustrates, the ratio of sheep/goat to pig and to cattle at Saliagos and Ftelia is essentially identical, whereas at Kefala there is a slightly higher percentage of cattle, at the expense of sheep/goat and pig (Phoca-Cosmetatou 2008, 2011; *pace* Sampson 2002:152). At Kefala, there is almost no evidence of fishing (Coy 1977), although it is not entirely clear which recovery methods were used. Indeed, the Final Neolithic sites of the Cyclades seem to have relied more on terrestrial resources as opposed to marine than their Late Neolithic counterparts. Accordingly, it may tentatively be suggested that large pelagic species assisted in occupying a calorific niche in Saliagos-culture sites that, in later subsistence practices, was occupied in part by greater reliance on cattle. Relevant to this is that increased emphasis on cattle consumption is also more reminiscent of Late and Final Neolithic behaviors on the Greek mainland (Phoca-Cosmetatou 2011:86). As will be reviewed below, there are good reasons for supposing the Final Neolithic settlements to derive from a mainland Greek origin, in contrast to the Late Neolithic, arguably derived from a southeast Aegean or Anatolian colonizing origin. Potentially, two separate colonization episodes retained differently constituted modes of subsistence, the greater reliance on cattle a relic of Final Neolithic mainland traditions.

Finally, both Saliagos and Ftelia/Mavrispilia (and, as will be demonstrated, other Saliagos culture sites, such as Cape Vani on Melos) both overlook wide, deep bays. The role of fish-spotting sites and the desire to be close to good fishing grounds in the formation of Late Neolithic settlement patterns has been advanced (Bintliff 1977:117-125, 538-543; Broodbank 2000:148; Cherry and Torrence 1982:33). It is perhaps no coincidence that Ftelia is, then, so close to such an ideal location for the hunting of large, open-water species.

This extended discussion on the relationships between the typical Saliagos culture projectile points and the composition of the faunal assemblages at both Ftelia and Saliagos is justified in underlining the extent to which subsistence choices made at both sites were noticeably similar. Such observations have been made previously, although not to the same extent (Phoca-Cosmetatou 2008). As Chapter Five of this dissertation will, however, elucidate patterns behind settlement location, it seems worthwhile at this stage simply to make plain the apparent parallels between these two sites and, correspondingly, suggest that this may indicate an underlying rationale in terms of the distribution of Late Neolithic settlement in the Cyclades. Both communities, more or less contemporary and seemingly equivalent in size (Broodbank 2000:145-149; Sampson 2008a), relied upon domesticated cereals, flocks of sheep and goat, and the exploitation of marine resources. In any given situation, there are clearly optimal and sub-optimal locations for pursuing such subsistence strategies. The vital question is whether proximity to these locations was a factor in the distribution of these settlements, or whether other variables appear to have been of greater significance.

Saliagos and Ftelia represent the only two Cycladic Late Neolithic sites at which research was primarily focused on the pre-Bronze Age material (in fact, at neither site are there subsequent architectural phases, and very few Bronze Age surface finds). During excavations at other Cycladic sites better known for their Bronze Age phases, however, Late Neolithic material has been uncovered. While the tendency for some of these discoveries to be published in periodicals with limited circulation (Davis 2001:19) renders establishing the veracity of some of these finds difficult, there is now a reasonably robust body of data which suggests that Late Neolithic settlement was moderately widespread throughout the central, southern, and eastern Cyclades. As the assignation of a Saliagos-phase date to such sites is usually based solely on the presence of white-on-dark pottery as opposed to radiometric dating, and as the lithic and zooarchaeological and palaeoethnobotanical assemblages are not published in as great a detail as at the type site-itself, for example, the discussion of these sites is necessarily brief.

During the unification of Paros and Antiparos into 'Greater Paros' (see Morrison 1968), it appears that Saliagos was not the only Late Neolithic settlement on the island. The hilltop site of Koukounaries on Paros has revealed some Neolithic material, of both the Saliagos and

Kefala phases (Schilardi 1990, 1991; Katsarou and Schilardi 2004; Katsarou-Tzeveleki and Schilardi 2008). The earlier levels are assigned a mid-fifth to fourth millennium date by the excavators on the basis of the associated ceramics, which find strong parallels with the assemblage from Ftelia; in particular, red crusted ware, and the presence of the so-called 'cheese-pots', is suggestive of a fifth to early fourth millennium date (Katsarou and Schilardi 2004:36-39). The discovery of a figurine of the 'fat lady' Saliagos type (Schilardi 1990:222; cf. Evans and Renfrew 1968: plate 42) is also indicative of a fifth-millennium date being suitable. Zooarchaeological remains largely parallel those from Saliagos and Ftelia, with caprines dominating (Katsarou and Schilardi 2004:41). No sieving of any kind was undertaken, so it seems strange that the excavators find the failure to recover fishbone "odd" (Katsarou and Schilardi 2004:42); the usual Saliagos-phase combination of projectile points and access to a large, deep bay, seem to be suggestive of an interest in maritime resources, and this is reinforced by the presence of mollusc remains (Katsarou and Schilardi 2004:41). Final Neolithic and Bronze Age overburden has prevented the exposure to any great lateral extent of the Late Neolithic material, but it seems reasonable to conclude that this site has a fifth-millennium date, possible extending into the fourth millennium, and the potentially into the long third millennium (hence the discussion by the excavators of a "sub-Neolithic"; i.e., Kefala – Grotta-Pelos transitional phase [Katsarou and Schilardi 2004:42-44]). Again, it is significant that it is very close to the (modern) coastline (although it would have been more distant during the mid-Holocene), and a large, deep bay. In these respects at least it parallels both Ftelia and Saliagos.

A Saliagos-phase presence is also attested on neighboring Naxos. Excavations in the northern section of Naxos town (Grotta) have produced Neolithic pottery with strong affinities to the Saliagos assemblage (Hadjianastasiou 1988a; 1988b:12-17). Straight-sided bowls, common at Saliagos, predominate, with light-on-dark painting the most obvious form of decoration (Hadjianastasiou 1988b: figure 3). However, the presence of so-called 'cheese pots' (distinctive vessels with perforations along the sides) and crusted ware (also paralleled at Ftelia) suggests to the excavator, along with a relative impoverishment of vessel types when compared to Saliagos, that Grotta may date from later than the main phases at Saliagos proper (Hadjianastasiou 1988b:19). Regrettably, no radiometric dates are available for the former site, and on the basis of the ceramics alone it should perhaps best be placed within the fifth millennium. There is also evidence for Late Neolithic activity at the Zas cave on Mount Zas, in the very center of the island. The largely uninterrupted stratigraphic sequence here seems to begin with the Late Neolithic, on the basis of light-on-dark sherds from the basal level (Zachos 1996:88; the cave also contains Kefala material in Zas IIa).

The chipped stone from Koukounaries is reminiscent of that from Saliagos and Ftelia, with tanged and also leaf-shaped points, and some bladelets (Katsarou and Schilardi 2004:40-41). Conversely, the chipped stone assemblages from both Zas and Grotta differ from those observed at Ftelia and Saliagos proper; at Grotta, parallel-blade technology was predominant, although the lithics have not been quantified, and it may be that this bias results from recovery constraints in a circumscribed, urban excavation with no surface material (Hadjianastasiou 1988b:17). Complete data on the chipped stone from Zas are as yet unforthcoming. However, considering the unique nature of this site — at least in the Cyclades, where Neolithic settlement is as a rule open-air — and its position, it would seem unlikely that hunting or, as argued here, fishing paraphernalia would be common. There is possibility that Zas cave occupied some ritual or non-mundane function during the Neolithic settlement of the Cyclades (Broodbank 2000:164-165), and this may explain why the assemblage in Zas I diverges from the other Saliagos-phase sites. The possibility of the site having some ritual function in the fifth and fourth millennia in the Cyclades is addressed later.

Light-on-dark ware is also represented at Thiran Akrotiri (Sotirakopoulou 1990, 1986:298), albeit by only a very few sherds (n=16 [Sotirakopoulou 1990:43]). These were revealed during the excavation of the deepest strata of buildings Beta and Gamma, yet these strata were disturbed, and the material seems likely to have been redeposited. Most sherds have white-painted geometric designs (Sotirakopoulou 1986: plate 17a; 1990: figure 1), certainly finding parallels at Saliagos and Ftelia. The small number of sherds recovered from Thira and the lack of any stratification are problematic, as is the absence of any chipped stone or architecture providing a corroborating date. Caution is probably necessary in defining this as a Late Neolithic settlement as the data stand. However, it does appear to fit the general preference (to be explored in detail later) for Late Neolithic sites to be situated near large, deep bays; Akrotiri is of course coastal, although reconstruction of the geography of Thira prior to the eruption in the mid-second millennium is inevitably somewhat speculative (Forsyth 1996).

3.4. The Melian Neolithic and Data-integration

These sites discussed above are the main ones from which excavation has produced reasonably secure Saliagos-phase material. Intensive pedestrian survey (in the sense of Cherry 1983) has also contributed to our understanding of the total distribution of human settlement and activity during the fifth millennium. Intensive surveys of Melos (Cherry and Torrence 1982; Cherry 1982b) and Kea (Cherry *et al.* 1991) have revealed evidence for Neolithic occupation on both islands although, as will become clear, this occupation seems to take very different forms. Furthermore, a coherent understanding of the spread of Neolithic settlement in the Cyclades is complicated by the data from Melos which, generated using a novel method (still heavily under-exploited in the Cyclades, excepting work in Keros) which generated results which may seem difficult to integrate with excavation-derived data. This extended discussion reviews the data from Melos, and attempts to clarify the relationship between the Melian pattern and the overall distribution of Cycladic settlement.

On Melos eight sites were, on the basis of the chipped stone recovered by surface-collection, assigned a Neolithic date (Cherry and Torrence 1982: table 3.1; Cherry 1982b). Division into Late and Final Neolithic was not attempted, although Torrence later attempted this for Kea (Torrence 1991). These sites ranged from very large scatters of chipped stone, such as at Agrilia (Melos site 25), a site whose existence was already well-known, to sites such as Phavas (Melos site 105), which may represent a single knapping event. Because of the nature of data-collection during intensive pedestrian survey, an attempt must be made to distinguish these collections of material into those which represent very few or brief prehistoric behaviors, and those which represent longer-term or larger-scale occupation. This is inevitably somewhat inexact. It remains perfectly possible that these sites may represent seasonal and opportunistic subsistence activities during visits to the island to acquire obsidian. Indeed, the relative biogeographical remoteness of Melos (e.g., Broodbank 2000: figures 39 and 40) from other centers of both Late and Final Neolithic settlement in the archipelago may suggest that this is the case. The absence of any pottery is also telling;

surface assemblages at both Saliagos and Ftelia, and also at Kefala, all of which were demonstrated to be settlement sites, contained ceramics as well as chipped stone. It seems most reasonable to review the evidence from Melos in its entirety, and then attempt to establish what can and cannot be determined about Late Neolithic activity on the island.

Agrilia (Melos site 25) and Kouphi (Melos site 34) are situated close to each other in the northeast of the island, immediately to the north of the obsidian flows. Both are large and relatively dense scatters of material, which included tanged and leaf-shaped points, blade cores, and some blades. The amount and variety of material indicates that reduction of raw obsidian was taking place in some form at both sites, and the concentrations argue for both Agrilia and Kouphi to have been important foci in the long-term, either revisited seasonally or sites of sedentary settlement. It is interesting, but not conclusive, that they are situated in an area of the island which contains the most productive soil formations; the relationship between these data will become clearer in the ensuing analysis. Two small and sparse scatters of obsidian debitage with some tools (Melos sites 28 and 33) may be related to Agrilia and Kouphi.

Also significant are three other clusters of Neolithic material on the island; that at Cape Vani (Melos site 111), Soleta (58), and the two small sites — perhaps aspects of the same concentration of artifacts — at Phavas (105 and 106). Soleta, in the southeast of the island, was a scatter of later diachronic material, but the presence of a leaf-shaped point and a biface — certainly not Roman — suggest the presence of Late/Final Neolithic knapping activity. Again, there was no Neolithic pottery recovered on the surface. Cape Vani is in the extreme northwest of the island, overlooking the entrance to the Bay of Melos. Only a limited amount of material was recovered, but the small assemblage was nonetheless diverse, including a tanged point, a biface, a core and, most interestingly, a large ground stone axe and unused obsidian nodule. It is tempting to interpret this as representative of an interrupted or incomplete knapping event or series of events. This is all the more interesting considering the view commanded by the site at Cape Vani, and its possible use as a location for spotting large near-surface schools of pelagic fish (Bintliff 1977:538-543; Cherry and Torrence 1982:26). Conceivably, the surface material here could represent a fishing station, which finds parallels in ethnographic accounts of Mediterranean fishing. Finally, there are two scatters of Neolithic obsidian tools and debitage on the southwest coast of the island, at Phavas. The proximity of these two assemblages (500 m) suggests that they may be related. Again, no pottery was recovered from surface collection.

With the publication of the Melos data, the number of sites of Neolithic activity in the Cyclades was effectively doubled, as Cherry and Torrence noted (1982:24). Even three decades later, and viewing unsubstantiated claims elsewhere in the archipelago with a skeptical eye, Melos is unique in the number of Neolithic sites of any phase. This observation leads to a number of further issues, and perhaps problems. Inevitably, data generated by different methods employed under different research strategies are hard to reconcile quantitatively. It is not clear, for example, whether the lack of intensive pedestrian survey on Mykonos means that large portions of the total number of Neolithic sites are hidden. In particular, the method adopted on Melos has obvious implications in that the total area observed was a 20 per cent sample of the island — does this indicate that observed sites, or clusters of sites, only represent 20 per cent of the total (Cherry and Torrence 1982:24)? This would make Melos even more of an outlier, unless, of course, there are similar numbers of as-yet unobserved sites on other Cycladic islands, although survey of Kea (Cherry *et al.* 1991) and (non-Cycladic) Kythera (Broodbank 1999b) perhaps suggest not.

Further, it is unclear to what extent we can extrapolate behaviors from surface assemblages when compared to excavated assemblages. Clearly, sites such as Saliagos itself and Ftelia represent domestic activities — eating, sleeping, producing, perhaps best conceived of as *dwelling*, sometimes over very long periods. It seems hard to make similar claims for sites like Cape Vani or Soleta which may represent nothing more than a single-instance knapping event. Situated between these two extremes are sites such as Agrilia — probably a site of dwelling, in a broad sense, but perhaps not comparable to a village such as Ftelia. Finally, there is the concern that it is the unique nature of Melos that renders its surface distribution of Neolithic cultural material so notably different from those of the other Cyclades. As will be shown, there is good reason to suppose that no overall control was exercised over the obsidian sources between the fifth and third millennia; it may well be that the highly esoteric distribution of Neolithic chipped stone across the island reflects a unique pattern of opportunistic access and processing over several millennia, a situation peculiar to Melos.

There is a large literature on problems of interpretation of survey data in Mediterranean environments, and on the relationship between data derived from survey and from excavation in the Aegean (among others Alcock 1993; Alcock and Cherry 2004; Bintliff *et al.* 1999, 2002; Caraher *et al.* 2006). It is not the intention to review this literature here; the problem is relevant, but not a central concern of this dissertation. It seems more useful to establish what propositions can and cannot be made about Neolithic Melos, and what implications we may draw from these propositions.

As has been seen, despite intensive research there is still no evidence for a Saliagos-like village on the island. That being said, there was clearly a population of some type on the island, probably during both the Late and Final Neolithic, which may or may not have been permanent. Even if this was only a transient population interest in procuring obsidian, knapping was certainly taking place (Torrence 1982), and this is in itself a relatively time-consuming process. This also implies some sort of temporary settlement, and also perhaps the keeping or transport of livestock. Opportunistic planting of cereals, maybe in anticipation of a return later in the season, is certainly possible, and the presence of projectile points suggests (Cherry and Torrence 1982), as elsewhere, the likelihood of fishing. Experimental archaeology and ethnographic data on canoe-based seafaring suggests that traveling to Melos from the islands where Late Neolithic settlement has been confirmed would have been time-consuming (e.g., Broodbank 2000:105), but not so much so that semi-regular travel would not have been possible, and considering the preference for Neolithic obsidian at Saliagos-phase sites regular — perhaps seasonal, or annual — access to the obsidian flows seems likely; this is considered in detail in Chapter Six. It is perhaps best to conclude that any population on Melos during the Neolithic was itinerant, but that during visits to obtain obsidian established itself in semi-permanent or at least seasonally re-iterated communities. If this were a regular practice, it is possible to imagine that these communities were re-established in the same part of the island. In this case, then a demographic center of gravity in the area of Agrilia and Kouphi seems most likely. As will be discussed later, this area has excellent access to both the obsidian flows and to land preferred historically for cereal cultivation (Wagstaff and Augustson 1982: figure 10.8). It is perhaps not coincidental that this is also the part of the island most readily accessible from the central Cycladic Saliagos-phase villages and, also, in the area of the island which saw population clustering during the Middle to Late Bronze age and the 1st millennium BC.

While it is perhaps most likely that any permanent fifth and fourth millennia populations on Melos were densest in the north-eastern part of the island, this cannot be argued with any certainty. Patterns of distribution and preferences for certain niches are explored in Chapters Five and Six, and shed light on the Melian data. Specifically, these analyses suggest that a possible settlement at Agrilia makes very little sense in the wider context of Saliagos-phase (or indeed Kefala-phase) settlement. This may indicate the likelihood or not of an itinerant population in this part of the island until the Grotta-Pelos Early Bronze I expansion.

The Neolithic data from the Kea survey (Torrence 1991; Whitelaw 1991) are slightly less problematic. The sites at Kefala, Paoura, and Sykamia were already known (Coleman 1977), and Kefala is reliably Final Neolithic; Sykamia presumably so (Coleman 1977:158). The presence of tanged-and-barbed points at Paoura, and the different morphology of the blades recovered from that site, led Torrence to suggest that Paoura may have a Late Neolithic/Saliagos component (Torrence 1991; cf. Whitelaw 1991). Based, however, on the ceramics recovered from the surface and evidence for copper metallurgy, Coleman argued for a fourth millennium date (1977:156-157). It seems safest here to classify Paoura as a fifth-fourth millennium site. Yet, as all three of these sites have surface signatures which include both ceramics and lithics they can all be interpreted as settlement sites, unlike the problematic Melian scatters.

These, then, are the main sites of the Saliagos culture phase, the first phase of Neolithic settlement in the Cyclades. They form the body of data for the fifth- (and possibly into the fourth-) millennium Aegean which are analyzed in Chapters Five and Six as regards their spatial relationships to each other and to natural variables. Already, several authors have noted emergent patterns, in particular the apparent preference for situation next to deep embayments (again the exception is the site in the Zas cave), and medium-to-large islands (Broodbank 2000:146-149; Hadjianastasiou 1988b:18). Considering the strong positive correlation between settlement location and these two factors, it seems likely that this pattern is real rather than an artifact of the data. It remains as yet somewhat inexact, however, and it is vital to establish and measure the relationships in question. In particular, amount of open sea/coastline accessible within certain watersheds of travel, and whether or not the ocean or coastline in question is hospitable or not to known taxa of exploited fish and other marine food-sources in terms of depth and water-column composition, both seem very relevant in any attempt to discern a pattern in the settlement data, considering the utilization of marine resources throughout the Neolithic. Secondly, the recognition of an apparent relationship between site-situation and island size is interesting, but demands further investigation, rather than assuming that larger size results in greater potential agricultural and pastoral productivity. These, and other factors (distances between sites, their topological relationships when modeled as networks, and the relative insularity of site-location in terms of cost-surface analysis) will be addressed subsequently. Suffice it to note here that there are emergent patterns in the Late Neolithic settlement data of the Aegean, and patterns which seem to contrast quite strongly with those for the subsequent Final Neolithic/Chalcolithic.

3.5. Settlement and Subsistence in the Final Neolithic/Chalcolithic (Kefala phase)

A subsidiary excavation to the University of Cincinnati's major project at Ayia Irini on Kea, the publication in 1977 of the excavation at the settlement and cemetery of Kefala, on the northern coast of Kea, established the existence of a Cycladic Final Neolithic. This was subsequent to the Saliagos culture sites and antedated the well-known Early Bronze in the Cyclades, the Grotta-Pelos phase, although in some respects prefiguring it in terms of material culture (Grotta-Pelos has now been shown to begin in the terminal Final Neolithic). The project revealed the existence of a hitherto-unexpected series of ceramic and chipped-stone types in the islands, owing very little to Late Neolithic antecedents. The ceramics from Kefala are markedly dissimilar; there is no white-on-dark ware, and indeed very little use of geometric motifs at all, excepting broad linear designs (Coleman 1977:9-11). So-called 'pattern burnished' ware of Kefala (1977: plates 40-43, 86-88), distinctive of the site, finds no parallel at Saliagos (but does at Ftelia [Sampson 2002:104], perhaps again indicating this site's persistence into the fourth millennium). The sole radiocarbon date for Kefala was, as has been noted, very low, probably erroneously so (Coleman 1977:110). Lacking stylistic parallels within the Cyclades, the use of mainland parallels placed the site in the mid-fourth millennium, previously a lacuna in Cycladic prehistory. The excavations also produced evidence, in the form of copper slags, of metalworking in the Cyclades. This, and the relationship of the distribution of Final Neolithic (essentially Chalcolithic; Broodbank 2008) to the ore-bearing islands (Kea, Syros, Sifnos, Serifos, Melos) of the Cyclades' Western String, may be significant in terms of choices behind settlement location.

If subsistence in the Saliagos phase can be argued to represent a partial adaptation of a characteristically Aegean-wide Neolithic package to a uniquely insular context — particularly as regards the exploitation of marine resources — it is difficult to make the same claim for Kefala. The relative frequencies of sheep/goat, pig, and cattle at Kefala are approximately the same as for the Late Neolithic sites for which data are available (figure 3.8), although with a greater percentage of cattle (by NISP), which perhaps recalls similar emphases on the mainland during the fourth millennium. Divergence from the subsistence regime at Saliagos is evident in the presence of pulses alongside six-row barley (J. Renfrew 1977); in this case, grass peas (*Lathyrus sativus*). *L. Sativus* is hardy, and resistant to drought-like conditions (Zohary and Hopf 2000:119-121). It is also toxic in large quantities (2000:119), causing the neurological disorder lathyrism, and is certainly in this regard cannot be considered a staple, but rather one in a spectrum of exploitable species. This is interesting in the context of environmental change in the fourth (and into the third) millennium, in which there is evidence for increasing aridity in the eastern Mediterranean (Roberts 1998:115-117); this theme is returned to in the final chapter.

The apparent willingness to exploit previously empty landscapes in the fourth millennium (Halstead 2008), and the diversification in exploited plant species seen at Kefala, may be aspects of the same phenomenon, being a response to environmental or demographic stress. It at least represents a departure from the regime at Saliagos, in which wheat was being produced, albeit in smaller quantities than barley (J. Renfrew 1968). This elides the problematic situation at Ftelia, where there is evidence for the production of *Lathyrus cicera*, a relative of *L. sativus*, as well as lentils (*Lens culinaris*) (Megaloudi and Marinval 2002; Sampson 2002:151). It remains possible that Ftelia's later phases may represent some Final

Neolithic activity (Sampson 2002:104, discussed below), which may account for the diversification of plant domesticates from the wheat and barley regime at Saliagos. Alternatively, we may note that peas of the genus *Lathyrus* are commonly used for animal fodder in liminal or challenging Mediterranean environments. It is conceivable that the greater amount of pasturage available on Greater Paros than on Mykonos or Kea had a bearing on the extent to which domesticated flocks could rely on naturally-available fodder alone. The situation remains unclear.

Most notable at Kefala, however, is the seeming absence of fish bones, and the drastic difference in the chipped-stone technology in comparison with Saliagos-phase sites. There was only one fish bone recovered during the excavations at Kefala, a vertebra (Coy 1977: table 1), on which the excavators offer no comment. It is unclear which sieving methods were utilized, although certainly not the fine-mesh sieving which was utilized at Saliagos; however, the authors note that fishbones had "completely disappeared" at the site (1977:132; the implication is by adverse taphonomic processes). This is in stark contrast to the 250 fragments of shellfish produced. This assemblage was dominated by limpets (61.6 per cent, n= 154), which displayed signs of having been pried from rocks — that is, they were still alive when harvested, suggesting procurement for consumption, rather than the shells being gathered on the foreshore for use as tools or ornaments. Moreover, all species of limpet represented are tidalzone dwellers; Spondylus (n=9) is certainly found in deeper water, but this assemblage taken as a whole suggests a regime of beach and foreshore combing.

The predominance of shellfish, and the absence of fish-bone, is interesting when compared to the lithic technologies which were utilized at the site. The tanged points, ubiquitous at Saliagos, Ftelia and Mavrispilia, are not found at Kefala. Indeed, there were only five pieces of material recovered which could be classified as points (Coleman 1977:7), out of a total number of 2,636 pieces of stratified obsidian, including debitage (i.e., less than one per cent). Rather, parallel-sided blades and expedient flake tools were most common; figures 3.9 and 3.10, compared to 3.6 and 3.7 illustrates the stark differences between the blades and bladelets from Kefala and the Saliagos points. If the suggestion that the Saliagos points were associated with fishing, and in particular open-water fishing, is sustained, then it seems probable that fish formed a much less significant component of the diets of those living at Kefala, in the fourth millennium, rather than those living at Ftelia and Saliagos (and elsewhere) in the preceding millennium. Even if this link is not sustained, very little of the chipped stone from Kefala can be directly associated with obvious fishing — or even hunting — activities. Moreover, despite evidence for the existence of textiles and other organics at the site, there is no suggestion of the presence of nets. It is clearly the case that the community present at Kefala was capable of crossing the open sea; all the obsidian found at the site appears to be from Melos, one hundred kilometers to the south, and there are no sources of copper on the island. The choice appears, however, to have been made not to use this seagoing technology to exploit pelagic resources. Rather, the focus of subsistence activities at this site seems to have been noticeably terrestrial.

The site at Kefala remains the only Final Neolithic site for which well-published zooarchaeological data exist, which in some part justifies this lengthy discussion. It also serves to highlight how dissimilar were lifeways between the Saliagos villages and the Final Neolithic settlement on northern Kea. Its smaller size (50-100 individuals, perhaps, at a maximum [Coleman 1977:111]) and apparent diversity in the domesticated plants exploited there, as well as their better suitability to arid environments than the wheat seen at Saliagos, suggest perhaps a more precarious grasp on island living. Certainly, the material indicates at least a strikingly different way of exploiting the landscape. Prizing shellfish from the foreshore, smelting small amounts of copper, and using different ceramics and stone tools in fundamentally different ways, makes it clear that the Late Neolithic modes of living, at least at Kefala, differed from fifth-millennium counterparts. It is a central contention that this difference is inherently reflected in settlement patterns, as will be discussed in Chapter Five dissertation, and in underlying logics of the distribution of settlements and people throughout the archipelago.

Aside from Kefala itself, there is evidence for the existence of at least four more Neolithic sites on Kea including Ayia Irini which, based on unstratified surface material, have strong affinities to the excavated assemblage from the main site (cf. Torrence 1991; Cherry *et al.* 1991: figure 9.2). Paoura and Sykamia are both coastal sites on the north-western coast of the island, facing Andros. Two published investigations (Coleman 1977:156-158; Whitelaw 1991:208-214) both suggest that Paoura and Sykamia probably represent small, coastal settlements approximately contemporary with Kefala (although again Torrence notes that a case might also be made for fifth millennium occupation of Paoura [1991]). Whitelaw, after conducting extremely detailed analysis of the distribution and composition of the surface assemblages at both Kefala and Paoura, follows Coleman in suggesting a population of 100 individuals or fewer at any given time for both sites (Whitelaw 1991:215). Ayia Irini clearly possesses a basal stratum with a terminal fourth millennium date (Wilson 1999:6-19). The extent of this site, or its significance relative to Kefala and its other neighbors, is problematic, however. Discussion in the final chapter considers the evolution of new settlement systems in the Final Neolithic, and there is reason to believe, based on this, that Ayia Irini may have played a more substantial role than tier 2 sites such as Kefala.

The contemporaneity — or not — of these sites naturally has a significant impact on our understanding of the relationship between these three sites, located as they are in such proximity (although not as close to one another as Ftelia and Mavrispilia). If they were occupied simultaneously, the distances between them surely indicates that their inhabitants must have maintained a relationship, of whatever sort (an ostensibly similarly dense pattern on Andros, discussed below, is encouraging in this regard, as is the prevalent pattern during the Grotta-Pelos phase). If not contemporaries, they may simply represent the 'migration' of a village over time, although the presence of a cist-grave inhumation cemetery at Kefala may perhaps speak to the rootedness of the developing community there. There is no obvious way of choosing between these two positions, and in the final discussion both will be adopted; the presence of three Final Neolithic communities on northern Kea, versus the presence of a single, peripatetic community.

The excavators of Kefala, lacking comparanda in the Cyclades, were forced to turn to mainland Greece to find parallels for their material. Since the publication of the Kea excavations, only a few more distinctively Final Neolithic sites have been noted. These include some sites which have already been discussed at some length, notably the later material at Ftelia. Here, the excavator notes pattern-burnished ware, although oddly rejects its association with the Final Neolithic (Sampson 2002:104); considering the parallels to Final Neolithic pattern-burnished elsewhere (2002: figure 115) it seems perhaps reasonable to conclude a presence, even if very slight, of a population at Ftelia into the fourth millennium. Aside from the equivocal evidence for fourth millennium activity on Mykonos, there is also Final Neolithic material at the already-discussed site of Parian Koukounaries. The excavators note crusted burnished ware, found at Kefala, incised vessels, use of lugs, and cheese pots (Katsarou-Tzeveleki and Schilardi 2008:69: figure 8.11; cf. Coleman 1977: plate 37). Neighboring Naxos also contributes Final Neolithic material, through its presence in the Zas cave, Zas IIa, immediately overlying Zas I (Saliagos phase [Zachos 1996]).

In all these cases it is hard to assess whether they represent Kefala phase settlements, based on the limited data recovered and the frequent lack of good stratigraphic association. Furthermore, the relationship between the preceding Late Neolithic material is complicated. I earlier stressed how Late and Final Neolithic ways of living and thriving in the islands were different. It is consequently not very easy to then determine whether these sites represent Late Neolithic villages which adopted Kefala traits or lifeways (at all three, ceramics are the main index of Final Neolithic occupation), or reoccupations during the spread of Final Neolithic populations and practices across the archipelago. With the data in their current state little can be argued with certainty, although it should be noted that at Koukounaries the excavators note an apparent hiatus between Late and Final Neolithic levels (Katsarou-Tzeveleki and Schilardi 2008:69), perhaps suggestive of a wider process of resettlement. In discussing Broodbank's (2000) model of island colonization later in this chapter, it will be noted that his argument presents a possible explanation of the processes at work.

Reconnaissance on northern Andros suggests that Kefala period sites may be especially dense on this island. Surface scatters of Final Neolithic material are reported at Vriokastro, Mikroyiali, and Strofilas (Televantou 2008), and Ayia Marina, Kastri, and Rethi (Koutsoukou 1992; 1993). Of these, only the large site at Strofilas, on the south-western coast facing Kea, has been investigated in any detail. The architecture is substantial, and recalls the presence of both rectilinear and apsidal buildings at Ftelia. The presence of landward fortifications foreshadows the site at Chalandriani on Syros (Broodbank 2000:220). Importantly, the stratified pottery is distinctively Kefala-phase, and a fourth-millennium date is also indicated by recent radiometric dates from the site (Liritzis 2010); this paper in fact suggests that occupation at the site may well continue into the Grotta-Pelos phase. The excavator notes the strong parallels between the Strofilas material and mainland finds, arguing for the existence of an Attic-Kefala complex in this area during the fourth millennium (Televantou 2008:51); this model is interesting, particularly because of its resonances with Broodbank's (2000) attempts to model the mainland origin of Final Neolithic populations. Pattern burnished ware is in evidence (Televantou 2008: figure 6.14), monochrome dark burnished wares, and plastic application of lugs. Copper was found in abundance, and one gold bead now represents fully half the known gold objects for the Cycladic Final Neolithic. Figurines were also noted, starkly different from Saliagos type C, but with stylistic similarities to the subsequent and well-known Early Cycladic II figurines. Finally, the lithic assemblage appears interesting; while not yet fully quantified, the presence of tanged (although apparently not barbed) points should be noted (figures 3.11 and 3.12). In the absence of Late Neolithic ceramics these are perhaps best understood as the adoption of a pre-existing insular fishing and hunting technology, or a uniquely local insular adaptation.

It is important, before concluding this section, to highlight that there are further sites within the Cyclades — although not many — which may also have a Final Neolithic component, but regarding which inadequate publication precludes saying anything conclusive about them. The site of Ayios Sostis on Sifnos is one such example (Gropengiesser 1986, 1987). While it may well be a Final Neolithic site, further research is required before it is considered in the corpus of data employed here. There is also the possibility of Final Neolithic settlement on Tinos and Syros; the likelihood of this is demonstrated in Chapter Five. Again, intensive pedestrian survey would clarify many of these quasi-lacunae.

3.6. Adaptation and Colonization Dynamics in the Neolithic Aegean: Emergent Patterns

In the foregoing description of the current known distribution of Late and Final Neolithic sites, the recent syntheses by Broodbank (2000:107-174) and Davis (2001) loom large. Broodbank not only corralled these varied data into a coherent and cognizable corpus, but, in his modeling of the potential colonization scenarios that may have resulted in the archaeologically-visible distribution of populations in the Neolithic Cyclades, recognized a number of factors which may have been held in common for the settlements of the Late and Final Neolithic respectively. Particularly interesting here is the apparent wide distribution of large village sites during the Saliagos phase, in contrast to the more dense spread of smaller sites with one (that we know of) very large site during the Kefala phase (and into the subsequent Grotta-Pelos), albeit limited to the north-western corner of the archipelago.

Broodbank's attempts to model the colonization of the group are also very significant for any study of the development settlement and subsistence patterns, particularly as the continued generation of data subsequent to the appearance of his study seem to corroborate his argument. Broodbank notes the favorable axes of movement into the Cyclades from the surrounding islands and mainlands (2000: figure 36), and, in a lengthy discussion (2000:133-141), explores the colonization dynamics along the two main axes (from Attica into the northern archipelago, and from Anatolia and the Dodecanese into the eastern) from an island biogeographical perspective. These suggest the attractiveness of Naxos and Greater Paros for colonizing movements of Anatolian origin, and the attractiveness of Andros and Kea for movements originating in Attica or Euboia (treated here as mainland). Considering these models, Broodbank's implication that the Saliagos-phase settlements in the south-eastern and central Cyclades were settled from the Dodecanese or Anatolian coast is seems to be supported by the new data from Ftelia; aside from light-on-dark ware, the ceramics suggest affinities with the south-eastern Aegean (Sampson 2002:156). This makes the excavator's comments (Sampson 2002:159) that the Late Neolithic settlements in the Aegean derive from a mainland Greek source, and his critique of Broodbank's (1999) modeling, seem rather odd; this author has, however, elsewhere argued for an indigenous development of the insular Neolithic from Mesolithic roots (Sampson *et al.* 2002). It seems fairest to conclude that a south-eastern Aegean or Anatolian origin is the best explanation for the distribution of the Cycladic Late Neolithic, and requires the least special pleading.

The parallels between Saliagos phase material from the south-eastern Cyclades and the Dodecanesian Neolithic, and the similar parallels between Kefala phase material and the Attic and mainland Neolithic, surely hint that the fifth and fourth millennia settlements in the archipelago derive from two separate instances or at least axes of colonization. This is reinforced by the apparently divergent strategies in landscape occupation — both in terms of settlement type and distribution, and subsistence choices — witnessed in both traditions, and will be a central concern in the following analysis of Aegean settlement location in the subsequent chapters. In such a model, the co-occurrence of Saliagos and Kefala material at certain sites (Zas, Koukounaries, perhaps Ftelia) would be indicative of either refoundation of fourth millennium sites on moribund fifth millennium villages, adoption of Kefala-phase lifeways in the increasingly arid and less hospitable fourth millennium Aegean, or an instance of hybridization at the frontiers of the colonizing movements.

As this discussion is concerned with teasing out the parallels and differences in Saliagos- and Kefala-phase modes of living in the Cyclades — and that patterns of resource-exploitation as they relate to settlement distribution are of relevance in this dissertation — it is necessary here to address the research of Nellie Phoca-Cosmetatou (2008, 2011) on 'transported landscapes.' Derived from Kirch's work on the subsistence regimes of Pacific colonizing populations (1982), Phoca-Cosmetatou suggests that the introduction of alien species into insular Cycladic environments represented a very obvious mode of coping with these environments and rendering them productive. Noting differing reliance on ovicaprids in island and mainland environments (Phoca-Cosmetatou 2011:86) and providing this as evidence for limited insular adaptation, she nonetheless concludes (taking Ftelia as her case-study) that mainland ways of living were transported wholesale, yet operated within a circumscribed series of ecological parameters. The result was not so much behavioral adaptation to insular conditions, but rather impoverishment of subsistence behaviors in the face of less-productive landscapes.

Phoco-Cosmetatou's analysis of the zooarchaeological material is exceptionally clear, and she is perfectly correct in that the opportunities afforded by island-living were essentially different, and much more challenging, than those offered by mainland farming. Her argument is surely correct in identifying the fragility of Mediterranean small-island archipelagoes. It was argued in Chapter Two, however, that the geographic, meteorological, and seasonal contingency of island environments renders them challenging for, but also presents novel opportunities to, colonizing populations. At both Saliagos and Ftelia, the only two Late Neolithic sites for which appropriate data exist, it seem that shellfish were being exploited for their flesh (Shackleton 1968; Phoca-Cosmetatou 2008). The majority were coastal, but some deep water species were represented (an approximately similar pattern in shellfish exploitation obtains at Kefala, with pronounced coastal emphasis). At Saliagos, large quantities of tuna meat were entering the community's diet; a minimum 65 *Thynnus thynnus*, at an average mature weight of 350 kg (Block *et al.* 2001), renders 22.75 metric tons of fish meat. This crude calculation simply serves to highlight the absolute minimum amount of fish meat available to the village at Saliagos. Even in the absence of evidence for the exploitation of ovicaprid secondary products until the fourth millennium, and the implied use of these flocks largely for meat, marine protein must have contributed a significant amount of the net protein intake of the population, barring practices related to deliberate wastage. Moreover, the inshore movement of *T. thynnus* and other pelagic species are sporadic, dependent on feeding and spawning behaviors. This makes pelagic fish a less reliable food source, a contingent opportunity for acquisition of calories simply unavailable to mainland populations. The capacity and inclination of the community at Saliagos to exploit this resource suggests flexibility in subsistence behaviors indicative of adaptability to insular conditions.

Admittedly, such unequivocal evidence of multi-zone marine exploitation (coastal and pelagic) comes, so far, only from Saliagos. I have argued that the tanged-and-barbed points found at Saliagos-phase sites represent projectile and thrusting weapons vital in fishing large game-fish species (of which *T. thynnus* is only one example) from dugout vessels in shallow water. If it is indeed the case that these points were employed in this type of fishing, then there exists proxy evidence for the exploitation of pelagic species at other Late Neolithic sites aside from Saliagos. Whilst Phoca-Cosmetatou's basic interpretation of how colonizing Neolithic populations adapted to their new environments still holds, it may be possible to reconsider the extent to which these communities failed to take advantage of new subsistence behaviors in a process of insular adaptation. The maritime adaptation of the Saliagos-phase communities certainly seems successful — both Saliagos itself and Ftelia appear to have been large and long-lived, and the existence of granaries and the large apsidal building at Ftelia perhaps hints at an early case of the disproportionate distribution of resources within the community.

Where Phoca-Cosmetatou's notion of 'transported landscapes' is arguably much more useful with regard to the Final Neolithic colonization of the northern Cyclades, not only in terms of the transportation of modes of subsistence, but also modes of distributing people and things throughout the archipelago. If — as seems likely considering Broodbank's modeling (2000:68-143) and the data which have emerged since that publication — the Kefala-phase settlement of the Cyclades has an ultimate origin in mainland Greece and was in some form the precursor of the Grotta-Pelos expansion, then the scale and distribution of these communities over the landscape will be relevant. This is not the place to discuss the fourth- and third-millennium 'infilling' of the Greek landscape, nor the concurrent social and climatic changes; these will be addressed during the analysis of patterns in the Cycladic Neolithic in Chapter Five. The very different experience of fourth- as opposed to fifth-millennium settlement in the Cyclades, however, perhaps suggests more wholesale transportation of social and cultural worlds into the islands, in the face of mounting pressures and novel catalysts, particularly demographic and climatic. It is in this process — the expansion of settlement throughout a small, liminal archipelago, after a period in which large, stable villages dominated — that it might be possible to discern the first potential parallel between the study areas; a move from an insular generalist optimum to an environment in which new niches were being exploited, but in which the cramped conditions of living may have been beginning to make themselves felt.

In this Chapter I have considered in detail the evidence for expanding systems of settlement and subsistence in the fifth to fourth millennia in the Cyclades. In particular, I have suggested that in subsistence patterns we see evidence for insular adaptation; whether or not this corresponds to certain types of ecological nice will be a subject for Chapter Six, as the development of increasingly intense settlement systems and networks of interaction will be for Chapter Five. Prior to that, in the subsequent chapter, I examine parallel and also divergent developments following the colonization by farmer-gardeners of another small, liminal, and fragile archipelago: the Leeward Islands.

Island	Site	Phase	References
Greater Paros	Saliagos	LN	Evans and Renfrew 1968
	Koukounaries	LN, ?FN	Schilardi 1990; 1991; Katsarou and Schilardi 2004; Katsarou-Tzeveleki and Schilardi 2008
Naxos	Grotta	LN, ?FN	Hadjianastasiou 1988a; 1988b
	Zas	LN – FN	Zachos 1996
Mykonos	Ftelia	LN, ?FN	Belmont and Renfrew 1964; Sampson 2002; 2008b; Phoca-Cosmetatou 2008
	Mavrispilia	LN, FN?	Belmont and Renfrew 1964; Sampson 2002
Thira	Akrotiri	LN	Sotirakopoulou 1990; 1986
Amorgos	Minoa	LN	Schilardi 1990; 1991; Sotirakopoulou 1990; 1986??
Kea	Kefala	FN	Coleman 1977; Whitelaw 1991
	Paoura[3]	??LN, FN	Coleman 1977; Torrence 1991; Whitelaw 1991
	Sykamia	FN	Coleman 1977; Torrence 1991; Whitelaw 1991
Andros	Strofilas	FN – ECI	Liritzis 2010; Televantou 2008
	Vriokastro	?FN[4]	Televantou 2008
	Mikroyiali	?FN	Televantou 2008
	Ayia Marina	?FN	Koutsoukou 1992; 1993
	Kastri	?FN	Koutsoukou 1992; 1993
	Rethi	?FN	Koutsoukou 1992; 1993
Melos	Agrilia	N	Cherry and Torrence 1982
	Kouphi	N	Cherry and Torrence 1982
	Cape Vani	N	Cherry and Torrence 1982
	Soleta	N	Cherry and Torrence 1982
	Phavas 1&2[5]	N	Cherry and Torrence 1982

Table 1. Sites included in this study, their location, date, and relevant publications.

Phase	Dates B.C.
Late Neolithic (Saliagos phase)	ca. 5,300 – 4,500
Final Neolithic (Kefala phase)	ca. 4,500 – 3,300
Early Cycladic I (late Kefala phase – Grotta-Pelos phase)	ca. 3,300 – 2,900

Table 2. The relative and absolute chronology of the Cycladic Neolithic. Data taken from: Barber 1987; Broodbank 2000; Liritzis 2010; Renfrew *et al.* 2012.

[3] Torrence (1991) considers that Paoura may have a Late Neolithic component based on detailed comparison of its assemblage with that from Kefala.
[4] These dates are queried as no detailed work on these sites other than Strofilas has been published.
[5] The sites at Phavas are here considered as one entity; Melos sites 28 and 33 are arbitrarily excluded due to their proximity to Agrilia and Kouphi. Please note that the sites on Melos were not differentiated into Late and Final Neolithic.

CHAPTER FOUR

THE HORTICULTURALIST COLONIZATION OF THE EASTERN CARIBBEAN: SETTLEMENT AND SUBSISTENCE IN THE EARLY CERAMIC OF THE LEEWARD ISLANDS

> I shall never forget that wade across the reef towards the heavenly palm island that grew larger as it came to meet us… Green cocoanuts hung under the palm-tufts, and some luxuriant bushes were thickly covered with snow-white blossoms, which smelt so sweet and seductive that I felt quite faint… The voyage was over. We were all alive.
>
> Thor Heyerdal, *The Kon-Tiki Expedition*, 1950

Heyerdal's experience of crossing from South America to the Tuamotus has probable points of similarity, but also of stark difference, with pre-contact modes of moving and living in Polynesia. In parallel, the archaeology of the Caribbean has points of connection, but also of pronounced difference, with Mediterranean archaeology. For a myriad of reasons relating to disciplinary development, polyglot research, and divergent research foci in separate branches of the academy concerned with Old and New World prehistory, Antillean and Aegean prehistory each have their own relative strengths and weaknesses. This poses a number of conceptual challenges for an integrative comparative archaeology. In addition, while both the Cyclades and the Leeward Islands function as heterogeneous and fragmented ecological spaces, they are also profoundly different in terms of biotic and abiotic context. In Chapter Two I argued that archipelagoes composed of relatively small islands probably encourage and permit different subsistence behaviors — and consequently social and settlement structures — in agropastoral and horticulturalist populations, and that this is in contrast to equivalent continental populations. Clearly, the geoecological properties of archipelagoes encourage and promote difference in this sense between archipelagoes also; the schist and gneiss-dominated typical Cycladic island with very low rainfall and corresponding prevalence of garrigue and macchia makes for very different subsistence options compared with thick tropical and semi-tropical forests of an andesitic Leeward Island, with its subtropical rainfall and thick clay soils. While the basic tenet for comparison — food-producing mainland-derived populations settling fragmented small-island archipelagoes — still holds, this difference has a number of consequences, not least that terms such as 'domesticate' and 'Neolithic mode of production' have varied connotations from study area to study area. The purpose of the first part of this chapter is to explore this difference. Subsequent to this, the long-term development of settlement and subsistence in the Leeward Islands archipelago will be considered in detail and within the adaptive framework outlined in Chapter Two.

4.1. Trajectories of Research in the pre-Columbian Caribbean

Antillean prehistory is a more recent discipline than Aegean prehistory, and its development within the academy has been such that it is barely recognizable as a cousin of its Old World relative, still less a sibling. Aegean prehistory was, until recently, concerned with ceramic styles and their continual refinement as chronological markers, within the context of large-scale excavations aimed at further defining the relationship between established stratigraphic sequences and ceramic typologies. Antillean prehistory, or at least its current Anglophone incarnation, matured largely within the American academy during the mid-twentieth century (e.g., Rouse 1977, 1985, 1986). This engendered a pronounced concern with ethnographic data, which were relatively rich for extant cultures understood to be related to the archaeologically observed ones of the Caribbean, and also for those data preserved at the point of European contact regarding the composition of 'Taíno' and 'Carib' society. The presence of Arawakan languages in the Antilles (e.g., Heckenberger 2002), in combination with interest in ethnographic research, resulted in a strong emphasis being placed on migration of peoples into the archipelago. Other factors have had a bearing on the types of archaeological data being produced in the Antilles. As in the Aegean, concern with ceramic types has been pronounced, yet the nature of prehistoric Amerindian Caribbean sites — with ephemeral architectural elements, mostly composed of taphonomically-fragile organics, and a general lack of deep stratification — has meant that the strong typological-stratigraphic-chronological relationships seen in the Aegean are largely non-existent. There is instead a heavy and useful reliance in the Caribbean on radiometric dating, some of which is perhaps not undertaken as rigorously as might be desired (Fitzpatrick 2004, 2006; but see Cooper 2010a and Rodríguez Ramos *et al.* 2010 for new efforts).

The Antilles in general and the study area in particular have, happily, witnessed a pronounced concern with the study of settlement patterns (Callaghan 2007; Cherry *et al.* 2012a; Cooper 2010a; Fitzpatrick *et al.* 2009; Goodwin 1978; Morse 1989; Rouse 1956; Watters 1984; Wilson 1989); this has largely not been the case in the Aegean. The relationship of these patterns to large-scale social structures has also been a subject of inquiry, again a debt to anthropological archaeology in the North American academy (e.g., Curet 2003; Keegan and Machlachlan 1989). As in the Aegean, however, these studies have tended to take islands, or subsets of individual islands, as their analytic universe. Consequently, understanding of the mechanisms governing archipelago-wide and diachronic settlement dynamics and ecological preferences remains somewhat conjectural, and no real pattern currently holds, excepting the rather crude observation that Ceramic Age (but not Archaic) settlement is mostly coastal. A possible exception to this is the argument that Early Ceramic settlements tend to occur specifically on the windward coast of each island (Wilson 2006:433-437; Bradford 2001; Haviser 1997). This generalization cannot be explained as an adaptive strategy, however, and nor does it in fact seem match well with newer data, taking more recent work into consideration (Boomert 2001; Callaghan 2007).

Partly because of the relevance of ethnographic data to the study of Antillean prehistory, a fundamental concern has historically been in identifying different units of population and their relative distribution throughout the archipelago. Importantly, discrete suites of material culture have traditionally been associated with these similarly discrete groups (Siegel 1991). Rouse, in a series of foundational publications (Rouse 1985, 1986, 1989), argued that it was possible to divide apparent spatio-temporal clusters of approximate similarity in Antillean prehistoric material culture into demic units. In this model, successive demic-cultural units replaced pre-existing populations in a constant process of colonization and replacement from surrounding mainlands. This gives rise to the traditional mode of framing the development of Antillean prehistory into the various series and sub-series identified by Rouse (1982); Casimiroid, Ortoirioid (Archaic), Saladoid, Ostionoid, Troumassoid, and Suazoid (Ceramic Age) (Keegan 1995). It also, somewhat teleologically, sets the stage for the distribution of peoples and cultures throughout the archipelago on the eve of contact, with Greater Antillean

Ostionoid equated with Taíno settlement and Lesser Antillean Suazoid with Carib (see Petersen *et al.* 2004).

With the incremental increase of data, however, such a system becomes unwieldy. The fundamental equation of a demographic group with a set of material-cultural traits means that the likely discovery of more traits, or their recombination, makes it necessary to devise ever-more nuanced means of labeling ethnic groups in the record. This has given rise to, for example, the distinction between Huecan Saladoid, usually associated with Zone Incised Crosshatch (ZIC) ware, and Cedrosan Saladoid, usually associated with White on Red (WOR) ware, polychrome, orange and black ware, and so on (e.g., Hofman and Hoogland 1999; Siegel 1989). Whilst no doubt heuristically useful, this distinction elides a series of possibilities about those communities that created these ceramics, not least by reifying them as static ethnic objects whose presence or absence can be determined by whether the material in question is present or not. It also implies a link between social or corporate identity and ceramic culture that is difficult to sustain. The co-occurrence of these wares (as at, for example, the site of Trants, on Montserrat, to be discussed shortly [Petersen 1995, 1996; Watters 1994]) raises serious problems of explanation for a proponent of the distinction. If this co-occurrence provides evidence of a multi-ethnic community, or the presence of more than one ramage, clan, or some other social unit, it remains to be seen why this pattern is not repeated elsewhere.

Moreover, the established narrative of successive replacements over time of populations by others (Rouse 1986), and the existence of commonly accepted dates for these processes, means that certain ceramic traits become unnecessarily fixed in the archaeological conception of time, leading inevitably to a creeping determinism and circular logic in which the trait indexes the period in which it was made, which in turn indexes the date of the trait. In fact, these ceramics do not always readily function well as hard-and-fast chronological markers, nor as reliable ethnic signifiers. White-painted red wares, for example, persist for perhaps as much as a millennium in the Leeward Islands, straddling substantial changes in social organization and subsistence behaviors. These highly distinctive wares are best as understood as dynamic objects in a lengthy tradition of potting, whose deployment in a spectrum of social contexts is representative of a multitude of cultural roles.

Caribbean prehistory nonetheless has a series of advantages over its Aegean counterpart when resolving issues of chronology. A recent series of publications have attempted to impose order on the Rousian system of typological-ethnic units, and by extension on the proliferation of ceramic types and their chronological relationships. Keegan (1995, 2000), followed by Wilson (2006, 2007), urges for simplicity in dealing with ceramic typologies and against refining their chronologies into ever-more defined structures, recognizing that the attempt to resolve ceramic typologies into anything more exact than a relative sequence in not heuristically useful. Keegan suggests that the subdivision of the later prehistory of the Antilles into Early (c. 500 BC – AD 500), and Late (AD 500 – contact) Ceramic periods captures the broad trends in both evolution of cultural suites and also major socio-cultural change in the Caribbean. Whilst this may seem crude in the face of Rouse's complex scheme, its junctures capture the main episodes of vital socio-cultural change in the islands and, when used in conjunction with the Rouse terminology to clarify particular stylistic points, is very effective.

A second, complementary means of imposing order on this mass of data is forwarded by Fitzpatrick (2006). The sheer number of radiometric dates available in the Caribbean (but only some parts of the Caribbean; Cooper 2010; Fitzpatrick 2006; Fitzpatrick and Giovas 2011; Rodriguez Ramos *et al.* 2010) presents a potentially enormously powerful data set for the analysis of issues of human dispersal at a chronological resolution unavailable in the Aegean. There is certainly a tendency in Caribbean prehistory to present these data inadequately, part of a wider reluctance to disseminate data to the widest possible extent (Fitzpatrick 2004). This notwithstanding, Fitzpatrick (2006) adopted the method of chronometric hygiene first attempted in the Pacific (Spriggs 1989) to help establish which data are the more reliable. In this process, radiometric dates are admitted into a corpus of "acceptable" dates only after passing certain criteria of acceptability. By dismissing dates which are under suspicion of being erroneous or under-evidenced (such as those with doubtful stratigraphic integrity, for example) Fitzpatrick was able to produce a clearer picture of the development of settlement in the Lesser Antilles.

This exercise reveals a significant disjuncture in the data. This will be discussed in some detail later, but the strategy indicates, as Keegan (1995) and Callaghan (2001, 2003) had both surmised, that earliest horticulturalist settlement was in the Leeward Islands and in Puerto Rico (Chanlatte Baik 1976; Chanlatte Baik and Narganes Storde 2005). The earliest acceptable dates of around the mid first millennium BC come from Puerto Rico, Montserrat, and St Martin, rather than the Windward Islands. This indicates that the supposed process of colonization by 'island hopping' northward from the Venezuelan coast (Rouse 1986, 1989) is in fact a less effective model of the colonization of the Lesser Antilles than that of a process or processes of targeted colonization directed at the northern end of the island arc. Because it now seems likely that, based on Fitzpatrick's (2006), Keegan's (1995, 2000), and Callaghan's (2001, 2003) argumentation, the Leeward sub-archipelago was the location of the first horticulturalist settlement of the Lesser Antilles, there is further reason for selecting it as the study area, alongside its parallels to the Cyclades noted in Chapter Two. The Fitzpatrick-Keegan model also suggested that 'Saladoid'/Early Ceramic material traits in particular polychrome and white-on-red ceramics, whilst distributed throughout the archipelago, are not necessarily contemporaneous. For example, WOR-utilizing communities were established on Montserrat hundreds of years prior to their appearance in the Grenadines (Fitzpatrick and Giovas 2011). The style seems, then, to have persisted in various iterations for a millennium (Bérard 2003) or perhaps longer. This should further suggest caution when trying to assign extremely precise dates on the basis of ceramic attributes alone.

This suggests that any attempted periodization of the horticulturalist occupation of the Lesser Antilles between colonization and contact is somewhat fraught. It seems unnecessarily cumbersome to construct a new framework, yet both the Rousian scheme and Keegan's division into Early and Late Ceramic are not quite satisfactory. The former is too overworked, not appropriately absolute, and burdened with ethnic and demographic assumptions that are largely unsustainable; the second is too broad to explore diachronic change between colonization and the mid-late first millennium AD.

A middle ground between these two methods, using them selectively and in conjunction, presents a fairly clear picture of the development of settlement in the Leeward Islands. The diachronic history of agropastoral settlement in the region can, I suggest, be divided into three main phases which are in themselves heuristic structures for exploring and defining social change, not reified blocs of isomorphic behaviors and material cultures. Early Ceramic I (500 BC – AD 1) captures the phase of initial intensive agropastoral occupation of the islands, with the appearance of Huecan and Cedrosan Saladoid-using communities in the north of the Lesser Antilles and Puerto Rico. Early Ceramic II (AD 1 – AD 500 witnesses the florescence of Saladoid-type settlements and ceramic styles throughout the archipelago, yet is prior to the series of profound changes in settlement distribution and material culture that occurs in the second half of the first millennium AD. This is succeeded by the Late Ceramic/'post-Saladoid' (AD 550/650 – contact) period, during which the Ostionoid expansion and development of complex polities in the Greater Antilles seem to have occurred. This has the added advantage of fitting well with the Antiguan sequence — Indian Creek Phase, Mill Reef Phase, and Marmora Bay Phase — with the Early Ceramic II corresponding closely with the Indian Creek and Mill Reef phases (Rouse and Morse 1999). It also mirrors closely the distinctions in the Early Ceramic period proposed by Haviser (1997:60).

This is, inevitably, a less than perfect distinction, and has a series of caveats. First, some sites obviously persist for long periods of time. Trants on Montserrat is a prime example, apparently occupied for over five hundred years; Antiguan Indian Creek (Rouse and Morse 1999) another. Second, the latter part of the Late Ceramic period is not as well known. Traditionally associated in the older ethnographic literature with the occupation of the Lesser Antilles by non-Arawak Caribs, the final Late Ceramic in the Leewards is problematic, with very few well-understood sites and potential depopulation. The scheme presented here, however, has the advantage of necessarily simplifying complex data, and this will help facilitate explanation. The proposed tripartite division captures quite well the apparent disjunctions between initial settlement, the appearance of large Saladoid sites across the region, and the profound change in settlement patterns seen between c. 600-800 AD and the accompanying developments in material culture.

The number of extant sites in the Leewards for which solid dates of occupation exist changes quite considerably depending on whether a skeptical or a credible position is adopted with regard to diverse reports and published radiocarbon dates (Fitzpatrick 2006:408). This is problematic; there are almost certainly more Early Ceramic I sites, for example, than allowed by the chronometric hygiene method, yet it is equally the case that a first millennium BC date should not be assigned simply because of the presence of WOR or polychrome vessels. Considering the history of sporadic publication in the Leeward Islands (Fitzpatrick 2004) and the problems Fitzpatrick outlines in much of the presented chronometric data, I am inclined to adopt a minimalist position — for the purposes of the ensuing analysis, only sites which have produced viable and generally accepted dates will be considered. This, in all probability, excludes a number of sites which certainly fall within the range 500 BC – AD 1, and certainly very many which fall within the range AD 1 – AD 500. As noted previously, however, the longevity of ceramic traditions in the Lesser Antilles suggests that relying on pottery typologies alone is extremely risky. Moreover, in exercising this sort of rigor, the emergence of any pattern will then indicate which of these excluded sites fits within the pattern, thereby reinforcing their credibility. If no such pattern emerges, then the question is rather moot. For the purposes of this dissertation, the criteria laid down by Spriggs (1989) and adopted with such effectiveness by Fitzpatrick (2006) are adopted.

4.2. Archaic Populations in the Caribbean Islands and their Subsistence Behaviors

The communities which produced the distinctive Antillean ceramic traditions were not the first inhabitants of the Caribbean islands. Before moving on to deal with the horticulturalist sites in question, it is important, as in the case for the Mesolithic settlement of the Aegean, to consider the prior established presence of hunter-gatherer populations.

The presence of aceramic, Archaic period (c.4,000-500 BC; 'preceramic' in some older literature) populations in the Greater Antilles is unequivocal (Keegan 1994; Wilson *et al*. 1998). Evidence for their existence in the Leeward islands is similarly plentiful, if unevenly distributed. Davis (1982, 1993, 2000) has demonstrated the extent to which Archaic age sites cover the Antiguan landscape, the most important of the total of 43 sites being that at Jolly Beach (as ever, it is difficult to know how to distinguish sites of settlement and dwelling from sites which represent a single instance of production when the surface remains are not investigated further; Antigua is more than a little reminiscent of Melos in this regard). These groups were exploiting the high quality chert sources of the island, producing a suite of chipped-stone tools that is highly distinctive. In particular, macro-blades and blade cores are particularly evident, alongside ovates and scrapers (Davis 2000). The middens from which this material was recovered yielded a series of radiocarbon dates which indicate that Jolly Beach was in use in the late third and second millennia BC (Davis 2000:97). Subsistence practices seem to have clustered around hunter-gatherer exploitation of local terrestrial and marine resources although, as Davis comments, the question of Archaic horticulturalist practices is by no means clear (Davis 2000:100-101; Newsom and Wing 2004:114-171).

While evidence across the remainder of the archipelago is considerably more sparse, it is probable that aceramic populations were present on St. Kitts and Nevis, as indicated by the site at Hichmans Shell Heap, Nisbetts, and the Seventeenth Hole site (Wilson 2006:33-40). Both Hichmans Shell Heap and Nisbetts produced evidence for the exploitation of marine fauna, as well as chipped stone tools which, under macroscopic analysis, seemed to derive from an Antiguan source. Hichmans Shell Heap yielded a radiocarbon date of the mid first millennium BC, certainly acceptable as an Archaic date, but interestingly close to the appearance of the first Early Ceramic I communities in the region (Wilson 2006:33). The Seventeenth Hole site was destroyed during the development of the Four Seasons resort on Nevis; if credible, it may hint at the presence of a 'Casimiroid' (i.e., Greater Antillean-derived) Archaic population on the island. Considering the very poor state of the evidence, however, this conclusion seems intolerably speculative.

Further evidence for Archaic occupation of the Leeward Islands comes from St. Martin (Nokkert *et al.* 1995) and Saba (Hofman and Hoogland 2003), providing radiometric dates within the second millennium BC. Both these sites are aceramic, and subsistence appears to have been wholly reliant on hunter-gatherer exploitation of native terrestrial and marine resources — although, again, the distinction between pre-horticultural and horticultural subsistence regimes may not be so pronounced in Neotropical as opposed to Old World environments. It is notable that at both of these sites, the chipped stone assemblages contrast strongly with that from the site at Jolly Beach; despite the use of Antiguan chert, the primary industry seems to be one focused on the production of expedient flakes at under c. 50 mm in length (Hofman and Hoogland 2003:18). This is in stark contrast to new evidence on Montserrat, where recent research has indicated the probable presence of an Archaic population on this island as well. Pedestrian survey at the site at Upper Blakes has revealed a concentration of surface artifacts which, morphologically, are extremely similar to the Jolly Beach assemblage, and markedly dissimilar from the lithics industries of Ceramic-age Montserrat (Cherry *et al.* 2012b). Macro-blades up to c. 160 mm, backed blades, blade-flakes, and one blade-core suggest a close relationship with the lithic industry witnessed at

Jolly Beach. Morphometric analysis is ongoing and should hopefully reveal a typological relationship with the well-published lithic industry of Jolly Beach. Despite a lack of radiometric dates for this site, the chipped-stone industry and total lack of prehistoric ceramics points strongly to an Archaic date of occupation.

The genetic or cultural relationship — or lack of one — between the people who lived in the Lesser Antilles during the Archaic period and those who established large, food-growing villages on the island during the second half of the first millennium BC is a problematic research question, and one which has been overlooked to a considerable degree. The dominance of migrationist theories in Antillean prehistory during the last century makes it extremely difficult to explore the relationship between aceramic and ceramic populations, and indeed between possibly heterogeneous aceramic populations; when the dominant mode of explanation is replacement, the study of similarity is usually foreclosed upon. There is reason to suppose, for example, that the aceramic population of the Caribbean islands derived from two separate episodes or processes of colonization. The first, Casimiroid or "Lithic", appears to have originated in Central America and moved into the Greater Antilles c. 4,000 BC, while another — Ortoiroid or "Archaic" — appears to have derived from somewhere along the northern South American littoral (perhaps the Orinoco River basin) and moved into the Lesser Antilles c. 2,000 BC (e.g., Rouse 1992; Wilson 2006:2-3). Typologically, the material from the northern Leewards has similarities to both the Greater Antillean assemblages and also those from South America. Diversity between Archaic sites in the northern Leewards further complicates the picture, with the site at Plum Piece, despite possessing a solidly Archaic date, exhibiting very little of the typical Antiguan (and perhaps now Montserratian) macro-blade assemblage. The insistence of a previous generation of demarcating this complex set of sites and materials into distinct instances of migration by discrete groups perhaps fails to deal appropriately with the diversity produced by cultural and genetic flow. The aceramic cultures of the Leewards should best be understood as outcomes of complex interactions between and within these episodes.

The relationship between Archaic and Early Ceramic communities is made even murkier by evidence for the exploitation of plant species by Archaic communities. Recent research in the Greater Antilles suggest that some Archaic period populations were exploiting species which would later become vegetable staples during the Ceramic period. These include manioc (*Manihot esculenta*), sweet potato (*Ipomoea batatas*), marunguey (*Zamia* sp.), and other tuberous forest species (Newsom and Wing 2004; Pagán Jiménez 2011). The evidence of the exploitation of maize (*Zea mays*) is equivocal. Domesticated maize cannot self-propagate, and in this sense, the use of *Zea* in its cultigen form points to horticultural practices. The exact implications of this are outlined below.

These data, the question of maize agriculture notwithstanding, seem to undermine the standard model of the development of subsistence practices in the Caribbean islands, with hunter-gatherer communities being replaced by populations utilizing the type of tropical horticulturalist practices witnessed on the South American mainland. Importantly, for this study, it may indicate that the horticulturalist/Neolithic mode of production was present in the Caribbean islands prior to the development of the Early Ceramic I villages. This has implications for the spatial and temporal limits of this dissertation, and needs addressing. To unravel this requires establishing the degree of difference along multiple axes between agropastoral modes of subsistence in the Neotropics and the Old World.

Whilst the development of food-producing subsistence regimes is globally a wholly Holocene phenomenon, trying to account for this emergence in a mono-causal fashion is likely to be unproductive (Zeder and Smith 2009). It is certainly the case that the adoption of food-producing strategies resulted in parallel, cross-cultural developments; indeed, the Neolithic Demographic Transition (Bellwood and Oxenham 2008; Bocquet-Appel 2002, 2008, 2009; Bocquet-Appel *et al*. 2012) is considered as an explanatory mechanism for social change in Chapter Seven. That said, generalizing about the nature and trajectory of the transition to agriculture unhelpfully elides differences that may, in turn, explain divergent patterns. In the Mediterraneanoid geoecological context in which the Cycladic Neolithic communities flourished (and in which Old World agropastoralism first emerged in the PPN), there are relatively few wild plant species which provide viable large-scale sources of calories. During the process of domesticating cereals which formed the core of Neolithic subsistence practices — in symbiosis with the exploitation of faunal calorific sources — intensive cultivation of these cereals in optimal niches was the norm. As the domesticated versions of these cereals cannot self-propagate, labor-intensive cultivation of organized field systems and associated iterative behaviors (White and Wolff 2012) is the most effective strategy of maximizing the nutritional return of these species. Consequently, we can draw clear distinctions between agropastoral and pre-agropastoral exploitation of these cereals; their presence and consumption implies the existence of subsistence practices related to their cultivation. We might describe these societies as agropastoralists by obligation. The transition to food-producing lifeways was rapid and irreversible, with profound socially-transformative effects (Belfer-Cohen and Goring-Morris 2009; Kuijt 2009; Zeder and Smith 2009).

This is not necessarily the case in Neotropical environments (Iriarte 2009). In the Central and South American forests, potentially useful food species — particularly tuberous, starchy plants — were ubiquitous, alongside a suite of other floral and faunal resources that have been eradicated by human predation and overexploitation, and the ecological cataclysm represented by European contact. In this context, the use of what later become components of the group of vegetable staples by Archaic communities certainly implies exploitation. It is certainly not clear, however, that this exploitation represents domestication, in the sense of the deliberate introduction, cultivation, propagation, and harvesting over the long-term of novel species. Pearsall's (2009:609) comment — "*Presence* of a domesticate is not the same as *dependence* on it (i.e., agriculture)" (author's italics) — is poignant. There is, as yet, little palaeoethnobotanical evidence to suggest such intensive interest in the cultivation of these species. Rather, the adoption of food-producing lifeways in the Neotropics can generally, if crudely, be characterized as gradual, an organic development from hunter-gatherer modes of living in vegetable rich environments.

The relative paucity of evidence for maize being included in the range of species being utilized by Greater Antillean Archaic communities is interesting in this regard. *Zea mays* seems to have been domesticated in Mesoamerica during the Archaic from the wild grass *teosinte* (Doebley 2004; Pohl *et al.* 2007; Pope *et al.* 2001). Its fully domesticated form cannot self-propagate, and requires human cultivation to reproduce, frequently via swidden based intensive forest horticulture. Pagán Jiménez and colleagues have identified starch grains, apparently from *Zea*, on 32 grinding and pulverizing stone tools from two Archaic period sites on Puerto Rico (Pagán Jiménez *et al.* 2005; Pagán Jiménez 2009). This is remarkable, and certainly may suggest that use of maize may predate the appearance of Early

Ceramic I communities in the islands. The presence of starch grains on a handful of stone tools is hardly conclusive, however. The number of tools implicated, at only two sites (Maruca and Puerto Ferro) hardly suggests reliance — it is impossible to extrapolate across the entire archipelago from such a narrow base. Further palaeoethnobotanical work is needed to clarify the extent to which *Zea mays*, in its fully domesticated type, formed part of the subsistence base of Archaic societies. In particular, presence of phytoliths or macrobotanical remains would strengthen the case, and these are as yet lacking. The absence of evidence for *Zea* in human dental calculus prior to c. 350 BC (Mickleburgh and Pagán Jiménez 2012) perhaps lends further weight to the conclusion that even if *Zea* were present in the Lesser Antilles prior to the first millennium BC, its calorific impact was minimal. Until further research is completed, the majority of the evidence indicates that maize either appeared in the Caribbean, or only became a central element of the Caribbean subsistence package, in the terminal first millennium. Its arrival in Caribbean contexts contemporaneously with Early Ceramic I settlements is suggestive; the most parsimonious conclusion is that it was introduced to the archipelago as a main component of a wider suite of cultigens, along with an agropastoral package that also included animals such as the agouti, opossum, peccary, guinea pig, dog, hutia, and rice rats (Giovas *et al.* 2011).

This lengthy discussion is necessary when trying to clarify the extent to which Archaic communities in the Greater Antilles — there is as yet no evidence from the eastern Caribbean — were horticulturalists. Unlike in the Eastern Mediterranean, the distinction between hunter-gatherer and food-producing modes of subsistence is not stark; rather, various types of calorific regimes exist along a spectrum. I would follow Pearsall (2009:608) and Newsom and Wing (2004:31) in characterizing this as exploitation of species engaged in a lengthy process of domestication, but nowhere near as intensive a process as the large-scale exploitation of whole suites of domesticates in the Ceramic Age. Palaeoethnobotanical, zooarchaeological, and settlement evidence suggests that Early and Late Ceramic Age communities were exploiting their landscapes much more intensively, and with much more extensive landscape modification, than were their Archaic predecessors. For that reason, subsistence in the Ceramic Age is defined here as much closer to a 'full' food-producing mode of subsistence, supplemented by exploitation of wild resources, in contrast to a prevailing mixed regime during the Archaic. This, as will be discussed in Chapters Six and Seven, can be seen to have had a bearing on settlement dynamics, and by extension, demographic dynamics, in the archipelago.

So much for whether Archaic communities in the Greater Antilles were horticulturalists. A further central question is whether their Lesser Antillean neighbors were genetically or culturally implicated in the first flourishing of large villages in the region in the second half of the first millennium. The confusing and incomplete mosaic of Archaic settlement in the Lesser Antilles is the context for the appearance of the first fully horticulturalist communities in the region, and complicates our understanding of the reasons behind this appearance. The emergence of villages making pottery and exploiting domesticates was interpreted by Rouse simply as the migration into the region of new populations from the mainland and their subsequent replacement of extant Archaic communities. This conclusion is now problematic. The co-occurrence in the Leeward Islands, with relative scarcity in the Windward Islands of both late Archaic and early ceramic material, might be taken to be suggestive. Added to this, little radiometric work has been undertaken on the Venezuelan type sites that are crucial for our understanding of the temporal and spatial extent of the Saladoid style of the Early

Ceramic period (e.g., Sanoja and Vargas 1983). Even taking a very limited view of these new data, it seems that this area of the greater archipelago was attractive to peoples employing different subsistence strategies; with a more credible stance, the co-occurrence may even suggest a demographic relationship between Archaic Leeward islanders and the first horticulturalist villages. It may yet be that we have fundamentally misunderstood the dynamics of the 'Neolithicization' of the Caribbean.

There are, however, reasons to hope that we have a clearer grasp of the processes at work than might seem the case. Oddly, some comfort can be derived from the apparent presence of pottery-making communities in the Greater Antilles (Rodríguez Ramos *et al.* 2008). As with the use of domesticates, it was previously assumed the Caribbean Archaic was aceramic. Rodríguez Ramos and colleagues argue that material previously erroneously categorized as Ostionoid should, in fact, be assigned an Archaic date. This pottery is so vastly different from that seen at the first Early Ceramic I settlements — which is in turn so conspicuously similar to the Saladero material — that there is no reason for supposing any cultural relation. In general, the whole material-cultural traditions and implied behaviors of the large village sites at La Hueca, the Hope Estate, and Trants seem so fundamentally different to those at, for example, the Hichmans Shell Heap or Jolly Beach (e.g., Wilson 2006:103-186), that any attempt to point to a direct linear cultural relationship will require intolerable intellectual gymnastics. The appearance of new colonists from the South American mainland is still the most efficient explanation of these strikingly novel forms of living, potting, and eating, with the caveat that new data will inevitably nuance this interpretation. Accordingly, as it cannot yet without dissent be conclusively demonstrated that the (mostly) aceramic communities of

Hispaniola, Puerto Rico, and the Leeward Islands were exploiting domesticated and imported species, this study will limit itself to an analysis of the distribution of Ceramic Age sites only.

Even if the broad picture of a series of colonization episodes originating from the Orinoco basin is correct, at the very least, these first early ceramic voyagers were not paddling in empty waters. As in the Aegean, eventual settlement of these islands only makes sense in the context of a process of gradual knowledge-acquisition ('landscape learning' — Rockman 2003), and probable engagement and cultural and genetic exchange with antecedent Archaic populations. As Curet has articulately expressed (2005), the processes whereby groups of people with ceramic and horticulturalist technologies came to live in the Leewards in the latter half of the first millennium BC were inherently complex and defy single explanations. This becomes significant when trying to account for patterning in the distribution of these communities; the lived spaces in which they appeared were not vacuums.

4.3. Settlement and Subsistence in the Early Ceramic I (500 BC – AD 1)

This study focuses on the Leeward Islands of the Lesser Antilles. In doing so, it deliberately ignores an important site, the excavation of which has greatly illuminated — whilst simultaneously made more complex — our understanding of the settlement of the region between Puerto Rico and Martinique in the first millennium BC. Before embarking on a description of the sites to be included in this study, then, it is important to discuss the impact of the significant research undertaken on the island of Vieques. Outside of the study area, the cultural sequence of Vieques has implications for our understanding of the development of food-producing societies in the Leeward Islands. Vieques itself lies off the eastern coast of Puerto Rico, between the larger island and the British Virgin Islands. The site at La Hueca was excavated by Luis Chanlatte Baik and his colleagues (Chanlatte Baik 1976; Chanlatte Baik and Narganes Storde 2005). As a large settlement site, it is important for a number of reasons, not least since it seems to represent a mid-1st millennium BC colonization — probably from mainland South America — of an island previously solely occupied by Archaic groups. The material culture derived from La Hueca is diverse, with a distinct lapidary industry utilizing zoomorphic and anthropozoomorphic imagery.

It is the highly distinctive ceramic types at La Hueca, however, which make the site so fascinating. ZIC ware — zone-incised crosshatch — predominates, to the exclusion of more recognizable 'Saladoid' morphologies familiar from the Ceramic age Lesser Antilles. This ware, represented by a variety of vessel types and shapes, is typically thin walled in a brown-buff fabric (figure 4.3 and 4.4). The surface treatment consists of the demarcation of zones via scouring, and then the in-filling of these zones with lightly-scoured crosshatches. Plastic decoration in the form of adornos is common (e.g., figure 4.3), although these tend not to be as elaborate as the adornos and plastic molding associated with Early Ceramic I and II WOR and polychrome wares.

The predominance of ZIC is remarkable, all the more so because La Hueca has produced no WOR ware, which is otherwise ubiquitous in the Early Ceramic of the Lesser Antilles. It is largely for this reason that La Hueca was considered to represent the appearance of a different ethnic group in the islands, distinct from colonists whose origin is represented in the Barrancoid and Saladero groups. This led Rouse to draw a distinction between the Huecoid/Huecan Saladoid subseries and the Cedrosan Saladoid subseries. Whatever the ethnic composition and origin of the site at La Hueca, it was certainly known to other early settlements in the Leewards; both Hope Estate and Montserrat exhibited ZIC (Haviser 1991; Petersen and Watters 1995), and it appears later at Indian Creek on Antigua and Hichmans on Nevis (Rouse 1974; Rouse and Faber 1999; Wilson 2006). It is entirely unclear what conclusions should be drawn from the relationship between La Hueca, ZIC, and the Leewards, but the possibilities are intriguing. Either vessels themselves were being transferred between sites, or the potting tradition was not static. Fabric analysis of materials from the Early Ceramic I and II communities in the Leewards has not yet determined an off-island origin for them; it may be the case that potters were moving between communities or, if the creation of these elaborate vessels was predominantly the preserve of one gender, there may be evidence for exogamous behaviors. Whatever the explanation for the spread of this tradition, the strong association between the first appearance of ZIC in the region and Vieques means that Lu Hueca and its material culture looms large in any discussion of the Early Ceramic I.

The site at Trants, on the eastern coast of Montserrat, was excavated by David Watters and Jim Petersen in the 1990s, continuing on from Watters' doctoral research on Montserrat and Barbuda (Watters 1980). It is situated on relatively well drained yet still clay based soil, on the most extensive piece of flat ground on the windward coast (Petersen 1999). It was presumably situated on the coast during its occupation; subsequent volcanic activity has both prograded the coast in this part of the island and destroyed the site. Extensive excavation and intensive pedestrian survey revealed a sizeable settlement (Petersen 1996; Watters 1994) although, as elsewhere in the Leeward Islands, no structures or solely domestic contexts were excavated. Rather, an extensive ring-shaped surface scatter demarcated a central zone devoid of surface material culture. Test pitting suggested that this oval feature was the plowzone signature of a series of laterally extensive middens, a pattern seen elsewhere in Early Ceramic sites (e.g., Antiguan Indian Creek; Rouse 1974). The assumption was that domestic structures would have been adjacent to this.

The site was particularly notable for producing both WOR and ZIC ware, apparently from the same stratigraphic units (figures 4.2 and 4.3; Petersen 1995); indeed, the relationship between the artificially demarcated stratigraphic units is not clear (e.g., Reitz 1994:299; Petersen and Watters 1991), although the ZIC appears to have been derived from the basal levels of the midden(s) (Petersen and Watters 1991:292). These same strata provided radiocarbon dates that placed this material firmly within Early Ceramic I, with Beta-44828 at 2340±80 (= 480 B.C.), confirming that the ZIC from Trants is contemporaneous with that from La Hueca, if not earlier. The excavators note that the populations utilizing both ZIC and WOR were probably coextensive; this has important implications for how we interpret the role of these elaborate and esoteric ceramic styles in Early Ceramic I communities, and for our understanding of the relationships between the Leewards and Puerto Rico. The lapidary industries at both Trants and La Hueca also betray strong parallels, particularly as regards zoomorphic imagery.

The lack of deep stratigraphy at Trants and the selective nature of the excavation makes any assessment of the zooarchaeological and palaeoethnobotanical remains somewhat impressionistic. Reitz (1994) manages, however, to identify several important features of the faunal assemblage which provide sorely-needed insights into Early Ceramic I subsistence strategies in the region (see also Newsom and Wing 2004:75-114). Happily, sieving is standard practice in Caribbean excavation in contrast to the Aegean, and varying sieving strategies employed at Trants indicate just how extensive and inclusive subsistence practices were in Early Ceramic I Montserrat. Mammals targeted as prey species included native Neotropic rodents, rice rats (*Oryzomys* sp.), probably hutias (subfamily Capromyinae), and the agouti (*Dasyprocta aguti*) (Reitz 1994:306); it is unclear whether domestic dog (*Canis familiaris*) was targeted as a source of calories, but an MNI of four, all disarticulated, suggesting that this may have been the case (Reitz 1994:314). These species formed only part of a wider spectrum of vertebrate predation, including an array of reptiles, both marine and terrestrial, and birds, the majority of these passiformes (see Giovas *et al.* 2011). Fish, as might be expected, predominated, both in terms of MNI and NISP. This probably reflects an actual pattern in subsistence regimes present at Trants, as it is reasonable to expect that marine animals contributed the majority of the faunal protein in Early Ceramic diets. The vast majority of taxa identified are reef-dwellers (Newsom and Wing 2004:95), and the implications of this will be considered in Chapter Six.

The faunal remains from Trants indicate a varied subsistence regime that effectively exploited a range of ecological niches. The range of species involved, and the willingness to take even very small and calorie-poor prey (e.g., snakes [Reitz 1994:306])[6], imply a concern with extracting the maximum possible return from the environment. This recalls the turn to subsistence generalism associated with the colonization of islands — as argued in Chapter Two and also seen in the Cyclades — which itself indexes the relative resource poverty of insular environments. That said, it is clear that the Early Ceramic I colonists on Montserrat did not passively reflect their surroundings in their subsistence decisions. The transport of non-local fauna — mostly species of rodent, but also domestic dog — provides evidence of a

[6] The presence of parrots (*Amazona* sp.) (Newsom and Wing 1995) might be explained by hunting for its plumage, rather than as a viable source of nutrition.

willingness to transform the productivity of the island via the introduction of familiar mainland food animals, even if not domesticates in the Old World sense. There is no evidence for the consumption of maize at Trants, but the appearance of *Zea* in the islands in the late first millennium and in islands to the north and south of Montserrat (Mickleburgh and Pagán Jiménez 2012) is suggestive. In Chapter Six the viability of the location of Trants as an optimal horticultural environment is explored, but already the pedology (Trants avoids the thick smectoid clays associated with older volcanics which cover much of the north of Montserrat) and the slope of the site perhaps indicate a concern with garden subsistence. Palaeoenvironmental reconstruction has not been undertaken, but species such as *Zea* would thrive better in low-lying wetland areas than on Montserrat's steep hillsides (e.g., Pope *et al*. 2001). A final intriguing clue in this respect is the preference of some species of rice rat for cleared or brushy environments (Reid 2009:207) — we may be witnessing predation by humans upon vermin in the maize and manioc gardens, or perhaps simply vermin expiring in middens.

It seems to be the case that Trants was not the only locus of Early Ceramic I on Montserrat, an island that appears to consistently punch above its weight in its contribution to Caribbean archaeology. Watters (1980, 1994) also identified WOR material during his test excavations at Radio Antilles, and reported the observation of the same from the mouth of the Belham Valley on the leeward coast. There also appears to be a surface scatter of both WOR and ZIC in the north of the island, at the Glendon Hospital site (Cherry *et al*. 2012a). Only one of these finds has been confirmed by radiometric dating (Radio Antilles at 760-380 BC [Fitzpatrick 2006: table 2]), although the presence of ZIC sherds — albeit fragmentary and badly degraded — at the Glendon Hospital site is very suggestive of an early date. The lack of solid chronometric support for an Early Ceramic I date for the Glendon Hospital site, and the unclear nature of the relationship between Radio Antilles and Trants, means that during the spatial analysis in Chapter Five, models are run which do not take these sites into consideration. It seems likely that these circumscribed entities — only one of which being confirmed by sub-surface prospection — represent satellites to the main site. As is argued in that chapter, there is reason to suppose that these sites in fact represent a strategy to deal with demographic expansion, associated with a new, fully horticultural mode of production in an archipelago with limited opportunity for settlement.

The strictures of chronometric hygiene mean that the only other site with a conclusively absolute date to match Trants is the Hope Estate site on St. Martin (Fitzpatrick 2006:398; Haviser 1988, 1991, 1997). This was noted by Haviser in his pedestrian survey of the island (Haviser 1988) and was subsequently excavated with a series of test pits (Haviser 1991). The site itself lies in the north of the low (mostly) limestone island, and is technically inland, being 1.0 km from the coast, although it is unclear how useful the distinction between coastal and interior is in such small islands as the Leewards. As is common in the Caribbean, excavated deposits seem to have been entirely middens — no structures were encountered, and the midden deposits themselves were shallow and laterally extensive (Haviser 1991:648-649). The ceramic evidence paralleled, to a certain extent, that from Trants. Polychrome-decorated, WOR, and ZIC sherds and adornos were recovered from across the site, although the limited extent of the excavation units inhibits the detection of any clear distribution patterns. Haviser detects a tendency for ZIC to occur more frequently in the lower strata of the site; 75 per cent of the ZIC sherds were from the lowest deposit, although as this ware comprised only 6.5 per cent of the total assemblage it is unclear how significant this distribution is (Haviser 1991:651). What is of note is the presence of ZIC sherds with red paint applied, and WOR with incised decoration; not in itself unusual, but in this case reminiscent of ZIC (Haviser 1991: figures 6 and 7).

The interpretation of this ceramic suite is difficult, yet the radiometric dates obtained from stratum III perhaps help to clarify the situation. The dates from stratum III — the lowest, containing the majority of the ZIC ware — cluster in the second half of the first millennium BC (PITT0450 = 2510±40; PITT-0449 = 2300±55). Yet the dates from the immediately subsequent layer, rich in WOR, black-on-red, and polychrome, follow hard on the heels of stratum III dates, within the margin of error (PITT-0219 = 2275±60; PITT-0220 = 2250±45) (Haviser 1997 table 7.1). Haviser (1991) would prefer to interpret this sequence as indicative of a 'Saladoid' community arriving on St. Martin and interacting with an extant ZIC using community. I have suggested in this chapter that the tendency in Caribbean archaeology to equate pottery styles with distinct ethnic groups is not necessarily helpful in understanding the dynamic relationships between past actors, and tacitly assumes that ceramic traditions are in some sense emblematic of large-scale identities. Haviser's interpretation at least, however, deals in terms of interactions between various groups with vested interest in the social activity at the Hope Estate site. As will become clear in Chapter Five, this seems to be the most productive stance to adopt in attempting to reconstruct inter-community relationships in the Leewards in the Early Ceramic I.

The faunal and floral remains from Hope Estate are noteworthy (Haviser 1991:649-650; Newsom and Wing 2004:104-105) for their terrestrial nature, with exploitation of rice rats (*Oryzomys* sp.) and terrestrial arthropods evident. There is the slight suggestion that reef carnivores (Newsom and Wing 2004:105) and pelagic carnivores, such as the Scombridae, were targeted during the Early Ceramic I; the later, Early Ceramic II strata at Hope Estate include previously underexploited herbivorous taxa such as Scaridae and Lambridae species. In general, though, the strong impression from a sample of a limited population is that the strategies in food-acquisition paralleled those employed at Trants. The presence of large, terrestrial invertebrates need not suggest reliance on undesirable species, with land crabs and snails slow moving yet rich in protein. The exploitation of pelagic species, including tunas and mackerels, indicates fishing in open water at considerable distances from the shore, combined with selective predation on certain reef species. Essentially, Early Ceramic I inhabitants were able to successively navigate the shoals of island living via selective exploitation of a variety of ecological niches, supplemented with the introduction of domesticated plants — including, in all probability, maize — and prey-animals.

It is only on Montserrat and St. Martin that there is conclusive evidence for Early Ceramic I occupation, although it may well be the case that initial settlement of Antigua and Nevis occurred prior to the earliest available radiocarbon dates. Saba, Eustatius, Anguilla, and Barbuda witness first horticulturalist settlement in Early Ceramic II, as is discussed below (Corre-Corre on Eustatius cannot be interpreted as possessing an Early Ceramic I pedigree due to the sole date's failing to meet the criteria of chronometric cleansing). St. Kitts complicates this distribution. In any instance, the lack of tolerable chronometric dates from any sites on the island would exclude it from consideration of the Early Ceramic I distribution. Goodwin's dissertation (1979) provides an excellent contextual discussion of the surface concentrations observed, but not about the cultural relationships of those entities to established frameworks of reference in the remainder of the archipelago. The discussion of the ceramics recovered during the survey (Goodwin 1979:269-320) suggest definite Early

Ceramic II settlement on St. Kitts, and probably Early Ceramic I, considering the presence of ZIC material at the Sugar Factory Pier site (Goodwin 1979:286-290) and perhaps elsewhere. In the absence of any radiometric dates, though, it is not possible to include St. Kitts in the discussion of the Early Ceramic I. In the spatial analysis undertaken in Chapter Five, a randomly generated point on St. Kitts is included in some runs, to assess the likelihood of a site on St. Kitts conforming to overall patterns.

These, then, are the major Early Ceramic I sites to be included in the initial analysis. Both these large sites — although perhaps not the smaller Montserratian settlements — seem to persist into the Early Ceramic II, AD 1 to AD 500 (Haviser 1991; Petersen 1995; Petersen and Watters 1994). Because of this they are included in the Early Ceramic II analyses in Chapters Five and Six, but are not discussed in the subsequent section on the expansion of 'Saladoid' material culture throughout the Leeward archipelago in the second half of the first millennium AD.

4.4. Settlement and Subsistence in the Early Ceramic II (AD 1 – AD 500)

I argued earlier that there is a real and valid distinction to be made in distinguishing the Early Ceramic I and II. Not the least reason for this is the florescence of settlement witnessed during this period, both in the Leewards and now in the Windwards. The Windward Islands lie outside of this discussion, but it should be borne in mind that the appearance of large settlements utilizing 'classic' Cedrosan Saladoid ceramics — WOR, black-on-red, orange-on-red, and polychrome — on Antigua, Nevis, and elsewhere is mirrored in the large volcanic islands to the south. The scale of the expansion within the Leewards themselves is considerable. There is an increase from two to at least eight sites, even utilizing the minimalist approach encouraged by undertaking to be chronometrically hygienic; the actual number is very probably several times this. The profound socio-cultural changes that this rash of settlement indexes are addressed in Chapter Five, as is the probability that this expansion reflects the same processes in both the Leeward and the Windward Islands.

Rich datasets are available for at least two of these large sites; Indian Creek, on Antigua (not to be confused with Montserratian Indian Creek) and Hichmans, on Nevis (not to be confused with the neighboring Archaic site at Hichmans Shell Heap). Indian Creek was excavated by Irving Rouse in 1973, with the assistance of avocational archaeologists from the island, and published with the assistance of Birgitta Morse (Rouse 1974; Rouse and Morse 1999). It was the excavation of this site, and Rouse's seriation of its extensive ceramic assemblage, which in part laid the foundation for his conceptualization of the Saladoid series. In a pattern now familiar from other Early Ceramic villages, excavated deposits were all laterally extensive middens, rarely deeper than 1.5 m (Rouse and Morse 1999:11-18). The middens surrounded an interior area devoid of surface material (Rouse and Morse 1999: figure 3), which Rouse initially interpreted as a plaza (Rouse 1974). This seems undersubstantiated, especially considering that no excavation units were placed in this area. As at Trants and Hope Estate, this may have been the main location of the settlement, with the encircling middens representing its outer extent. Informal reconnaissance in 2011 suggested that this pattern still holds, and that the middens are experiencing soil deflation, resulting in a thick carpet of increasingly degraded artifacts. As Rouse's goal seems to have been to obtain a large and internally diverse assemblage of sherds in order to undertake seriation, it is possible to understand why site structure and domestic contexts were ignored.

The ceramic evidence from Indian Creek fits neatly into the periodization proposed in this chapter. The basal strata — levels 7-6 and 6-3 — contained classic examples of WOR and ZIC (figures 4.1 and 4.4; Rouse and Morse 1999: figures 7, 9-12). The WOR sherds were characteristically more massive-walled and apparently harder fired than the ZIC, a pattern seen at Trants (Petersen 1995); there is evidence for incision, although not to the extent that true ZIC material exhibits, demarcating different zones of decoration. Rims are typical for material of this period, with a tendency to adopt a more vertical stance than Late Ceramic vessels (Rouse and Morse 1999: figure 8) and less-pronounced carinations. Unrestricted shapes include bowls and griddles, restricted shapes seem limited to 'jars' (Rouse and Morse 1999:21). Adornos and lug-decoration, although not quantified, seems very common on the WOR (Rouse and Morse 1999: figure 11) — research conducted in the Montserrat National Trust in 2011 suggests strong stylistic parallels with the assemblage from Trants (figure 4.1 and 4.2). The ZIC, largely derived from these same lowest contexts, is typical of ZIC from La Hueca, Hope Estate, and Trants, in a light buff — 'tan' — fabric, thin-walled and with few inclusions.

The radiocarbon dates from Indian Creek place the earliest material at 90 BC – AD 320 (Rouse and Morse 1999:45-47; cf. Fitzpatrick 2006: table 2; I-7830 and I-7842 should be rejected as erroneous), placing it after the first florescence of Trants and Hope Estate but contemporary with their Early Ceramic II phases. This also anchors the later phases witnessed at Indian Creek within a wider Leeward archipelago chrono-typological framework that looks increasingly solid; the higher strata at Indian Creek produced material which clearly retains a stylistic and morphological debt to vessels of the Late Ceramic (Mill

Reef and Marmora Bay styles) which is now paralleled on Nevis and Montserrat, supported on the later island by radiocarbon dates (Cherry *et al*. 2012a). This will be discussed below.

Indian Creek's position as the doyenne of Antigua's Early Ceramic has recently been challenged by research in the very north of the island, on the Antigua Formation, at Royalls. Excavations here in the late 1990s, followed by further salvage work subsequent to this, have revealed an extensive site belonging to the Early Ceramic II (Healy *et al.* 1999; Murphy 2001). The full extent of the site, and its spatial organization, are not fully understood — the excavators had reason to suppose that they had not delimited the boundaries of the site (Healy *et al*. 1999:217), although why this should be the case is unclear. It is also unclear what the nature of the excavated deposits was, considering the presence of nearly complete vessels (Murphy 2001:170) and the absence of middens containing Mollusca (Healy *et al.* 1999:220). This is very unusual in the pre-Columbian Antilles, and makes this site appear rather anomalous. The concern must be that domestic contexts and/or intact floor surfaces or burials were encountered yet not recognized. In the absence of further information, it seems difficult to establish what was being excavated. Reassuringly, both radiometric dates and strong stylistic parallels to the material from the basal deposits at Indian Creek confirm an Early Ceramic II date (Healy *et al.* 1999:216; Fitzpatrick 2006: table 2).

Zooarchaeological remains at both Indian Creek and Royalls are very similar. Analysis of the faunal material recovered from the Indian Creek middens parallels observations made about Early Ceramic subsistence choices in the preceding section of this chapter. Introduced rodent, especially rice rats (*Oryzomys* sp.; MNI = 32 [Rouse and Morse 1999: tables 4 and 5), were especially noticeable, alongside an unfortunate *Cavia porcellus*, surely not the only member of its tribe to meet a grisly end on Antigua. Agoutis complete the picture of

Neotropic mammals transported to the island as prey species (see Giovas *et al.* 2011), suggesting a willingness to maximize calorific return through environmental modification (it is impossible to reconstruct the impact of viable breeding populations of these rodents on the depauperate and delicate endemic fauna, but worth recording that Europeans are not the only colonizers who have upset ecosystemic balance in the Antilles). Sieving at Royalls allows for the reconstruction of an MNI of 133 for rice rats (Healy *et al.* 1999:219), confirming patterns seen at Indian Creek, alongside *Canis familiaris* and *Dasyprocta aguti*.

The characterization of Antiguan Early Ceramic II subsistence strategies as primarily terrestrial is in this context understandable (Healy *et al.* 1999:220), but not necessarily accurate. It is certainly the case that the communities at Indian Creek and Royalls were exploiting terrestrial species, both endemic and imported, and that neither site is situated directly on the coast (although both lie under 1.0 km from the ocean). The presence of both reef and pelagic taxa at both sites, however, indicates an inclination and a capacity to take sizeable prey species in deep water, including barracuda and snapper at Royalls (Healy *et al.* 1999:219) and Scombridae (frigate mackerel and tuna) at Indian Creek (Rouse and Morse 1999: table 2), alongside a willingness to hunt birds and turtles (during nesting, or perhaps at sea). This is not a terrestrial strategy, but a generalist strategy, targeting the many diverse ecological niches that Antigua, as the other small islands of the Leeward archipelago, offered. Palaeoethnobotanical data are not available for either site; it seems safest to conclude that species exploited elsewhere in the archipelago during the first millennium were also present here, further complementing the picture of Amerindian foodways in the first millennium AD as fully diversified as possible. The viability of both sites as loci of horticulture — especially considering their access to well-watered and relatively flat expanses of loam at opposite ends of Antigua — is explored in Chapter Six.

The site at Hichmans on Nevis follows closely from any discussion of Indian Creek, to which it retains a series of similarities. Subject to sporadic test-pitting, the most extensive and informative discussion of this important site derives from the survey of Nevis undertaken by Samuel Wilson and colleagues (Wilson 1989; 2006:83-97), with subsequent limited test-excavation at the site. The site itself lies on the windward coast of the island, facing Montserrat, Redonda, and Antigua, where the gently sloping flanks of Mt. Nevis meet the sea. This section of the island is divided by parallel seasonal ghauts, and the site lies between two of these (Wilson 2006: figure 3.9); informal reconnaissance in 2011 confirmed that the surface distribution of artifacts is still extremely dense, despite the lack of agricultural interference. The internal structure is not yet clear, although we may suppose that the middens lie external to the main cluster of structures (although this may of course have changed over time).

Wilson, in discussing the stratification at the sites, notes that the earliest material is Cedrosan Saladoid; his discussion makes clear that this Hichmans Phase I material contained a mixture of WOR, polychromes, red-slipped, and ZIC, a pattern already seen at Indian Creek and, prior to that, at Hope Estate and Trants (figure 4.7; Wilson 2006:84-85; figures 4.12-4.15). The fabric and color is very similar to that of the ZIC recovered at Indian Creek (2006:89; Rouse and More 1999: 27-29), even though fewer ZIC sherds were recovered from Hichmans. WOR decoration, morphology, and stylistic variation were typical for Early Ceramic II. Radiometric dates from Hichmans are not assessed during the chronometric survey undertaken by Fitzpatrick (2006), due to their publication in Wilson (2006). The variety of dates from charcoal samples from Hichmans is largely consistent with an Early Ceramic II date, perhaps trending towards the end of the period (Wilson 2006: table 7.2); Beta-106772 is notably low, and may be erroneous — no contextual information is supplied with it.

The mixture of ZIC, WOR, and WOR-related forms should no longer surprise, but adds to the apparent conundrum of establishing what behaviors or social distinctions these two traditions reference. The co-occurrence of such apparently divergent potting traditions at Indian Creek and Hichmans (not forgetting the apparent tendency at all Early Ceramic sites for WOR to adopt incised decoration to some extent), therefore, presents the same interpretive challenges as at the initial Early Ceramic I sites considered earlier. Again, to read this as evidence of two separate ethnic groups existing in parallel is problematic, and more worryingly forecloses on several lines of inquiry. Moreover, at all sites so far considered, coarsewares do not display the kind of dualism that seems to characterize the fineware assemblages. Is this dualism — surely a deliberate choice of which the individuals in these early communities were aware — representative of a geographic or cosmological distinction, with each ware deployable and appropriate only in certain contexts? Wilson raises the intriguing possibility that, based on their properties — hard-fired, massive WOR and thin-walled, untempered ZIC — that the two forms may have possessed different use-functions. In the absence of evidence from Early Ceramic intact domestic contexts, Chapter Five deploys spatial models that might seek to account for this relationship.

The excavated deposits from Hichmans were subjected to palaeoethnobotanical flotation to isolate and identify macro remains (Newsom 2006:103-144). Regrettably, very few seed remains were identified during the floatation process (Newsom 2006:120), with carbonized wood forming the majority of the body of evidence. Of interest is the identification of a fragment of manioc tuber, *Manihot esculenta* — corroborating evidence for the horticultural mode of subsistence at Hichmans. Aside from this, the identification of carbonized wood fragments is most useful in palaeoenvironmental reconstruction, suggesting that the proximate environment (and presumably by the extension all the low-lying areas of the windward coast island, away from orogenically induced rainfall) was of dry evergreen forest and scrub (2006:139). The zooarchaeological record is slightly more informative (Kozuch and Wing 2006). Exploited species cover the spectrum of environmental niches proximate to the location of site; rice rats (MNI = 19) and grouper (Serranidae), a reef-dweller (MNI = 5) are numerically dominant, but a suite of birds — passiformes and maritime species — are present, as are a full complement of reef fish (the tendency for Early Ceramic sites to cluster near fringing reefs is explored in more detail in Chapter Six). Fully pelagic species, again represented by the Scombridae, are present, as is a solitary Monk seal (*Monachus tropicalis*) (Kozuch and Wing 2006: table 6.7). Whilst it is inherently difficult to balance the extent to which terrestrial and maritime environments contributed percentages of calories — and not forgetting the exploitation of domesticated plants, again possibly including *Zea* (although Newsom 2006:142) — it seems to be the case at Hichmans, as elsewhere, that Early Ceramic communities targeted their calorific needs at varied sources, with the switch to more extensive exploitation of near-shore resources a Late Ceramic phenomenon.

Hichmans and Indian Creek represent those Early Ceramic II sites for which the richest chrono-typological, subsistence, and palaeoenvironmental data are available. As a result of this, the remaining clutch of sites for which Early Ceramic II radiometric dates are available will be understood, in the absence of data of this quality, to represent communities who employed broadly parallels strategies of inter-communal organization and subsistence. This may elide differences between these sites to some extent. In the existence of environmental pattering in terms of the distribution of Early Ceramic II sites, however, any outliers should indicate at least the possibility that subsistence behaviors differed to some degree from the norm, if any such patterning exists.

Aside from these major sites, there are other settlements in the Leewards with Early Ceramic II pedigrees. Of these, the islands of Saba and St. Eustatius contribute three; Spring Bay on Saba, and Golden Rock and Smoke Alley on Eustatius (Haviser 1985; Versteeg and Schinkel 1992; Versteeg *et al.* 1993). Golden Rock (Versteeg and Schinkel 1992) is especially noticeable for the excavators' detailed examination of the internal structure of the site, and the ensuing contribution to modeling how the negative spaces between the usual encircling middens may have been occupied; the evidence for subsistence is more equivocal, but the environmental setting may be suggestive of largely parallel strategies. Ceramic data and radiometric information both at Golden Rock and Smoke Alley are suggestive of an Early Ceramic II date (Fitzpatrick 2006: table 2; Haviser 1997: table 7.1; Wilson 2006: table 7.2), and for this reason they are included in the ensuing analysis; the small site at Spring Bay on neighboring Saba is also included for this reason. St. Martin and Anguilla possess three Early Ceramic sites between them; at Rendezvous Bay, whilst reported by Fitzpatrick as having a technically Early Ceramic II date (2006: table 2), there are strong reasons to believe that this site only flourished as a settlement in the Late Ceramic (Watters and Petersen 1995); the earliest date from this site (Beta-19957 = 1550±70) is from the basal stratum and may represent the very first occupation right at the cusp of the Early to Late

Ceramic transition (if so clear-cut a cusp is even viable). Anguillan Fountain Cavern and Forest North (Crock 2000) may be assigned Early Ceramic II dates.

These sites, spanning Early Ceramic I and II, comprise the main datasets employed in the analyses of Chapters Five and Six. As with the Cyclades, the earliest phases of settlement (coincidentally, perhaps, just over a millennium or so in both cases) form the main focus of the analysis: the Early Ceramic I and II and the Late and Final Neolithic. In both archipelagoes, however, immediately subsequent to this, there is a notable spike in settlement numbers, perhaps the amplification of trends witnessed in immediately preceding periods. In both cases, then, the spatial relationships between these subsequent settlement distributions are modeled — primarily in Chapter Five — to establish to what extent they differ from their predecessors. They will not be subject to the same level of interrogation as regards the impact of environmental variables and modes of subsistence, though — the incorporation of the large amount of spatial data from the Late Ceramic (Antillean) and Early Bronze I (Cycladic) with environmental data largely lies outside the scope of this research. The internal relationship of the settlement distribution will, however, be addressed.

4.5. Emergent Patterns in the Settlement Ecology of the Leeward Islands

In the preceding chapter the concept of ‘transported landscapes’ was considered (Kirch 1982) in the context of the adaptation of Neolithic communities to the stark landscapes of the Cyclades. I argued that while colonists certainly imported a package of techniques relating to subsistence and land management into their new environments from their old, it is not accurate to suggest that they failed to recognize the stiff challenges mounted by island living, nor occasional bounties offered. I go on to argue in Chapter Six that it was this adaptive effectiveness — the turn to *insular generalism* in the face of new and isolated fragments of land, outlined in Chapter Two — that had a transformative effect upon the demographic dynamics of these colonizing populations in places where breathing spaces were few and far between. This, in turn, encouraging the new adaptations that we begin to witness in the terminal fourth millennium, both in the walls of Strofilas and in the occupation of sub-optimal geoecological niches on Kea.

Whilst enormously separate in time and space, there were cognate processes at work in the centuries either side of AD 1 in the Leeward Islands. The large village sites at Trants, Hope Estate, and only marginally more distant La Hueca, were occupied by communities profoundly well adapted to Neotropical living (perhaps in this following the example set by antecedent Archaic peoples). Yet the challenges and affordance of islands demanded and encouraged responses. To describe Early Ceramic lifeways and subsistence practices as terrestrial misses the point; in a sense, it is hard to imagine colonists from the Southern American landmass as anything other than terrestrially focused. Rather, it should be the capacity to develop riverine subsistence practices and adapt them to these (relatively) brave new worlds that should be remarkable. It is in the willingness (and apparent occasional selectivity) of the Early Ceramic colonists to hunt, fish, and plant in the whole range of ecologies that the Leewards had to offer that we witness a parallel response of subsistence generalism, or divergence in the face of fragility and risk. As in the Cyclades, I suggest that it was this highly effective strategy — combining landscape-learning with tested horticultural techniques and animal importations — which profoundly transformed the socio-cultural constitution of these groups during the first millennium AD in a process of niche construction and the maximization of fitness via subsistence. The long-term outcomes of these choices, as I discuss in Chapter Seven, may have resulted in altered demographic dynamics, with concomitant social and perhaps political forms.

In this Chapter I have considered the development of settlement and subsistence practices in the Early Ceramic Leeward Islands, as well as outlining the major differences — but the retention of comparative potential — between the horticulturalist Caribbean and Neolithic Aegean colonizations. In both cases, I suggest that systems of settlement were not static, but evolved over the long-term as fragile populations expanded. This development — the growth of these sites and their networks in both archipelagoes during a millennium or so of occupation — forms the subject of the next chapter.

Island	Site	Phase	References
Vieques	La Hueca	Early Ceramic I	Chanlatte Baik 1976; Chanlatte Baik and Narganes Storde 2005
Montserrat	Trants	Early Ceramic I/II	Petersen 1995, 1999; Watters 1994
	Radio Antilles[7]	Early Ceramic I	Watters 1980, 1994
	Belham Valley	Early Ceramic I	Watters 1980, 1994
	Glendon Hospital	Early Ceramic I	Cherry *et al.* 2012a
Antigua	Indian Creek	Early Ceramic II	Rouse 1974; Morse and Rouse 1999
	Royalls	Early Ceramic II	Healy *et al.* 1999; Murphy 2001
St. Kitts	Sugar Factory Pier[8]	Early Ceramic I	Goodwin 1979
Nevis	Hichmans	Early Ceramic II	Wilson 2006
Saba	Spring Bay	Early Ceramic II	Haviser 1985
Eustatius	Smoke Alley	Early Ceramic II	Versteeg *et al.* 1993
	Golden Rock	Early Ceramic II	Versteeg and Schinkel 1992
Anguilla	Forest North	Early Ceramic II	Crock 2000
	Fountain Cavern	Early Ceramic II	Crock 2000
	Rendezvous Bay	Early Ceramic II	Watters and Petersen 1995
St. Martin	Hope Estate	Early Ceramic I/II	Haviser 1988, 1991, 1997

Table 3. Sites included in this study, their location, date, and relevant publications.

Phase	Dates B.C. and A.D.
Early Ceramic I	500 BC – AD 1
Early Ceramic II	AD 1 – AD 500
Late Ceramic	AD 500 onwards

Table 4. The relative and absolute chronology of the Lesser Antillean Ceramic. Data taken from: Fitzpatrick 2006; Keegan 2000; Wilson 2006.

[7] It is unclear whether these very small sites represent satellite settlements of Trants, or non-settlement activities. They are included in some runs of the analysis and not others, to see how they affect any patterning.
[8] There is no radiometric evidence to support an ECI date for Sugar Factory Pier. It is included in some heuristic analyses to see how a site on St. Kitts affects any patterning.

Chapter Five

Settlement Ecology and Cultural Variables in Small Island Archipelagoes

> You've never been to see any of us. You just stay here in this one corner of the forest waiting for others to come to you. Why don't you go to them sometimes?
>
> A.A. Milne, *The House at Pooh Corner*, 1928

> Area is the devil's own variable.
>
> H.W. Anderson, *Relating Sediment Yield to Watershed Variables*, 1957

In their book on the current state of island biogeography, Whittaker and Fernández-Palacios (2007:77-106) light-heartedly describe the early project of their subject as concerned with 'species-numbers games.' In this they drive at the heart of the attempts of, in particular, MacArthur and Wilson and their students to attempt to relate geographic variables (distance, area) with ecological variables (rates of speciation and of extinction). 'Species-number games' as a concept implies a willingness to approach one problem from a multitude of positions, an insistence on trying a series of quantitative and semi-quantitative techniques to elucidate patterns in the data. In this chapter, similar games are played in relating geographic variables to the fuzzy sets that constitute the settlement data for both areas under study. In doing so, this chapter approaches human distribution across space from the perspective of settlement ecology: that systems of human distribution do not exist in isolation, but are embedded in a wider ecological and cultural matrix, which includes not only strictly environmental variables, but also behavioral ones, such as the existence of social hierarchies. In essence, the underlying assumption is that all modes of human organization — spatial, social, technological — are embedded within each other, forming a wider adaptive framework that is itself embedded within geoecological contexts and processes. Beginning from this position and from a series of angles, an attempt is made to grapple with the distribution of (diachronic) human settlement in both archipelagoes; to see 1) whether it exhibits patterns relative cultural variables, most notable the proximity of other human communities (and not environmental variables); 2) whether these patterns are similar or dissimilar; and 3) to provide an account of the behaviors underlying these patterns. Beginning with density- and cluster-analysis, we move to network- and gravity-modeling, and Proximal-Point Analysis for the Leeward Islands; all techniques have some inherent value but, when used together, they allow for powerful and robust accounts of post-colonization dynamics in both case studies that chime well with previous arguments made about the development of increasingly complex social forms in both the Aegean and Caribbean.

5.1. Patterning in Settlement Data

The total settlement data sets to be considered were explicated in the two preceding chapters, as were the modes of subsistence encountered in these settlement systems. A simple, yet instructive way to begin to attempt to make sense of this bundle of spatial data is to consider the relationships between distribution of people and their social organization. It is clear that human spatial organization is both reflective of, but also actively implicated, in social organization — the relationship between spatial and social dynamics is mutually constitutive (e.g., Adams 1966; Clarke 1968; Feinman and Marcus 1998; Renfrew 1972:225-507; Smith 2003; Yoffee 2005). In the case of archaeological data, this is most obvious — and most often investigated — from the perspective of settlement hierarchies and their relationship to degrees of social complexity. In this model, an attempt is made to distinguish the presence or absence of a hierarchy in settlement, being the presence of quantitatively variable classes of site. Qualitatively variable behavior is also understood to accompany this quantitative difference, with sites of differing size and frequency being, in theory, the locus for varying types of activity. This approach to spatial analysis owes much to neo-evolutionary anthropological theory and its central concern of categorizing human societies into hierarchies which undergo transition to higher evolutionary states through emergent processes, the most well-known being the progression in complexity from very simple egalitarian social organization — band — through a range of interstitial social forms to the state (Carneiro 1970; Fried 1967; Service 1962). Because of this preoccupation with the state and its definitions, most research has focused on the relationship between settlement hierarchies and the points of transition from pre-state to state-level societies, with a four-tier settlement hierarchy typically being taken as indicative of the existence of state-like mechanisms.

In the Early Ceramic Lesser Antilles and the Neolithic Cyclades it is clear that we are dealing with pre-state social structures; certainly, there is no evidence for the existence of anything like four tiers in the settlement system[9]. That point aside, we should perhaps be more generally cautious in attempting to fit overarching models — such as four tiers equating a state model — on diverse and incomplete datasets. The basic central component to this mode of reasoning, however — that variation in human spatial organization may reasonably be understood to reflect varying types of social organization — is a useful one. A cursory glance at Figures 5.1 and 5.2, which represent in spatial form the data included in Tables One (Chapter Three) and Three (Chapter Four) certainly suggests that both in terms of internal diachronic dynamics, and when compared to each other, the settlement systems in both areas were noticeably different; this much has been obvious to researchers in both the Caribbean and Aegean, and has formed the basis for speculation about emergent social complexity. In the current section of this chapter, these data are quantified with regard to the extent to which they can be seen to exhibit patterns in their distribution vis-à-vis one another. Following this, any apparent patterning — which there is — will be related both to the presence or absence of settlement hierarchies in the study areas, and also to ethnographic data.

It is necessary, before moving on to consider the data in full, to consider the benefits and disadvantages of artificially demarcating spaces in which analysis will be undertaken. In Chapter Two, and tangentially in Chapters Three and Four, the suitability of the Cyclades and the Leeward Islands for comparative analysis was considered; by virtue of their geographical and ecological organization and their settlement histories, they make ripe candidates for the comparative approach. Also, clearly, objects of inquiry have to be bounded in some fashion, and the boundaries of the Cyclades and the Leewards are in some senses self-selecting. That said, the artificial selection of certain islands and sites for subsequent

[9] Although, as discussed below, there do exist hints that incipient social complexity in the subsequent Late Ceramic of the Leewards can tentatively be understood as an outcome of spatial processes, probably spatial-demographic processes, witnessed in the Early Ceramic II.

geospatial analysis in part unavoidably divorces these case studies from their human and environmental context. For example, the proximity of Attica to the northwestern Cyclades, or of massive Guadeloupe to Montserrat, certainly influenced the development and communication of early agropastoral and horticulturalist communities. It may well be productive, in future iterations of the models built here, to include peripheral zones to the main study areas, to establish how this nuances the results. This notwithstanding, and especially as regards the gravity and network modeling attempted in this chapter, there are no reasons to suppose that inclusion of peripheral areas in the analysis would drastically alter the results offered here, nor falsify the general conclusions drawn.

5.2. Settlement Density and Clustering in Small Island Archipelagoes

A basic yet useful cluster of questions in considering distribution of human settlement across space deal with the distance between loci of human activity. Issues regarding proximity to neighbors, number of these neighbors, and their types may all reflect underlying behavioral or social issues, if we accept that presence or absence of other groups has an effect on the lived experience of humans. A central technique in spatial analyses concerned with the proximity of humans and their material to one another has been and remains the use of kernel density functions to quantify the density of discrete sites in space. This technique becomes more powerful as more points are included in the analysis; moreover, to be of any true use, kernel density calculations require that each part of the space in question has the capacity to have a point occupy it. In an archipelagic environment (with only relatively few settlement sites) this is clearly not possible, with large areas of space being ineligible. In essence, the construction of a density raster depicting the density of Late Neolithic Cycladic sites only demonstrates the trivial - that settlements in archipelagoes cluster on islands. The one interesting point of consideration which arises here is just how central are Naxos and Greater Paros, in that settlement on them is so relatively dense and so close that they emerge as a homogeneous block. This is heuristically useful in dealing with these prodigiously large, but also isolated (in biogeographical terms from a mainland perspective) islands, whose uniqueness will become apparent in further, more substantive analyses.

What is required is a metric which bypasses the inevitable but analytically unfortunate fact that islanders live on islands. A crude way to begin to consider this is to deal with 'nearest neighbors' — to define, for any given settlement, the distance to the next nearest settlement, with the assumption that it is easier to interact with closer rather than further communities (although that may not be desirable, depending on context — it is the increased possibility rather than any increased probability of interaction which is the central element in this reasoning). Accordingly, in a settlement system in which sites were located much more closely to one another than in a system in which sites were located comparatively further away, we can assume a difference in the nature of inter-site interaction. Put simply, those people living in a more densely-packed settlement system would have greater opportunity to interact with their neighbors on a more frequent basis; in such systems, the social cost of the conquest of distance is relatively lower. A caveat here from the perspective of the current study is that, in the Cyclades at least, the chronological resolution is insufficient to be exactly certain that two given settlement sites were occupied synchronously, e.g., the Final Neolithic (based on the ceramic evidence) phases of Ftelia and Koukounaries. The operating assumption, in the absence of any more effective method of refining the chronological relationships between these and other sites, remains that contemporary material culture implies contemporary occupation.

Simple straight-line distance between two sites may not reveal as much as is immediately obvious, however. We could imagine a system — perhaps counter-intuitive, but not impossible — in which sites clustered in binary pairs; in this scenario, measuring nearest-neighbors, would falsely indicate clustering when we may in fact have reason to suspect that the social reality was very different to one which might be implied by the high degree of clustering that nearest-neighbor measurement would indicate. There are several viable techniques to move beyond this problem; in the present analysis, two further variables are introduced in an attempt to delineate clustering or absence of clustering; Thiessen polygons and next-nearest-neighbor.

Thiessen polygons have a lengthy pedigree in archaeological analysis. Their major use was — in association with the spatial analysis popular within the New Archaeology — in determining likely socio-political boundaries based on settlement data (Haggett 1965; Hodder 1972). This rightly attracted extensive critique in the reaction against the New Archaeology, particularly because the interrelationships between individual polities are massively more complex than putative relationships based on simple distance, as in classic Thiessen analysis. Here they are used very differently, not least because it is entirely unclear whether the sites in question can be ordered into distinct socio-political units in the manner of peer-polities or Early State Modules, for example. Given a random distribution of contemporary sites across space, calculation of the area of a polygon around each point is a proxy metric for clustering, in that the greater the number and concentration of neighbors, the lower the total area around any point. Clearly, this is in part because the calculation of

Thiessen polygons is a function of distance, not only to the nearest neighbor, but also surrounding points, so in that regard Thiessen-area and nearest-neighbor distance are partly related. Their combination in a bivariate plot may still be illuminating, however, in that total Thiessen-area for a site which only has one close neighbor will be relatively high, with its nearest-neighbor distance also relatively low; such a relationship would indicate binary clustering of a type given in the above fictitious scenario. Conversely, a high nearest-neighbor score (that is, a larger distance) in combination with a low Thiessen-area score would indicate very regular spacing of sites across a landscape. While the two metrics are, then, in part related, they provide different means for accessing presence or absence of patterning in spatial data.

The generated Thiessen plots for the Cycladic Late and Final Neolithic are illustrated in Figures 5.3 and 5.4 respectively. The scarcity of radiometrically-dated Early Ceramic I sites is such that Thiessen-area and nearest-neighbor scores are largely meaningless, so these data were excluded from this aspect of the analysis. These figures warrant some discussion, especially as regards which sites were included and excluded, and the rationale behind this, as such decisions impact the ensuing analyses.

Figure 5.1 is the basic plot for the Late Neolithic (Saliagos phase) of the Cyclades, with — as previously — sites with solely a Late Neolithic component in yellow, those with solely a Final Neolithic component in red, and sites with the possibility of occupation over both phases in orange. As noted in Chapter Three, the possibility of occupation on Melos, both in the Late and Final Neolithic, is problematic, based on the inability to distinguish surface scatters of lithic material based on their morphologies alone. It is hard to reconcile the data generated by intensive pedestrian survey there with patterns seen elsewhere, considering the absence of systematic and intensive survey on other islands in the group, excepting Kea. This may be indicative that Melos is something of an outlier, or that intensive pedestrian survey on other islands would exhibit similar variation, or perhaps both. As will become clear, the spatial analyses undertaken in this chapter provide further reason (beyond the absence of any surface ceramics) to argue that Melos was not home to permanent human settlement in the Saliagos phase, and possibly into the Kefala phase. In an attempt to establish whether the island fits into any wider patterns, a putative Late-Final Neolithic site of permanent settlement is included at Agrilia. The same reasoning lies behind the inclusion of Paoura on Kea which, as Torrence (1991:189-191) notes, may include a Late Neolithic component. Parian Vouni is excluded, as its absence of potsherds in the surface assemblage and the proximity to Saliagos itself suggest a satellite relationship with the larger site. Naxian Zas is excluded in this run of the model, as the cave-site arguably represents very different types of activities than those occurring at the large, coastal villages, although the significance of Zas itself may derive partly from the apparent centrality of Naxos during the fifth and fourth millennia. In Figure 5.4 (Final Neolithic), Melian Agrilia is included for the same reason as for the consideration of the Late Neolithic, and Paoura is assumed again to be a multi-component site.

The initial correspondence between Thiessen-area and nearest-neighbor is given in Figure 5.5. This figure is a bivariate plot of nearest-neighbor distances (y) in kilometers and Thiessen areas (x) in square kilometers, dashed lines indicating both the mean nearest-neighbor distance and the fit-line; Final Neolithic sites are plotted in red, Late Neolithic sites in yellow. A general weak positive correlation can be observed (r square = 0.44796), as might be expected – in essence, as distance from nearest-neighbor increases, so does

Thiessen-area. There are two pertinent observations to be drawn from this plot. First, the Late Neolithic sites tend towards the upper scales of both nearest-neighbor and Thiessen-area, indicating their tendency to be further both from their closest neighbor and from other contemporary sites than their Final Neolithic successors. The greatest degree of clustering is evident between Saliagos, Koukounaries, and Grotta, as also revealed by kernel density analysis — these are the only Late Neolithic sites to fall under the mean nearest-neighbor distance for the entire dataset. This is not coincidental, and presumably relates to their presence on Naxos — the largest island in the archipelago, at 429 square kilometers — and Greater Paros, which would have rivaled Andros prior to its separation via eustatic sea-level rise into Paros and Antiparos in the fourth millennium; the vital importance of the Greater Paros-Naxos block will become increasingly apparent throughout both this chapter and Chapter Six. Second, in the lower ranges of both variables (Thiessen-area smaller than 1,000 square kilometers and nearest-neighbor distances of less than 10 km) can be found several of the Final Neolithic sites; specifically, those located on Andros and Kea. As Thiessen-area is partly a function of proximity to nearest-neighbor, this is not altogether surprising — that none of these sites is an outlier in the Thiessen-area score, however, suggests a regularity to their spacing. These sites do not appear in random clusters within islands, but rather are spaced with some degree of regularity across the northern parts of Andros and Kea.

This observation is underscored by correlating Thiessen-area with next-nearest-neighbor scores for these sites (Figure 5.6). The correlation is again positive but very weak (r square = 0.27931), with the degree of correlation weakening towards the upper end of both variables (this is in part a product of Agrilia's inclusion in both plots). It can still be observed that, for the dense patch of Final Neolithic sites on Andros and Kea, next-nearest-neighbor scores are not much greater than those for nearest-neighbor, with no great outliers in Thiessen-area. This further suggests that the distribution of these sites on their respective islands is uniform, rather than representing sub-clusters. One concern here may be the paucity of peers for these Final Neolithic sites on southern Andros; the mega-site at Strofilas may be a factor in this lack of data, as may unsystematic prospection for the surface signatures of Final Neolithic settlements. The role of Strofilas will be considered in a subsequent part of this chapter.

To better illustrate the relationship between these three interrelated variables, it is possible to construct a scatterplot. Figure 5.7 depicts Thiessen-size plotted against both nearest-neighbor and next-nearest neighbor. The expected positive correlation between all three variables is exhibited, again with this correlation becoming less obvious in the upper reaches of all three. This confirms Agrilia's status as an outlier, both in the Late and Final Neolithic data, suggesting that if there were a site of permanent settlement on Melos in these phases, it was greatly and peculiarly isolated. The scatter of smaller lithic surface assemblages across the island may be indicative of Final Neolithic-style first-tier satellites, but the total absence of contemporary ceramics would suggest otherwise (or hint at highly unusual taphonomic processes). The pattern previously seen on the bivariate plots is re-emphasized, specifically that small Final Neolithic sites in the northwestern Cyclades exhibit dense and regular spacing. Conversely, those sites in the central part of the archipelago that seem to retain a Final Neolithic phase do not. Strofilas, the large center on the coast of Andros, lies slightly between the two modes of spatial organization, proximate to the dense clustering of northern Andros and Kea, but distinguishable from it.

The wider conclusions that it might be possible to draw from this very preliminary analysis will be returned to and expanded upon during the course of this chapter, especially as regards how these tentative patterns relate to network- and gravity-modeling of site interaction in this phase, and how ethnographic data can inform interpretation of these data. What does seem clear is that the possibility of regular contact between neighboring small sites on Andros and Kea — again, assuming contemporaneity — must have been significantly greater than that for the communities in the Saliagos-phase villages of the previous millennium. This regularity largely prefigures a similar and relatively well-understood pattern for subsequent Grotta-Pelos systems of landscape occupation stretching into the third millennium (Broodbank 2000:166-174; Renfrew 1972:152-169), and hints at a distinct departure from Saliagos-phase ways of living in island contexts. Evolving modes of distribution underscore differences in subsistence patterns delineated in Chapter Three that are further considered in Chapter Six. Operating on the principle that varied modes of spatial organization suggest corresponding differences in social organization, the two systems are noticeably divergent. The extent to which this relates to the range of available technologies of communication (in this case, small paddled vessels; Chapter Two) is considered in more detail following the gravity-model analysis.

The Caribbean data exhibit similarities, but do not conform entirely to the same patterns. Plotting Thiessen-area by nearest-neighbor is a useful tool in delineating patterning, but in terms of establishing the presence or absence of clustering, then correlating nearest-neighbor with next-nearest-neighbor is arguably a more secure technique. On this basis, this method was used in interrelating the Caribbean data with the Aegean data. As Early Ceramic I settlement was excluded because of the paucity of overall points (only Trants and Hope Estate, with only two points generating exactly the same nearest-neighbor and Thiessen-area scores), only Early Ceramic II settlements were included. Also excluded is the Fountain

Cavern site on Anguilla which, similar to Zas, seems to index highly esoteric and non-domestic behaviors. Conversely, as for Melos, a point is generated for St. Kitts — randomly, however, and not located over the Sugar Factory Pier site — in an attempt to establish what impact a Kittian Early Ceramic II has on the overall patterns.

This information is displayed in Figures 5.8 and 5.9, with the Caribbean data for sites listed in Table 2 depicted as filled blue triangles. A stronger positive correlation (r square = 0.73896) is observed than witnessed in the previous analysis, although some outliers require comment. Highlighted in Figure 5.8 are three pairs — one from the Cycladic Final Neolithic dataset, two from the Lesser Antillean data — which lie unexpectedly low on the y-axis, i.e., sites which have a close immediate neighbor but a next-nearest-neighbor which is distant by comparison. These are — respectively — Koukounaries/Grotta in the Cyclades, and Royalls/Indian Creek and Hope Estate/Forest North in the Leeward Islands. These groups constitute binary pairs which do not fit with the overall trends observed in the data, and discussed in more detail shortly. In the Caribbean data, this binary clustering may be derived from the fact that Royalls and Indian Creek are on the same island (Antigua) that is nonetheless comparatively isolated when compared to other islands in the archipelago. The peculiar relationship between St. Martin and Anguilla in the first millennium AD, hinted at in this analysis, has been the subject for discussion elsewhere (Crock 2000; Crock and Petersen 2004) — the Proximal Point Analysis later in this chapter considers this in more detail. The Cycladic outlying pair, Koukounaries and Grotta, is more intriguing. As has been demonstrated, very different modes of landscape occupation seem to characterize the Late and Final Neolithic, but the comparative isolation of the Naxian and Parian sites, without any obvious satellites, is more reminiscent of the Late Neolithic pattern. This may be a problem of chronological resolution; that we have no clear idea of the extent or role of either site in the fourth millennium, largely thanks to Early Bronze Age and later overburden, does not help to clarify the situation.

These settlements notwithstanding, there is a clear positive cline in the relationship between nearest- and next-nearest neighbor, illustrated by the fit-line in Figure 5.9 (r square = 0.73896). In practical terms, this means that any given site with a very close neighbor is likely to have a next-nearest neighbor that is also comparatively close. The majority of sites do not form binary pairs, nor is any clustering randomly or unevenly distributed over an island (the separation of islands, of course, means that clusters are unevenly distributed between them). This establishes basic regularity in distribution which suggests that proximity of other settlements was, in both cases, a pertinent factor in the existence of settlement sites; that is, distribution is not random.

The fact that there is patterning in both settlement systems is inherently interesting, and in part addresses the question of whether human or environmental variables are relevant in exploring how islanders in both cases chose to distribute themselves in post-colonization contexts. Of further interest are several points which emerge from considering these data in more detail.

One such is the spatial parallels between the Late Neolithic of the Aegean, and the Early Ceramic II of the Leeward Islands. Lowest nearest-neighbor scores are comparable, as are highest scores; this reflects both the geography and spatial comparability of environmental contexts as small-island archipelagoes, but also the apparent tendency in these two areas under study for large, comparatively isolated sites, to occupy single islands. It is certainly the case, as was stressed in Chapters Three and Four, that we may have an incomplete understanding of the full spread of human settlement in both situations, but it does not seem to be an artifact of patchy data that in the Late Neolithic and Early Ceramic phases, individual islands tended to be dominated by a single primate center. Exceptions include Antigua (Royalls and Indian Creek) and Greater Paros and Naxos (Saliagos, Koukounaries, Grotta, and possibly Zas). These exceptions are illuminating, however, all three being (if we reconstruct Greater Paros as a peer of Andros) the largest islands in their respective archipelagoes. This once more indicates the apparent importance of regularity in spatial distribution in these phases in the areas in question: rather than having some islands containing a very large number of sites irrespective of size, and some containing only one site, the demonstrable preference is for large (in the case of Saliagos, Ftelia, Trants, and Indian Creek, at least), stand-alone sites, separated from neighboring large sites on other islands. This suggests that ease of contact with nearest populations was not a primary concern in the distribution of these settlements. Viable canoe-travel is modeled in the second half of this chapter, but it is noteworthy here that in both instances — the Early Ceramic II and Late Neolithic — these sites lie beyond each other's readily accessible daily voyaging ranges. Irrespective of this, in both cases these settlements clearly were in communication with each other, both partaking in a broad material-cultural *koine*. Splendid isolation as a reason for even distribution (or even constant internecine conflict; Runnels *et al.* 2009) is not a viable explanation. The social reality underlying this parallel distribution in both cases is considered in Chapter Seven.

The Final Neolithic of the Cyclades exhibits, as we have seen, a very different degree of spatial patterning from the Late Neolithic in the same archipelago, with clustering seeming to be the norm, rather than wide distribution over islands. To explore this further a short digression and discussion of some ethnographic comparanda are useful.

5.3. Spatial Organization, Ethnographic Analogy, and Settlement Hierarchy: the Kefala-phase Northwest Cyclades

The Final Neolithic in the Aegean, as was made clear in Chapter Three, is confusing. In any analysis, Andros, and the extensive and impressive walled site at Strofilas, loom large. Broodbank (2000:107-174), in his discussion of the spatial dynamics of Cycladic colonization, points out how different Kefala-phase modes of occupation seem when compared to their Saliagos predecessors, and how much Kefala lifeways prefigure the organization of the Grotta-Pelos settlements as they spread throughout the archipelago. He also highlights — tellingly — that the florescence of Final Neolithic settlement in the Cyclades suggests a point of origin very different from that of the Late Neolithic; specifically, Attika and Euboia appear to be culpable. The goal here is not to reiterate these points, although Broodbank's insights seem to be largely borne out by both the foregoing and subsequent analyses in this chapter. Rather, the attempt here is to get to grips with the social implications of the spatial patterning seen on Andros and Kea, and also to explore why this patterning is not yet evident on Mykonos, or indeed elsewhere in the central part of the archipelago. To do this, we might employ ethnographic settlement data.

The caveats in ethnographic analogy are well understood, as are the philosophical limitations of the uniformitarian assumption that parallel patterns in material culture in the ethnographic present index parallel patterns in behavior in the archaeological past. The exploration here is more open-ended than this; if we know what the spatial organization of Final Neolithic society looked like, issues of new data generation and taphonomic processes notwithstanding, are there any parallels in the ethnographic literature? If so, are these parallels actually or heuristically useful, or are the cultural and temporal gulfs simply too large to cross and yet retain meaning? It will become clear that the answer is a little of both.

Considering the scale of social organization, modern means of food production, and the presence of powered technologies of communication, anthropological data from the Mediterranean are largely useless in trying to find Final Neolithic parallels. A rich dataset which may be of use, however, is that derived from early formal ethnographic research undertaken by — first — the founding members of the structural-functionalist school of anthropology in the Indian and Pacific oceans in the early twentieth century. The settlement patterns of these islanders was not the primary concern either of Radcliffe-Brown (1933), Malinowski (1922), or Firth (1936), but in their attempts to delineate the cultural organization of the Andaman, Trobriand, and Tikopia islanders, respectively, they also generated useful data as regards the equivalent spatial organization to the social organization which was the object of study. These data need some refinement, but can be incorporated into the nearest- and next-nearest-neighbor analyses undertaken for the archaeological data.

The nature of the horticultural regimes operating in the ethnographic past of the Pacific, and the specific intra- and inter-household relationships that the ethnographers explicated, means that the settlement distribution of Melanesia (Trobriands) and Polynesia (Tikopia) is not as fully nucleated as we might expect in the archaeological record of the Cyclades, and the attempts to record this in early Pacific ethnographic writing underline that. In the Trobriands in particular, settlement seems to have clustered densely around certain given points, with satellite hamlets assigned different names reflecting subtle lineage differences (Malinowski 1922:27-48). A comparable situation is seen on Tikopia, where settlement — while often spread along the coastal strand — nonetheless exhibits dense clustering at certain points, again reflecting an accumulation of high-status family units (Firth 1936:51-88). These central village sites can then be taken as the points for which to calculate the various neighbor scores (on Boyowa in the Trobriands this includes the villages of Omarakana, Kabwaku, Olivilevi, Gumilababa, Kavataria, Sinaketa, Giribwa, and Vakuta; on Tikopia the main settlement of the Faea and Raveŋga clusters, and Namo, Potimus, and Tai). These data are depicted in Figures 5.10 and 5.11, with the data from Tikopia as pink crosses, those from Boyowa in the Trobriands as green crosses, and the Final Neolithic Cyclades as red circles. Figure 5.10 can be dealt with briefly, demonstrating, as it does, how the Final Neolithic sites in the central Cyclades — Ftelia, Grotta, and Koukounaries — are relative outliers. As has been emphasized previously, these do not fit into the overall pattern; this aberration is worthy of further investigation if we consider that the Grotta-Pelos system of organization, largely analogous to its Kefala-phase predecessor, seems to have gradually spread to these very islands (Paros and Naxos). In terms of material it seems hard to dispute that these sites exhibit material which is certainly post-Saliagos in date — the question of what sort of social organization these outliers represent is one to which we will return.

The most important aspect of this bivariate plot is illustrated in Figure 5.11; namely, that there is a strong positive correlation in the ethnographic data between nearest- and next-nearest-neighbor, and that the archaeological data and ethnographic data — excepting the noted outliers — cluster in the same area (r square = 0.64870). This demonstrates similarities between the modes of settlement distribution: that binary clustering does not occur; that no site is further than 15 km from its nearest-neighbor; and that all sites fall within the ideal 20 km daily range for a paddled canoe which, incidentally, is considerably less than the maximum range of a Pacific sailed canoe (e.g., Irwin 2010). The range of maritime transport may be a much less significant factor considering that these data represent settlements on individual islands rather than island groups (Kea, Andros, Boyowa, Tikopia) in which moving between sites via terrestrial routes may often have been the preferred, or the only, option. Plotting the data in this manner reveals that settlement on Tikopia — tiny and isolated — clustered more densely than on Boyowa, or in the islands implicated in the Final Neolithic Cycladic settlement pattern. The Trobriand data and the Cycladic data, however, largely plot over one another (Figure 5.11). That is, the pleasures and stresses of having one's neighbors at a certain distance were largely uniform both within the Trobriand ethnographic present and the northwestern Cycladic Final Neolithic, and also between them.

This leads to some fruitful speculation, based on our knowledge of how Trobriand society was organized. From Malinowski's work and that of subsequent anthropologists (e.g., Brunton 1975), it is clear that life on Boyowa was centered around the village or hamlet as the locus of daily activity, craft production, and familial and ritual life. Each settlement was not, however, isolated: in particular, genetic or fictively-genetic relationships were maintained between settlements with accompanying formalized social obligations. There is no need here to dwell at length on the concept and material of *kula*, but this system of formalized exchange also created individual-to-individual relationships between settlements. It is not necessary to speculate on the origin of these formalized inter-community ties, but simply to note that they existed. Intra-island exchange seems to have been conducted on a relatively *ad hoc* basis; however, inter-island interaction (the main theme of Malinowski's work) was large-scale, highly organized, symbolically charged, and articulated differences in status both within, but also between, groups. As regards this last remark, also noteworthy is the presence of social stratification in Trobriand villages; not as highly stratified[10] as their Polynesian counterparts, but with some senior members of society and their lineages with greatest access to real and symbolic capital, particularly but not only in the *kula*.

There are, depending on the level of credulity we wish to adopt, possible signs in the material record that approximately similar social dynamics premised on status and exchange may have operated in the late fifth and fourth millennia in the northwestern Cyclades. Considering the nature of the data on small, ephemeral sites such as Mikroyiali and Vriokastro, it is impossible to speculate on the degree of interconnectivity between such sites. It is illuminating to consider a site such as Kefala, however, in some detail; the hamlet — and the cemetery — presumably remained the focus for mundane activities, and this is certainly evidenced in the record. Food-processing, burial activities, and perhaps weaving and cheese-making were all occurring at the site. Despite the evidence for varied on-site domestic activity, it seems impossible to imagine Kefala existing in isolation such as — perhaps — is more credible for Late Neolithic Saliagos, or Early Ceramic I Trants. Kefala would, at the very least, be demographically unviable at fewer than one hundred individuals, and this holds true of the other small Final Neolithic sites, if they are comparable to Kefala itself. Certainly, the copper recovered during the excavation was not derived from the immediate hinterland: Kefala was linked in some meaningful sense to other aggregates of population. If Paoura and Sykamia are indeed synchronous, it is again hard to imagine that

[10] In Figure 5.9, the fit-line could also fit with relative social stratification, with the greatest degree of social stratification in the Polynesian 'chiefly' society of Tikopia decaying to apparently egalitarian Saliagos-phases systems in the upper reaches of the plot. This raises an opportunity to consider the correlation between demographic growth, settlement density, and the development of social complexity in cross-cultural context; there is no opportunity to do so in the text here, but the exercise may be productive.

some social ties did not exist between these neighboring populations considering their basic proximity. Whether such ties existed between, for example, Paoura and Ayia Marina on Andros, is a problem of a different scale. This is largely a topic for the network analysis which is presented below, but it is less easy to conceive of a reason that sites such as Kefala and Ayia Marina were in meaningful, continuous contact that was not mediated through some larger or primary center.

This consideration brings us back finally to a point made at the beginning of this chapter: that social stratification may be reflected in spatial stratification. Settlement-hierarchy analysis is not undertaken in this chapter, and deliberately so: in both the Caribbean and the Aegean, precise data about the physical extent of some sites, and so their relative position in settlement tiers, is lacking. In either case, there is very little evidence to suggest that in the Late Neolithic of the Cyclades, or the Early Ceramic I and II of the Leewards, self-evident settlement tiers existed (the sites of the Anguilla Bank in the Early Ceramic II may form an exception to this); for sites where the full extent can be approximated — such as at Indian Creek, or Hichmans — site size is comparable. The only dataset for which this is not the case is that for the Final Neolithic. Accepting that our knowledge of the full extent of Ftelia, Koukounaries, and Grotta in their Final Neolithic phases is incomplete, this leaves a host of small sites along the Kefala model, and Strofilas. The size of Strofilas (2.5-3.0 ha; Liritzis 2010:1368) dwarfs any other settlement. Not only simply qualitatively different, it also appears to have been a focus for activities which are comparatively underrepresented at contemporary sites – copper working is evident, and the presence of a gold bead, alongside figurines and pecked depictions of vessels and birds, is notable; the only other gold object in the Cycladic Neolithic is derived from the Final Neolithic deposits in Zas (Zachos 1996, 1999).

The existence of Strofilas, and many smaller sites around it — Ayia Marin, Rethi, Vriokastro, Kastri, and Mikroyiali — means that we can demonstrate the presence of a two-tier hierarchy. It is unclear whether Strofilas was the sole Final Neolithic site in the Cyclades which achieved this size (and this behavioral variety) in the fourth millennium, or whether it was peerless, although the latter seems extremely unlikely. What this does at least seem to indicate is the likely existence of a greater degree of social stratification in the Final Neolithic of the Aegean than in the Late Neolithic (this correlates moderately well with the architectural phasing at Ftelia, if we accept that increased storage capacity denotes increased differential access to cereal wealth). It is unlikely that the relationship between tier two sites (e.g., Kefala) and tier one sites (Strofilas) was entirely equal, considering the concentration of actual and symbolic wealth in the second tier. By implication, the relationship between certain individuals in these two centers cannot have been entirely equal. Whether or not this unequal, yet demonstrable, series of interactions resembled ethnographic examples from spatially-comparable societies is unclear. What does seem to be the case is that significant differences begin to appear between fifth millennium and fourth millennium ways of interacting in the Cyclades. In the Late Neolithic Aegean, distances were further, inequalities absent — similar, perhaps, to modes of engagement in the Early Ceramic I and II Caribbean. By the time Strofilas had been established, villagers may have known their near-neighbors well, with genetic and other formalized ties, but the gulf between islands was as wide as ever. When it was crossed, that crossing may not have been welcome news. The question of distance, its conquest, and identities of the winners and losers in this conquest forms the next theme in this chapter.

5.4. Networks and Relative Interaction in Small Island Archipelagoes: The Leeward Islands

In the previous half of this chapter, we saw evidence to suggest that the distribution of people and their settlements in both areas under study was nonrandom; some tentative suggestions were made about the nature of the interactions between these nonrandomly distributed sites, based on their size, composition, and organization as part of a larger system. Here, I delve further into the organization of settlement, by modeling this interaction — that is, based on certain sets of knowledge, establishing the likelihood of the intensity of exchange between two given sites. This both builds upon and complements implications drawn from the foregoing density analysis, and conclusions drawn by other researchers.

The state of research in both cases is such that we may be reasonably sure certain types of artifact were moving between sites. The copper on Kea and Andros mentioned above is one example (copper not being native to either island), but Long Island chert and Melian obsidian are two further obvious cases in which the presence of either material in other parts of the archipelago indexes medium-distance acquisitive voyaging, down-the-line exchange, or a range of behaviors in between; this distribution, regarding which we can have a definitively exact knowledge, is explored in the first part of Chapter Six. As discussed in Chapters Three and Four, though, there are a number of classes of shared material culture — not least pottery, and lithic typologies — which suggest sustained contact in both archipelagoes in post-colonization phases. The relative absence of archaeometric evidence in both cases means that alternative methods for modeling the organization and intensity of inter-site contact — hence accessing issues about inter-site relationships and ideally thereby social organization — must be used. In the following analysis, a gravity model of inter-site relationships is constructed for both areas to form a network of putative interaction. These ideal networks are then iterated twice, at different scales of tolerance of weak links, to model how hubs may or may not have emerged in both settlement systems.

Gravity-based models have a long history in the social sciences (e.g., Anaya Hernandez 2003; Butzer 1982:215-216; Hodder and Orton 1976:185-195; Tobler and Wineburg 1975; Wilson 2007). The principle underlying their construction and use is simple: entities with greater mass are more attractive to other entities than those with less mass, and two entities situated closer to each other than farther are, all other things being equal, more attractive to each other than comparable entities situated farther from each other. Distance as a concept is one which we can readily imagine to have an impact on the conduct of human group relations (although varied modes of moving over distance complicates any calculation). Mass, however, is a separate issue: here it equates to the aggregate attractiveness of a point or site in relation to settlements and individuals outside of it. We can imagine that several variables may render a site attractive: presence of or advantageous access to material resources, finished goods, or symbolic capital are good examples, but so might be the presence of a wider pool of potential mates or the offer of safety in times of social unrest. Put crudely, we might expect a higher degree of interaction between, for example, Early Ceramic II Trants and Indian Creek as large, close sites with access to varied resources, than between Trants and Anguillan Rendezvous Bay. In any given situation it is most readily defensible to base the calculation of mass on factors which we can demonstrate, or reasonably assume, to have been socially significant. Having done so — the calculations are laid out in detail in Appendix 1 — and knowing the distances between any given set of points we may use any of a series of equations to calculate the likely degree of attraction between two sites. The equation used here is:

$$I_{ij} = k((P_i \text{ x } P_j)/(D_{ij}))$$

where $_i$ and $_j$ are given sites, *I* is degree of interaction, *P* is population (mass), *D* is distance, and *k* a constant (=2). In this instance, we need a mode of calculating *P* values which reflects likely social concerns in both the Neolithic Cyclades and Early Ceramic Leewards, avoiding likely culturally-specific concerns. This analysis largely follows the example set by Knappett *et al.* (2008, 2011) in taking site size as a proxy for population and likely behavioral variation within that population to be a key variable. This analysis, however, makes the further assumption that island size may also be a pertinent concern in both cases — it is not trivial to suggest that a large island with a varied pedology and geology (Naxos, Antigua) would have been more attractive than a small, depauperate island (Antimelos, Redonda), and settlement distribution in both archipelagoes bears this out. In this model then, a large site on a large island will have a far higher *P* value than a small site on a small island; again, exact systems of scoring sites are outlined in Appendix 1. Having calculated *P* values for all sites in both the Aegean and Caribbean cases – with the scoring systems remaining the same to allow for comparability – *D* values can then be tabulated, providing a score I_{ij}. In this particular model, because of the requirements of the software used when dealing with very small integers, I_{ij}

values were multiplied by a factor of a hundred – again across the dataset, comparability remaining unaffected – and then plotted visually.

The raw outcome of such an analysis is demonstrated in Figure 5.12, which depicts the raw I_{ij} values for the Early Ceramic II Leewards. It can be immediately seen that a number of key relationships emerge, but that the model requires refinement. The I_{ij} value for Golden Rock and Smoke Alley, for example, is larger by almost an order of magnitude than the next nearest score. This is solely because of the very close proximity of the two sites; it does, however, have some social correlates. The massive degree of interaction predicted between these two sites makes it inherently unlikely that there was any meaningful degree of social separation between them. If it can be reasonably assumed that they represent, in essence, the same center of population, then we can aggregate them and re-run the analysis; this second iteration is illustrated in Figure 5.13. This is a cleaner version with the removal of the Eustatian data, which confuses the current analysis, but is still inadequate. First, although the putative Early Ceramic II site on St. Kitts is depicted, it has not yet been included in the analysis, skewing the gravitational relationships between, most obviously, Hichmans and Golden Rock. Barbuda remains excluded from the analysis based on inadequate radiometric data — however, as will be seen in the ensuing proximal point analysis, a population on the island is probably implicated in a close relationship with Antigua.

The more severe problem is how to gauge the social meaning of very low interaction values. Considering Figure 5.13, we might agree that very intense interaction between sites on the Anguilla bank (Anguilla, St. Martin, Barths, and neighboring islets) was likely; indeed, arguments by Crock and Petersen (2004) suggest that the gravity model, even in this initial phase, corresponds to very intense engagement and resulting social processes in the first millennium. Similarly, Hichmans as a point of mediation — between the volcanic islands to its northwest, and Antigua and Montserrat (once again, punching above its weight) — makes sense, both intuitively, but also arguably archaeologically, considering the strong parallels between ceramic types seen between this site, Indian Creek, and Trants (e.g., Figures 4.1-4.14 and 4.7). It is, however, hard to rationalize the consequences of very low values. For example, that between Royalls and Forest North (I_{ij}=8) or between Trants and Hope Estate (I_{ij}=18). It is highly improbable that any direct contact, unmediated by intervening centers, was occurring between such distant sites with such relatively attractive intervening neighbors. That is, comparatively low interaction values should probably be best understood as indicating a probable absence of direct interaction, at least according to the model. To move beyond this apparent limitation it is constructive to borrow some concepts from the study of complex networks.

The method and theory of complex network studies do not immediately lend themselves to archaeological analysis. The primary reason for this is the paucity and inexactitude of archaeological data compared to datasets routinely employed in network studies, which have a tendency to be massive, exactly quantifiable, and moreover to exist in a series of definite iterations over a period of time (e.g., Barabási 2002, 2009; Miller and Page 2007; Watts 1999); the nature of archaeological data does not lend itself to this sort of approach. There are, however, some key observations in network studies that allow us to begin to make sense of the sort of data that gravity models generate. Firstly, it is inherently unlikely that every node in a given network is connected to every other node, which is the configuration of the model in Figure 5.13. As networks grow, some key nodes become more attractive by virtue of having an advantageous position within the network and attracting more connections at the expense of more isolated nodes. We can access these nodes, and remove extraneous noise from the data, by conceiving of the gravity web as a network with certain degrees of tolerance, meaning the recognition that certain types of link (i.e., those with interaction values below a certain threshold), are meaningless in social network terms[11]. In Figure 5.13, tolerance is essentially set at zero. In subsequent iterations of the gravity web for the Leewards and the Cyclades, tolerance thresholds are set at 20 and 50, connections with interaction values lower than these thresholds being excluded. These thresholds, it should be stressed, are arbitrary; setting thresholds at natural breaks, Jenks breaks (Jenks 1967), and so on may also be revealing. As the scoring process from which these values are derived is also arbitrary, however, setting arbitrary thresholds is not problematic. More importantly, doing so reveals some extremely interesting patterns, which are discussed shortly.

The utility of imposing thresholds on the data is illustrated in Figures 5.14 and 5.15. It was observed previously that the Early Ceramic I data for the Leewards are so scarce as to make density analysis largely meaningless. The same can be said for gravity modeling of these data, although there are actually very good reasons, discussed at the end of this chapter, to suppose that this reflects an actual underlying phenomenon. Figure 5.14 depicts the weighted gravitational attraction between the sites; La Hueca is included as, despite lying outside of the immediate area of analysis, it is almost certainly implied in the Early Ceramic I colonization of the wider area. When I_{ij} values are demonstrated, however, it becomes clear just how weak are the links between the three sites in question. The connection between La Hueca and Trants is so weak as to reference an absence of interaction. This is problematic, as not only does the presence of ZIC at Trants presumably indicate some knowledge of La

[11] This is not to dismiss the role of weak links, which can cause the retention of connectivity in otherwise poorly connected networks; Miller and Page 2007; Watts 1999:15.

Huecan traditions, but the lapidary industries are also very similar. The role of Hope Estate as a point of connection between the two former sites is, then, intriguing in this case — are we witnessing interaction between Puerto Rico and the southern Leewards mediated via the Anguilla Bank? If so, how might this explain the divergent horizontal and stratigraphic distributions of ZIC and WOR at these three sites? The fascinating possibility of interaction between the Greater and Lesser Antilles in the earliest phase of their colonization by horticulturalists being oriented along the island arc and based on a fulcrum on St. Martin is supported by proximal point analysis, and the likelihood is considered in more detail in Chapter Seven.

So much for instances in which combined gravity and network modeling is less than effective. We are now in a position to explore the extent to which such modeling allows us to make sense of the archaeological data for the Early Ceramic II and for the Cycladic Neolithic. Figure 5.15 depicts the gravity network for Early Ceramic II sites (still excluding an Early Ceramic II site on St. Kitts because of the lack of radiometric data from Sugar Factory Pier; Fitzpatrick 2006) in the Leeward Islands excluding all network links where I_{ij} falls below 20. Immediately some connections become more obvious. The proximity of Royalls and Indian Creek, and their fortune to be situated on large Antigua, makes for a very strong connection —although, as noted in the density analysis, they are as far from each other as possible on a north-south axis (if we were to play games and divide Antigua into two islands between them, each would be the sole site on an island the size of Montserrat or Nevis). The importance of Hichmans and Trants as emergent nodes is underlined, with five and four substantive connections respectively, and the same can be said for Golden Rock, with a high of seven (although four of these are comparatively weak). The central problem with this run of the model is that the vacuum on St. Kitts becomes increasingly obvious, situated as it is between two hubs. There is, as we have seen, good reason to suppose that, despite a lack of radiometric data, Sugar Factory Pier may well belong to the Early Ceramic II. Figure 5.16 represents the inclusion of this site in the analysis. Immediately, St. Kitts emerges as a central player, chiefly by virtue of its size (total extent for the Sugar Factory Pier site is lacking, so it necessarily receives a low score in that regard), not only in terms of its immediate neighbors but also generating weak links to Antigua and the dense complex on the Anguilla Bank. This latter — the dense network of strong links between St. Martin and Anguilla — is obviously worthy of extended comment.

When the tolerance threshold is increased to 50, as in Figure 5.17, the outcome is noteworthy. Most obviously, Trants becomes a vital node in retaining connectivity in the southern part of the archipelago, with an equal high (three) off-island links. This is, of course, excluding giant Guadeloupe to its south — which may well have attracted links, if included in the model — and also Barbuda which would have been linked to Montserrat via Antigua. The possibility of a central role in communications is underscored if we consider Montserrat's intervisibility as regards Antigua, Guadeloupe, and Nevis, but the only sporadic intervisibility between Antigua and Nevis. Describing 'sea deserts' in such a small and dense archipelago may seem a definition too far, considering the various evidence for considerable Amerindian technological competence in voyaging, but it remains the case that the high island of Montserrat bridges something of a gulf. If not for Trants, the relationship between the outer and inner arcs would look much more like a putative relationship between low-lying Barbuda and St. Barths. The linking of these major Early Ceramic II sites — Indian Creek, Trants, Hichmans, probably Sugar Factory Pier, and Golden Rock is all the more interesting in that there are extremely strong stylistic parallels in the WOR assemblages from each site, in a way which is not necessarily the case for WOR-using sites to the south. One potential reason for this is illustrated in Figure 5.18. While knowledge of the range of pre-Columbian watercraft is based on some informed guesswork, it seems likely that 20 km represents a (rather conservative) estimate for daily travel (the impact of oceanographic and meteorological conditions on canoe voyaging is considered in Chapter Six). The unified buffers in this figure, overlying the gravity network, demonstrate maximum daily range from the Early Ceramic II sites based on this value. This readily indicates that the high islands from Saba to Nevis are, at a push, in daily reach of one another. Montserrat and Antigua are rather different propositions, and potentially represent much more serious undertakings. This simple technique, in conjunction with density and gravity modeling, suggests that a voyage from Hichmans to Trants would not have been a totally casual affair, considering a potential night spent at sea.[12]

Figure 5.18 underlines a pattern evident in Figure 5.17, namely the chronically introspective nature of sites on Anguilla and St. Martin; even if Fountain Cavern is excluded from the analysis as (probably) not a site of settlement, an approximately similar pattern obtains. This is a function not only of the dense cluster of islands in this archipelago and their comparative isolation from their southern neighbors, but also the archaeological reality of a higher number of Early Ceramic II settlements per island area. It is unclear why this might be, but it may — possibly — be a signature of a process which, in the Late Ceramic, seems to have led to increased social complexity on the Anguilla Bank. Crock (2004) has argued at

[12] In this context, the find of a quadriform celt in the Antigua Museum, with an alleged provenance of Redonda, is interesting; Redonda could, despite its imposing topography, have functioned as a stopping point when traveling between the islands. Detailed archaeological work on this island would generate useful data at little cost.

length that both portable material culture and settlement evidence suggests that, after the Early to Late Ceramic transition, a 'chiefdom' emerged on the Anguilla Bank. In this model, the incipient complex societies on Puerto Rico — what would become the *cacicazgos* of the contact period — are heavily implicated, with the Lesser Antillean chiefdoms an outgrowth of this process. Without wishing to take issue with definitions, the argument for increasing hierarchical social structures in the northern Leewards during the later first and second millennia is strong. Conceivably, the intensely internal focus suggested by the gravity analysis reflects a situation in which the populations of settlements were interacting on increasingly less egalitarian terms in the first half the first millennium AD. What we might be witnessing in the abstract is the development of divergent modes of living in the southern and northern Leewards, with the emergence of a broad interaction sphere between Saba and Antigua contrasting with emergent inter-site inequality in the densely-settled northern islands. Similar processes may be at work in the Final Neolithic of the Aegean, and both cases pose the broader question of the relationship between demographic increase, social stress, and emergent hierarchies.

In this context, and before moving on to the Aegean data, it is important to present the implications of proximal point analysis for the Leeward archipelago, as it underlines patterns both in the archaeological data and the foregoing analyses, and provides clues as to why these patterns may have emerged. As proximal point analyses have been used before with some success in island archaeology (Terrell 1977; Broodbank 2000:180-195), a lengthy explanation of the reasoning behind such analyses is not necessary here; Appendix 2 details the exact method of calculation used in this instance. In essence, however, proximal point analysis aims to model the changing connections between sites in a configuration as demographic increase causes more sites to appear over time, with each site arbitrarily permitted three connections to its three nearest neighbors; the number of sites generated for each island is a function of island size. Figures 5.19-5.22 depict a proximal point distribution for the Leeward Islands over four temporal iterations.

Such an analysis is solely heuristic, but the extent to which it, in certain cases, parallels patterns seen elsewhere is revealing. PPA1-2 are almost analogs of the settlement system seen in the archipelago in the Early Ceramic I and II, with very few large sites dominating. Two primary and two secondary considerations may be made about these phases of the model. First, most trivially, Saba, Statia, and Barths are demographically marginal because of their small size; this clearly does not reflect the archaeological reality during the second phase of the Early Ceramic. Less trivial but still relatively uninteresting is the relative isolation of Barbuda, incorporated into the system only thanks to the proximity and mass of Antigua. More important observations are the nodal position of a large, single site on Montserrat, especially in PPA2. Guadeloupe (as well as Anegada) was included in this analysis, yet the single Montserratian site cleaves rather to Nevis and Antigua (in Chapter Six it will become increasingly clear just how attractive Antigua must have been, along a series of axes). A second important fact to consider is the retention of a link, in PPA1-3, from Anguilla outside of the archipelago to, in this case, Anegada; this is essentially because of the distance of Nevis and Barbuda from Anguilla. This is illuminating in the context of the Figures 5.14 and 5.18. Based on the gravity analysis depicted in Figure 5.14, it was proposed that connections between Trants and La Hueca may have been mediated through Hope Estate, based on relative interaction scores. The fact of Anguilla’s retention of links to Anegada and the Virgin Islands and thereby to Vieques is thought-provoking in this context, possibly reflecting the existence of networks converging on the Anguilla Bank in the Early Ceramic I. The subsequent development of hierarchical social systems on Anguilla and St. Martin has also been discussed in the context of gravity modeling (Figures 5.17 and 5.18), as has the relationship between this emergence and the proximity of these islands to Puerto Rico. Could the western link retained by Anguilla hint at the mode of transmission of exotica flowing out from the incipient complex polities in the Greater Antilles to be redeployed in local contests for status in the northern Leewards?

The gravity-based network analysis of interaction in the Early Ceramic II Leewards Islands suggests that the patterns seen in the archaeological material may reflect developing (and also differing) strategies of spatial organization, and thereby social organization. The question of the relationship between these patterns and changing subsistence strategies will form part of the subject of Chapter Seven. In the following and concluding section of this chapter the emergent networks of the Leewards are compared and contrasted to their peers in the Neolithic Cyclades.

5.5. Networks and Relative Interaction in Small Island Archipelagoes: The Cyclades

When modeling the possible gravitational attraction between sites in the Late and Final Neolithic sites of the Cyclades, the same cross-cultural attractive elements were taken into consideration as in the Caribbean run of the analysis (Appendix 1). In the simulation for the Late Neolithic data, Zas and Vouni were excluded from the analysis for the same reasons as outlined previously; similarly, a mooted settlement at Agrilia was included in attempt to see how viable a permanent occupation of Melos seems when compared to results across the archipelago. The results of this analysis are presented in Figures 5.23-5.26.

Figure 5.23 demonstrates the basic results for a run of the analysis with the tolerance threshold at 20. Immediately the centrality of the Naxos-Greater Paros group becomes obvious. What is moderately surprising is the relative isolation of Minoa on Amorgos and Akrotiri on Thira, barely connected to the central hub and not at all to one another. This is, in part, a function of these sites being awarded low scores for total size, necessary, but not entirely fair: total horizontal extent of each site during the Late Neolithic is unavailable. In that sense, the analysis is unavoidably skewed towards Saliagos and Ftelia. That said, the results for these sites do illustrate how important Naxos may have been, not only in and of itself, but as a point of mediation between outlying Saliagos-phase settlements. Considering both the regularity in spacing seen in the analysis in the first part of this chapter, and now subsequent network modeling, the absence of a Saliagos-phase settlement on Ios is odd — what made Thira a more attractive alternative? This may, in part, be dependent on environmental factors (Thira must have been biogeographically more attractive prior to the final eruption in the second millennium) or social factors, or the absence of intensive archaeological prospection on Ios. Unsurprising is the outlier status of any site on Melos, barely connected to Saliagos, its closest neighbor. This, and foregoing analyses, serves to emphasize just how isolated any permanent settlement on that island would have been during the fifth and fourth millennia, approaching Knossos-like levels of insularity.

Figures 5.24-5.26 explore in greater detail the dominance of the central Cyclades, with the tolerance threshold moved up to a value of 50. This higher threshold results in the disappearance of outlying settlements — Akrotiri, Minoa, Agrilia — but the central core of

Saliagos, Koukounaries, Grotta, and Ftelia remains completely unaffected. These latter four sites have amongst some of the highest gravitational scores in any of the analyses run, and their proximity only exaggerates the degree of interaction. This is all the more interesting in that, unlike sites such as Minoa and Akrotiri (very little Late Neolithic data) and Paoura and Agrilia (uncertain Late Neolithic data) these sites were almost certainly all large villages of no fewer than one hundred individuals, very probably contemporary. While not as closely packed as the Final Neolithic settlement system of Andros or the same area during the Grotta-Pelos phase, Figure 5.25 reveals the relative ease of canoe-travel between the sites, again using the value of 20 km as a feasible daily range. Perhaps, at a push, Grotta was within a day's hard paddling from the southern coast of Mykonos, with a following wind (oceanographic factors are considered in the subsequent chapter); this would bring the sea-goers within reach of Koukounaries, Saliagos, and also Zas. What is especially notable within this model is the absence of any obvious hubs; while the Naxos-Greater Paros axis may be seen as a form of 'mega-hub' for outliers such as Akrotiri (e.g., Figure 5.23), with the threshold of tolerance increased to 50, all the sites in the central archipelago retain 3-4 links (finding parallels in Broodbank's proximal point analysis for the Cyclades at his stage 2; Broodbank 2000: figure 53). This may be taken to indicate that no single site dominated any interactions between them, although admittedly Koukounaries' central position certainly looks advantageous (Figure 5.26). The retention of comparable numbers of links between these large central sites suggest a lack of stratification in the network derived from the gravity model, and this is mirrored in the archaeological record. There is no evidence for intra- or inter-site hierarchies prior to the very late (fourth millennium) deposits at Ftelia, and increased evidence for storage at that site (Sampson 2002); this is in stark contrast to the model for the Final Neolithic, considered below. It is also of interest that the sites are not located so closely to one another that daily inter-site contact is a reasonable assumption, and that access to large hinterlands are retained.[13]

The outcome of this analysis, at least for the Late Neolithic phase of the archipelago, has illuminating parallels and contrasts to the data for the Early Ceramic of the Leewards. The configuration of each archipelago makes for the formation, in the model, of differently organized zones of interaction, with hub sites potentially of more relevance in the Caribbean system. There, are, however, telling similarities: in both contexts large villages, ideally situated on large islands, seem to retain strong degrees of interconnectivity, yet are not within easy reach of one another — in the Aegean and Caribbean, accessing neighboring populations would not have been a casual, very short-term undertaking. As we have seen, this reflects strong regularity in settlement-distribution in both cases. In the settlement organizations, moreover, there is very little evidence for the development of hierarchies in either system: these villages seem, all else being equal, to be peers. Considering the ecological catchments of both modes of organization and evidence for insular-generalist patterns of subsistence within each, it seems hard to imagine that exchange of surplus or specific food resources was a central concern in this common distribution.

Demographic viability is considerably harder to access, both because of problems of demographic modeling in prehistoric contexts and because of the impossibility of reconstructing kinship systems or cultural behavior about intra-lineage intermarriage in either case. Mooted populations for villages the size of Trants or Saliagos (very generally, between perhaps 100 and 300 individuals) would technically be viable in isolation, although it is most

[13] The Erimonisia are decidedly liminal in this analysis (e.g., Figure 5.23). If Zas, or an as-yet undiscovered Late Neolithic site in southeastern Naxos, were included in the analysis, they would become central to the axis out of the central Cyclades and towards Amorgos and Anatolia; cf. Broodbank 2000: figures 39 and 40.

unlikely that this would be socio-culturally desirable. The retention, in both cases, of very similar suites of material culture, and in particular ceramics, may provide a clue. If we assume ceramic production to have occurred in both instances at the level of the household, and moreover to have been a gendered task, then we might reasonably expect exogamous modes of living to produce larger, more homogenous stylistic zones, whereas endogamy could conceivably result in increasing heterogeneity over time. The existence of the *koine* of light-on-dark and WOR certainly could be derived from other behaviors, and more work is required on the relationship between exogamous modes of living and the development of stylistic suites, but there must have been a means in both archipelagoes for the retention of commonality in the creation and decoration of pots. At a more basic level, injection of fresh genetic material is generally profitable not only for human populations, but also for domesticates, although this would of course not feature in the horticulturalist villages in the Leewards.

In the Early Ceramic I and II of the Antilles and the Late Neolithic of the Cyclades, obvious ecotonal and geographic differences notwithstanding, there seems to be some patterning in the models of the interaction between nodes of human settlement. These degrees of interaction are substantiated by the archaeological data, in as much as is possible. Considering the limitations imposed by island living, the Neolithic mode of production, and demographic imperatives, this patterning may indicate underlying and long-term processes at work. The issue of whether this is true is returned to in Chapter Seven, when the issue of post-colonization time-depth is also introduced. Before doing so, and before moving on to consider the impact of environmental — as well as human — factors in these distributions, we need to address a case in which a very divergent result can be seen; network-models of settlement ecology in the Final Neolithic of the Cyclades.

As with the previous two gravity analyses, two thresholds were added to the interaction data for the Final Neolithic sites in the Cyclades, transforming a latticework (with every node connected to every other) into something approximating a network; as previously, the same mode of calculating gravitational scores was used (Appendix 1). The first run of the model at a threshold tolerance of 20 is illustrated in Figure 5.27. The data here are very noisy, and there are some generated interactions which seem inherently unlikely: connections between, for example, Sykamia and Grotta, or Kefala and Mikroyiali, are probably archaeologically erroneous, with the analysis producing them because of the size of Andros and Naxos. Some elements do require comment, however. Based on the density analysis in the foregoing part of this chapter, it is unsurprising that Andros and Kea produce such dense webs of interactions — at this tolerance, no hubs which may have mediated this interaction emerge. Despite this, and the absence of any intervening settlements on Tinos and Syros, connections are retained with distant sites on Naxos, Ftelia, and Greater Paros (perhaps, considering sea-level stabilization in the fourth millennium, simply Paros at this point) — this is due primarily to the massive mutual attraction of Andros and Naxos, the largest of the Cyclades. This is very interesting in the context of both unconfirmed Neolithic data in the archipelago, and the final distribution of Grotta-Pelos settlement (Broodbank 2000: figures 34 and 43). These suggest that Syros may well feature a Final Neolithic component, and that Grotta-Pelos (i.e., Early Cycladic I) settlement forms a dense rash across the central part of the archipelago. Operating on the assumption that Kefala-phase movement into the archipelago seems to be least recent in the northwestern area, and that this may reflect actual movement of a population originating on the Greek mainland, we may conceive of the size and attractiveness of Naxos as drawing the Final Neolithic colonists further into the archipelago, along the Andros-Tenos/Syros/Mykonos-Naxos axis. It should be mentioned that if Attika and quasi-insular Euboia were included in the network model, then this axis would extend back to the Greek mainland.

The existence of a basic settlement hierarchy — the only one encountered in all the datasets — has been noted for the Final Neolithic. Specifically, Strofilas dwarfs its neighbors, although we have no idea of the size of more distant Koukounaries and Grotta in this phase. When the tolerance threshold in the network is raised to 50, something startling happens (Figure 5.28). The small Final Neolithic sites across northern Andros become highly insular, losing all external links, although inclusion of Euboia may have altered this this apparent introspection. Kea becomes, if less insular, only so because of one site on Andros which now emerges as a classic and dominant hub: Strofilas. All interaction between Kea, Andros, and islands further to the southeast is now mediated through this center; this would also hold true if Final Neolithic sites were confirmed on Syros and Tenos. Strofilas' massive gravitational score is derived from the size of Andros but also the size of the site itself; considering this size, the evidence for fortification, and internal social stratification, this score does not seem unjustified. Figure 5.29 reiterates these data, with maximum canoe range from the pertinent centers overlaid. This produces some observations which chime in accord with Strofilas occupying a (deliberate) central position in this part of the archipelago; within an easy day's reach of Tenos and the far-flung Final Neolithic sites of northern Andros, it is also — at a concerted push — within reach of northern Kea. The gaps in the data lying over Tenos and Syros are ones which may be infilled with future research; the possibility of a

Final Neolithic predecessor to Chalandriani-Kastri is tantalizing. The gulf lying over Tenos may be an artifact of research or, conversely, have some social correlate: was this a developing no-man's land between incipient Final Neolithic colonists on Andros, and remnant Late Neolithic communities in the central Cyclades, stressed beyond tolerance by the increased desiccation of the fourth millennium? In this context it is a productive exercise to consider whether the appearance of the Strofilas canoes — monthly, or perhaps annually — was welcomed by the lookout on the hill at Kefala. Or was the ancestor of the third millennium site at Ayia Irini beginning to assert itself?

The central question regarding Strofilas here is whether the model has produced an anomalous result, or whether the dominance of one site provides some sort of analog for the conditions of inter-island relations in the fourth millennium. It certainly underscores the sheer difference between Strofilas and tier 1 sites, although again, it has to be reiterated that knowledge of fourth-millennium Grotta is very limited. The publication of the Strofilas data is, as yet, preliminary, and this includes the pottery and small-finds; to that extent, the degree to which it attracted people and materials moving throughout the islands, or dominated social relationships on Andros, remains moot. However, in this context, its location on the southern shore of the island — facing the cluster of Final Neolithic activity on Kea (unless that cluster is facing Strofilas) — is intriguing. Whatever the extent to which the population or a subset of the population of Strofilas had preferential access to physical and ideational goods in the terminal fourth millennium, however, this system appears a great deal less equal than those operating in the fifth millennium Aegean or the Early Ceramic Lesser Antilles. The reasons for this, and the merest hint of a parallel in emergent hierarchies on the Anguilla bank, are considered in synthetic fashion in Chapter Seven.

The analysis represented by Figures 5.3 and 5.31 approaches this difference from another angle. In 5.31, the number of connections for all sites (in the Leewards Islands as well as the Cyclades) are plotted with I_{ij}>50. It can be seen that it is usual for sites to have between two and five connections to other sites (the mean is three). Not only is Strofilas remarkable in the number of connections (ten), but there is a gulf separating this site from the other data, rather than a gradual cline. Its isolation from other sites suggests that it lies in a different class as regards site function. This hyper-connected state is demonstrated via a different means in Figure 5.31. Here, the individual weights (I_{ij} values) of each connection for every site (here, the Cycladic Final Neolithic only) are aggregated, and plotted against the number of these connections. Because there is a relationship between number of connections and total overall weight (which might be better conceived here as potential 'flow'), there is a strong positive correlation between the variables, unsurprisingly, being 0.8322. If, however, a density ellipse is constructed (p=0.75) for these data, Strofilas lies well outside of it; it deviates substantially from this ellipse and the fit line, showing that we would not expect a site with such weight/potential flow to have so many connections — a number ranging from five to eight would be expected. This reinforces the interpretation of Strofilas as not only unusual in comparison with its comtemporaries, but also perhaps performing a unique function in the spatial organization of the area in the Final Neolithic. Its greater-than-expected degree of connectivity may well result from deliberate placement of a primate center, rather than gradual organic development. This interpretation is reinforced by the environmental modeling in Chapter Six.

These analyses further delineate the sheer difference between Strofilas and tier 2 sites, although again it has to be reiterated that knowledge of fourth-millennium Grotta is very limited. The publication of the Strofilas data is, as yet, preliminary, and this publication largely excludes the pottery and small-finds; to that extent, to degree to which it attracted people and materials moving throughout the islands, or dominated social relationships on Andros, remains moot. However, in this context its location on the southern shore of the island — facing the cluster of Final Neolithic activity on Kea (unless that cluster is facing Strofilas) — is intriguing. Whatever the extent to which the population or a subset of the population of Strofilas had preferential access to physical and ideational goods in the terminal fourth millennium, however, this systems looks inherently a lot less equal than those operating in the fifth millennium Aegean or the Early Ceramic Lesser Antilles. The reasons for this, and the merest hint of a parallel in emergent hierarchies on the Anguilla bank, are considered in synthetic fashion in Chapter Seven.

The series of models constructed in this chapter are generalizing and — inherently — thereby involve a degree of simplification. Nonetheless, they serve to draw out patterns in the archaeological data which might otherwise go unobserved; the cluster-analysis further suggests regularities of which we might otherwise be unaware. This suite of analyses suggests that in both cases, the existence of other communities was a structuring factor in systems of distribution and, moreover, that as these systems evolved they developed increased complexity. In at least two instances, we might be able to correlate increased complexity in settlement ecology with similar trajectories in social structures, perhaps from an original and immediate post-colonization in which social stratification was not inherent. The co-development of these forms in — possibly — both contexts is of interest, but it is unclear to what extent this is a function of processes specific to behavioral-ecological context. Before considering this in Chapter Seven, a second class of factors which may reasonably be supposed to have an impact on distribution systems is considered in the next chapter.

In this chapter I have, via a number of routes, approached the settlement ecology of both case studies from the assumption that systems of landscape occupation were a function of social relationships. On a very basic level, that this is the case is supported by density analysis; the distribution of sites in both the Cyclades and the Leeward Islands is nonrandom, with sites situated relatively evenly in space. I suggest that this has some meaningful social correlates. A way to begin to tease out these social implications is to consider these data in parallel with ethnographically observed settlement systems, in this case in the ethnographic present of the Pacific. Discussions of a possible relationship between increasing density of settlement and the development of inter- (and intra-site) hierarchies is reserved for the final chapter. I then used a combination of gravity models and Proximal Point Analysis to construct tentative models for exchange and movement in the case studies. A number of observations emerged from this analysis, not least that heavily egalitarian systems seem to experience a tendency toward inequality as settlement systems expand. This is heuristically interesting, but remains at best a series of models. In Chapter Six, I attempt to fill out these models, by considering evidence for the use and movement of natural resources in both archipelagoes.

Chapter Six

Archipelagic Resources: Their Exploitation, Movement, and Implications for Settlement Ecology

It's the world, dear. Did you expect it to be small?

C.S. Lewis, *The Lion, the Witch, and the Wardrobe*, 1950

This chapter builds upon and attempt to unite issues raised in the preceding chapters. In particular, it addresses whether social and spatial organization in both the Cyclades and Leeward Islands reflects preferences for certain types of the insular niches considered in Chapter Two. I begin by examining observed patterns in the distribution of materials throughout each archipelago, assessing whether easily provenienced types of material correspond to any of the network configurations outlined in the preceding chapter. The interest here is whether highly traceable materials — in this case Long Island chert and Melian obsidian — moved around the archipelagoes in manners which suggest certain patterns of connection, and whether these patterns mirror the network models built previously. As both systems of settlement were built by food-producing — but also food-gathering — communities, I then move the focus to pedology and geology, establishing whether settlement may have been located in terrestrial plots which optimized conditions of plant cultivation. I also consider the distribution of coastal and maritime ecologies — mangroves, seagrass beds, and reefs in the Leewards, near-shore runs for schooling fish (and also possibly extinct wetlands) in the Cyclades — as a possible factor in the distribution of early colonists.

Throughout this chapter I return to an idea advanced in Chapter Two. In that chapter, it was argued that human behavioral ecology, and particularly the application of optimal foraging theory to agropastoral and horticulturalist societies, suggests that subsistence strategies of island colonists should reflect a preference for exploitation of diverse food-sources. This is indirectly supported by evidence in non-human species for a tendency to generalize in subsistence practices. Correspondingly, a central theme in this chapter is whether insular generalist strategies of niche-exploitation were adopted in the study areas; if so, whether they are reflected in the spatial organization of settlement; and whether changing spatial distributions of populations over the long-term indexes similarly dynamic subsistence choices.

6.1. Chipped Stone Tools: Trade and Movement in the Leeward Islands

In the prehistory of both the Leeward Island and the Cyclades, certain types of resources and raw materials were moved between islands. If it were possible to identify the sources of these materials, their ultimate destinations, and the modes of transmission from island to island, then we would be able to build realistic networks of movement to flesh out the model networks of Chapter Five. A number of factors, though — not least the extremely complex geology of both archipelagoes, lack of resolution at this scale in isotopic studies (in terms of the movement of organisms), and a general paucity of archaeometric research in the Neolithic of the Cyclades and Early Ceramic of the Leewards — mean that tracing the movement of most classes of material in space and time is problematic. Fortunately, there exist types of resource in both archipelagoes which were heavily utilized, and which also — thanks to the conditions of their formation — have unique geochemical signatures and macroscopic profiles. These are the obsidian of the two flows on Melos and the chert from Long Island, off Antigua, in the Cyclades and the Leeward Islands respectively. The microcrystalline structure of both materials is relatively homogenous compared to other types of mineral in each archipelago, with the consequence that each rock fractures in reasonably reliable ways. In permitting the consistent reproduction of certain forms, this rendered them preferable sources of chipped stone tools in both periods and areas under question (despite fracturing conchoidally, the obsidian from Antiparos in the Cyclades exists only in very small, and apparently undesirable, nodules; Carter and Contreras 2012). The variation and production techniques related to these knapping traditions have been studied in some detail. In the Aegean, the work of Torrence, Carter, Renfrew, and Dixon (Carter 2008, 2011; Renfrew *et al.* 1968; Renfrew and Dixon 1976; Torrence 1982, 1989, 1991) has led to the development of a very complete understanding of the exploitation of obsidian from Demenegaki and Sta Nychia in prehistory; in the Caribbean, research by Knippenberg (2001, 2007) has been central to current interpretations of the use and exchange of Long Island chert.

The traditions of stone tool production in the Neolithic Cyclades and the Early Ceramic Lesser Antilles were extremely different, with the repertoire of the Aegean obsidian knappers relatively more complex than the somewhat expedient industry of the Caribbean stoneworkers (see Chapters Three and Four). That said, their spatial and diachronic aspects may reasonably be expected to be of some use in understanding how lithics and the people who carried them moved between islands and settlements on islands. Pertinent issues here are the extent to which raw lithic material was carried from the point of origin in both archipelagoes, whether stone tools produced from this material were traded or exchanged or used only at a local level, and how these two types of behavior overlapped spatially and over time — this may suggest expanding or contracting networks of exchange, or the existence of discrete zones of interaction. Simple presence and absence of these materials might similarly hint at the existence of socio-geographic divisions (of the sort which emerged from the modeling in Chapter Five) within each study area. The frequency of chipped stone tools with these proveniences, when contextualized within the lithic assemblages from sites as a whole and considered alongside frequencies from neighboring sites, may — or may not — imply modes of access to these resources common to neighboring communities. Finally, proprietorial control, or lack of it, over these resources by certain groups may be suggested by evidence for the spatial heterogeneity of primary and secondary reduction processes. Once expressed in spatial terms, it is possible to relate any obvious linkages or lack of connectivity with the various network models developed in the preceding chapter, to establish whether or not there is a correspondence. This will indicate the degree of validity of the overall modeling.

The genesis of the Lesser Antilles lies in Cenozoic tectonic processes (e.g., Brasier and Donohue 1985; Defant *et al.* 2001; James 2005), and specifically in the ongoing subduction of the Atlantic plate under the Caribbean plate. The long-term dynamics of this process have resulted in a complex igneous and sedimentary geology in the island arc. This includes ongoing geotectonic processes which have subjected this geology to metamorphism that produced, amongst other chert and flint beds, the well-known chert formation on Long Island, Antigua. Long Island is a small island lying in the shallow water off the north-east coast of Antigua; it belongs, geologically, to the Antigua Formation, that part of the island which is derived from sedimentary processes occurring on the extinct Miocene volcanic arc. There are several outcrops of chert on the island (e.g., Knippenberg 2007: figure 4.1), and it exists in cobble form along the northern coast in Flinty Bay, where it is readily accessible. It varies in color from dark grey to honey buff, but the crystalline structure is mostly uniform. It is this regularity which made it a preferred substance for the creation of chipped stone tools during prehistory in the Lesser Antilles.

Long Island chert was first utilized by Archaic and pre-ceramic populations, and preference for it may go some way towards explaining Antigua's density of pre-ceramic sites (Davis 1982, 2000), which is very high when compared to its neighbors (e.g., Cherry *et al.* 2012b; Hofman and Hoogland 2003). It appears to have been equally popular with the horticulturalist populations which colonized the Leeward Islands, who used Long Island cobbles in their lithic industries; these are primarily characterized by expedient multi-polar production of flakes from polyhedral cores. Chipped stone tools deriving from the Long Island sources tend to be ubiquitous in the northern part of the island arc in the pre-Columbian period, with this material clearly preferred over other sources of metamorphic rock for the production of lithics. Knippenberg, in his dissertation and a subsequent monograph (2007), has exhaustively cataloged the spatial and temporal distribution of the use of Long Island chert — amongst other stone resources in the Lesser Antilles — and it is upon his work that the following discussion relies.

With access to many of the assemblages from Early Ceramic sites in the Leeward Islands and beyond and combined with detailed work on the geochemical composition of the stone resources of the island arc, Knippenberg was able to summarize the total distribution of Long Island chert at Early and Late Ceramic sites in question. It should be reiterated here that many of the sites included in his study do not meet the criteria outlined by Fitzpatrick (2006) as regards the reliability of their radiometric dates, despite the probability that several of them probably have solid Early Ceramic credentials (e.g., Sugar Factory Pier on St. Kitts, Anse de Pères on St. Martin). For this reason they are excluded from the ensuing discussion, with the outcome that some of the results do not correspond fully with Knippenberg's results. Additionally, as the focus of this study is on the Leeward Islands, sites in the northern Windwards — notably on Guadeloupe and Martinique — are also not considered. Usefully, Knippenberg's chronological-stylistic division of the Early Ceramic matches closely with the scheme offered in Chapter Three of this dissertation, with the advent of the Late Ceramic at around AD 600 (Knippenberg 2007:16-17).[14]

The most interesting aspect of Knippenberg's work, from the perspective of this study, is his quantification of ratios of Long Island chert tools in complete lithic assemblages, and the qualitative differences within each assemblage which may hint at differential access to the source. First, I will consider how models of exchange and movement in the Early Ceramic can be built from a combination of spatial analysis and evidence for percentage decay of Long Island chert as a component in chipped stone as distance from source increases.

[14] It is confusing, therefore, when later Knippenberg re-defines the Early Ceramic into two phases; 500 BC – AD 400 as Early Ceramic A, while no dates are offered for Early Ceramic B (2007:228). For the ensuing spatial analysis, all sites which have solid chronometric Early Ceramic I and II credentials are included, even if falling by Knippenberg's terms into Early Ceramic B.

Knippenberg, building on work undertaken by Torrence (1989) and Renfrew (1975; Renfrew *et al.* 1968), points persuasively to the existence of fall-off curves in the data. By this is meant that there is a strong negative correlation between increasing distance of a site from Long Island and the percentage of Long Island chipped stone tools within a lithic assemblage from a site (2007:231-238). This appears to conform to the Law of Monotonic Decrement (Renfrew 1977), which indicates linear decay from source. For example, Long Island chert tools as a percentage of total lithic tools declines from 72.3 per cent at Royalls on Antigua to 7.7 per cent at La Hueca on Vieques, a distance of some 400 km. Figure 6.1 shows the relationship between the two variables, with all Early Ceramic I and II sites discussed in this dissertation as red circles; the r-square value is 0.70406. When excluding imprecise chronometric data from consideration, however, the fall-off is not quite so linear as we might expect from considering all data, and this is expressed spatially in Figure 6.4. Beyond Saba, heading in a westerly direction from the island arc and at sites in the northern Leewards, the Virgin Islands, and Puerto Rico, the decline in percentages of Long Island chert is very steep from those islands situated more closely to Antigua (Figure 6.2), mirroring the exponential decay predicted by Renfrew (1975). If, however, we deal with only those sites which lie between Antigua and Saba and exclude data with questionable radiometric credentials, the percentage of Long Island chert within whole lithic assemblages for the whole Early Ceramic increases slightly but distinctly in a southeast to northwest cline (Figure 6.3) with Trants as 60.7 per cent, Hichmans 72.7 per cent, Golden Rock 75.9 per cent, and Spring Bay as 78.0 per cent. This runs contrary to the overall trend seen in the data, and requires some more detailed examination.

Knippenberg accounts for these two factors — the very rapid fall-off beyond Saba, and the contrary positive trend in distance from source and prevalence of Long Island chipped stone between Antigua and Saba — with two suggestions. In explaining the increasing steepness of the decay curve beyond Saba, he posits the existence of zones of supply and of distribution (represented in Figure 37; cf. Renfrew 1975: figure 11). In this model, sites lying between Saba and Guadeloupe in the Early Ceramic had direct access to nodules of Long Island chert in an unmodified state either via direct acquisition from the source, or from down-the-line movement of unreduced nodules — Knippenberg favors the former explanation. The data regarding the presence or absence of cores at these sites is problematic, but the higher frequency of corticated flakes at sites within this area suggests to Knippenberg that primary and secondary reduction processes were taking place within this part of the archipelago. While not necessarily following Haviser's (1999) contention that chipped stone tools were arriving on the Anguilla Bank in the Early Ceramic II fully-formed, Knippenberg accepts that the relatively lower percentage of corticated flakes in assemblages from the north and west of Saba results from prepared flakes rather than raw nodules arriving at these sites from areas of reduction within the supply zone in a down-the-line manner (Renfrew 1975). Knippenberg also provides an account for the apparent tendency sites between Saba and Antigua to have higher percentages of Long Island chert as distance increases from source. He suggests that sites such as Trants, during expeditions to Long Island to acquire chert, also exploited neighboring mineral resources (Knippenberg 2007:237). Why communities on the islands lying between Montserrat and Saba would not be similarly interested in acquiring other types of stone, if the mode of acquisition for these sites was direct access, is not clear. This weakness in Knippenberg's model is considered below

Both these considerations make a degree of sense, yet it is important here to push these further by integrating them with socio-spatial models constructed in the previous chapter. It is encouraging, then, that there is a degree of correspondence between Knippenberg's analysis and the outcomes of prediction from gravity-network and proximal point modeling undertaken in Chapter Five. Knippenberg draws the boundary of his zones of supply (direct access) and distribution (down-the-line exchange) for his Early Ceramic Phases A and B between Saba and St. Martin; Figure 6.1. While his chronological divisions are slightly different to those employed here, if we grant Spring Bay and Golden Rock an AD 500 date, then we may push this boundary so that it extends for the duration of the Early Ceramic II phase employed in this study (AD 1 — 500). This essentially means that, for all sites included in this study, one of two distinct modes of acquiring Long Island chert were in operation. The first comprised a zone including all sites on the Anguilla bank, although it is as yet unclear whether one mode of acquisition was operating for all the sites in this area, or whether primary centers, such as Hope Estate, were exercising control over processes of distribution (some of the sites included in this study are not discussed by Knippenberg due the lack of data concerning lithic assemblages). The second zone included all other sites between Saba and Antigua, probably including the likely Early Ceramic site at Sugar Factory Pier on St Kitts.

In the gravity-network analysis undertaken previously, a socio-geographic rift emerged between the islands of the southern Leewards and the sub-archipelago on the Anguilla Bank, specifically when the network tolerance was decreased so that connections with *i*-values lower than 50 were excluded. This is plotted in Figure 6.5; sites with evidence for primary reduction of Long Island chert nodules (via frequency of corticated flakes) are depicted in blue, and sites with no such evidence plotted in green (note that the site on the north coast of Antigua with little evidence for reduction is Royalls, not Long Island itself). The network depicted is that for a tolerance threshold of 50, and all sites buffered at 20 km, a conservative estimate for one day of canoe travel. This clearly demonstrates that all sites with evidence for primary reduction of Long Island nodules remain interconnected in a linear manner (the data from Royalls are equivocal), while those sites on the Anguilla Bank with no evidence for reduction of cores are similarly interconnected. All the sites to the southeast of Spring Bay on Saba were loci of working of Long Island chert, whereas those to the north and west were not. The Early Ceramic populations of the Anguilla Bank were clearly obtaining their stone tools from a source within this southern network, and proximal point analysis hints at possible candidates for such a source.

In the proximal point analysis undertaken previously, Saba and St. Eustatius have an unusually parochial status until the fourth iteration of the model. In this iteration, by virtue of their size, many of the larger islands become highly insular. An exception is the retention of links between Nevis, St. Kitts, St. Eustatius, and Saba. Crucially, Saba is the only island in the southern half of the Leewards which retains links to St. Martin on the Anguilla Bank. Previously isolated, it becomes, in this model, very central as a hub uniting disparate parts of the archipelago. In Figure 6.6, proximal point analysis in its fourth iteration is plotted against the distribution of sites with evidence for reduction of Long Island chert in the Early Ceramic. In this figure, the relative size of blue circles corresponds with increasing importance of Long Island artifacts as a component within a given lithic assemblage, indicating the southeast to northwest cline. This begins to hint at how we might conceive of the role of Spring Bay — and predecessor and successor sites — in the distribution of Long

Island chert outside of the immediate supply zone. Long Island chert dominates the assemblage in percentage terms here, accounting for over three quarters of all chipped stone. The reasons for this peculiar preference for Long Island material to the detriment of all other available resources is explored shortly; what these data do indicate is that any arrival seeking chipped stone implements at Spring Bay would be likely — sociocultural specifics or taboos aside — to leave Saba clutching something made from Long Island chert.

Figure 6.7 is a speculative attempt to reconstruct a relationship of this sort between Saba and the islands of the Anguilla Bank. As we have seen, these sites were not acquiring Long Island nodules in the raw state, and certainly not from the source itself. The closest point to them, both in absolute terms but also as regards gravity-network and proximal point analysis, is a site at which Long Island artifacts are notably implicated. Tentative exchange links are depicted as hashed lines, with maximum daily travel buffers at 20 km. As discussed in Chapter Five, there is evidence that in the first millennium AD a stratified society was developing on the Anguilla Bank (Crock 2000; Crock and Petersen 2004; cf. Knippenberg 2007: figure 6.3). Accordingly, we might expect that acquisitive processes were regulated in terms of, or impacted by, socio-political organization. This figure does not take into account potential differential access from sites on the Anguilla Bank, which might be implied by the emergence of social and spatial hierarchies. Whatever the internal dynamics of acquisition on St. Martin and Anguilla, the proximity of Saba to them raises questions. Lying outside of any nascent political formation but closer than any of the larger islands to the south, and in possession of a ready supply of the desirable material, Spring Bay (and predecessor and successor sites) is a very promising site for interaction between these neighboring populations, and as a locus of exchange (perhaps transferring chert for St. Martin greenstone; Knippenberg 2007:243-254).

Relative abundance of Long Island chert does not provide the whole story. While it dominates the lithic assemblage at Spring Bay, the number of artifacts made from this material was not — by comparison to larger islands to the south — particularly high, with only 110 chipped flakes deriving from the Long Island source. This suggests that this chert may not have saturated the island in any way comparable to the much larger quantities found at Trants and Golden Rock. If we factor this into the tentative model of exchange between Saba and points north, it is important to note that at no site on the Anguilla Bank included in Knippenberg's analysis does Long Island chert constitute more than half the assemblage. Neither is it particularly common in absolute terms, with the mean number of chert artifacts recovered from sites on Anguilla and St. Martin being 79. If Long Island chert was being acquired from Spring Bay and environs, then it was not moving north in quantities comparable to that in which it was arriving on the island. Such decay may hint at proprietorial relationships with the material, and an unwillingness to meet the inevitably high demand for such a high-quality stone in full. This again suggests that the chert was subject to an exchange relationship, with the flake preforms moving into the Anguillan sub-archipelago in proportion with another resource moving south into the main part of the Leeward Islands.

If considering percentages of Long Island chert in comparison to absolute numbers is useful in delineating possible exchange relationships between Saba and islands to its north, it is also productive in teasing out how the Early Ceramic communities on St. Kitts, Nevis, and Montserrat acquired the material. The on-site reduction of nodules of the material certainly indicates that nodules were arriving in un-tampered form on the islands between Antigua and

Saba. This information is of no use, however, in determining how these nodules were being acquired. The two extreme points on the spectrum of models are down-the-line, site-to-site movement of the raw material versus expeditions mounted by individual sites to the point of origin to satisfy local demand (Knippenberg's position), with the reality lying at some indeterminate point between these extremes. Simple intuition suggests that it is perhaps unlikely that the situation illustrated in Figure 6.8 ever obtained, despite Knippenberg's reasoning; comparatively very distant sites such as Golden Rock presumably had, in the Early Ceramic II, little interest in organizing large-scale movements involving several days' travel to obtain the material from the source *if* there were a more efficient mode of acquiring it. In Figure 6.8 the banded buffers, at 20 km intervals, highlight the difficulty in mounting such an expedition from sites such as Golden Rock. The effects of distance have not only temporal implications (upwards of ten days of travel based on ethnographic parallels; Chapter Two) but also logistical, requiring space for food, water, an effective labor force, and space to transport large and weighty pieces of chert. This multiplies the size of a flotilla to the extent that such an expedition would be a significant social event, thereby, incidentally, becoming effected by logistical concerns that affect all convoys — the larger the flotilla, the more slowly it moves, all other factors being equal. While the model of itinerant craftspersons is attractive, it is unlikely that individual stoneworkers were in a position to mount solo voyages across more than a hundred kilometers of open ocean.

There is reason to be optimistic, intuition aside, that we can choose between these competing factors. Doing so involves considering in more detail the implications of the available quantitative information when displayed in space. It was highlighted earlier that, perhaps contrary to expectations, the proportion of Long Island chert within total chipped stone assemblages increases away from the source in a northwest trend from Trants to Spring Bay. This should not be taken to mean that there is more, by weight or number, of the material as distance from source increases. Figure 6.9 shows the relationship between percentage of Long Island chert as a portion of a given assemblage, and the total number of pieces of the chert from that assemblage. This indicates a clear disparity between Spring Bay, on the far left of the *x* axis with very few pieces of chipped stone from Long Island, versus — progressing along that axis — Golden Rock, Royalls, and Trants. Clearly, more of the material was being transported to Royalls and Trants than to Golden Rock, and more to Golden Rock than to Spring Bay. As we have seen, Knippenberg accounts for this by suggesting that sites close to Antigua were utilizing other rocks from the Antigua formation with relatively fine-grained microcrystalline structures, Antigua being unusually blessed with mineral resources in the Leeward Islands because of its highly varied geology. A pertinent question here is why, if individual sites had direct access to stone sources on Antigua of which Long Island chert was only one (albeit a preferred one), the percentages of these other resources are not constant between sites. That is, if no proprietorial control existed over these sources and direct access was the mode of acquisition, we should not be able to see an obvious cline of increasing percentages from Trants to Spring Bay, unless there was a reason for incremental decrease of attractiveness of these other sources which corresponded in some way with straight-line distance.

A more effective way of explaining this pattern is to consider how other modes of acquisition might have produced this cline in the data, and the dominance of Trants in terms of absolute counts of Long Island material (n = 573) is important in this regard. To do this it is necessary to return to the network model constructed previously and shown in Figure 6.5.

It is not unreasonable to suppose, based on straight line distance and the model, that access to Antigua from Montserrat was easier than from other points under consideration. Indeed, considering the amount of Long Island chert and the diversity of Antiguan stones from Trants, it does seem as though material was flowing between these two islands more readily than between Antigua and other points in the archipelago. It was suggested in the preceding chapter that Montserrat appears to act, at least when network modeling is undertaken, as a hub, connecting Antigua, Guadeloupe, and the Nevis-St. Kitts subgroup. If this were the case, it may have proven easier for populations of this latter to acquire Long Island chert from Trants, rather than undertaking the longer journey to Antigua. Crucially, if Trants was a point of acquisition, we might expect there to be a preference on the part of neighboring populations for higher-quality material; in this case, Long Island chert. Just as groups from Trants preferred Long Island chert over other materials, so more distant communities arriving on Montserrat would exercise an obvious preference, exacerbated by increasing scarcity of all types of material. By extension, this preference would be exercised also by inhabitants of St. Eustatius acquiring the material from St. Kitts and Nevis, and of Saba from St. Eustatius. Accordingly, percentage of the material within total lithic assemblages would grow with distance from source, just as total amount decreased — these patterns are evident in the data. Such behavior looks, *pace* Knippenberg, very much like classic down-the-line exchange (Renfrew 1975: figure 11; cf. Renfrew *et al.* 1968), with linear decay in total abundance (but not abundance in relation to other materials) over an inner zone, with exponential decay beyond this.

If down-the-line exchange of raw nodules was the mode of transmission between sites from Antigua to Saba, then this has a series of social implications which, in conjunction with the possible social correlates of earlier gravity-network modeling, require some consideration. Prior to that, though, some attempt must be made to explain why the qualitative difference in processes of acquisition existed, if indeed sites beyond Saba were acquiring Long Island chert in much smaller quantities, and that material was already in the form of preformed flakes .

It has been noted, and is expressed in Figure 6.4, that absolute quantities of Long Island chert fall-off rapidly from Montserrat to Saba. It is true that Spring Bay may have been occupied for a relatively shorter time than long-lived sites such as Golden Rock and Trants but, in general, absolute numbers continue to decline from southeast to northwest. If it is assumed that Long Island chert was a relatively desirable material, then this decrease in abundance would proportionately increase its desirability as the chances of encountering it declined away from source. That is, depending on the frequency of down-the-line contact, we might expect very few whole nodules to be arriving on islands such as Saba during the Early Ceramic II, and these to be proportionately more valuable in local context than in points to the southeast. The relative paucity of the material by this stage in the chain may have made it accordingly so valuable that exchanging nodules with points even further from source was very undesirable and, accordingly, it was reduced into smaller packets in order to limit the flow of material. This tipping point in terms of linear increase in value may explain the existence of Knippenberg's supply and distribution zones. Rather than each site within the supply zone having direct access to the source — which I have argued to be unlikely, considering the non-uniformity in lithic assemblages within this area — the linear increase in desirability from the source may have resulted in the chert becoming so desirable, at a given distance, that further exchange of it in bulk form was not promoted. This would give rise to the exponential decay in frequency, and the absence of evidence for primary reduction, in the distribution zone.

It was suggested in Chapter Five that it is possible to demarcate a zone of interaction between Saba and Antigua — and potentially further south, towards Guadeloupe and its sub-archipelago — in the Early Ceramic II in terms of ceramic styles, and in particular at the sites of Golden Rock, Hichmans, Trants, and Antiguan Indian Creek. Proximal point analysis and gravity-network modeling suggested that interaction between this set of islands may have been relatively more common than, for example, between these islands and those of the Anguilla Bank. This analysis of access to and treatment of Long Island chert further underscores the differences in behavior between the northern and southern parts of the Leeward archipelago, differences which have been noted by Crock (2000; Crock and Petersen 2004), and which seem to be increasingly accentuated from the Early into the Late Ceramic. This is reassuring, in that the predictions of the modeling undertaken in the previous chapter seem to be borne out by observations about one class of material, and its associated behaviors; further detailed work on the movement of other types of object between the Anguilla Bank and the islands to the south may be similarly illuminating. These differences in behaviors, however, and the accompanying social-geographic rift between these two parts of the archipelago in the Early Ceramic II, require some form of explanation. This might be made easier if similar processes of delineation and decay of wider spatial-cultural homogeneities can be noted in the other case study at hand — that is, whether these processes are effects of trajectories common to post-colonization insular living.

6.2. The Movement of Obsidian in the Neolithic Cyclades

The Neolithic Cyclades provide fruitful grounds for such a comparison. To undertake such a comparison, however, involves overcoming difficulties deriving from the fact that there seem to have been different prevailing traditions of resource acquisition in the fifth and fourth millennia Aegean than in the first millennium Caribbean. The Melian obsidian flows were exploited since at least the terminal Pleistocene, with tools made from this stone found at Franchthi, Maroula, and in the Cave of the Cyclops (Laskaris *et al.* 2011; Sampson *et al.* 2010; Sampson 2008a, 2008c). None of these were connected to Melos (or greater Melos, at the likely terminal Pleistocene sea-stand), which indicates that Mesolithic populations must have been traveling to the island to acquire obsidian. Despite intensive investigation there is no good evidence for Mesolithic settlement of the island (Cherry 1982a; evidence for Palaeolithic settlement is questionable; Chelidonio 2001), although the discovery of Maroulas, and now the Mesolithic material from Cretan Plakias (Strasser *et al.* 2010, 2011), mean that the possibility of a Melian Mesolithic can still not be categorically ruled-out. During the Late Neolithic colonization of the Cyclades, and the subsequent expansion of settlement in the Final Neolithic, Melian obsidian is found — in a variety of forms — at all sites (e.g., Coleman 1977; Evans and Renfrew 1968; Sampson 2002). Neolithic exploitation of the material in fact extends far beyond the central Aegean, being found in Thessaly, Macedonia, (Perlès 2001) and in Anatolia (e.g., Çilingiroğlu *et al.* 2012; Çilingiroğlu 2011). The ubiquity of the material across a very wide spatial and temporal span makes it, perversely, difficult to deal with. This is exacerbated by patchy publication of total counts of obsidian, its significance within the total lithic assemblage (often extremely high for all sites in question, so this might be trivial information), weight, and detailed information on debitage. Frequently this information is passed over in discussions, which are nonetheless important, of tool morphologies and possible uses.

It has been argued that the movement of Melian obsidian around the Cyclades and beyond was dependent upon a process of direct acquisition of the material (Renfrew 1972:442-444; Torrence 1982, 1986). There is no good evidence for proprietorial control of the material at source. Such control would, presumably, be premised upon there being a permanent population present on Melos for the duration of the Neolithic, and, despite the plentiful data suggesting a Neolithic presence on the island, permanent settlement is quite another matter. The peculiarity of the surface distribution of Neolithic material culture and the absence of ceramics certainly militates against a permanent population; Chapter Five underscores this by highlighting just how isolated a Late or Final Neolithic settlement on the island would have been. Later in this chapter, the environmental factors militating against Melos as a preferred site of Late (and potentially even Final) Neolithic are laid out in detail. In short, though, it seems unlikely that any fifth or fourth millennia village on Melos was controlling access to the Sta Nychia and Demenegaki obsidian flows. What should be considered in more detail, and with the aid of the spatial models constructed in the preceding chapter, is how likely it is that each site in consideration in the Neolithic of the Cyclades was undertaking or countenancing individual, and often long-distance, sea journeys to Melos. As Carter (2008) points out, it is not clear that the range of communities in the Neolithic Aegean were pursuing the same strategies of acquisition, or that they were capable of doing so. In the context of the probabilities outlined previously, and the obvious disparities in settlement size, location, and perhaps importance, the central question is whether uniform strategies of exploitation should be expected.

One way to begin to deal with issues of access across the entire archipelago, and those sites implicated in this study of the archipelago, is to consider issues of reduction, as in the Caribbean — where it takes place, in what form, and whether this has implications for the movement of raw material. Figure 6.10 indicates all sites in the Saliagos- and Kefala-phase archipelago with published evidence for Melian obsidian. At sites lacking detailed publication — such as the small Final Neolithic sites of northern Andros — obsidian was almost certainly being used, but these are excluded from consideration because of lack of usable data. Sites which have evidence for the reduction of raw or decorticated nodules of obsidian are indicated with blue circles, and those with only evidence for the consumption of finished tools in green. Color graduated buffers indicate increasing distance from Melos in 20 km divisions. This figure, for clarity and to facilitate the ensuing discussion, conflates both Late and Final Neolithic phases in the archipelago.

It becomes clear on consideration of this representation of the spatial distribution of Melian obsidian throughout the Neolithic Cyclades that, in comparison to the Early Ceramic I and II Leeward Islands, no immediately obvious pattern emerges. Blade cores — solid indicators of on-site reduction processes, despite the relative rarity of parallel-sided blades in especially Late but also Final Neolithic lithic repertoires — appear to conform to no obvious distributional logic. Moreover, it may well be the case that for sites such as Grotta and Sykamia — with no published cores or debitage — the absence of evidence for reduction is an artifact of limited excavation and modes of publication, rather than a reality of the record (cf. Carter 2008:234). The most productive avenue of investigation, in the absence of obvious patterning, is to compare the distributional data to the models of interaction constructed in Chapter Five; prior to that, however, a number of relevant points may be made, in attempting to get a firmer grip on the behaviors underlying this distribution.

First, and something subject to more extensive consideration in explicitly comparative perspective in Chapter Seven, are the issues of distance from source and corresponding dynamics in exchange networks (or direct acquisition); this value of detailed quantification in elucidating these dynamics was demonstrated in the previous part of this chapter. Renfrew (1972:442) noted comparatively early that abundance of Melian obsidian decreased with distance from source in Mesolithic and Neolithic deposits on the Greek mainland. Relative paucity in the northern, eastern, and southern Aegean was matched by a corresponding abundance in the western Aegean (and this pattern still seems, in general, to obtain, although data remain patchy; e.g., Marangou *et al.* 2008:103). This is unsurprising, perhaps, considering greater proximity to the source of the material — yet, as in the Caribbean, the concern must be in understanding how a direct-access mode of acquisition resulted in disproportionate absolute amounts of the material in different sites. Here it is instructive to quote Carter's discussion of Renfrew's conclusions at length; despite his comments being directed at the Early Bronze I-II Aegean, the thinking is illuminating:

> Because the idea of a 'supply zone' deals in relative terms… rather than absolute terms… vast areas of the Aegean have been afforded a form of equality which simply never existed. The Cyclades are a case in point, for one is left with the distinct impression that each community had equal ease of access to Melian obsidian; this is extremely unlikely… One gains the *impression* that during EB I-II there were certain communities outside the Cyclades, not least Poros-Katsambas, Mochlos, Aghios Kosmas, Manika and Lithares, that were procuring far larger amounts of obsidian than their contemporaries in, for example, the interiors of Paros, Naxos, or Amorgos. (Carter 2008:234, author's italics).

We might easily substitute Saliagos and Ftelia, in the fifth and fourth millennia, for Mochlos and Manika in the third. While two sites such as Ftelia and Kefala are comparable in some terms — both were loci for the reduction of obsidian nodules, and both have comparable relative frequencies of obsidian — the total weight of obsidian recovered from the (limited) excavation of Ftelia was 17.267kg (Galanidou 2002:318). This clearly dwarfs the amount of obsidian recovered from Kefala, and it would be hard to maintain that there is any form of equality between the two assemblages (Coleman 1977:5-8). Again, different modes of quantifying lithics make direct comparison difficult, but the excavation at Kefala, combined with intensive surface survey (excluding data generated by Whitelaw's [1991] revisit), produced 3,829 fragments of obsidian, of which 85 per cent were debitage; by contrast, Saliagos produced 24,000 fragments (Cann *et al.* 1968:105), six times as much material by number, if not weight. The overall 'impression' of Ftelia and Saliagos, and potentially sites like them, is of superabundance, especially considering the veritable carpet of material from Saliagos, and the presence of two enormous blade cores (Figure 6.13; Evans and Renfrew 1968: plate 34). This picture is obscured by limited access (because of Bronze Age overburden) to the Saliagos-phase deposits at sites likely to be other candidates for such preferential access, such as Grotta and Akrotiri. There is a strong possibility, though, that this superabundance was a general feature of the larger, more evenly-distributed Late Neolithic settlements such as Saliagos and Grotta, and that differential access to Melian obsidian is a function of the development of incipient settlement hierarchies (Halstead 2008) in the fourth millennium. It seems generally unavoidable to conclude at this stage, however, that some sites had much readier access to Melian obsidian than others. Is it tempting to attribute this to differential modes of access; this temptation is best examined by considering how such differences might manifest themselves spatially.

Most obviously, when dealing with this disparity from a spatial angle, it does not seem to be a direct function of distance from source, as seen in the Caribbean example — at least, not at the local scale. In the immediate ‘supply zone’[15] — a concept which still retains some utility in drawing a distinction between an intra-Cycladic zone of general abundance versus general paucity beyond this limit — sites such as Ftelia and Strofilas lie almost twice as far as Saliagos from Melos, yet seem to have had comparable access to the material. Vouni and Zas lie much closer than Ftelia, and Sykamia lies closer to the source than does its precociously large neighbor on Andros, and yet none of these exhibits evidence for reduction, or quantities of obsidian approaching the Saliagos-phase sites. If there is a ‘supply zone’ of obsidian in the Neolithic Cyclades, sites within this zone participated in it to very different extents.

The best way of making sense of these data may be related to considering site size. While, as pointed out in Chapter Five, it is extremely difficult to model site size for the Cycladic Neolithic, Saliagos and Ftelia (at least in its earlier phase of occupation) both seem to have been large villages for their period — if there were any larger fifth millennium settlements in the archipelago they have yet to be unearthed, although the obscured basal levels at Grotta and Akrotiri may be spoilers in this regard. Turning to the Final Neolithic, Strofilas, as we have seen (Chapter Five), bestrode the northwestern part of the archipelago like a colossus. While detailed recording of the chipped stone industry is currently lacking, it

[15] Renfrew never actually referred to the Aegean third millennium situation as one in which a ‘supply zone’ maintained, although the concept is of some use, considering the correlation between distance, total abundance, and relative abundance; he refers to Near Eastern obsidian, not Aegean, as exhibiting ‘supply zone’ characteristics associated with down-the-line exchange (Renfrew 1975: 46).

seems that obsidian was ubiquitous (e.g., Televantou 2008: figure 6.19), and it is not unreasonable to suppose that it approached levels comparable to its Late Neolithic forbears, although the advent of metalworking, as witnessed at Strofilas, must have had profound implications for the value system in which obsidian was enmeshed. By contrast, less extensive sites for which data are available — Kefala, or Paoura, for example — record much smaller numbers, 3,829 and 648 respectively[16]. Based on this limited dataset, it is an unsurprising, although not necessarily given, conclusion that there is a positive correlation between site size and total amount of obsidian, with relative abundance by contrast comparable across all sites in the study area for which these data exist.

There are several reasons why site size and abundance of stone tools might correlate, and some of them are obvious to the point of triviality. Clearly, we might expect larger sites to have greater populations, and presumably a corresponding greater demand for the activities afforded by obsidian tools[17]. What I would like to consider here, however, is the logistical and ideational aspects of obsidian acquisition and use. We have reasonably secure information about the likely capacity of Neolithic seagoing craft in the Aegean, and about the probable demographic parameters — and fragility — of Saliagos- and Kefala-phase communities (see Chapter Two for insular demographic fragility). Figure 6.10 illustrates the distance from the sites in question to Melos. From sites with secure fifth-millennium

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[16] The data from Paoura, of course, were derived via intensive surface collection (Whitelaw 1991), so are not fully comparable. It is also important to note here that Whitelaw uses the actual figures of material observed to extrapolate proportionately towards possible sizes of the surface assemblages as a whole, being 23,000 and 57,000 for Kefala and Paoura respectively. It is impossible to ascertain how viable such figures might be; clearly, they are comparable to the total numbers available for excavated deposits at Saliagos. If such intensive work had been undertaken on Saliagos islet, however — and the full extent of the site is unknown — the surface assemblage may have been considerably more massive. As it is, only observed data seem admissible in this discussion.

[17] Although it is interesting to note that, in the Caribbean case study, site size and abundance of stone tools do not necessarily correlate; for example, Early Ceramic II Hichmans and Trants, both large sites, have markedly different total counts and weights of chipped stone; Knippenberg 2007:234).

credentials, this implies a voyage of several days through what we have reason to believe was not space occupied by sedentary communities (although Agios Sostis on Sifnos is an unknown quantity; Gropengiesser 1986, 1987). This has attendant implications for water and food necessary to complete this journey, and a period of time spent on Melos when extracting and pre-forming nodules suitable for secondary reduction (time spent pursuing behaviors which potentially account for the Neolithic surface signatures on the island). This, combined with the number of small dugout vessels necessary to transport the relevant craftspersons, attendants, and supplies, along with space to accommodate the raw material, suggests that forming any such convoy would have been a major undertaking, or at least one of note, for a community comprising no more than 200 people at the upper bounds of likelihood. While the size of several Late Neolithic sites are obscure, and the demographics even more so, it is not unreasonable to suppose that settlements like Ftelia and Saliagos could have undertaken such expeditions, most likely during the summer when sea surface and weather conditions were more ameliorable. Considering the large amounts of obsidian at these two sites, and demonstrable evidence for reduction processes, direct access may then make a degree of sense for sites such as this; this mode of access is represented in Figure 6.11. Behaviors of this sort fit in the context of probable retention of contact between these fifth-millennium villages, yet contact maintained on an infrequent basis, as discussed in Chapter Five. This contact may also have provided occasion for exchange with the few Late Neolithic sites not implicated in a direct access mode of acquisition, such as satellite sites like Vouni, or non-domestic sites like Zas (Figure 6.12). The conjunction of demographic and genetic imperatives, long-distance expeditions across the archipelago, and perhaps the necessity of ecological buffering via exchange and storage, can be argued to have resulted in a dynamic of formalized travel in the Late Neolithic Cyclades, and this scenario is outlined in more detail in the subsequent chapter. Of more immediate concern here is the transition to a two-tier settlement hierarchy, and the implications for behaviors associated with Melian obsidian.

The key issue is whether the smaller total abundance of obsidian at sites such as Kefala results from identical processes of acquisition, only writ proportionally smaller, or whether they derive from the operation of qualitatively different processes. The data themselves do not permit a choice between these two alternatives. If the logistics of acquisition are considered in detail, however, it seems inherently unlikely that the way in which Kean villagers got their obsidian in the fourth millennium paralleled the way Parian villagers got theirs in the fifth. The capacity to mount long distance convoys would have been at or beyond the capacity of demographic units as small or as fragile as the communities at Kefala or Sykamia, or indeed Mikroyiali; the social risk would have been intolerable. If demographic units of this size were the only occupants of the landscape, we would be forced to model small-scale and risk-laden voyages, or perhaps itinerant knappers, supplying this dispersed pattern of settlement. As it is, and as discussed in Chapter Five, the site at Strofilas is quite the gorilla in the room, and one which may provide answers.

Whether or not Strofilas has any peers is a speculative subject, and one considered in the next chapter. What does seem clear is that both in heuristic modeling, and according to the excavated assemblage, Strofilas was a very important site in the (late) fourth millennium archipelago, whose existence almost certainly impacted surrounding, and smaller, contemporary communities. It also appears closely to parallel the large centers of Early Bronze II — Ayia Irini and Chalandriani, for example — in the concentration at it not only of material but also symbolic wealth. Broodbank (1993, 2000), in his discussion of the Early

Bronze II centers, suggests that only by occupying the apex of the settlement hierarchy in the third millennium, with the accompanying demographic clout, were they able to mount the type of long-distance voyages through which social capital was accrued. Strofilas, occupying a similar position in the terminal fourth millennium and a demographic peer of the preceding Saliagos-phase settlements (perhaps even exceeding the upper demographic limits of the Late Neolithic villages), would have been capable of organizing expeditions of the size demanded by at-source obsidian acquisition. Moreover, whoever made Strofilas their home undeniably seems to have been interested in controlling and acquiring items of status; the only other fragment of gold besides that from the Zas cave, which might itself have been a ritual center, derives from Strofilas, and the site is heavily implicated in copper working. This is not the place to consider in detail changing economies of value in the fourth millennium Aegean, but the concentration of goods with exotic or non-local implications surely suggests targeted strategies of acquisition. In this model, also outlined in Figure 6.11 by dashed lines, initial acquisition by tier 1 sites such as Strofilas is followed by secondary distribution to tier 2 sites, such as Kefala. Differential total numbers at small sites are derived not from small-scale access — demographically and socially non-viable — but by distance decay from origin, with tier 1 sites paradoxically 'closer' to points of extraction than tier 2 sites (Figure 6.14). If we accept that accruing non-local goods can be a mode of accreting social capital, then, at least in this instance, it seems that Strofilas had annexed that privilege to itself. This again underscores emerging inequalities in the island system as the fourth millennium drew to a close.

While methods of acquisition and technologies of use as regards stone tools very clearly differed between the Neolithic Cyclades and the Early Ceramic Leeward Islands, the comparative exercise is useful. Most obviously, it suggests that sites which were predicted to be likely neighbors in a network of interaction (Chapter Five) were very probably conjoined via systems of exchange, particularly in the Early Ceramic II Leewards, but also in the Final Neolithic Cyclades. While control differed, it does appear that access to valued resources was corralled, although in very different ways: distance decay in the Leeward Islands suggests changing forms of acquisition related to the increasing desirability of chert as its total abundance in systems of exchange declined, whereas in the Cyclades it seems that emergent inequalities of access and modes of distribution account for changing total abundances at sites of different sizes. It is noteworthy that, in both cases, developing disparity in settlement systems seems to be implicated in changing exchange behaviors. Despite evidence for long-distance exchange of Long Island chert in the late first millennium BC, an increasingly parochial stance, and one accompanied by social stratification, seems to have impacted distribution of chert in the northern part of the Leewards by the mid first millennium AD. In the Cyclades, it is the transition to a two-tier hierarchy of settlement in the fourth millennium (Chapter Five) which seems to be associated with the reorganization of resource access. The obvious possibility in both situations is that this reorganization and the appearance of spatial hierarchies are both outcomes of the same structural processes. What these processes might be is the subject for Chapter Seven. First, I focus more closely on the micro-niches chosen for settlement, and whether particular configurations of land and sea proved more attractive than proximity to or distance from neighboring communities.

6.3. Environmental Attractors as Conditioning Factors in Early Island Settlement: The Cyclades

It was argued in Chapter Two that we might expect early colonizing food-producing communities to pursue conditionally optimal strategies. That is, they should be expected to maximize their own fitness (especially considering demographic fragility of island populations) and make subsistence and organizational choices accordingly (bearing in mind that there are different configurations and sets of optimally-fit strategies). It is inherently unlikely that any environment exists in which the choices of others do not impinge on a group's decisions; that said, we again might expect to see most optimization in a newly-colonized environment, such as the two which are dealt with here, being relatively free from competition in the short term. Optimization in a small island context, I suggested, implies maximum exposure to a diversity of resources, at least in early post-colonization phases. A strategy of this sort maximizes the chances of an encounter with a higher-ranked (i.e., preferable) prey species, while minimizing the risk of over-reliance on one species or set of species in an environment in which ecological fragility is comparatively great. The main concern here must be translating this into coherent geo-ecological terms for the two archipelagoes in question. In essence, and taking the Neolithic Aegean and the subsistence options available to its inhabitants as an example, an optimal niche would combine: good land for cereal production (considering the preferences of other Aegean Neolithic communities, in Thessaly, Macedonia, and Crete, for example, alluvial soils would be most desirable); neighboring grazing landscapes (with ovicaprids dominating the zooarchaeological assemblages); proximity of fresh water, a challenge in the typically karstic

Mediterranean and especially so in the parched Cyclades; yet with ready access to seasonally valuable maritime resources, most obviously the pelagic fish implied by barbed-and-tanged points, but also potentially shellfish.

In this analysis I consider mainly the large Late Neolithic villages in the center of the Cycladic archipelago, for several reasons. Firstly, in looking for optimal behaviors and strategies of insular generalism, earlier rather than later sites are prime candidates, and Saliagos and its peers represent the first (known) farmers in these islands. Secondly, it happens that detailed geo-ecological data — generated for the purposes of the natural sciences, but clearly of use here — happen to be more prevalent for this section of the archipelago. North of the active volcanic segment of the Hellenic arc the geology of the Cyclades is no less complex than in the area of active volcanism. Ultimately derived from the subduction of the African plate under the Eurasian plate and associated orogenic processes, the near-surface geology of the islands from Andros to Naxos and Amorgos is characterized by the presence of metamorphic elements, primarily schists and gneiss, with intrusive igneous domes — granites, granitoids, and granodiorites. This diversity — a partial cause of the overall ecological patchiness of the archipelago, as argued in Chapter Two — has prompted intensive study of the area, to the extent that the geology, but more specifically the geological dynamics of the central part of the archipelago are well understood (Bargnesi *et al.* 2012; Bulle *et al.* 2010; Denèle *et al.* 2011; Feenstra 1996; Philippon *et al.* 2012). Individual islands are not equally heterogeneous, however; Paros (Figure 6.15; data from Bargnesi *et al.* 2012) is considerably more diverse with intrusive granitoids mantled by Cycladic blueschist and gneiss than is, for example, Mykonos, the entirety of which is essentially an igneous intrusion through the blueschist complex (Denèle *et al.* 2011). Diverse metamorphic conditions have similarly produced divergent outcomes in the northwestern part of the archipelago, where Tenos and Andros are dominated by varying schist complexes (Bulle *et al.* 2010), contrasting with Naxos and its combination of marbles, granodiorites, and gneiss (Feenstra 1996; Feenstra and Wunder 2002; Jansen and Schuiling 1976). This diversity is obviously a direct cause of the mineral wealth of the archipelago, but also has profound geomorphological and hydrological impacts (e.g., Dazy *et al.* 1997; Evelpidou *et al.* 2012). It is the confluence between geomorphological and hydrological processes which gives rise to the two main issues considered here: questions of access to fresh water, and to Pliocene-Quaternary alluvial deposits.

This large dataset clearly allows us to establish which types of resource lie near which sites. Initially, a correlation between Late Neolithic villages and alluvial beds can be observed (e.g., Figure 6.16). The problem is one of quantification: we need a way to measure the relative worth of each site, as it were, in geo-pedological terms. One way to begin to deal with this is via a consideration of ease of access. Cost surfaces provide one avenue to deal with access, but rest on the assumption that an individual at a given point was concerned with access to large swathes of territory. Cost-surfaces are most effective at regional scales, when dealing in hundreds of kilometers. Considering the size of the Saliagos-phase villages, their scarcity, their maritime orientation, and the size of the islands in question, it is not clear what benefit it would be to understand whether Saliagos or Koukounaries was better placed to access the steep hinterland of Paros. What is important is to deal with relative degrees of immediacy of access to desirable niches.

There are reasons to suppose that farmers, in nucleated villages — as the Late Neolithic villages seem to be — will travel certain distances to crops located away from the village, but that beyond a certain distance it becomes undesirable for them to do so. It also seems possible that such distances are cross-cultural. Data from the Thessalian Neolithic, but also from Iron Age Greece and Bronze Age Mesopotamia, seem to indicate that a distance of 2.5 to 5.0 km is the maximum desirable under normal circumstances; that is, anything further than an hour's distance on level ground is less likely to be tolerated (Bintliff 2012:60-62; Perlès 2011; Wagstaff and Augustson 1982; cf. Vita-Finzi and Higgs 1970). There is no evidence to suggest a dispersal of settlement in the Late Neolithic Cyclades (although, in the Final Neolithic, we need better data on the exact function that tier 2 settlements are performing), which might suggest that subsets of the population resided in the hinterland for part of the growing cycle. Proceeding on the assumption that normal behavior involved a nucleated population exploiting arable around the settlement nucleus, it becomes possible to construct zones of likely access. To do so, alluvial units were isolated from the geological and pedological data. Because of the richness of the data for the central archipelago, Late Neolithic Saliagos, Late-Final Neolithic Koukounaries, Grotta, and Ftelia, and Final Neolithic Strofilas, were chosen for study. Selected sites were then buffered at 1.5, 2.5, and 5.0 km distances, with a radius greater than 5.0 km considered unlikely to be viable for exploitation from a nucleated site; this is demonstrated in Figures 6.16 and 6.17, with approximate walking times for the various zones of access in Figure 6.18. The total area of alluvial soils lying within each zone was then calculated in hectares. The results are displayed in Figure 6.20, and spatially for Naxos and Paros in figures 6.17-6.19.

The most obvious, but nonetheless significant, conclusion to be drawn initially is that all sites included in the study, whether fifth or fourth millennium, were preferentially located with regard to alluvial deposits. Based on a regime of cereal and legume exploitation, and considering Mediterranean Neolithic predilections for types of pedological unit in general, this is unsurprising. This observation does, however, underscore the active capacity for island colonists to isolate and select preferable niches for cereal cultivation. While colonization dynamics are not a main concern of this study, noting this niche-preference again reinforces the extent to which colonization of the archipelago was purposeful and directed. When considering the relative abundance of preferential alluvial niches, however, unexpected patterns arise.

An initial circum-site maximum radius of 1.5 km seems to be unhelpful in drawing out commonalities (Figure 6.20). Values range from 310 ha for Ftelia to 41 and one for Grotta and Strofilas respectively (Strofilas lying on a promontory and away from the alluvial beds to the northeast). Indeed, the total scores for Ftelia and Saliagos may well have been higher, considering that eustatic rise has affected the configuration of the hinterlands of these sites more profoundly than for the others. This is not enormously problematic, however, as there is no evidence to suggest that a radius of 1.5 km has any meaningful, cross-cultural bearing on changes in subsistence practices — this zone was included in the analysis to see if any patterns obtain at a truly micro scale and, in this instance, it can be seen that none do. When moving to 2.5 km out from the site nucleus, there is a more obvious relationship between the numbers. The mean total alluvium within this radius is 315.80 ha; this rises to 356.75 ha when Strofilas is excluded from the calculation. Two considerations follow from this. Firstly, the four sites with Late Neolithic components have broadly comparable access to preferential niches for cereal cultivation, ranging from 461 ha at Ftelia to 251 ha at Grotta. Areas on this scale make sense in terms of well-spaced village communities, with perhaps a hundred or so inhabitants, meeting their own subsistence needs. It has been suggested that approximately

450 ha of land under a mixed farming regime is adequate to support a population of 200 individuals (Perlès 2001:121-151). If we assume that alluvial zones were being monocropped — or at least reserved for cereals and legumes — in the Late Neolithic, with ovicaprids being pastured away from alluvial plains when the crop was on, this could perhaps be readjusted into the 350-450 ha range (also considering the calorific input of maritime resources), the Late Neolithic mean being within this range. This matches well with Broodbank's conservative suggestion of 70-150 individuals at Saliagos-phase sites (2000:146), and Renfrew's (1972:251) higher estimate of 200 per hectare in the Neolithic in general.

If the tentative demographic figures are accepted, then it seems likely that Late Neolithic Saliagos, Ftelia, Grotta, and Koukounaries were essentially isolated units within the subsistence system, although probably connected by genetic and cultural ties. The fact that none of the four Late Neolithic settlements under analysis deviates substantially from this mean provides reasonable grounds for arguing that this mode of subsistence held across the settlement system in general. The relatively benign climatic context of the fifth millennium, combined with a low overall population in the archipelago, provides further grounds for thinking that each site could subsist based on access to extensive alluvial patches in the immediate hinterland, complemented by more distant areas of macchia for grazing ovicaprids.

Once again, Final Neolithic Strofilas deviates from the pattern seen in the fourth millennium data. Figure 6.20 shows — via the dashed line — the zone between 251 and 461 ha into which all alluvial scores at a 2.5 km radius for the Late Neolithic sites fall. Strofilas is well below this zone, at 152 ha. The lack of comparanda for the Final Neolithic is problematic, and there is not at this point any way of ascertaining how much of an outlier

Strofilas is in this regard. Some basic calculations, however, demonstrate the problem. The site itself seemed to occupy 3.0 ha at its maximum extent (Liritzis 2010). If this space in its entirety was occupied, then using the equations of area and demographic concentration applied elsewhere (Broodbank 2000:146-147; Renfrew 1972:251; Whitelaw 1991) we might expect a population ranging from 300 to 600. A population of this size would be very difficult to sustain with the available arable; even at a maximum 5 km radius, available alluvial area is only 632 ha for Strofilas. At face value, then, the site is too large to be sustained in the ecological niche which it occupies.

There are a number of situations which may account for this, and it is not immediately obvious if it is possible to choose between them. It may be that population density within Strofilas was unusually low, although its size, and the range of activities which seem to have taken place at the site, would then seem extremely unusual. It might alternatively be the case that non-optimal pedological contexts were being exploited for cereal and legume production. While the fourth millennium in the Aegean certainly witnesses expansion into non-optimal agricultural zones (e.g., Halstead 2008), very few of these sites approach the size or complexity of Strofilas.

Two more persuasive explanations, which may in fact operate in tandem, relate to modes of exploitation of the wider hinterland. Conceivably, small and hitherto unlooked for sites — especially considering the lack of intensive survey on Andros — beyond the 5 km radius may have hosted communities who were producing surpluses in the alluvial niches of southern Andros to meet the larger site's needs. It is possible that tier two sites such as Mikroyiali and Rethi existed closer to Strofilas and simply remain undetected by non-systematic research in the island, expanding the known second tier of settlement to the south. A complementary possibility is that these smaller sites to the north (Rethi, Mikroyiali, and other sites in the hilly terrain of north Andros) existed in an asymmetrical relationship with Strofilas, with surplus from across the island flowing in to the large center to keep it alive. Considering evidence discussed in previous chapters for the development of a settlement hierarchy in this part of the archipelago in the Kefala phase that may index unequal social and spatial relationships, the exploitative model is an appealing one — perhaps a retention of value-laden goods and behaviors at Strofilas provided the exchange material for upwards flow of cereals and meat within the system. This site, its relationships to its contemporaries, and possible parallels in the spatial evolution of settlement in the Leeward Islands, will be an object of extended discussion in Chapter Seven.

The propensity for sites associate with initial (successful) colonization to occur in agriculturally-optimal niches is reassuring in terms of supposing geoecological factors to have some bearing on the development of settlement systems, at least in the Cyclades. According to the insular generalism model, however, conditionally optimal colonists should be interested in maximizing frequent encounters with highly-ranked prey items. In Chapter Two, I suggested that, in highly heterogeneous and patchy island environments, this would imply ready access to a variety of ecological niches. If access to alluvial beds was the only conditioning factor in site location, it would seem hard to argue that early colonists in the fifth millennium were pursuing a generalist strategy from the perspective of optimal foraging theory.

Encouragingly, it appears that this was not the only environmental element which affected the growth of settlement in the Late Neolithic. It has already been observed (Broodbank 2000:147) that Saliagos-phase settlements tend to cluster near embayments. As discussed at some length in Chapter Three, this probably relates to exploitation of maritime resources, particularly schooling pelagic fish which would require corralling in restricted shallows. Considering the supposed importance of maritime connections in the fifth millennium, sheltered stretches of strand offered by such embayments (admittedly in their current form, and ignoring the effects of eustatic sea-level rise) may also have been attractive for beaching canoes in the lee of wind and waves. Furthermore, pelagic fish may not have been the only attractive factor about such embayments. Reconstruction of early-mid Holocene coastal geography on Naxos (Evelpidou *et al*. 2012) suggest that current coastal wetlands were shallow lagoons up to 3,000 BC (Figure 6.21), with a major embayment and associated lagoon system lying close to Grotta. This reinforces — the dire need for more palaeoenvironmental data in the Cyclades aside — how little we know about the configurations of coastal areas in deeper Aegean prehistory; not simply the location of ancient coastlines, but more importantly the extent to which such coastlines were ecologically diverse. In the case of Grotta, it appears that deep water, lagoonal environments, extensive alluvium, and hilly scrub were all readily accessible from the settlement. This location of settlement at a point in which several ecologically diverse niches (with corresponding diversity of prey taxa) conjoin is highly suggestive of the adoption of insular generalist strategies, as indicated by the zooarchaeological and palaeoethnobotanical data from Saliagos and Ftelia. The similar location of Late Neolithic sites throughout the archipelago is not coincidence; while the excavation-derived data are currently relatively few, environmental consistency implies that early farmers in the (comparatively) balmy fifth millennium were choosing to settle in locations which were optimal in terms of the propagation of cereals and livestock, supplemented by wild resources. This seems to have changed profoundly in the Final Neolithic, for reasons which will be considered subsequently.

A final component of the ideal niches occupied by Late Neolithic settlement appears to be a preference for the metamorphic, rather than the volcanic, components of the Cycladic archipelago. The exception here, of course, is the Saliagos-phase settlement at Akrotiri; aside from this there is a demonstrable preference for locations on or near Cycladic blueschist or gneiss. Even Ftelia, situated as it is on a granodiorite intrusion, is very close to a surviving schist formation (Denèle *et al.* 2011). There is no obvious pedological advantage gained by a preference for metamorphically derived rather than volcanically derived soils, especially if, as we have seen, alluvial beds were selected for cereal cultivation anyway.

What may be of more relevance here is the relative impermeability of schists and gneiss; impermeable compared to Neogene sedimentary units, but permeable compared to the igneous formations of Melos, for example (Dazy *et al.* 1997). This permits some retention of rainfall in the geology and the formation of springs, not relevant for cultivation, but perhaps significant for watering livestock (especially cattle and pigs) and also human populations. It is interesting in this regard that Late Neolithic settlement on Greater Paros seems to avoid the sedimentary geology of the east coast of the island, in preference for the smaller alluvial beds, but retains proximity to water-bearing metamorphic units, in the north and northwest. Similarly, Neolithic (and also modern) settlement on Naxos trends away from the calcium carbonate units in the west of the island (e.g., Feenstra 1996). Access to groundwater in preferential geological niches would be all the more significant considering the relatively low rainfall for the Cyclades compared to peninsular Greece (Maheras *et al.* 2004). In an environment with low annual rainfall, and that unpredictable, access to groundwater would have been more important than for comparable mainland communities. This further suggests that the location of fifth millennium sites was purposeful and deliberate, and not representative of process driven by immediate stressors. This, as I discuss in the final chapter, seems not to have been the case for the succeeding fourth millennium settlement system.

6.4. Environmental Attractors as Conditioning Factors in Early Island Settlement: The Leeward Islands

The relationship between optimal environmental niches and early settlement in the Leeward Islands represents a different type of entanglement than is witnessed in the Aegean. Clearly, Early Ceramic I and II communities were exploiting domesticated plant species, but the configuration of taxa exploited, and associated configurations of behavior, are strikingly different. The spectrum of plants involved in Early Ceramic foodways is broad and, as discussed in Chapter Four, was supplemented by introduced feral species (agouti, rice rat) and a substantial marine component. It would not be unsurprising to find that optimal niches for these horticultural populations look very different to optimal niches for agropastoral populations. That said, it is clear that some locations in the Leewards Islands would have afforded better opportunities for living than others in a manner of which we have a reasonably solid grasp (e.g., Newsom and Wing 2004). The concern is whether the distribution of Early Ceramic settlement corresponds to the distribution of optimal patches.[18]

[18] Because the settlement data for the Early Ceramic I are so few (two sites), the Early Ceramic II is the focus of this discussion.

The geoecological base might appear to be a promising point of departure, but it rapidly becomes clear that this is perhaps not the case. As has been discussed, the Leeward Islands derive from tectonic subduction (James 2005), forming an inner actively volcanic arc – Saba, St. Eustatius, St. Kitts, Nevis, Redonda, Montserrat (Defant *et al.* 2001; Sigurdsson *et al.* 1980) — and an outer arc – Antigua, St. Barth's, St. Martin, and Anguilla (Christman 1953) — which is comprised of volcanics, sedimentary overlay, and some metamorphics (Barbuda is sedimentary but anomalous, lying beyond the outer arc; Brasier and Donahue 1985). The volcanic heritage of the archipelago has had a profound impact on its ecological development. The andesitic nature of the arc results in andesites and basalts forming the surface geology; this, in combination with volcanic ejecta in the form of pyroclastic flows, results in the formation of clay-based soils. In the 'high' islands of the inner arc, geology and pedology conspire to limit the development of alluvial units, with rainwater run-off tending to cut deeply into the flanks of the volcanic cones forming the 'ghauts', or torrential ravines, characteristic of the area. On the low lying islands of the extinct arc, karstic caps on igneous material similarly tends to result in soils which are less than optimal for cultivation of domesticates, particularly on Anguilla and Barbuda. Antigua forms an exception to this, mostly because its geology is unique, but also because its large size allows for the formation of larger streams and ghauts, with lengthier courses, than on the inner arc.

Unlike in the Cyclades, there appears to be little initial correlation between site location and geological and pedological units. Sites appear on young volcanics and associated soils (Trants, Hichmans, Golden Rock), older volcanics (Indian Creek, Hope Estate), and limestone (Royalls, Forest North, Rendezvous Bay). If we were to push this analysis back into the Early Ceramic I we might tentatively argue for a preference in very early settlement for volcanics over sedimentary complexes, but the data are so few that this seems very tenuous. Nor is there an obvious preference for alluvial or loam deposits on those islands which possess them. Figure 6.22 shows the main pedological units for Antigua — clay-based, alluvium and loam, and coastal (beach sand and mangrove). While it is certainly true Indian Creek is ideally placed to exploit the most extensive loam beds on the island, Royalls — a contemporary — is very poorly situated in this regard. The same can be seen for St. Martin in Figure 6.23; Hope Estate (precociously early, so presumably not simply settled from expediency) lies at a distance from the richest soils on the island. Figure 6.24 is remarkable, not because of the proximity of Indian Creek to very rich soils, but because this is the only site under consideration which provides figures which are remotely comparable to the Aegean; 380 ha within a 1.5 km radius, and 551 ha within a 2.5 km radius (indeed, if it were a Late Neolithic site, it would lie comfortably within the zone inhabited by Saliagos and Ftelia). Clearly, other sites contemporary with Indian Creek were executing viable subsistence strategies for populations of comparable size which did not necessitate access to similar soil configurations. If there is ecological patterning in this settlement system, it does not relate to preference for pedological niches.

The lack of interest on the part of Early Ceramic colonists in settling near optimal geological settings probably relates to the nature of the plant species being exploited, the method of exploitation, and the fact that cultigens only formed one part of their diet. Squashes and tubers are Neotropic endemics, and it is unlikely that clay-based soils would have an observable disadvantage in terms of yield when compared to loamy or fluvially derived soils (maize [*Zea mays*] may be an exception); furthermore, while there is no direct evidence for the spatial organization of pre-contact horticulture, a working assumption is that stands of exploited species were dispersed in non-contiguous 'gardens' in the hinterland of a settlement. Both these considerations suggest that, in seeking conditionally optimal niches for settlement, terrestrial factors are unlikely to have been significant. This recognition is instructive, as is the fact that maritime resources formed a significant component of Early Ceramic foodways (e.g., Reitz 1994; Newsom and Wing 2004). Despite evidence for the capacity and willingness to exploit deep water species, a preference for foreshore, reef, and sea-grass bed species (particularly *Strombus gigas and S. pugilis)* is evident in the zooarchaeological assemblages (e.g., Healy *et al.* 1999). Establishing the relationship of these ecologies to settlement distribution is illuminating.

Figure 6.25 shows the relationship between the distribution of sea-grass beds around Antigua and the location of Royalls and Indian Creek. Species from this type of habitat are heavily implicated in the faunal assemblages from both sites, and it appears that they are situated for relatively easy access to these beds. The same concern with access to sea-grass is not so evident on Nevis, where the majority of the grass lies in the lee of the island (Figure 6.26), although this is little more than a half day's travel from the foreshore at Hichmans. Hichmans is, however, preferentially located for access to the windward fringing reef off Nevis – not the only reef complex near the island, but certainly the largest. Both Indian Creek and Royalls (Figures 6.27 and 6.28) are situated close by fringe reef ecologies. Because of a steep subsurface topography Montserrat possesses no sea-grass beds, but Trants was ideally positioned to take advantage of the largest fringing reef the island possesses (prior to the pyroclastic progradation of the windward coast since 1995). This proximity would have facilitated exploitation of desirable species such as wrasse (labridae); accessing these zones by seacraft would have brought them within daily range of the villages themselves.

As in the Late Neolithic for the Cyclades, it appears that Early Ceramic settlement in the Leewards Islands was impacted by consideration of geo-ecological factors. The distribution of settlement when compared to the distribution of insular micro-niches, however, suggests that in both instances no single type of environment was preferred. Rather, points at which ecological patches met or coincided were favorite areas for locating villages in early post-colonization environments. In such settings the diversity of prey items (plants or animals) would have been maximized. This broadly fits with the parameters of an insular generalist strategy of subsistence, in which generalist behaviors buffer against the risk of ecological instability by providing multiple axes along which food can be acquired. Especially considering that there is little evidence for social storage in the fifth millennium Cyclades or first millennium Leewards, such buffering would have been particularly important for community longevity.

Clearly, environmental and resource-derived considerations were not the only factors affecting the distribution of human settlement, as discussed in Chapter Five — the presence or absence of other communities, and the need to both interact and compete with them, informed the spatial organization of settlement. The outcome — socio-spatial organization — should be seen as the sum of a huge number of individual choices and cultural preferences rooted in subsistence behaviors and individual relationships. That is, separating environmental from cultural variables, while useful in attempting to unravel the skein of developing insular systems, is not in the final analysis the most productive way of conceiving the development of spatial organization. Settlement ecology recognizes that the total system — the ecology itself — contains other actors, actors who also actively transform the biotic and geologic aspects of the system. Human choices and larger, long-term strategies are couched in this recognition. This aspect of the development of systems of spatial organization in small archipelagoes will be returned to in the final chapter.

In this chapter I have largely ignored the phases subsequent to this (apparent) cross-cultural period of exploitation of optimal niches. This is partly because environmental data are patchy across both archipelagoes, but mostly because we are now in a position to chart several ways in which the trajectories of development in both archipelagoes crudely parallel one another. In both cases, and adopting a generalizing framework, it seems that subsistence and settlement strategies underwent diachronic change in both cases. This change was accompanied by changing exchange behaviors, changing portable material culture, and — at least in the Cyclades — incipient unequal access to previously ubiquitous desirable goods. This transition, from immediate post-colonization organization to more complex and less equal forms of spatial organization, and its causes, is the subject for the next chapter, in which I attempt to draw together the separate threads of this discussion.

CHAPTER SEVEN

CONCLUSIONS

> It is my belief that the concept of environment should not be considered synonymous with a body of static, descriptive background data.
>
> Karl Butzer, *Archaeology as Human Ecology*, 1982

> Conciseness is possible only when data are fully understood.
>
> Julian Steward, *Handbook of South American Indians,* 1948

This final chapter aims to achieve several purposes. Most obviously, I would like to draw together the various strands of investigation in this dissertation, and return to my original questions: how people chose to live in the two fragile archipelagoes under discussion, and how these choices were made. I would also like to discuss some themes which emerge from the various analyses, not least issues of demographic growth in circumscribed environments, and sociospatial responses to this and other stresses. Specifically, the development of settlement systems in both the Cyclades and the Leeward Islands will be considered, contextualizing this within changing patterns of subsistence and modes of resource acquisition and exchange. The differences seen in the case studies are also explored and accounted for, dealing in part with the very long-term evolution of settlement systems beyond the chronological limits of this dissertation. At the risk of prefiguring my more general conclusions later in this chapter, it is argued that the conjunction of increasing demographic pressure (not simply in terms of nutrition, but the social aspects of perceived stress) in both archipelagoes with the nature of insular environments gradually reduced the options available to communities in both cases. In the final part of this chapter, I move from specific conclusions developed in the context of this research, and offer a theoretical position for future work on human adaptation in small islands.

7.1. Distribution and Behavior in Post-colonization Contexts

The distribution of initial settlement in both archipelagoes was informed by both cultural and environmental factors. It is extremely difficult to establish what preferential niches for settlement in a Neotropic and a Mediterranean archipelago might be, but in both cases there seem to have been underlying logics in how colonists distributed themselves, during and in the generations after colonization. Because of the extremely varied modes of subsistence in both case studies, these logics were very different.

In both archipelagoes, the distribution of settlement was not random, or at least not in the immediate generational time following colonization. This was explored by analysis of nearest-neighbor and next-nearest-neighbor in Chapter Two, with an r-square value of 0.73896 (Figure 5.9). Rather than clustering, Late Neolithic sites in the Cyclades and Early Ceramic I and II sites in the Leeward Islands are evenly distributed. There should be, as was suggested previously, a social correlate for spatial patterning of this sort if distribution in space and social structures relate to one another. Aside from the other factors which seem to be relevant to distribution, this hints that early populations in both the Aegean and Caribbean situated their settlement with respect to the location of other settlements. Specifically, and other factors not yet taken into consideration, these communities seem to have aimed to space themselves at maximum possible distances. This suggests that constant or highly regular contact with contemporary settlements was not a major concern in either case.

Clearly, meaningful contact of some form was being retained in both archipelagoes: ceramic suites and lithic technologies in particular are very homogeneous between sites in both the Late Neolithic and the Early Ceramic I-II. There is also evidence, at least in the Caribbean, for contact between settlements in terms of the exchange of mineral resources. Additionally, the crude population estimates for sites such as Trants, Indian Creek, or Saliagos suggest that it is unlikely that any of these villages contained more than 200-300 inhabitants. Figures of this sort would imply that, while these individual sites would have been genetically viable if practicing endogamy, genetic input from other populations would nonetheless have been strongly desirable, and not only for humans. All these considerations taken together suggest that understanding an evenly-distributed settlement system as a reflection of hostile inter-site relationships is not necessarily the best interpretation. In both the Cyclades and Leeward Islands, early colonists retained links with one another, but nonetheless situated their settlements out of reach of regular contact.

One way to understand this phenomenon is to consider the available ecological niches in each archipelago, and which niches were preferable. As demonstrated in Chapter Six, the expectations of human behavioral ecology and island biogeography are broadly met by the distribution of settlements in both case studies. In both instances, settlement gravitates towards confluences of the type of ecological niches which characterize small island archipelagoes. This distribution in principle maximizes chances of encounter with the greatest number of potential food items, providing the most possible choices within an overall subsistence strategy. This generalist behavior is a risk-buffering strategy in environments which tend to be more diverse and fragile than continental contexts. Such ideal points of settlement are not distributed evenly. The development of settlement systems in both archipelagoes can be understood as an attempt to maximize access to this type of ecological setting, while retaining significant distance from other settlements. For example, the most dense clustering observable in the Late Neolithic Cyclades is in the central archipelago, with Saliagos, Koukounaries, and Grotta consistently spaced at 20 km apart on Naxos and Greater Paros. This dense cluster corresponds with the greatest concentration in the archipelago of the type of environment which seems to have been preferred in the fifth millennium: access to extensive alluvial deposits, deep embayments, upland pasture for ovicaprids, plentiful groundwater, and possibly lagoonal or coastal wetland environments. In the Leeward Islands, distribution is unusually dense on — for example — Antigua. Again, this is best understood in terms of Antigua's attractiveness as regards coastal resources (and possible mineral resources, like Long Island chert), yet it is notable that contemporary settlement — the sites at Indian Creek and Royalls — are situated as far from each other as possible. It seems initially, then, that early post-colonization settlement in both cases is conforming to the expectations outlined in Chapter Two.

The islands which witness unusually dense early settlement in both case studies happen to be largest islands in both archipelagoes, and this introduces a problem. Island biogeography predicts that larger islands will be more attractive to colonizing populations than smaller islands. Settlement systems in both the Cyclades and the Leeward Islands exhibit a strong preference for larger, rather than smaller, islands. It is unclear whether this preference is derived from the random distribution of preferential ecological niches throughout the archipelago, or because larger islands were preferable sites of settlement. It may actually, however, be possible to unite these two explanations. In the Cyclades, Naxos and Greater Paros were inherently more attractive because of their gross greater area, but this greater area allows for a proliferation of environmental niches not seen on smaller islands. For example, Naxos — 429 square km at current sea level — contained (in the mid-Holocene) alluvial deposits, coastal wetland environments, upland pasture with a varied underlying geology, marbles, and a topography which encouraged orogenic rainfall. Donousa, by contrast, is small — 14 square kilometers — low, barren, and dry. Basic biogeographic properties operating in tandem with ecological patchiness made Naxos and the central part of the archipelago attractive both in biogeographic and insular generalist terms when compared to other parts of the archipelago.

The impression which emerges from considering the distribution of early post-colonization settlement in both archipelagoes is one of general parity, both between and within settlements. Material culture and modes of living seem to have been largely held in common between these distributed populations; indeed, in both case studies elaborate traditions of potting exist that are nonetheless homogeneous in their richness (a productive future avenue of research would be considering the role of such elaborate potting traditions in articulating and creating inter-island identities). Analysis of access to productive hinterlands, undertaken in Chapter Six, suggests that the populations at Late Neolithic sites were primarily concerned with village-level subsistence, with a relative lack of flow of resources between sites; the extent to which subsistence choices across the archipelago paralleled each other is reinforced by a consideration of the (limited) zooarchaeological data (Figure 3.8). While the same detailed work cannot be undertaken for the Early Ceramic I and II Leewards, the same impression — of daily subsistence activities focused at the level of the individual village — emerges.

This overall sense of parity is reinforced to some extent by the network modeling undertaken in Chapter Five. As suggested in that chapter, it is inherently unlikely that the networks which derive from the initial gravity-web models are truly equitable. Some sites retain stronger links to their peers than do others, and some retain more overall links — the cultural reasons underlying this are explored in the first part of Chapter Six. That said, when comparing the Early Ceramic II and Late Neolithic network models at both iterations (I_{ij}>20, I_{ij}>50), no obvious distinctions between sites emerge — specifically, no distinct tiers of connectedness are evident. Some sites are certainly preferentially situated, retaining more connections. This is especially the case for the large Saliagos-phase villages in the central Cyclades, and for sites, such as Trants, Montserrat, which may have functioned as centers for exchange in the Leeward Islands. In general, however, the connectivity of the most as opposed to the least connected sites does not approach anything like the classic power law distribution expected in large, complex networks (Barabási 2009); strong aberrations (in particular the very high I_{ij} value of Royalls-Indian Creek) are probably functions of island size as a scoring factor in the calculation of site gravitational weights, which is problematic for sites on the same island.

While this network modeling remains only heuristic, it is another factor which serves to indicate that there was no great disparity in the attractiveness of sites, either in the Early Ceramic I-II or the Late Neolithic (excepting extra-mundane sites like Fountain Cavern and Zas Cave). In both cases, well-distributed sites, exploiting preferential environmental niches, of approximately the same size, seem to have been operating as peers — this should have some social correlation. I do not wish here to become involved in depth with arguments for and against egalitarian ideational structures in cultures which are only observable archaeologically. Instead, it seems preferable to note that there is, in general, a lack of evidence for social stratification in the Caribbean or Late Neolithic Aegean sites in question. It is admittedly difficult to imagine what would comprise such evidence, at least in the Leeward Islands. The socially stratified societies of Puerto Rico and Hispaniola in the Late Ceramic perhaps provide the best models of what to expect, and there is certainly very little intra-site differentiation (and certainly no preserved monumental or ritual architecture) in the Early Ceramic of the Leeward Islands. In the Aegean, we have a better grasp of the vectors which might indicate increasingly inequitable access to material and symbolic resources. The general lack of evidence for storage, for preferential access to copper, and for elaboration of wealth in funerary contexts, suggests that social relations were not as complex as in the Final Neolithic or Early Bronze I-II. It is not too speculative, then, to suggest that this apparent inter-site parity in the settlement ecologies of both the post-colonization Cyclades and the Leeward Islands was related to intra-site parity. Egalitarian or non-hierarchical social structures were related to modes of spatial distribution which were preferentially adaptive. The intriguing possibility emerges that non-hierarchical sociospatial behaviors were, on a general level, somehow adaptive in the early agricultural and horticultural settlement of both archipelagoes; or, at least, that hierarchical modes of organization conferred no obvious adaptive advantage in behavioral ecological or biogeographic terms. Despite the obvious differences in the behaviors and choices of the populations which settled both archipelagoes, this seems to be an underlying theme.

The tentative conclusions established so far, drawing on several aspects of the analyses undertaken in previous chapters, have emphasized commonalities: both in the distributional and adaptive behavior seen within both archipelagoes, but also to some extent between them. The long-term development of settlement in both the Cyclades and the Leewards, however, involved the emergence of pronounced disparities. In the Cyclades, the fourth millennium seems to witness increasingly complicated systems of distribution, culminating in the two-tier settlement hierarchy that possibly prefigures a similar Early Bronze II hierarchy. In the Leewards, the 'chiefdom' which has been argued to have emerged on the Anguilla bank in the late first millennium AD (Crock 2000; Crock and Petersen 2004) has, according to the spatial analysis undertaken in Chapter Five, its roots in changing patterns of settlement in the Early Ceramic II. The next section of this chapter charts the development of these more complex modes of landscape exploitation, and accounts for them.

7.2. Prospero's Cell: The Neolithic Demographic Transition and its Implication for Small Islands

By way of introduction to this section, some basic concepts are considered at a more general level. In particular, I would like to return to Chapter Four as a place to begin thinking productively about motors of social change in small, circumscribed contexts. In that Chapter, the distribution of the archaeological data (in terms of nearest neighbor and next nearest neighbor) was plotted against available ethnographic settlement data from two Pacific islands (Figure 5.9). This is an inherently interesting heuristic exercise, but the fact that the earlier phases of settlement in both the archaeological case studies do not correspond to the densities of settlement seen in the Pacific data is suggestive. The Pacific islands in question — Tikopia and Boyowa — are, compared to the Cyclades and the Leeward Islands, small and relatively isolated. This perhaps provides initial hints that the distributional and demographic processes occurring on these islands in the ethnographic present may have been very different to those occurring in the earliest phases of settlement of the Leewards and Cyclades in the archaeological past. This introduces the problem of human populations (and the dynamics of these populations) and suggests its relation to systems of spatial and social organization. In particular, we might reasonably expect increasing or decreasing populations, over generational time, to impact modes of organization within small island archipelagoes.

Bocquet-Appel and Bellwood (Bellwood and Oxenham 2008; Bocquet-Appel 2002, 2008, 2009) have argued at length that the conditions of agricultural and horticultural subsistence have important ramifications for the population dynamics of human societies. They argue that, when contrasted with the calorific sources available to hunter-gatherer societies, the capacity to produce food — supplemented with wild resources — steepens the trajectory of demographic growth. In both instances in question, different cultural approaches to food, varying degrees of reliance on fully domesticated species, and the different calorific values of available resources, suggest that trajectories of demographic growth are unlikely to have been the same. That notwithstanding, we might expect a given food-producing community to experience steeper demographic growth than a corresponding hunter-gathering community.

Reorienting this discussion towards long-term developments in island societies introduces a further series of complicating factors. Demographic dynamics in islands seem to display an erratic element which is not present in mainland communities (Demetrius *et al.*

1994). This erratic behavior is in part, although not totally, derived from island size and isolation, the recognition of which lay at the heart of the turnover model in island biogeography (MacArthur and Wilson 1967). Human populations may, indeed, have gone extinct frequently within the prehistory of the archipelagoes in question; when they did not do so, however, they would have encountered very different challenges to similar yet non-insular populations. The notion of sustainability is considered below, and it is suggested that social sustainability is perhaps a better way of approaching prehistoric island demography; that said, a circumscribed environment such as an island presents problems as a given population increases. There are a number of viable solutions to perceive demographic stress in island environments — artificial means of population control, intensification of landscape exploitation, and further colonization of other islands being the most obvious[19]. By extension, the smaller the island in question, the more quickly it will attain and cross thresholds of toleration compared to larger islands, a factor which may also impact the preference for larger islands during initial phases of colonization. This recognition, allied to steepened growth curves associated with the Neolithic Demographic Transition and the fact that small island archipelagoes have very unevenly distributed environmental patches, may be a central element in the emergence of novel social and spatial organization in the case studies.

It is not the goal here to construct a simple model of demographic growth and resource stress; more people in and of themselves do not equate to increasingly complex modes of social organization (Keegan 1995). What I would like to emphasize is something that has

[19] The colonization of oceanic islands by humans is a uniformly late phenomenon (e.g., Gamble 1996:203-240). There is no space to consider here the role of demographic processes in accounting for the general disinclination of hominins to colonize islands and the counter-intuitive fact that, having done so, they then proceeded to move rapidly into increasingly biogeographically-remote islands.

largely been absent from discussions of the impact of demographic growth on island societies. Gradual and long-term growth in small, face-to-face communities would have impacts on social structures long before any imagined carrying capacity might be reached. There is, anyway, little to reason to suppose that the population in the Early Ceramic Leewards and the Neolithic Cyclades approached anything like an unsustainable limit, however modeled. This approach presupposes that social stress would only be experienced at the point at which carrying capacity was exceeded, however. It is possible, if speculative, that gradual increases in the populations of relatively isolated villages could have a destructive impact on egalitarian logics of sharing and concomitant modes of organization. We have no knowledge of modes of horticultural organization in the Leeward Islands during the Early Ceramic — the most that can be said with certainty is that a broad spectrum of resources was being exploited. Whatever the social organization of subsistence practices, though, gradual increase in population — probably not perceptible at the individual level — would eventually demand adaptation as increasing demands were made on resource patches. Similar processes would have occurred in the Cyclades, albeit with very different choices and solutions being presented.

The long-term distributional data seem to suggest that adaptive processes like these occurred in both archipelagoes. Before exploring these in detail, it is worth noting an aspect of this research which hinders this comparison. For reasons relating to periodization and availability of data, the first phases of the Late Ceramic period in the Leeward Islands are not included in the analyses in this dissertation. One corollary of this is that the spatial organization of Late Ceramic populations is not discussed at length; during this phase (the terminal first millennium AD), settlement organization appears to have shifted from relatively few large village sites to small settlements spread along island coasts (e.g., Cherry *et al.* 2012a; Delpeuch and Hofman 2004; Wilson 2006). This may well be indicative of a general response to pressures already evident in the Early Ceramic II. Either way, the density of sites on the Anguilla Bank in the Early Ceramic II seems to prefigure the Late Ceramic mode of landscape occupation.

As has become obvious in Chapter Four, the pattern of human spread over the island landscapes of the Cyclades in the Final Neolithic is very different to the prevailing Late Neolithic distribution. Again, it is important to reiterate that there are lacunae in the data, not least as regards the Kefala-phase credentials of Koukounaries and Grotta, the lack of systematic investigation on Tinos and Syros (amongst others), and the poor-quality data available on sites on northern Andros. It becomes clear in the analysis, however, that two tiers of settlement developed in the fourth millennium to replace the single tier in the fifth. The smaller second tier sites within this system (so far limited to the northwestern archipelago) such as Kefala, Sykamia, and Mikroyiali occupy very different niches than their Saliagos-phases predecessors; frequently but not exclusively coastal, but with no access to the large alluvial deposits with which the Late Neolithic colonists seemed so concerned. Importantly, they cluster much more densely than their predecessors, at distances which would allow — but does not imply the existence of — frequent contact. What is surprising is that the only definite first tier site, Strofilas, also does not follow the distributional logics of the Late Neolithic, situated on a rocky coastal promontory away from the fertile valleys of Andros (Figure 6.20); this is considered in more detail below.

This transition can be explained as the aggregate outcome of a series of choices made in response to the social perception of pressure. One response to increasing demands made on a series of subsistence patches would be to diversify, expanding the definition of culturally acceptable places to live and farm. If we were to interpret the Final Neolithic distribution of settlement as a direct and organic development from the Late Neolithic distribution, this would involve the budding-off of elements of expanding kin groups and their relocation in sub-optimal niches. As discussed in Chapter Three, there is in fact reason to suppose that the fourth millennium settlement of the Cyclades may result from new colonists from the Greek mainland, as it is during this period that occupation of previously liminal zones across the Aegean begins to occur. Either way, the uneven distribution of unevenly sized communities across an inequitably resource-rich landscape, a result of choices made in the face of demographic pressure, would have long term ramifications for social structures.

Disparate developments in social and spatial organization in the Leeward Islands may also derive, in part, from the operation of Neolithic demographic processes in small island contexts. In Chapter Four I noted that the Anguilla Bank — the islands of Anguilla, St. Martin, and St. Barth's — have an unusually high concentration of Early Ceramic II sites, even after discarding several under the rubric of chronometric hygiene (Fitzpatrick 2006); if we were to adopt a less rigorous approach, the number of Early Ceramic II sites in the sub-archipelago may well be doubled. Data on the size and extent of many of these sites are lacking, so understanding their interrelationships prior to the Late Ceramic is problematic. What is relevant in the current discussion is the total available area: all three main islands are, in sum, still slightly smaller than Antigua (at 281 square km). Comparatively isolated and small by Leeward Islands standards, demographic trajectories shared with Antigua, Nevis, and Montserrat may have exerted pressures peculiarly early in post-colonization time in the northern Leewards, with these pressures less keenly felt in their larger southern neighbors. The spread of individual communities across the archipelago may, again, represent at attempt to alleviate this stress by exploiting new or farther niches, with resulting difference in access to resources patches and dislocation of social and kin groups having profound effects on islanders' social logics.

This model of incipient social complexity is tentative. While it is tantalizing that increasingly complex systems of human distribution map well over the first nascent ranked societies in the Leeward Islands (Crock 2000; Crock and Petersen 2004), correlation does not imply causation. It is important to recall the relative proximity of the islands of the Anguilla Bank to Puerto Rico, where socially stratified communities were well-developed by the end of the first millennium AD — the processes on Anguilla and St. Martin may be related to the appearance of off-island materials with connotations of social distinction and differentiation. As regards this last point, it is encouraging that the combination of Knippenberg's (2007) work on the movement and exchange of Long Island chert with spatial analysis in Chapter Six seemed to suggest that real quantitative distinctions can be observed in how Anguilla Bank sites, and sites to points south, received this raw material. This might indicate a social distinction of the sort implied by the gradual development of two different modes of spatial organization in two different areas of the archipelago, or that emergent dominant groups on the Anguilla Bank maintained an interest in restricting the flow of a valuable resource. Either way, there exist hints that Amerindian communities on Anguilla and St. Martin were, by the mid first millennium AD, pursuing different strategies of landscape occupation than their contemporaries to the south.

Long-term processes of social and cultural development (in the sense of Yoffee 2005) in both the Cyclades and Leeward Islands were clearly very different, and tied to context-specific behaviors and ecological cycles. Yet there seem to exist certain sets of challenges which in both cases were exacerbated by the insular nature of the context of settlement systems. The fragility, patchiness, and reduced scale of the newly-settled landscapes were common challenges; similarly, the demographic trajectory associated with food-production was a shared feature. The uniquely problematic confluence of these factors limited the choices available to farming and gardening communities in both archipelagoes in the very long-term. Insular adaptation, perversely, laid the conditions for growth which in turn forced the production of new distributional logics. These new logics — not the only response to increased social pressure, but an archaeologically visible one — manifested as individual behaviors had profound impacts on social organization in both cases. In the Cyclades especially, however, human pressures were not the only long-term forces encouraging change.

7.3. Between Scylla and Charybdis: The Emergence of Social Complexity in the Cyclades and the End of the Holocene Climatic Optimum

The most efficient way of explaining the spread of settlement into hitherto unoccupied nooks in the Final Neolithic Cyclades involves considering effective responses to gradually increasing demographic pressure. This was not the only imperceptible yet powerful factor conspiring to limit individual choice in the archipelago in the fourth millennium.

Studies of the climate of the Pleistocene and Holocene are only problematically correlated with archaeological data. While both archaeological and climatic data have an appropriately gross resolution, it remains difficult to fully correlate climate dynamics with large-scale social change. Moreover, different indices of climatic change tend to have different lags in their responding to individual events. For example, the 8.2 kya event — commonly assumed to represent the final collapse of the Laurentide ice sheet and a corresponding influx of melt water from Lake Agassiz into the North Atlantic — produced effects in different vectors that persisted over different time scales. That said, increasing resolution of the peaks and troughs in certain climatic indices provides reason to be confident that we can conservatively identify trends on a millennial scale.

Despite cycles of oscillation throughout the Holocene, general trends have emerged in the data, both at a planetary (e.g., deMenocal *et al.* 2000; Mayewski *et al.* 2004; Roberts 1998) and a regional (Geraga *et al.* 2005; Magny 2004) scale. The transition from the Holocene Climatic Optimum to current Holocene conditions seems to be one such general trend, peppered with smaller oscillations which run counter the overall pattern on smaller temporal scales. The full establishment of the current climatic regime — generally drier and cooler than during the Optimum — can be placed at around 3,000 BC (Roberts 1998:115-117), although smaller-scale climatic cycles may have exaggerated the effects of this transition (Mayewski *et al.* 2004). The outcomes of these processes would have been context specific, but in general resulted in greater mid- and low-latitude aridity (deMenocal *et al.* 2000). The effects of this trend in the East Mediterranean seem to largely have paralleled wider changes, with the basin becomingly increasingly arid (Geraga *et al.* 2005) between approximately 5,000 and 3,000 BC. This broadly coincides with the period of interest — the Late and Final Neolithic — of this study, and should be considered an important factor in the long term social changes seen during these millennia.

There is a shift, based on what little palaeoethnobotanical data exist for the Cyclades, from cereal regimes based on wheat to regimes which incorporate wheat, barley, and pulses. Of these, wheat is the most susceptible to fluctuations in rainfall. It is possible to argue that this transition represents not only diversification, but specifically diversification towards species less reliant on regular rainfall — *Lathyrus sativus*, the grass pea recovered via floatation at Kefala, is notably drought resistant (Zohary and Hopf 2000:119-121). This development occurred simultaneously with other changes in subsistence, notably an increased reliance on shellfish (never, perhaps, enormously significant in the Cycladic Neolithic diet), and the increasing frequency of cattle in zooarchaeological assemblages (Figure 3.8). This transition accompanied the social developments to which we have returned in Chapters Five and Six: namely, the emergence of hierarchies, both within and between sites, by the terminal fourth millennium.

The settlement and subsistence data taken as a whole represent different aspects of the same process. As the population of the Cyclades gradually grew under the conditions of the Neolithic Demographic Transition between 5,000 and 3,200 BC, greater strain was placed on the productive niches which had been targeted by the initial colonizers. Allied to this, increasing aridity negatively affected cultivation of wheat while, season by season, the number of drought years increased. Following Halstead (1989, 2008) it is suggested that, in the face of this dual assault, choices which aimed to minimize risk were made. A number of solutions were available, including: subsistence diversification; expansion into previously under-used niches; the establishment of storage; and the development of social storage, in which reciprocal obligations between communities allowed access to external resources when crops in one microniche failed. The transformed settlement landscape of the late fourth millennium — small sites, evenly spaced yet within reach of one another, with diversified growing regimes — makes considerable sense. In this way it can be seen that the transformation in settlement patterning was the aggregate outcome of many individual adaptive decisions, made over generational time.

These aggregated decisions nonetheless had emergent properties. There is little evidence which allows reconstruction of kinship structures for the Final Neolithic, but their dislocation, and the dislocation of previous modes of access to certain types of resource, would have had socially transformative affects, as would increasing awareness of the importance of rights over surplus. It is in this context that the development of inequalities in the settlement system is best explained, as social distinction emerged as a byproduct of the resilience of the system. This, in combination with new regimes of value — most notably with worked metals (e.g. Renfrew 1972:308-338) but also with obsidian (Carter 2008) — provided the fodder with which emergent elites could articulate difference. Strofilas is the prime example of this; a large site, replete with symbols which would become associated with power in the Early Bronze II, it was argued that Strofilas was extracting surplus from its hinterland in a manner which suggests the capacity to exert some collective will. This is not a fully redistributive model — Strofilas is a long way from the Late Bronze palaces, and anyway the type of solution to the aridification of the Mediterranean that Strofilas may represent seems to come to a halt in the late third millennium. By virtue of coercive power, however, symbolic or otherwise, the population of Strofilas was able to extract more from its surroundings than a Late Neolithic village, situated in the same place a thousand years earlier, would have been able. Strofilas is, as has been demonstrated, unusually hyper-connected, emerging as a classic hub (Figures 5.30 and 5.31). Its advantageous position within the network of human activity in the Final Neolithic Cyclades would certainly have facilitated such extraction.

The extent to which Strofilas was unique and aberrant in the terminal fourth millennium is an open question. No comparable sites exist, although they have not been searched for systematically across the whole archipelago. Nor is their evidence for a similar two-tier settlement hierarchy in the subsequent Early Bronze I/Grotta-Pelos phase (3,200 — 2,900 BC). Considering the remarkable degree of similarity between the hierarchies seen in the Early Bronze II and the Final Neolithic, these lacunae may well be artifacts of research. Systematic intensive pedestrian survey may reveal a more extensive spread of Final Neolithic settlement across the northern Cyclades; the progenitors of Strofilas could well lie under Ayia Irini and Grotta, where the grasp of the horizontal extent of the Neolithic settlement is limited by the overlying Bronze Age sites.

7.4. Human Behavior as Embedded Deep Ecology

A specific theoretical perspective was deliberately avoided when framing this investigation of insular living; this is the root cause of the multi-valent approach adopted throughout. This is partly because doing so seems a little like voluntary incarceration, but also because several intellectual frameworks current in archaeological thinking seem to have more in common than their practitioners would like to suppose; there is probably disciplinary capital to be made in shouting about difference. That said, what I would like to do here is articulate a broader theoretical position, that can embrace and tolerate several approaches to prehistory. I argue that human cultural choices, and the emergent properties of these aggregate choices, are made in symbiosis with deep ecological rhythms. This initially sounds like an environmentally determinist position, or Darwinism dressed up in agency; in the following discussion I aim to show that this is not the case.

This dissertation is entitled *Logics of Island Life* because a primary concern has been with structures that underlay decision making processes in fragile island environments. The 'logics' in question are larger systems of cultural reasoning that inform aggregate behaviors and their outcomes. This concept clearly resonates with a theme within the social sciences, represented primarily by the work of Giddens (1984) and Bourdieu (1997), in which large systems of thought and behavior emerge from (while simultaneously reproducing) microscale behaviors. This work is deeply attractive, in that it unites individual human action with the more massive structures evident in human society. My dissatisfaction with these two theorists in particular derives from the overpowering role given to the social in both models. The failure to consider the materials and materiality makes both arguments very problematic for the archaeologist to adopt. This is in part the root of the challenge presented by advocates of human behavioral ecology: culture cannot simply be a function of culture (Bird and O'Connell 2006:171). Any account of human behavior has to be rooted in materials, as the media of action.

The work of Fernand Braudel (1972) offers a potentially attractive solution to this problem, the primacy of the social in how large-scale human structures are built. For Braudel, human action is couched in different temporal scales: *histoire événementielle*, *conjonctures*, and the *longue durée*. The deep structural base, for Braudel, is the integration of subsistence behaviors with the environmental unity of the Mediterranean, the cyclical dynamics of the *longue durée*. This draws practice and human-environment dynamics into the consideration of development of social structures. In Braudel's conception, however, only at the level of the very long-term does human activity interlock with environmental cycles. This activity is reactive — the timeless Mediterranean peasant is yoked to timeless Mediterraneanism. Braudel does not allow for mutually constitutive relationships, and nor is it clear how the multi-scale gears of the three levels of time gain traction on one another.

The various branches of ecological thinking utilized in this dissertation — historical, behavioral, and human niche construction theory — inform a multi-scalar Braudelian perspective. I am sympathetic to these approaches in particular, and to the wider tenets of archaeological thinking as it has been applied in archaeology more generally. Historical ecology especially recognizes the osmotic nature of people and the contexts in which they live. Human behavioral ecology and human niche construction theory have been extremely useful, in this research and elsewhere, in modeling human responses to semi-pristine island environments — it was suggested in Chapters Two and Six that they can generate models of early colonization distributional choices which seem largely correct. Yet these approaches remain partly unsatisfactory in that they maintain a dualist opposition between the natural environment and cultural behavior; in maintaining this distinction we simply replace the ideational base of structuration theory with an ecological base. The cultural becomes a function of natural processes working as a superstructure, an outcome of — in particular — subsistence behaviors. This is essentially a form of ecological structuralism, not inherently a flawed approach, but one that fails to define human actions as a constitutive element of ecological dynamics, rather than a product of them (cf. Zeder 2012). Furthermore, we might be suspicious that human behavioral ecology has, for the most part, restricted itself to studies of hunter-gatherer societies, or societies with relatively simple internal structures (e.g., Keegan 1986; Kennett and Winterhalder 2006). This suggests an inherent difficulty in using human behavioral ecology to move from subsistence activities to questions about higher-order human behaviors.

Here I would like diverge from these approaches, or at least nuance them. I suggest that we need to understand human behavior, especially but not only in deeper prehistory, as rhythmical and embedded within geological and ecological dynamics. 'Geoecological' is a clumsy coinage, but it has the advantage of capturing the recognition that the 'environment' which provides the context for human action is neither monolithic or static; rather, that various environmental scales are embedded within one another, with ecological systems rooted in geological and climatic systems, themselves the products of more massive tectonic and atmospheric processes over longer cycles. The work of Karl Butzer (1982, 2005) is central here. Butzer, like Braudel, recognizes the different scales at which cyclical environmental dynamics and human behavior intermesh (e.g., Butzer 1982:26), and that these nested scales exist from the daily to the epochal. Unlike Braudel, he also understands the changing environment, and changing human behavior, as overlapping zones of action (2005). In this Butzer, in a manner not often seen in the human behavioral ecological literature, situates human action within ecological processes: the behavior of other individuals comprising part of the overall ecology to which people and communities react, and then impact through this reaction. The limitation of Butzer's approach is a resolute focus on the multi-scalar interplay between subsistence practices in short cycles and environmental long cycles. He experiences some difficulty, especially when closest to the environmental data, in tying this interaction to long-term ideational and social-structural change in human societies. In the account given below, I hope in some part to redress that.

Human behavior, then, on islands but elsewhere is an aspect of this confluence of organic and inorganic processes, albeit clustering at one end of the scalar spectrum: tied to, derived from, and sometimes productive of them. Total ecological processes at multiple scales — from seasonal cycles of growth and decay, to massive geotectonic and climatic rhythms — come together to provide the contexts and horizons of human action. Titanic processes, unobservable at the generational level, nonetheless had enormous effects on the spheres of human action in both the prehistoric Mediterranean and Caribbean. The Aegean data in this dissertation offer an example, and a way to think through the concept of embeddedness.

Increasing aridity in the Mediterranean basin in the fifth-fourth millennia — itself a minor fluctuation of the glacial-interstadial oscillations of the Quaternary — transformed the productive landscapes of the Cyclades, almost certainly making the Aegean less hospitable to cereals. Almost imperceptibly from the generational perspective, rainfall decreased over a millennium, transforming the biotic landscape; this gradual decline was interspersed by sudden peaks of short-term drought that would have severely challenged farmers of the Late Neolithic. This provided the context in which marked demographic growth — perversely encouraged by the effectiveness of the Neolithic mode of subsistence in small islands — proved increasingly maladaptive. In the face of this dual onslaught and resulting keenly-felt need, ideational structures rooted in long-stable rhythms of the Holocene Climatic Optimum collapsed: adaptive egalitarianism fell away as new systems of landscape occupation (and new technological suites) evolved, premised upon expansion of social and spatial structures in less ideal ecological niches, with concomitant effects on access to material and symbolic riches. This represents an Aegean-specific set of choices which proved very resilient in the face of the emergence of fully modern environmental conditions in the third millennium, and reached its apogee in sites such as Chalandriani and Manika. In this new set of logics, new modes of framing the relationships between people and material emerged, including notions of storage, retention, and household versus communal rights. In the rush to articulate these new modes and the new social relationships they implied, new social behaviors and accompanying objects were produced, not least items made from metal and marble.

In such an explanation, human behavior is not determined by an abstracted environment. Multi-scale ecological dynamics open and foreclose on opportunities seasonally, annually, and generationally. Within these fluctuating horizons individual farmers and their communities pursued conscious and unconscious strategies: planting more barley, growing more pulses, or paddling farther in search of tuna. Other choices involved storing surplus in the expectation of straitened times, as concepts of individual rights versus community rights to food were articulated by new architectures and material grammars. This approach does not restrict human agency or choice, but rather situates the operation of agency within real choice-sets.

This notion of embeddedness also provides the reason for the use of 'sociospatial' in this dissertation. If human social behaviors are deeply implicated within ecological frames, these frames are not only temporal but also spatial. I have tried to emphasize, in this chapter but elsewhere, that changing spatial dynamics (changes in the spatial distribution of humans from generation to generation) correspond closely with changes in social structures. This is an outcome of the distributional choices made in adaptive response to ecological dynamism; these choices in aggregate have emergent properties. In both the Leeward Islands and the Cyclades novel patterns of distribution across inequitably spaced productive niches had impacts on kin structures and modes of the mobilization of resources within communities.

Spatial organization and social evolution (*sensu* Yoffee 2005), in this case, appear to have been mutually reinforcing processes. Again, this does not attempt to restrict the individual's capacity to act: it simply suggests that the sum of these individual choices about where and how to live had profound and transformative social and environmental effects.

The intention here is to provide a productive means of thinking about long-term social changes as outcomes of ecological processes, with human action as a decisive agent in these processes. It might be that because of the inherent human and environmental fragility of islands, but also the unique windows of action that small islands afford, such an approach is best suited to the study of prehistoric insular societies. It certainly appears that human impacts can very quickly become exacerbated in island environments (e.g., Erlandson and Rick 2008; Fitzpatrick and Keegan 2007; Keegan *et al.* 2003; Kirch 1982). That said, I would argue that any attempt at joined-up thinking about human ecological processes (in the sense of Butzer 1982) is productive, especially if it attempts to bridge the span between daily subsistence, ecological rhythms, and higher-order social forms.

7.5. Final Remarks

The kernel of this dissertation is an issue of generalization: specifically, whether choices made in two case studies paralleled one another, and if this suggests that there are preferable strategies of living for a certain type of human community in a certain type of setting. The initial answer seems to occupy an uncomfortable halfway position.

Behaviors, as indexed by archaeological evidence for settlement and subsistence, were very different in the Caribbean and Aegean. The most obvious area of overlap is in how initial colonizing populations settled these small worlds — choice of settlement location frequently seems to have been purposive and considered. In the Early Ceramic and Late Neolithic niches which best suited the subsistence strategies of the first islanders were targeted, yet in both cases there is an evident willingness to adapt to the presence of new maritime resource sets. This has a number of corollary points, not least that such decisiveness implies an intimate awareness of the landscapes to be settled. These were not unknown landscapes, as the case of early exploitation of Melian obsidian suggests: we have not considered in enough detail, however, how relationships between hunter-gatherer islanders and newly-maritime Neolithic populations were mediated, and the differing parameters of insularity for Mesolithic and Archaic communities.

The common features underlying the distribution of early agricultural and horticultural populations in both the Leewards and the Cyclades seem to derive from a preference for certain confluences of environmental niche. While the results in this dissertation are preliminary, the hint at least exists that generalist strategies of distribution and subsistence were self-selecting. Logics of living, at least in this regard, were held in common despite separation in space and time. This is encouraging, not only in that it has an element of predictive power in both archipelagoes, but also in that it suggests human behavioral ecology and island biogeography taken in tandem may have some general explanatory capacity beyond these two case studies. It would be productive to turn to comparable examples — potentially the Californian Channel Islands, or the Balearics — to establish whether modeling of optimal niches for early colonists in these archipelagoes has any relationship to initial sociospatial organization. Of further interest is how these well-spaced communities organized their relationships with one another. The elaborate ceramic suites of both the

Neolithic Aegean and Early Ceramic Caribbean surely provide a clue, as does the startling homogeneity of both traditions. The spatial organization of potting in early island contexts and in comparative perspective will be a fruitful subject.

The early settlement histories of both archipelagoes diverge over the long-term. The chronological limits adopted in this dissertation mean that we are probably observing an archaeological record which corresponds to the activities of thirty to fifty generations in both cases. Over this significant span of time, the problems posed by insular environmental heterogeneity and the peculiarities of the demographic dynamics of food-producing severely limited the behavioral choices open to both sets of islanders. These restrictions were more or less keenly felt in both case studies, and I do not suggest that the responses to this pressure were the same in both the Leewards and the Cyclades. While changes in how people distributed themselves over their landscapes seem to be implicated in both archipelagoes, the social organizations that emerge at the very end of the periods in question seem very different, aside from a general trend towards more complex modes of distribution. This suggests that the interplay between demographic increase and insularity needs further examination cross-culturally to establish the full variety of responses. Comparable logics of spatial organization in the face of burgeoning island populations are not yet clear. Nor is it clear how such reorganization of social landscapes would transform kinship structures and reciprocal obligations, mostly because we have little idea — especially in the Aegean — of what these structures were. This is a very difficult issue with which to deal, but explaining the emergence of ranked societies in the third millennium can only make sense in the context of beginning to model how changes in community structure encouraged this emergence. Clearer accounts of this emergence are also required for the Lesser Antilles.

Better drowned than duffers; neither in the Leeward Islands nor in the Cyclades were colonizing populations and their successors duffers. Both were adaptive and creative, living in sync with and responsive to ecological rhythms, while constructing their own environmental niches. These logics of living were, on a structural level, common to both communities. This willingness to adapt in the face of long-term environmental and human ecological trajectories, combined with the unique properties of these small worlds, nonetheless had transformative effects. In the sink-or-swim archipelagoes which emerged from these colonized landscapes, some seem to have sunk further than others. The processes by which this differentiation emerged — the development of social complexity in insular and comparative context — provides the future direction of research.

APPENDIX ONE

GRAVITY MODELING

Gravity models operate on the principle that interaction between two given human communities is proportional to their mass, and inversely proportional to the distance between them. That is, two more massive communities situated more closely to one another will interact more intensively than two less massive communities situated at a greater distance from one another (Butzer 1982:215-216; Hodder and Orton 1976:187-195; Tobler and Wineburg 1975; Wilson 2007). The equation for this used in this dissertation is:

$$I_{ij} = k((P_i \text{ x } P_j)/(D_{ij}))$$

where $_i$ and $_j$ are given sites, *I* is degree of interaction, *P* is population (mass), *D* is distance, and *k* a constant (2). *D* values are obviously extremely easy to determine; the problem lies in determining *P* values. A mode of calculating *P* values has to be established which might reasonably reflect cultural preferences in the population being addressed. Moreover, in comparing two different case studies, *P* values will to reflect cultural relevance in both situations. Site size is often taken as the sole determinant of *P* (Knappett *et al.* 2008, 2011) — this is not unreasonable, as site size can often correlate with population size. It is not immediately clear, however, that population densities between the two case studies in question can be directly compared. Either way, very little data on site size is available for the

Aegean or the Caribbean. While Strofilas, for example, is clearly larger than Kefala, detailed data are not available for other sites in the archipelago, and a similar situation holds in the Caribbean.

To circumvent this limitation, *P* values were calculated taking two variables into consideration. Environmental modeling and island biogeography suggest that island size was an attractive factor in the colonization of both archipelagoes, with larger islands being more attractive and smaller islands less attractive. Whatever the reason for this (discussed in Chapter Seven), this attraction appears to be cross cultural. Island sizes are, moreover, very easy to calculate, eustatic sea level rise notwithstanding. On this basis, sites on larger islands were deemed to have been more attractive than sites on smaller islands. *P* values were calculated, then, via a summing of scores for island size and site size. Island size scores were assigned arbitrarily: islands below 200 square kilometers assigned a score of 1.0, between 200 and 400 square kilometers 3.00, and above 400 square kilometers 5.00. Site size, harder to calculate and potentially less significant in settlement systems with broadly similar sized settlements, were deemed less important: where a site was obviously extensive compared to its peers, it was arbitrarily awarded a score of 2.00; when clearly equal to or smaller than its peers, or where data on lateral extents are lacking, a score of 1.00.

This scoring system was applied in both case studies. For example, Late Neolithic Grotta is a site for which data on the horizontal extent are lacking; it is awarded 1.00 for site size (although it may well have been a peer of Saliagos). Situated on Naxos, at 429 square kilometers, it receives an island size score of 5.00, aggregating to P=6.00. When calculating the I_{ij} value for this and another site (taking Late Neolithic Ftelia as an example), the equation is as follows, where $k = 2$:

$$2((6 \times 5) / (38.73)) = 1.54$$

giving the I_{ij} value for this link as 1.54. This produces values which are not whole integers, and some which are <1.00. This causes significant problems when exporting large sets of values into ArcGIS 10.1. For this reason, all I_{ij} values were multiplied by 100. This does not affect the comparability of the calculation or the data, but does allow for ease of expressing these values in a way in which relative weight is readily comprehensible.

APPENDIX TWO

PROXIMAL POINT ANALYSIS

Proximal Point Analysis is a method of modeling interaction between populations over a series of temporal iterations, assuming these populations expand in each iteration (e.g., (Terrell 1977; Broodbank 2000:180-195). Population is represented by single points, expansion of this population by increasing the number of points. Moreover, increase in population is a function of island size, with points being awarded based on area. As the exercise proceeds, the necessary amount of area required for the reward of one point is reduced, simulating demographic increase. Arbitrarily, points are permitted only three links, and these have to be to the three closest neighboring points. In this analysis, islands are awarded 1 site for every 100 square kilometers in the first iteration; 1 for every 75 kilometers in the second; 1 for every 50 kilometers in the third; and 1 for every 25 kilometers in the fourth iteration.

For example, Antigua, at 281 square kilometers, is awarded 2, 3, 5, and 11 points from iterations one through four; Montserrat, just over a third of the size, is awarded 1, 1, 2, and 4. Tiny Saba, at 13 square kilometers, is awarded 0, 0, 0, 1, only becoming relevant in the final iteration. Clearly, the placement of these points within an island cannot be random, as this placement impacts to which other points they are linked. To impose order on the data, points were placed accordingly: 1 point only = center of the island; 2 points = along the longest axis of the island; 3 points = along the longest axis of the island; 4 points plus = as far from the other points as possible. This mode of placement can be seen in Figures 5.19 through 5.22. such an organization means that very close islands, and very large islands, will become highly parochial very quickly, potentially providing a model for a transfer from obligate exogamy to endogamy. The social correlates of this model are considered in Chapter Five.

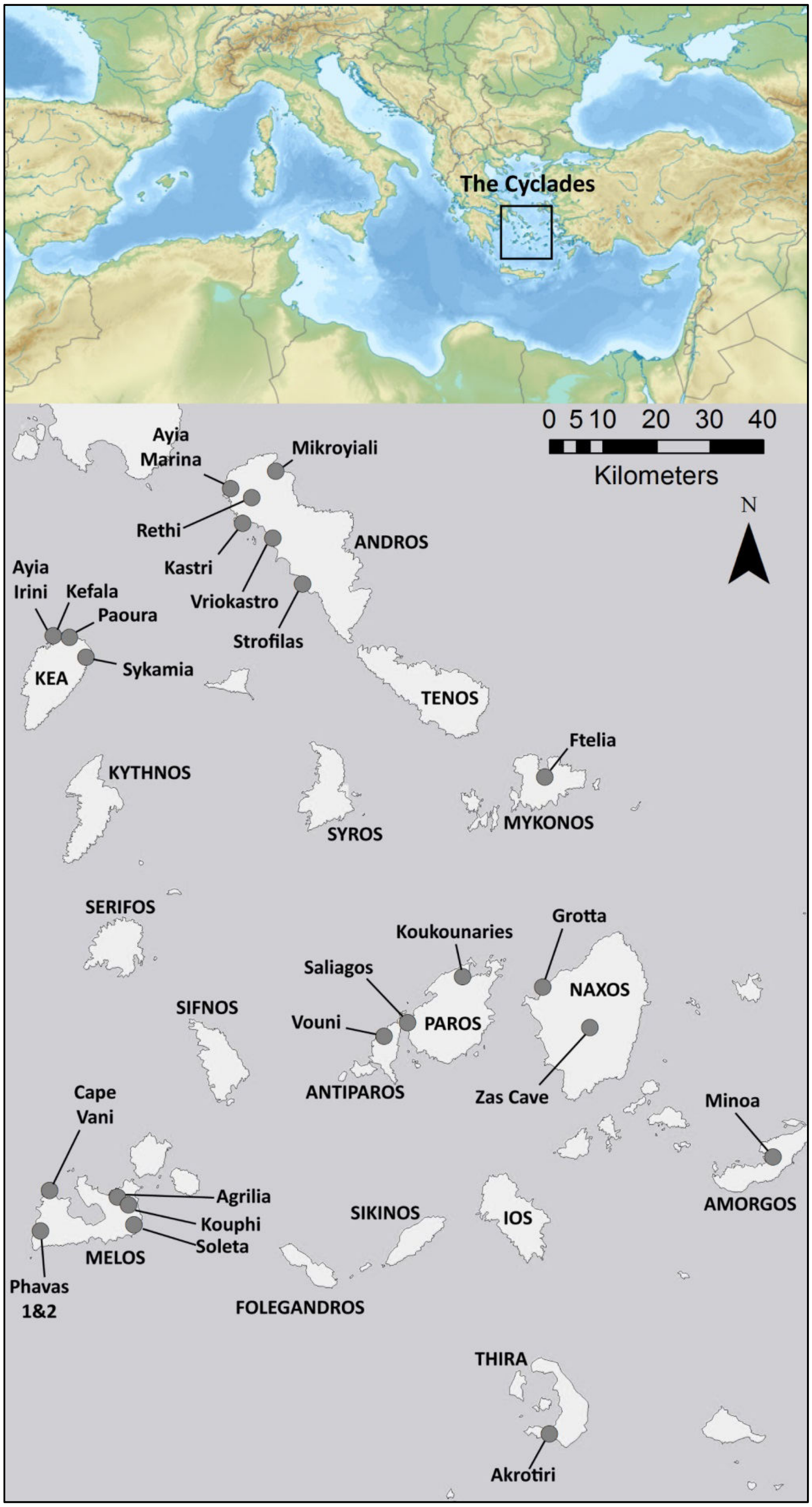


Figure 1.1. The Cyclades; sites and islands mentioned in the text.

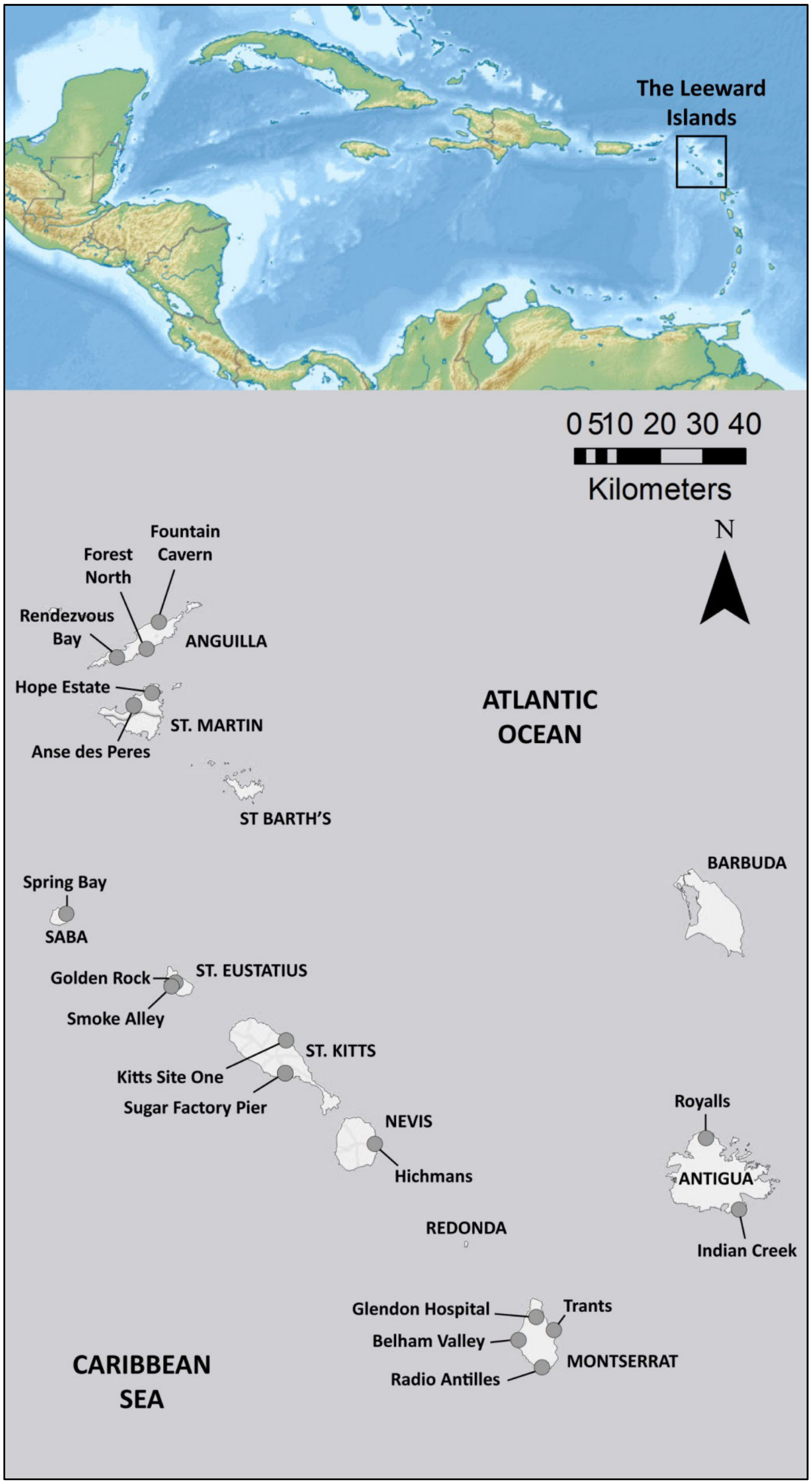


Figure 1.2. The Leeward Islands; sites and islands mentioned in the text.

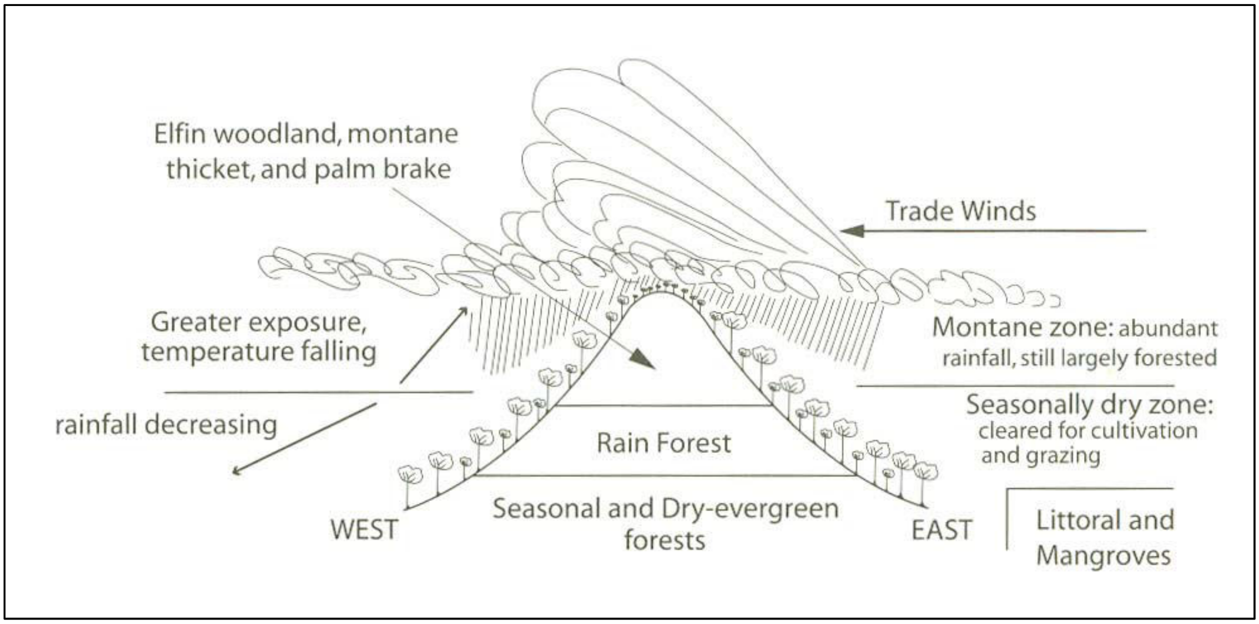


Figure 2.1. Heterogeneity in island environments; topography and meteorology combining to produce microniches in a 'typical' Leeward Island. After Beard 1947: figure 7.

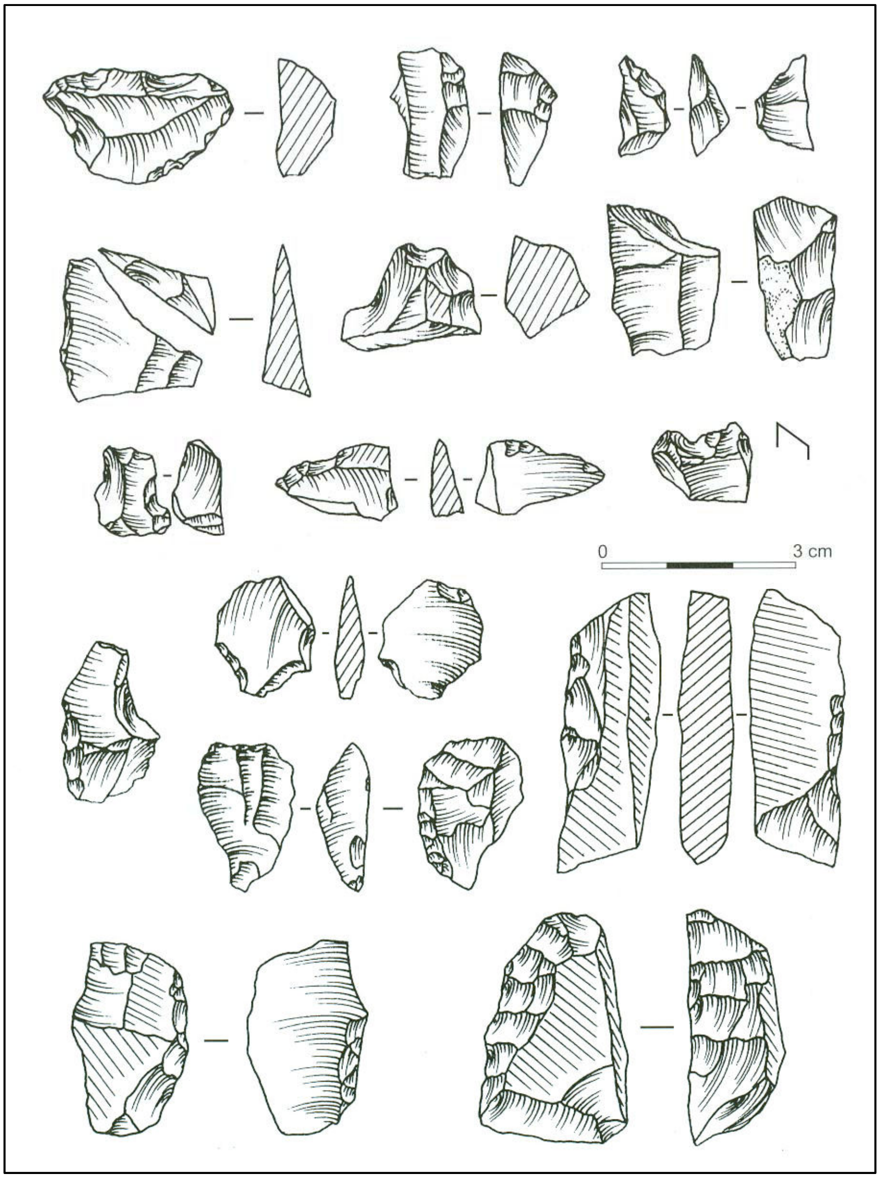


Figure 3.1. Chipped stone tools in Melian obsidian from Maroula, Kythnos. After Sampson 2008c: figure 2.7.

Figure 3.2. Typical Late Neolithic ceramic types; white painted sherds from Saliagos. After Evans and Renfrew 1968: plate 20.

Figure 3.3. Typical Late Neolithic ceramic types; white painted sherds from Saliagos. After Evans and Renfrew 1968: plate 20.

Figure 3.4. “Crusted ware” rim sherds from Saliagos. After Evans and Renfrew 1968: plate 26.

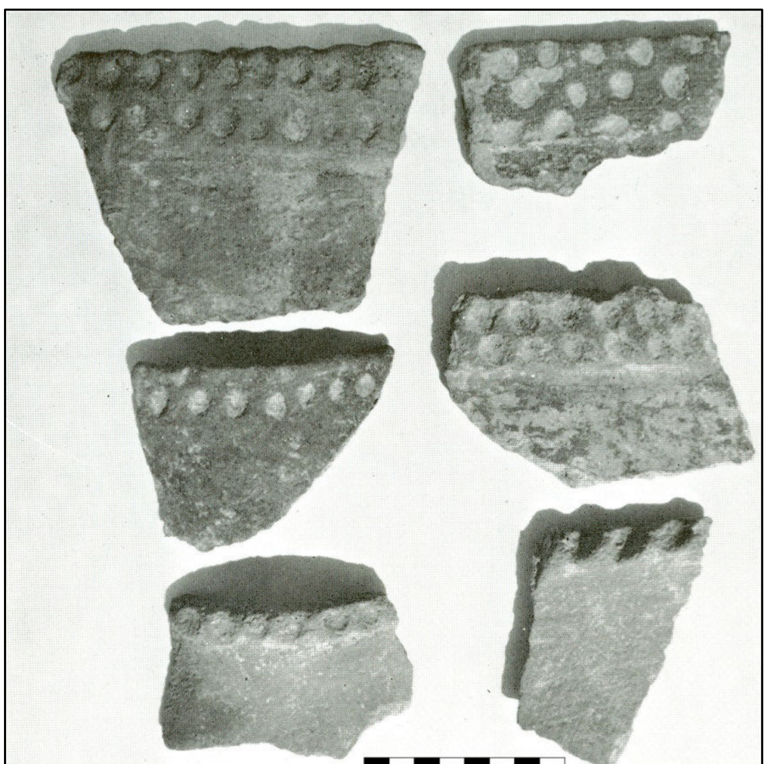


Figure 3.5. “Crusted ware” rim sherds from Saliagos. After Evans and Renfrew 1968: plate 26.

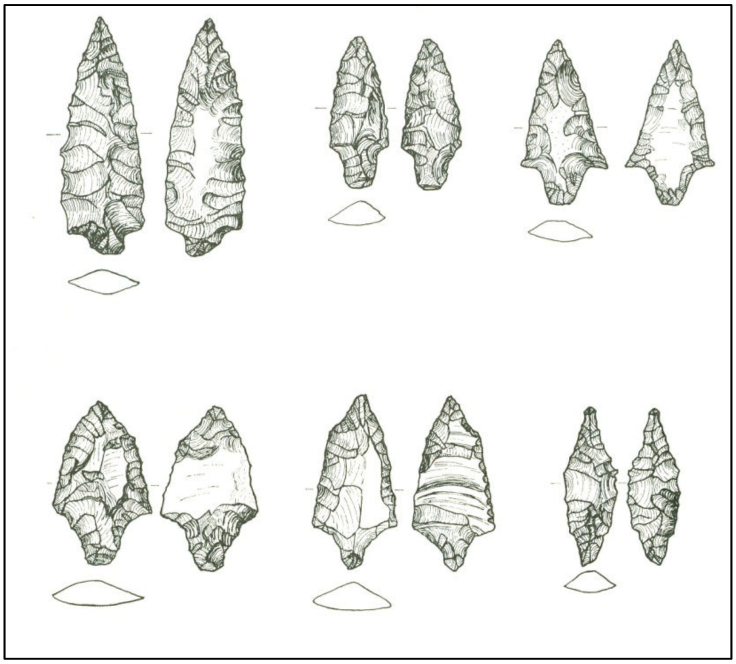


Figure 3.6. Tanged-and-barbed obsidian points from Saliagos. After Evans and Renfrew 1968: plate 62. Same scale as figure 3.7.

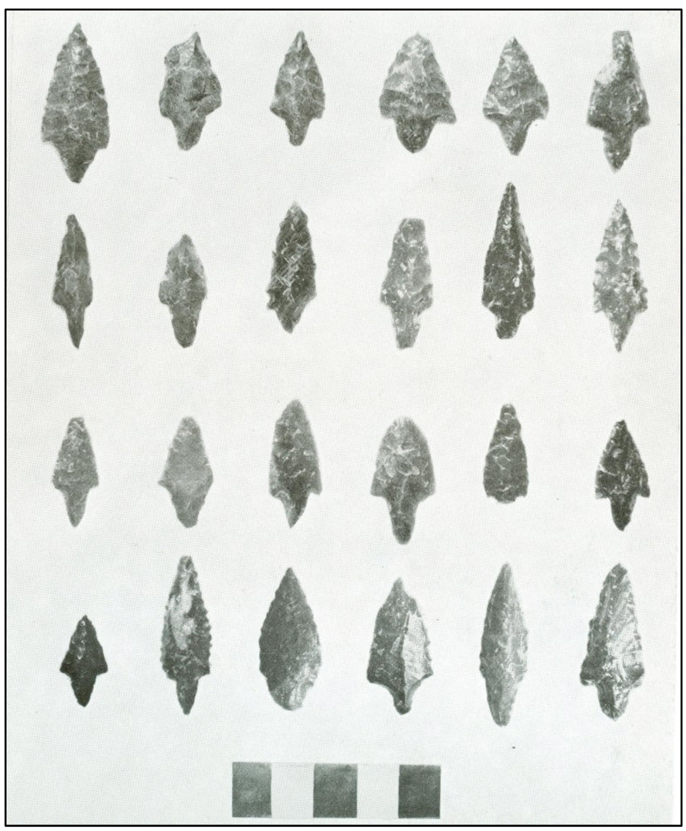


Figure 3.7. Tanged-and-barbed obsidian points from Saliagos. After Evans and Renfrew 1968: plate 37.

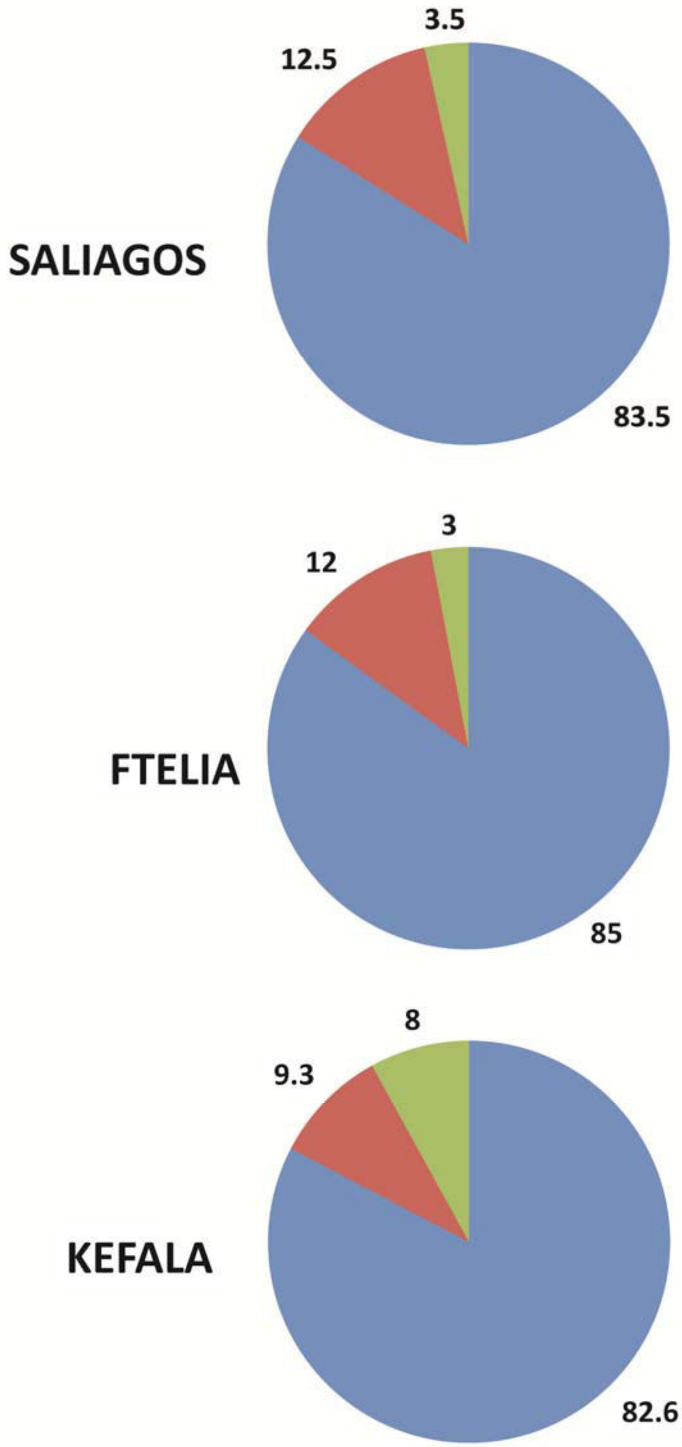


Figure 3.8. Faunal assemblages from Late and Final Neolithic sites in the Cyclades in percentage terms of NISP, showing the increasing significance of cattle in the Final Neolithic; blue = sheep/goat, red = pig, green = cattle. Data taken from Phoca-Cosmetatou 2008: table 5.2.

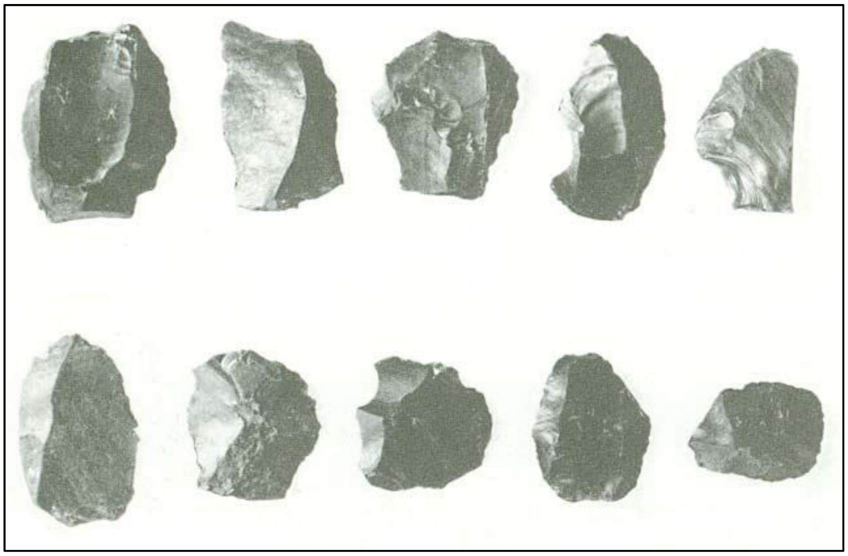


Figure 3.9. Obsidian microtools from Kefala. After Coleman 1977: plate 67. Same scale as figure 3.10.

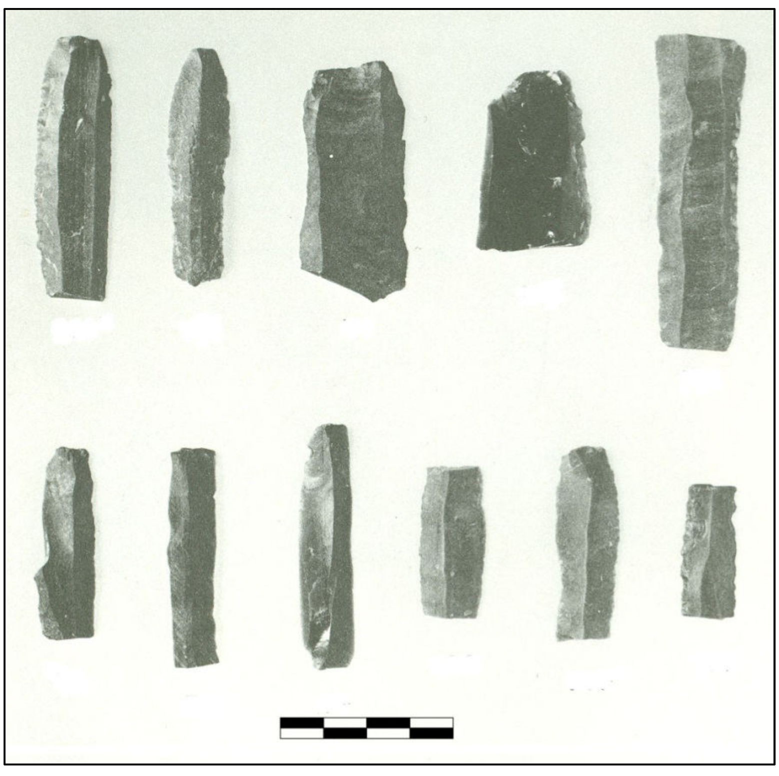


Figure 3.10. Parallel-sided blades from Kefala. After Coleman 1977: plate 67.

Figure 3.11. Tanged and tanged-and-barbed points from Strofilas. After Televantou 2008: figure 6.19. No scale given in initial publication.

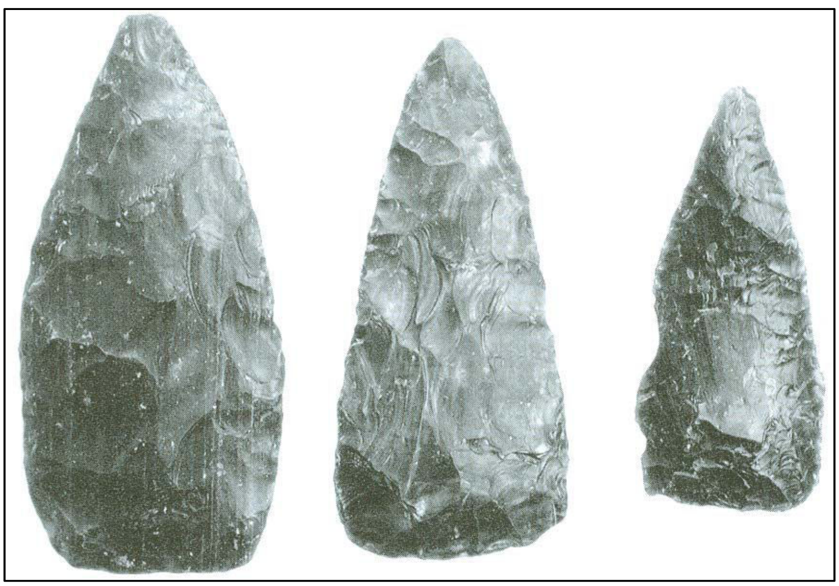


Figure 3.12. "Large obsidian points" from Strofilas; probably hafted axe heads. After Televantou 2008: figure 6.18. No scale given in initial publication.

Figure 4.1. WOR/polychrome vessel from Early Ceramic II Indian Creek, Antigua. Photo by author, courtesy of the Dockyard Museum.

Figure 4.2. WOR sherds from Early Ceramic I-II Trants, Montserrat. Photo by author, courtesy of the Montserrat National Trust.

Figure 4.3. ZIC rim sherd from Early Ceramic I-II Trants, Montserrat. Photo by author, courtesy of the Montserrat National Trust.

Figure 4.4. ZIC body sherd from Early Ceramic II Indian Creek, Antigua. Photo by author, courtesy of the Dockyard Museum.

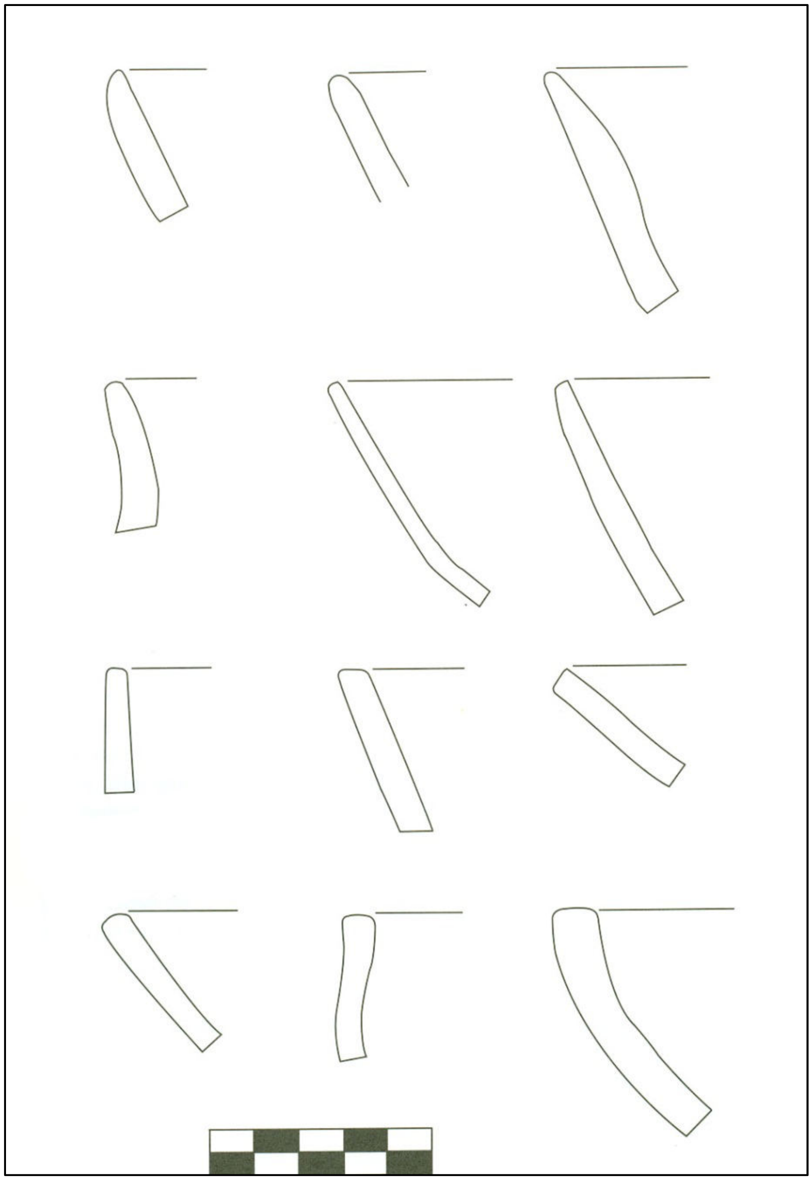


Figure 4.5. Early Ceramic I-II WOR rim profiles from Hichmans, Nevis. Note the steep stance of the bowls, and 'square' rims. After Wilson 2006: figure 4.4.

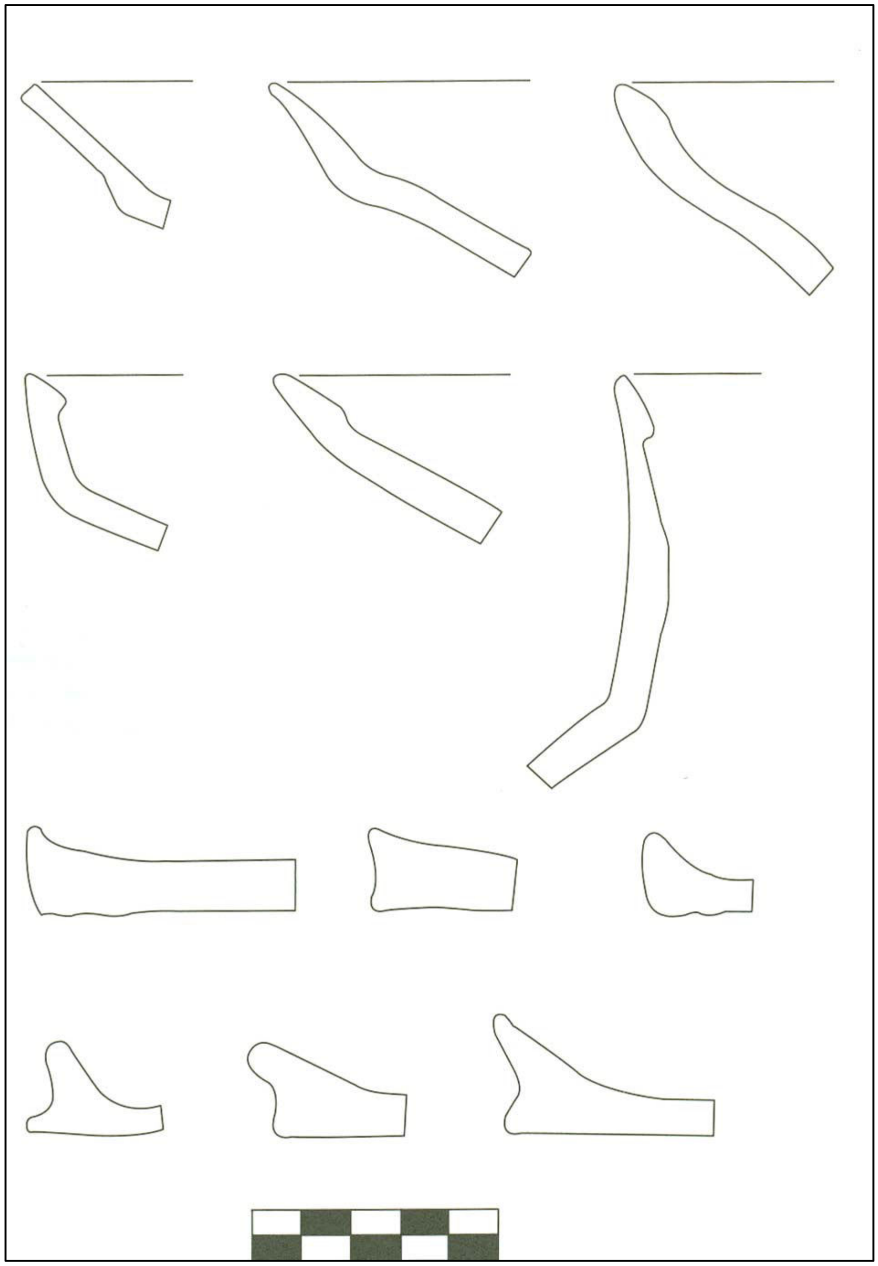


Figure 4.6. Late Ceramic rim profiles from Indian Castle, Nevis; the bottom two rows of profiles are of griddles, commonly assumed to be for grinding tubers and starchy foods. Note the shallow stance, carinations, and tapering rims typical of Late Ceramic assemblages. After Wilson 2006: figure 4.5.

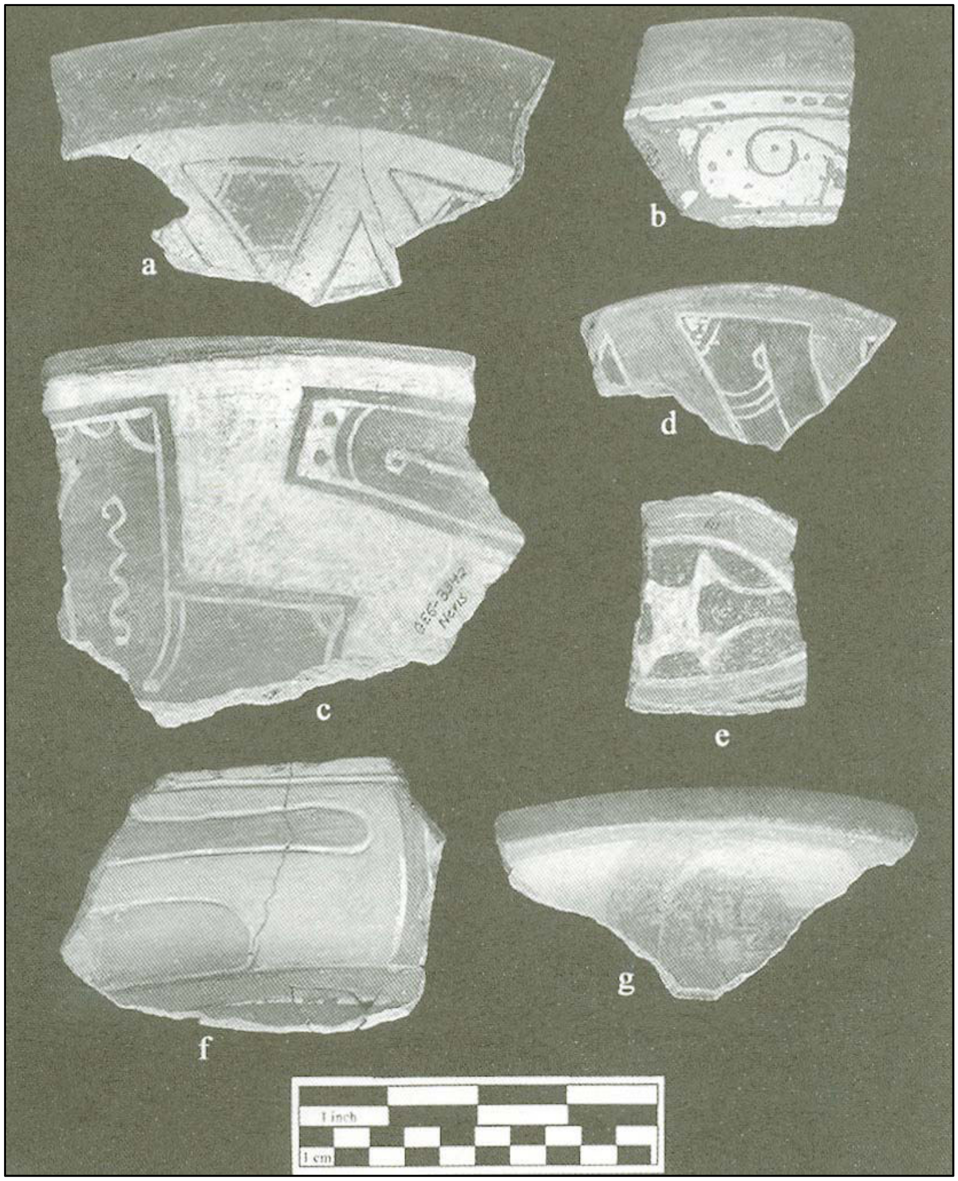


Figure 4.7. WOR and polychrome sherds from Early Ceramic II Hichmans. After Wilson 2006: figure 4.14.

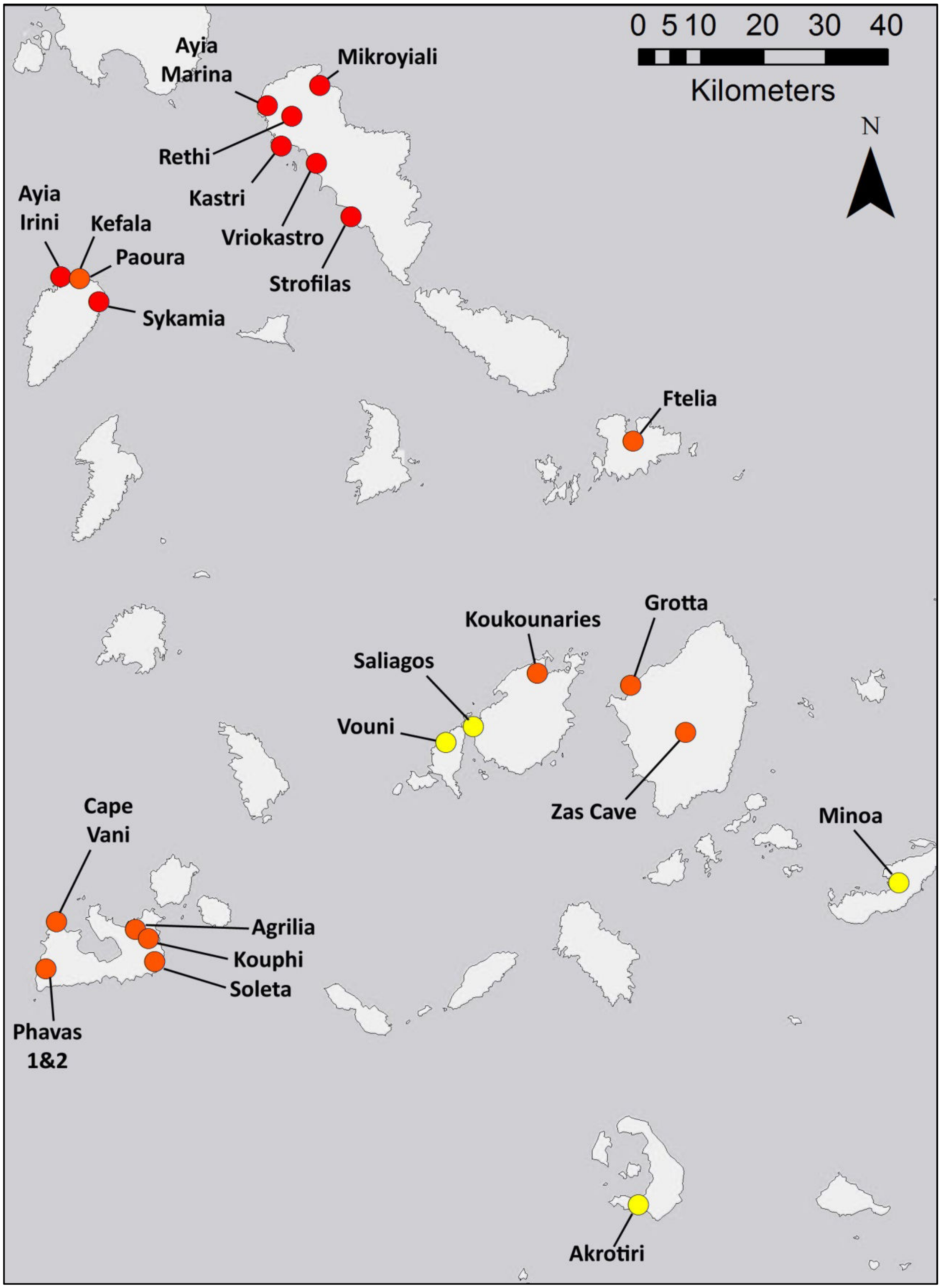


Figure 5.1. Late and Final Neolithic sites in the Cyclades, Late Neolithic in yellow, Final Neolithic in red, and multi-phase sites in orange.

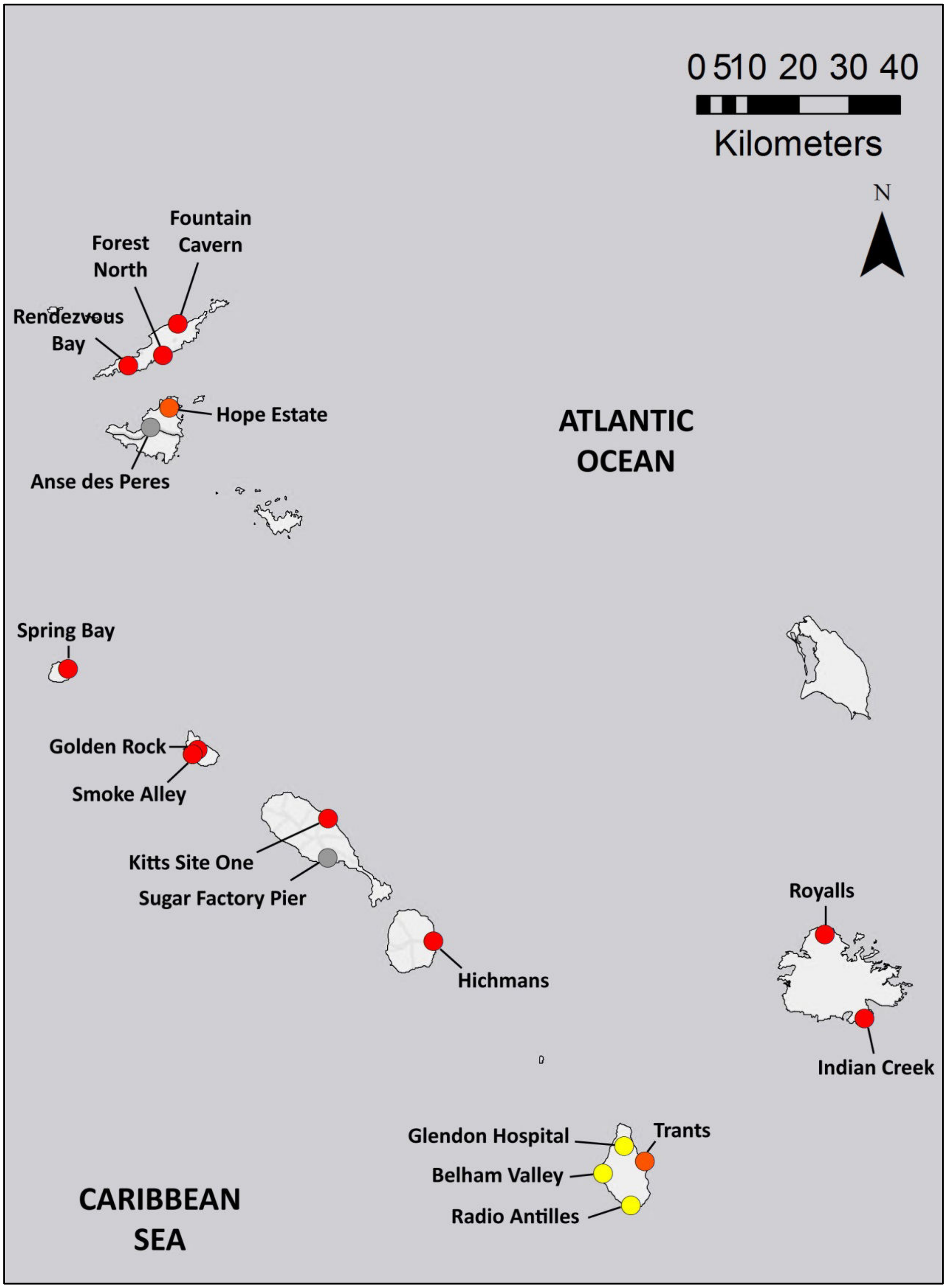


Figure 5.2. Early Ceramic I and II sites in the Leeward Islands, Early Ceramic I in yellow, Early Ceramic II in red, and multi-phase sites in orange. Sites in grey are those mentioned in the text but not included in the analyses.

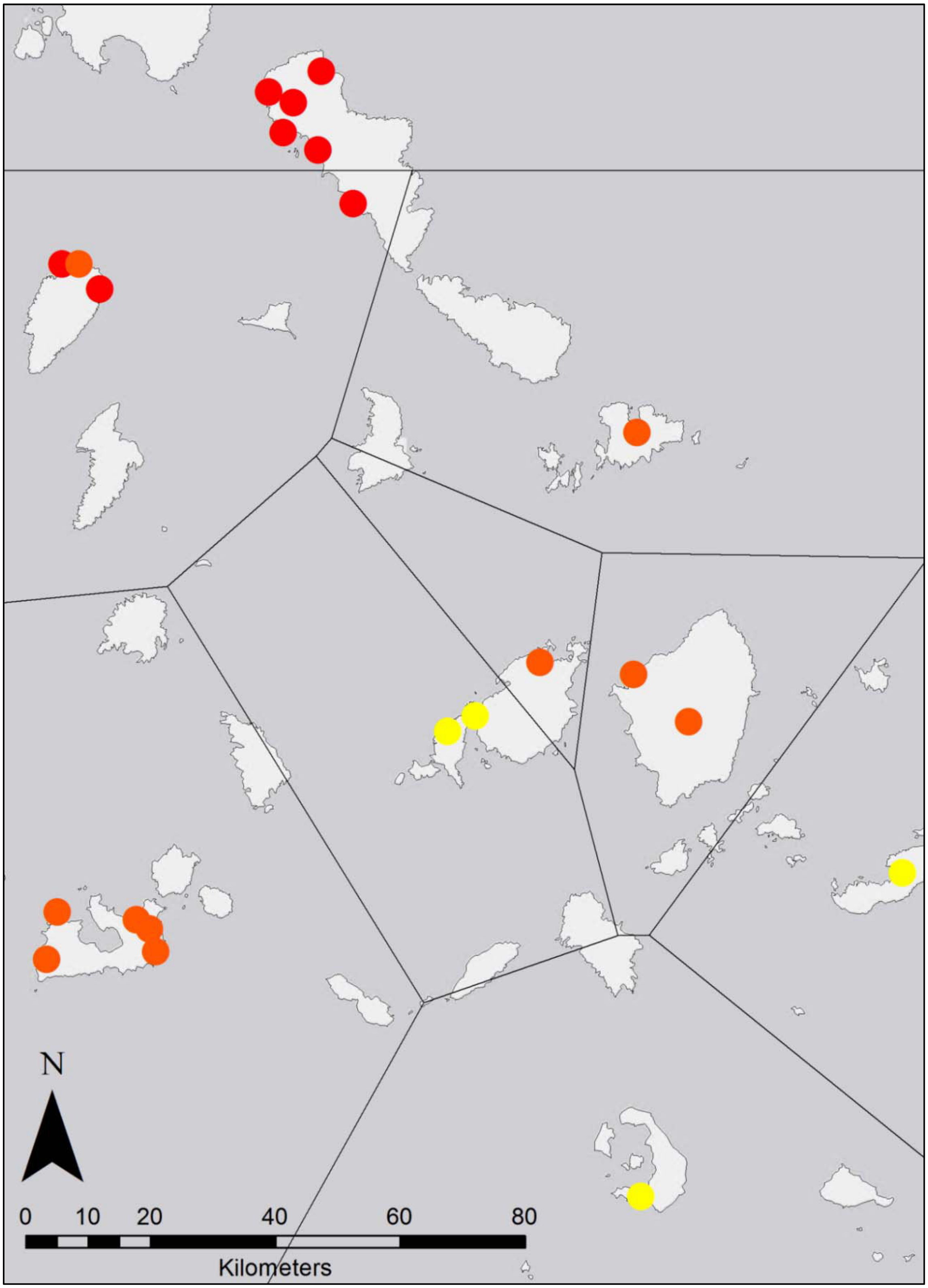


Figure 5.3. Thiessen areas for Late Neolithic sites (yellow points), ignoring Final Neolithic data.

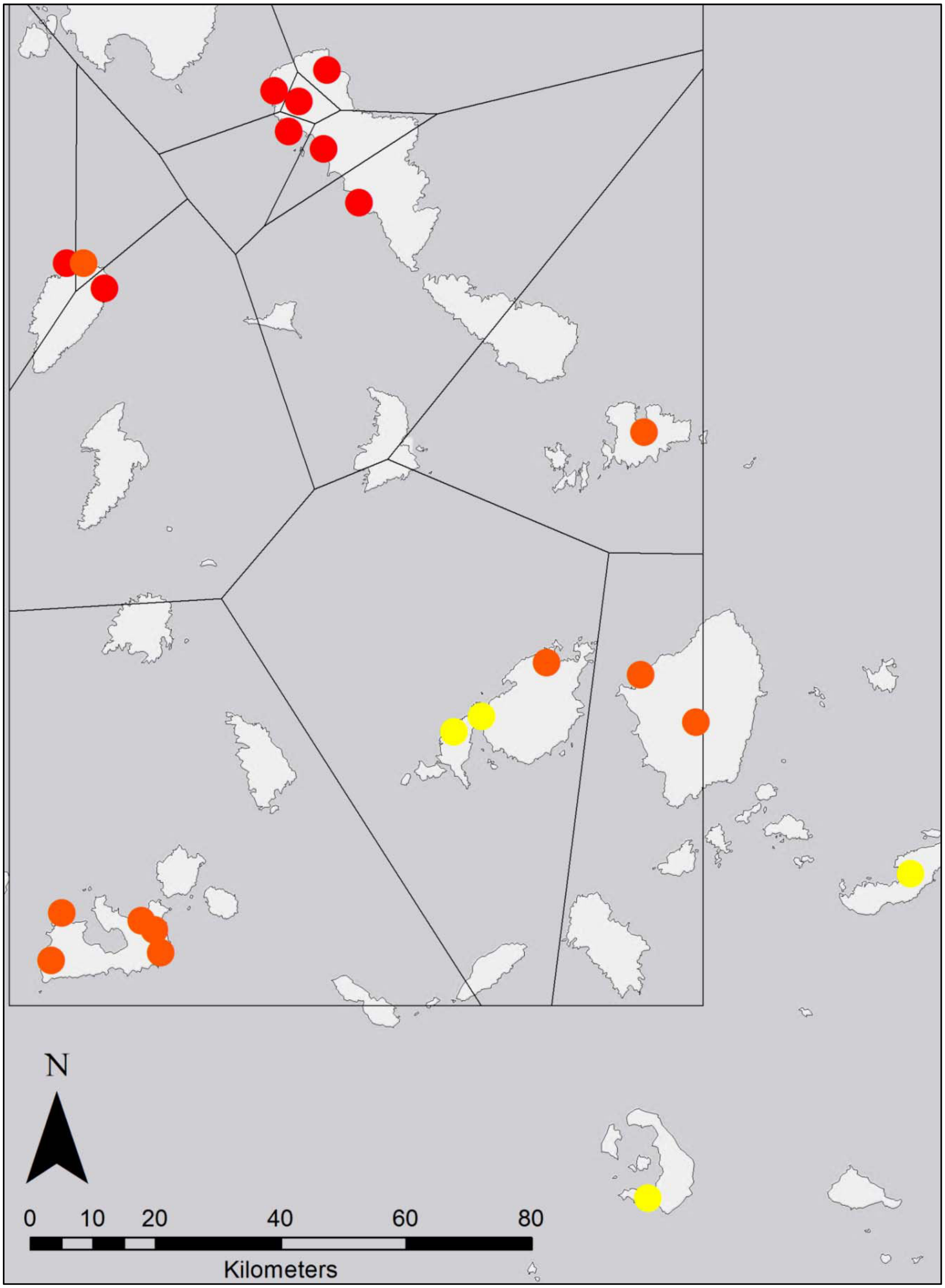


Figure 5.4. Thiessen areas for Final Neolithic sites (red points), ignoring Late Neolithic data.

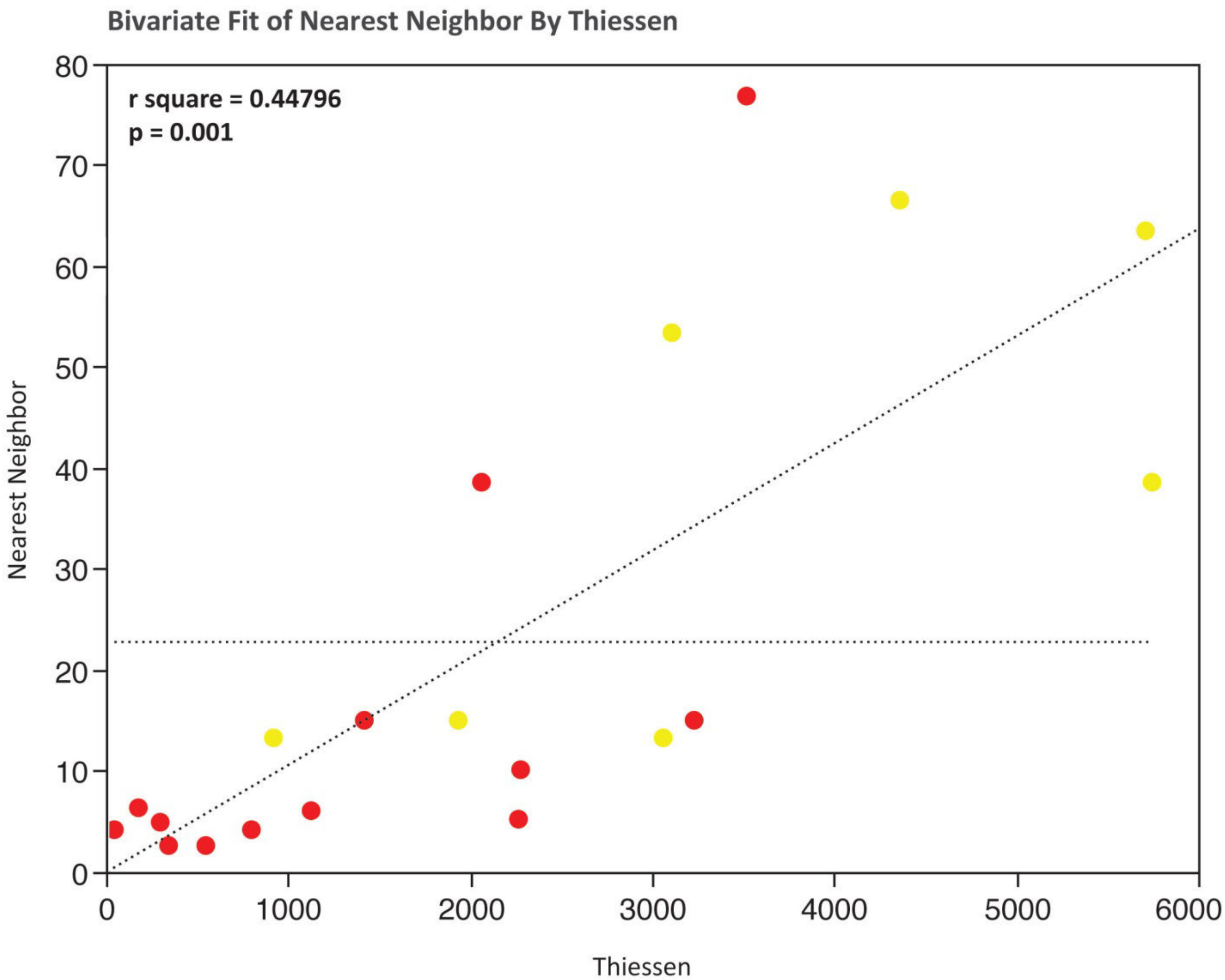


Figure 5.5. Bivariate plot of Thiessen-area (square km) by Nearest-neighbor (km) in the Cyclades, with yellow points indicating Late, and red points Final, Neolithic sites. Fit line and mean nearest-neighbor line included.

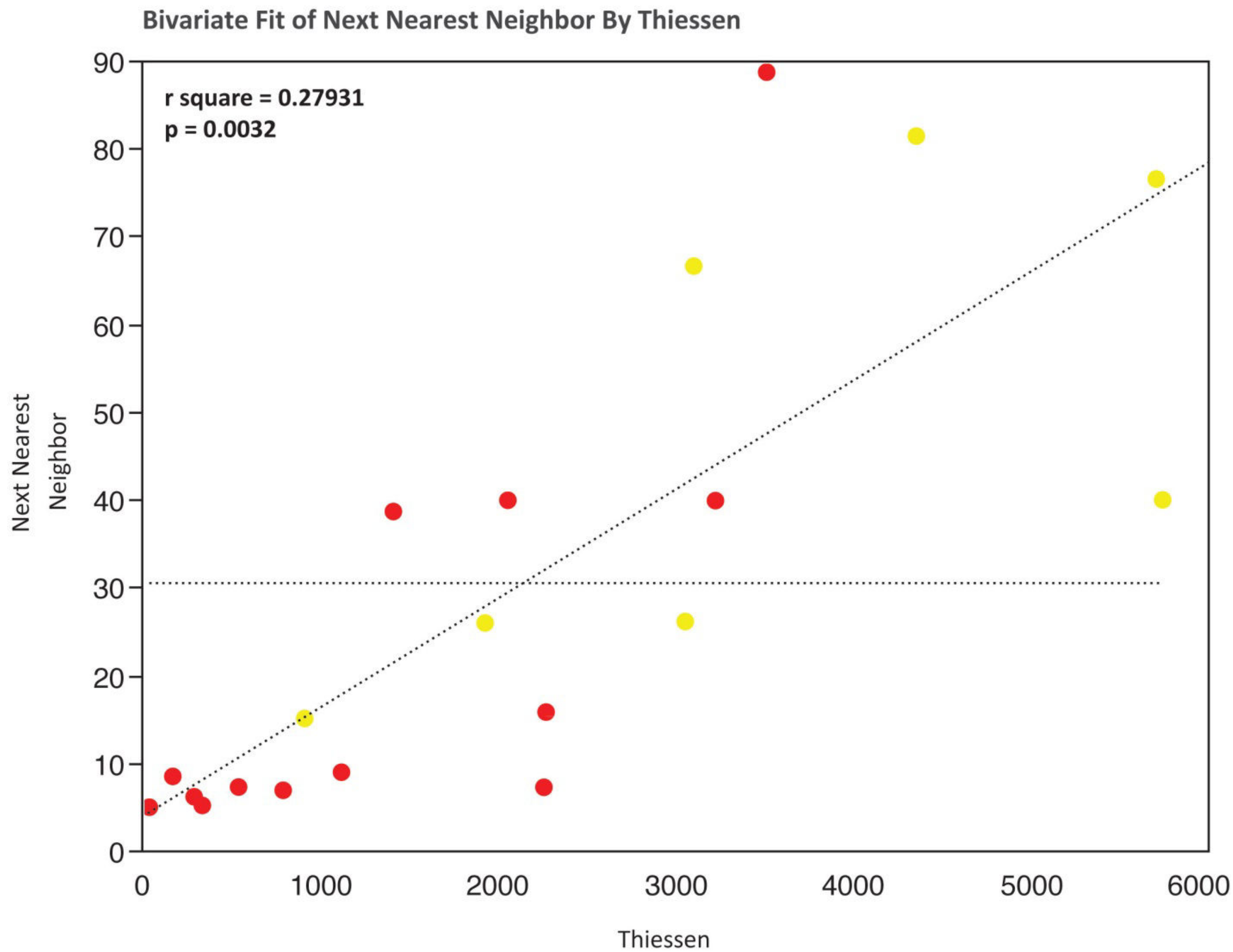


Figure 5.6. Bivariate plot of Thiessen-area (square km) by Next-nearest-neighbor (km) in the Cyclades, with yellow points indicating Late, and red points Final, Neolithic sites, demonstrating a weaker correlation than seen in the previous figure. Fit line and mean nearest-neighbor line included.

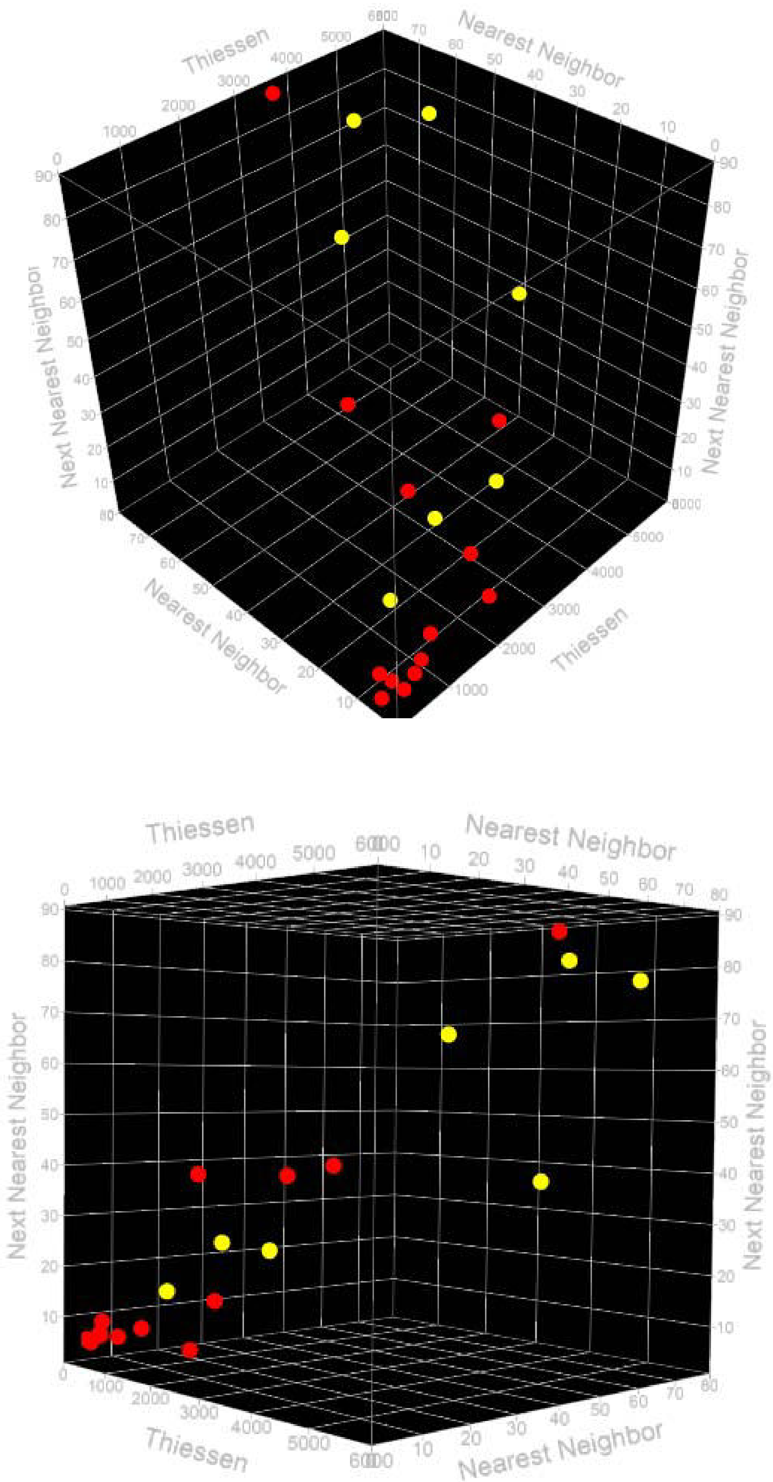


Figure 5.7. Two views of a scatterplot of Late (yellow) and Final (red) Neolithic sites in the Cyclades by Thiessen-area (square km) Nearest-, and Next-nearest neighbor (km). The clustering of Final

Neolithic sites near the origin is indicative of very low values along all axes, and also comparability of these values.

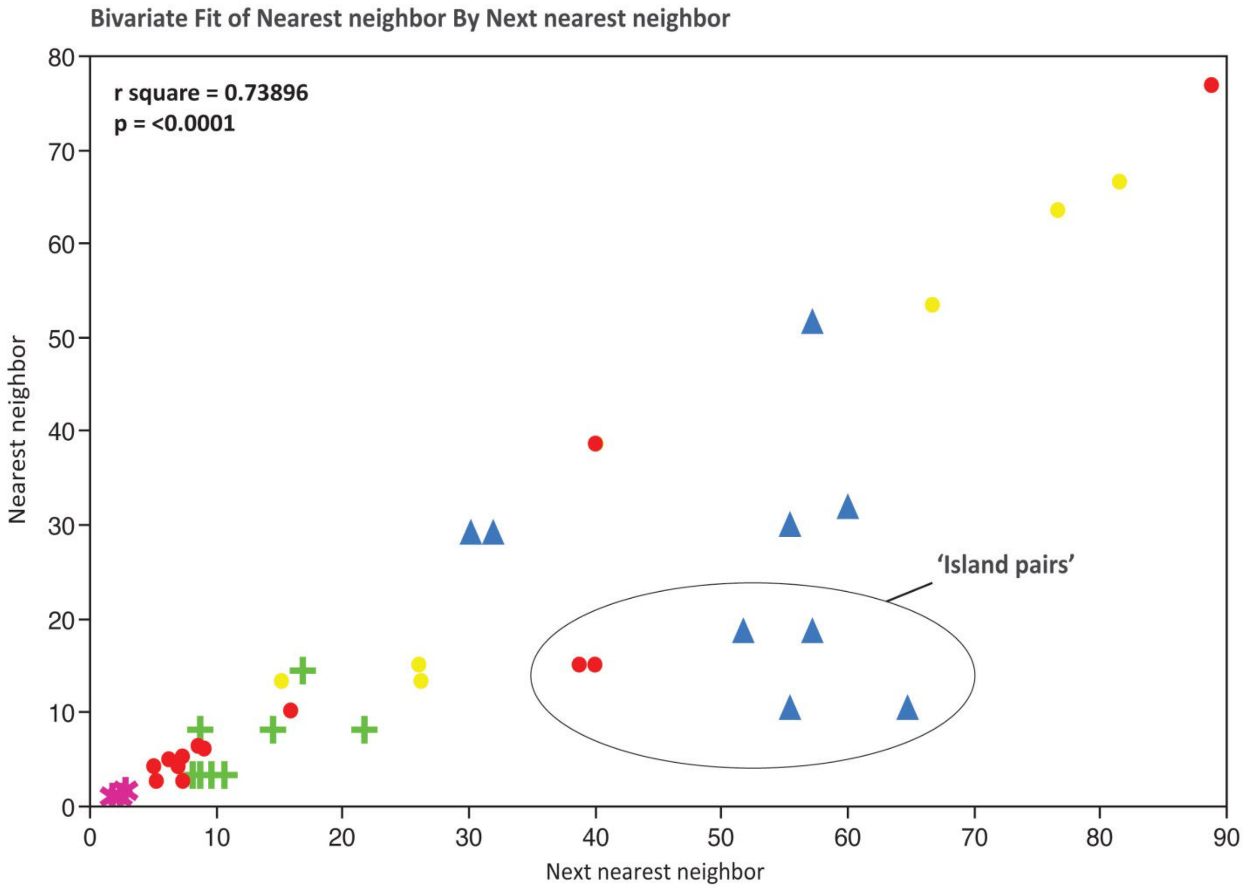


Figure 5.8. Bivariate plot of Nearest- by Next-nearest neighbor for Cycladic Late Neolithic (yellow dots); Cycladic Final Neolithic (red dots); Antillean Early Ceramic II (blue triangles); Melanesian data (green crosses); and Polynesian data (purple asterisks). 'Island pairs' are highlighted as outliers.

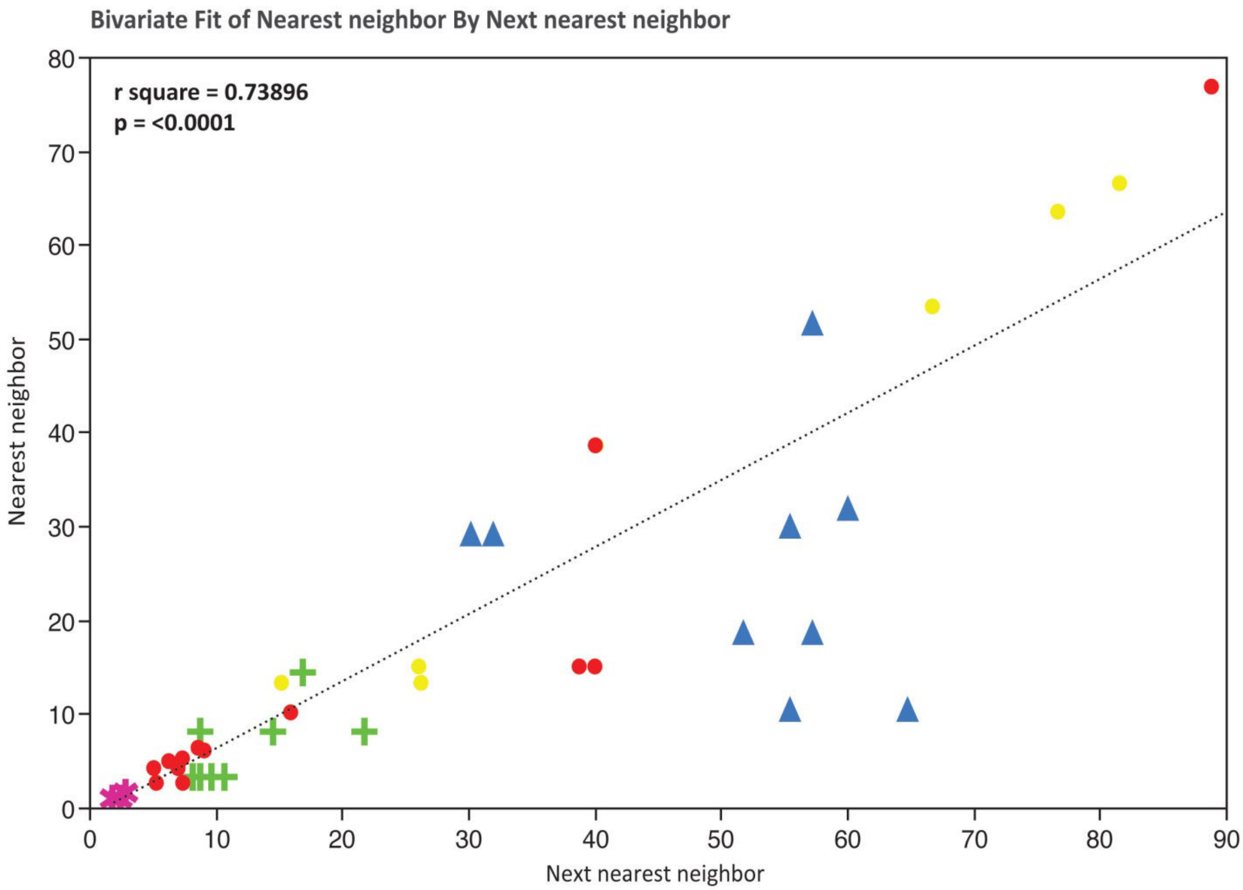


Figure 5.9. Bivariate plot of Nearest- by Next-nearest neighbor for Cycladic Late Neolithic (yellow dots); Cycladic Final Neolithic (red dots); Antillean Early Ceramic II (blue triangles); Melanesian data (green crosses); and Polynesia data (purple asterisks). Fit-line shows the strong positive correlation, demonstrating that in more dispersed as well as more dense settlement systems, sites are distributed evenly.

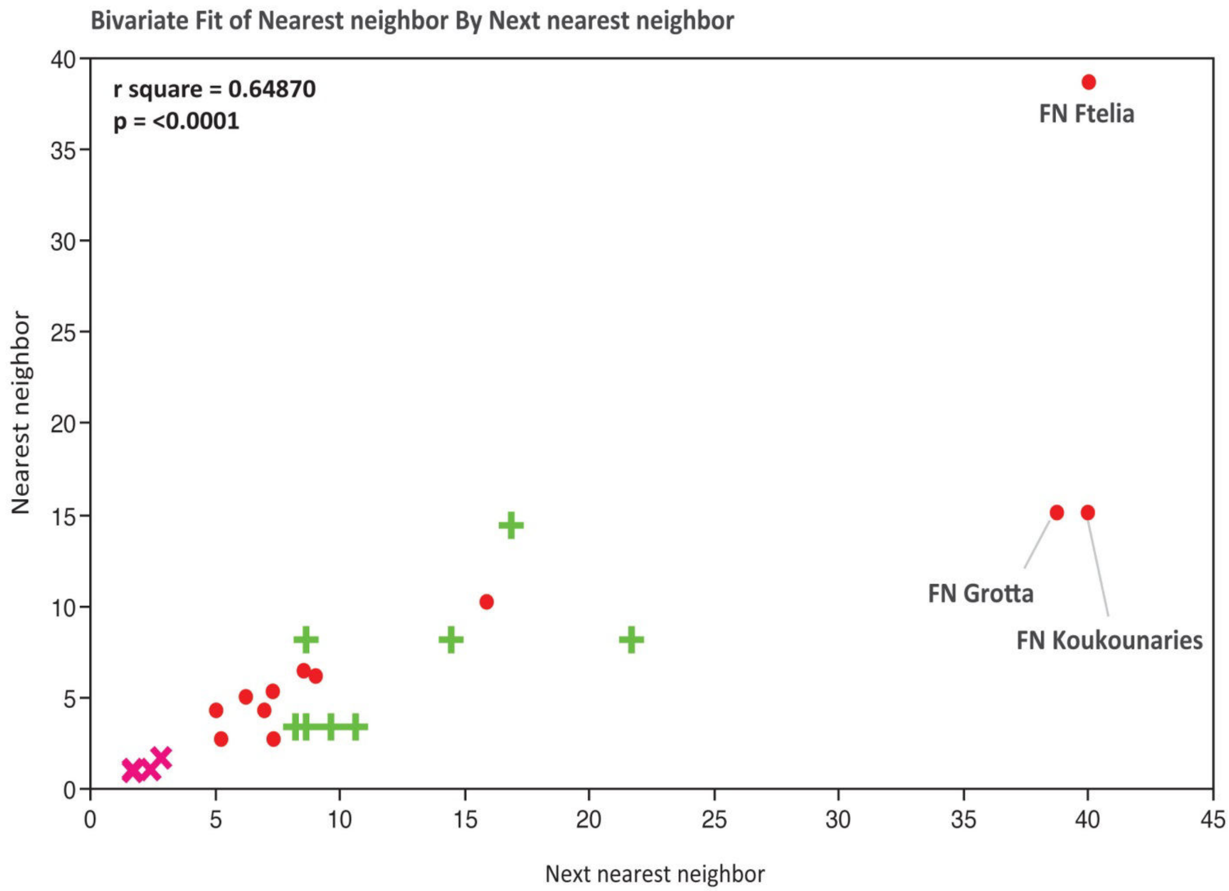


Figure 5.10. Bivariate plot of Nearest- by Next-nearest neighbor for Cycladic Final Neolithic (red dots); Melanesian data (green crosses); and Polynesia data (purple asterisks). This demonstrates the Final Neolithic outliers (sites with questionable Final Neolithic credentials) in relation to the ethnographic data.

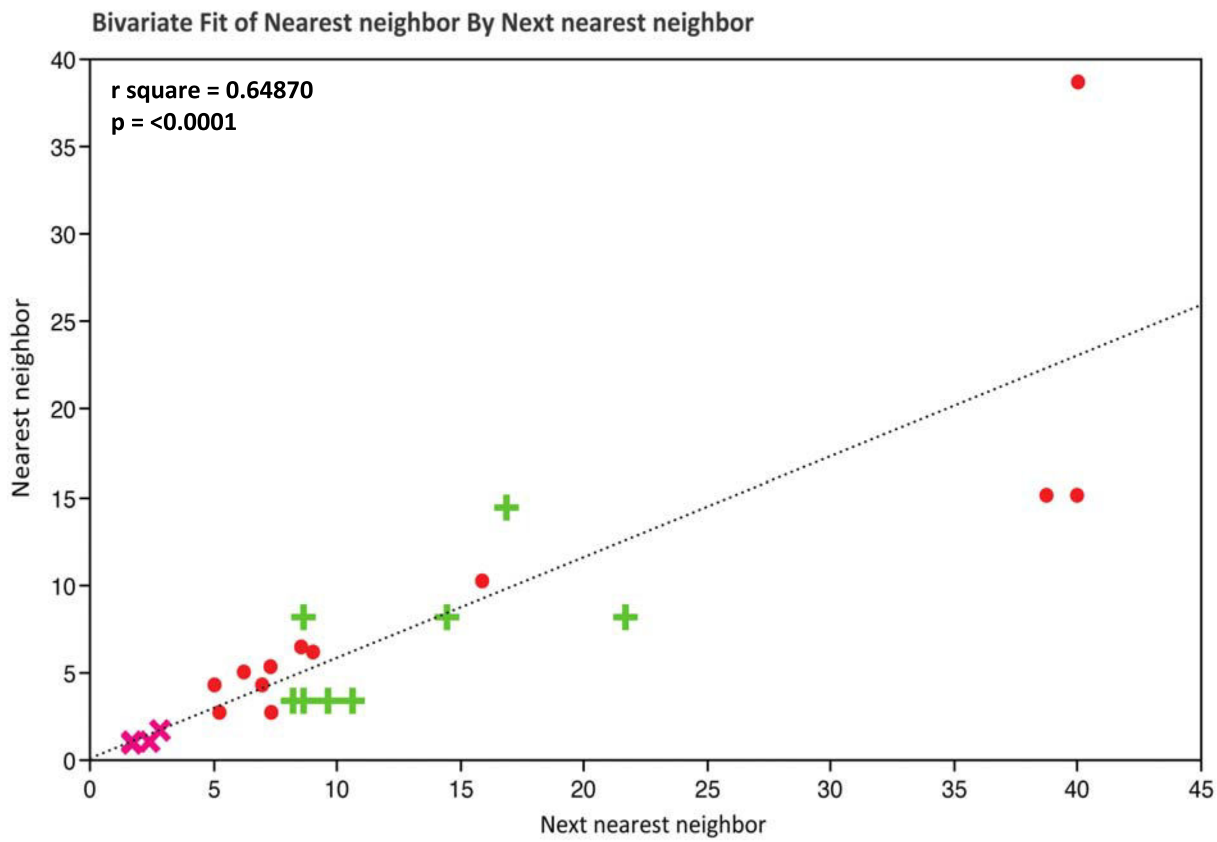


Figure 5.11. The previous figure, demonstrating the overlap between the archaeological and Pacific ethnographic data (ignoring the outliers), with fit-line.

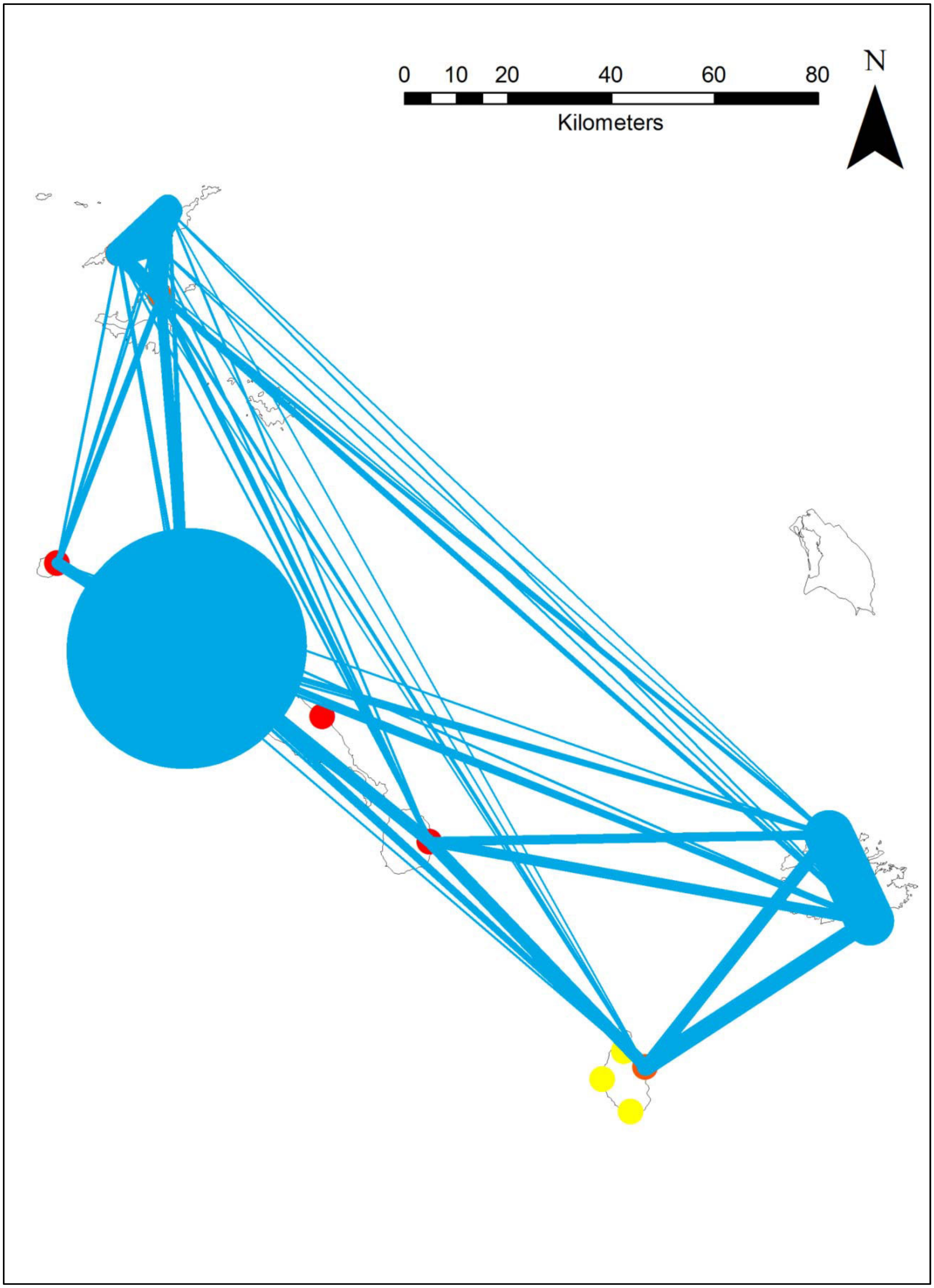


Figure 5.12. Unmodified gravity web for the Early Ceramic II Leeward Islands in its first (unmodified) iteration. The proximity of Smoke Alley and Golden Rock creates an erroneous spike in the I_{ij} value for that graph.

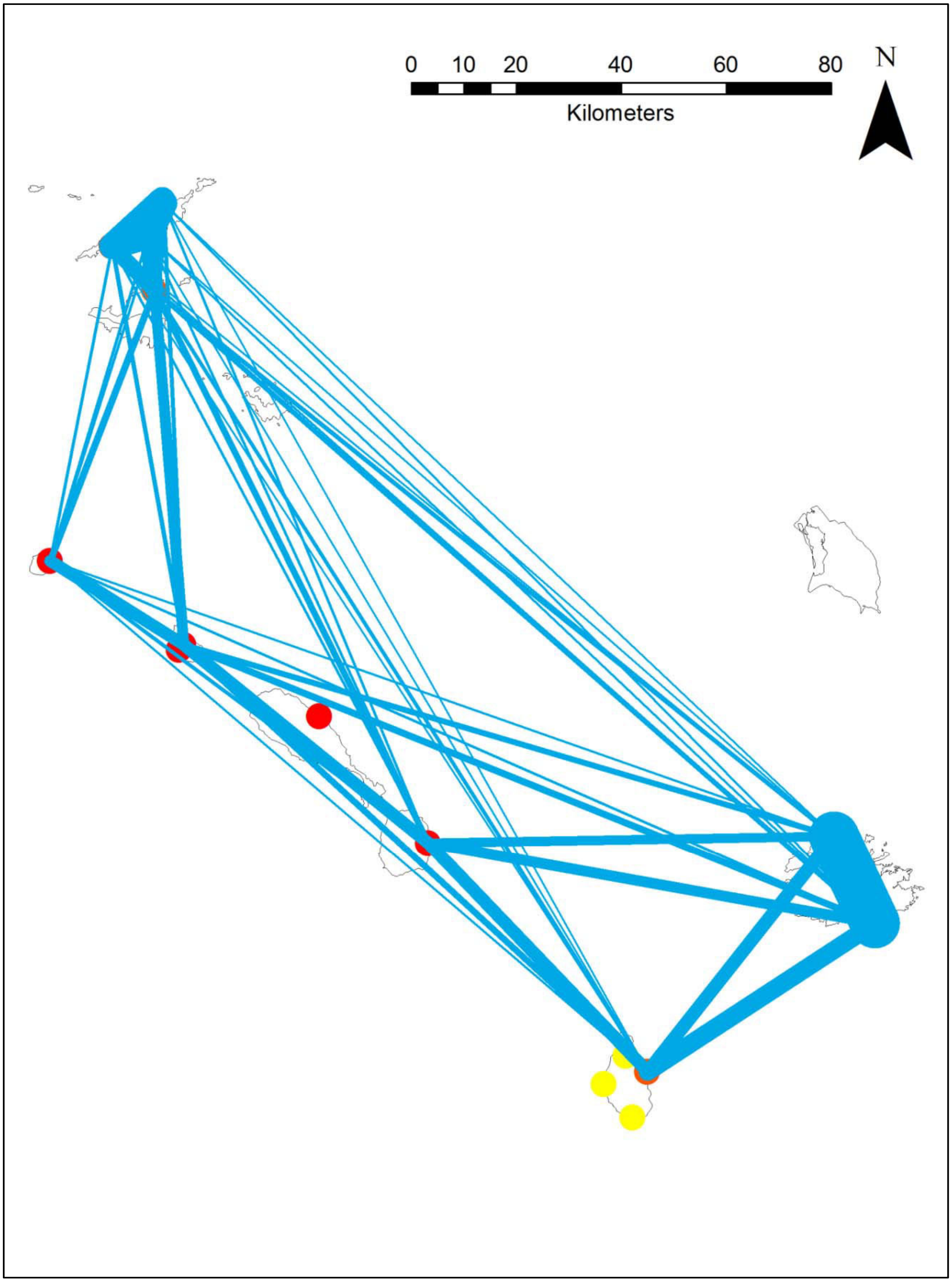


Figure 5.13. Unmodified gravity web for the Early Ceramic II Leeward Islands in its second iteration. The Golden Rock-Smoke Alley graph has been removed from the model. The gravity web, however, expressing even very low I_{ij} values as graphs, has no useful social correlate.

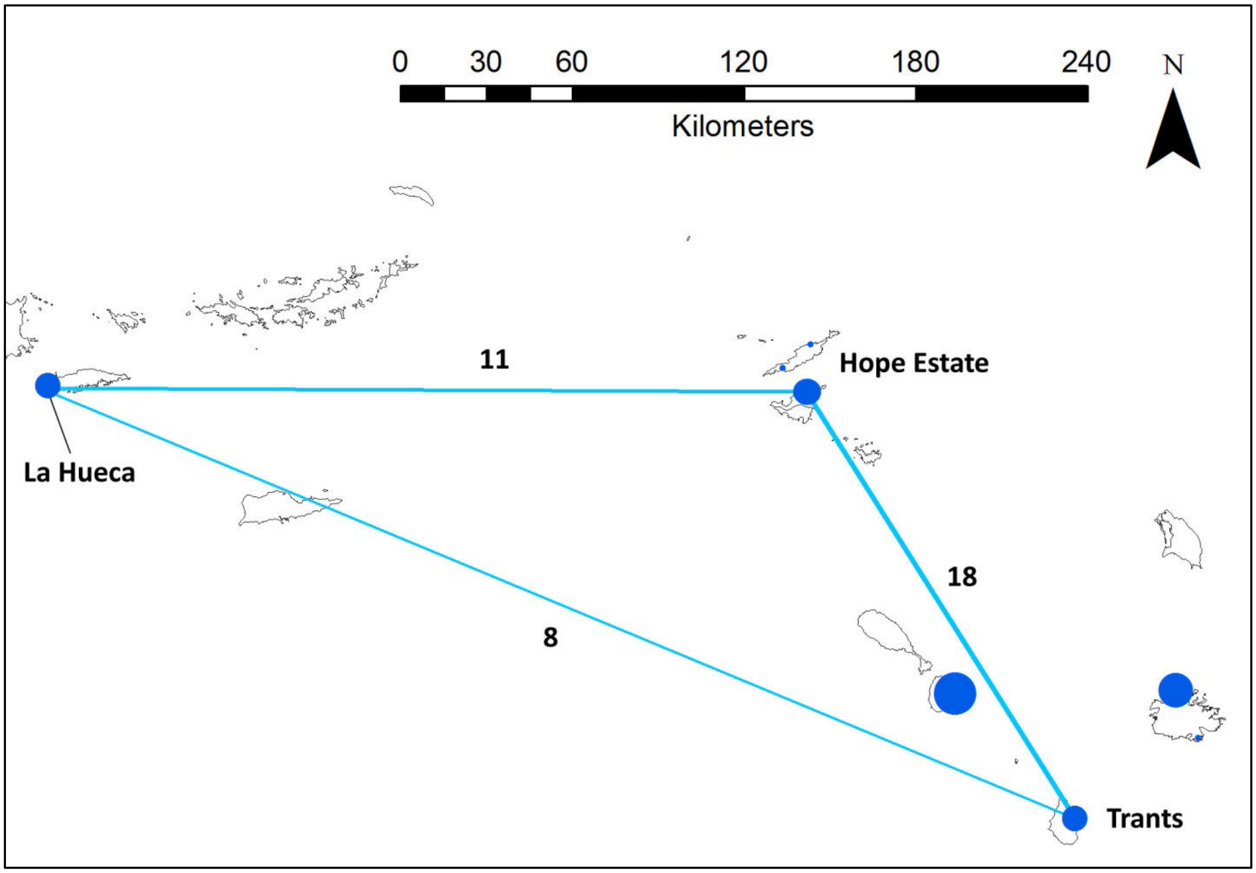


Figure 5.14. Gravity web for the Early Ceramic I with I_{ij} values. The values are so low for these early sites that gravity modeling sheds little light on possible connections, although hints at a possible nodal role for Hope Estate, perhaps supported by Proximal Point Analysis.

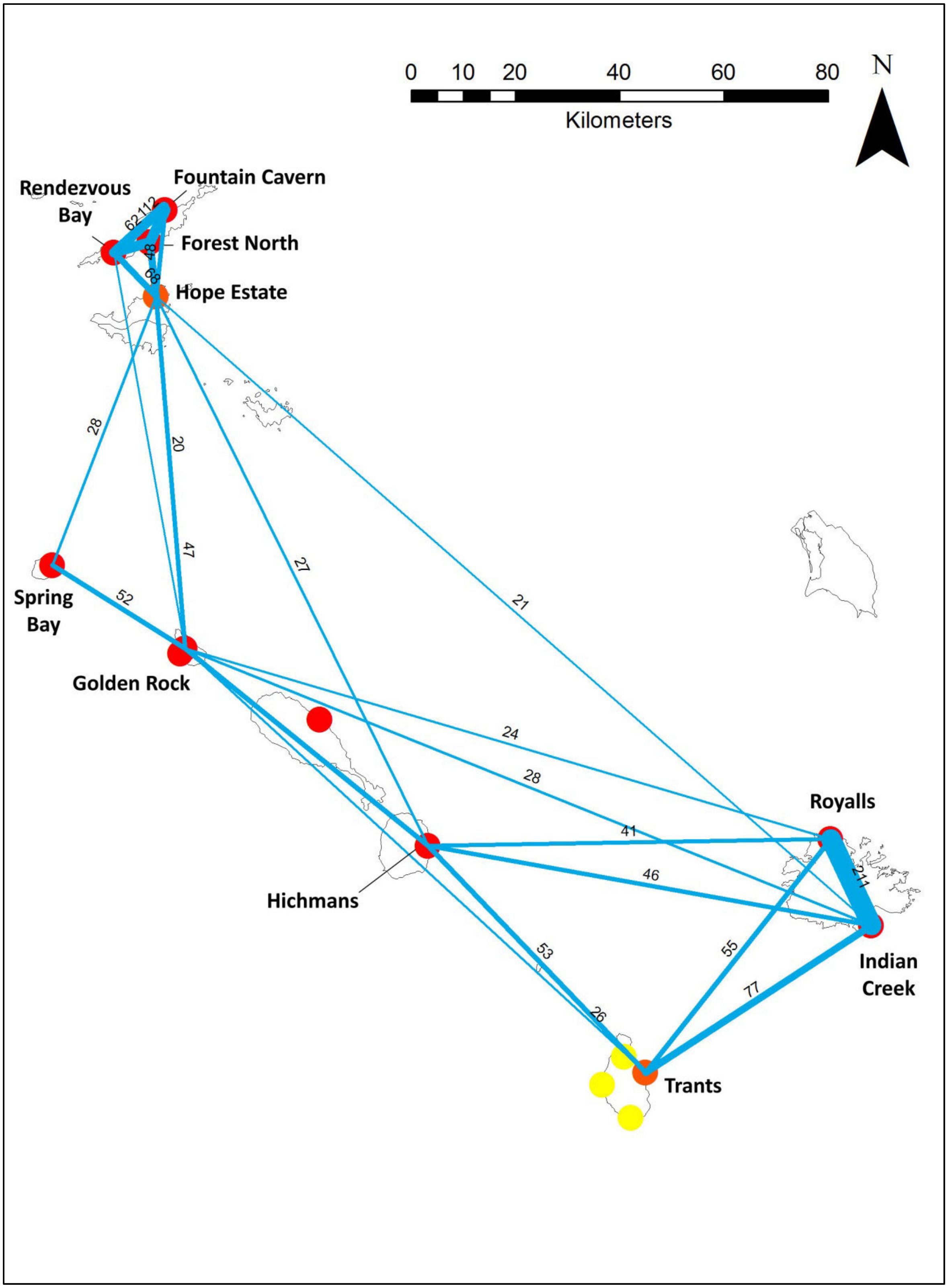


Figure 5.15. Interaction network for the Early Ceramic II with I_{ij} >20, excluding an Early Ceramic II site on St. Kitts.

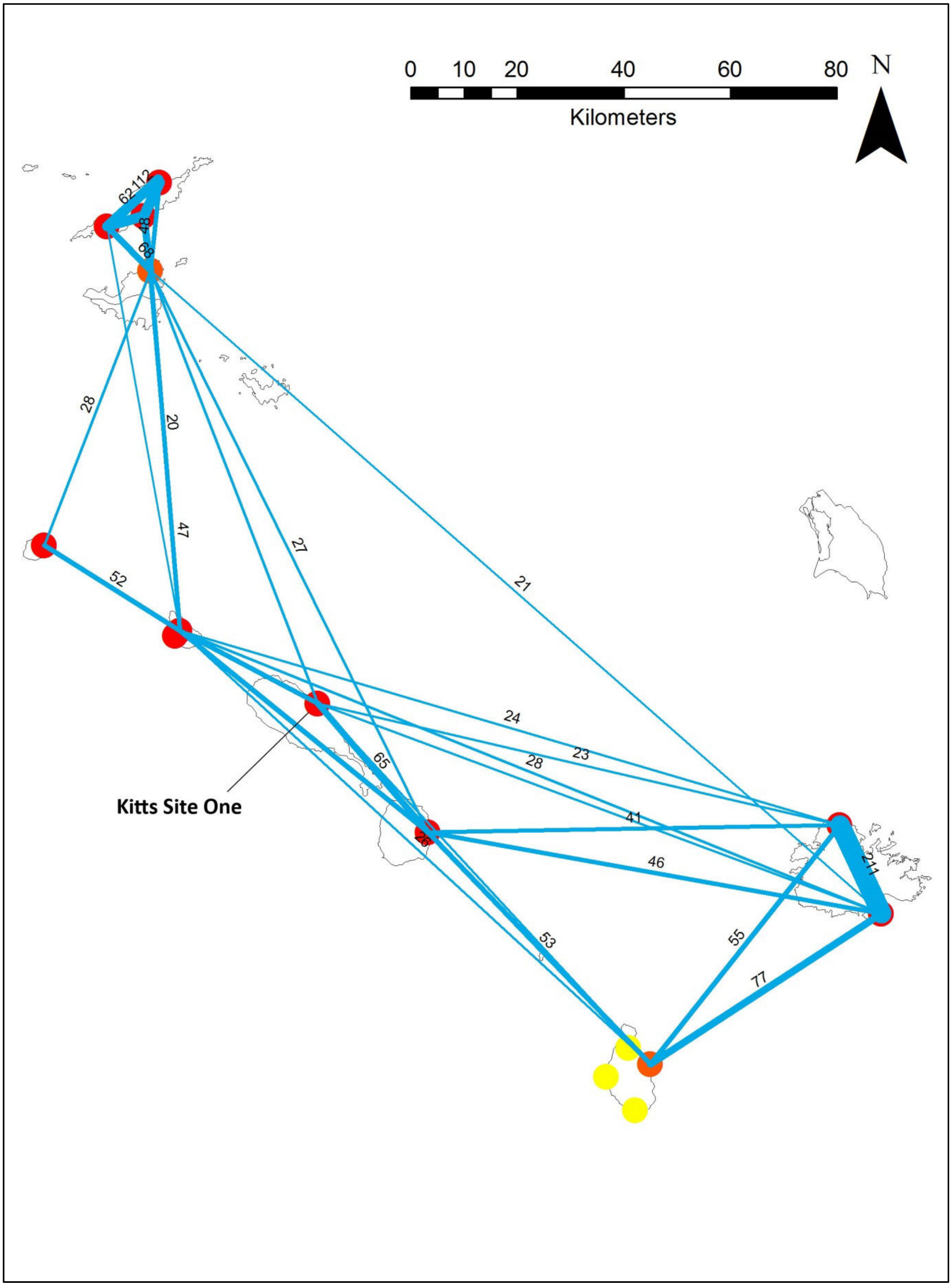


Figure 5.16. Interaction network for the Early Ceramic II with I_{ij} >20, with an Early Ceramic II site on St. Kitts included.

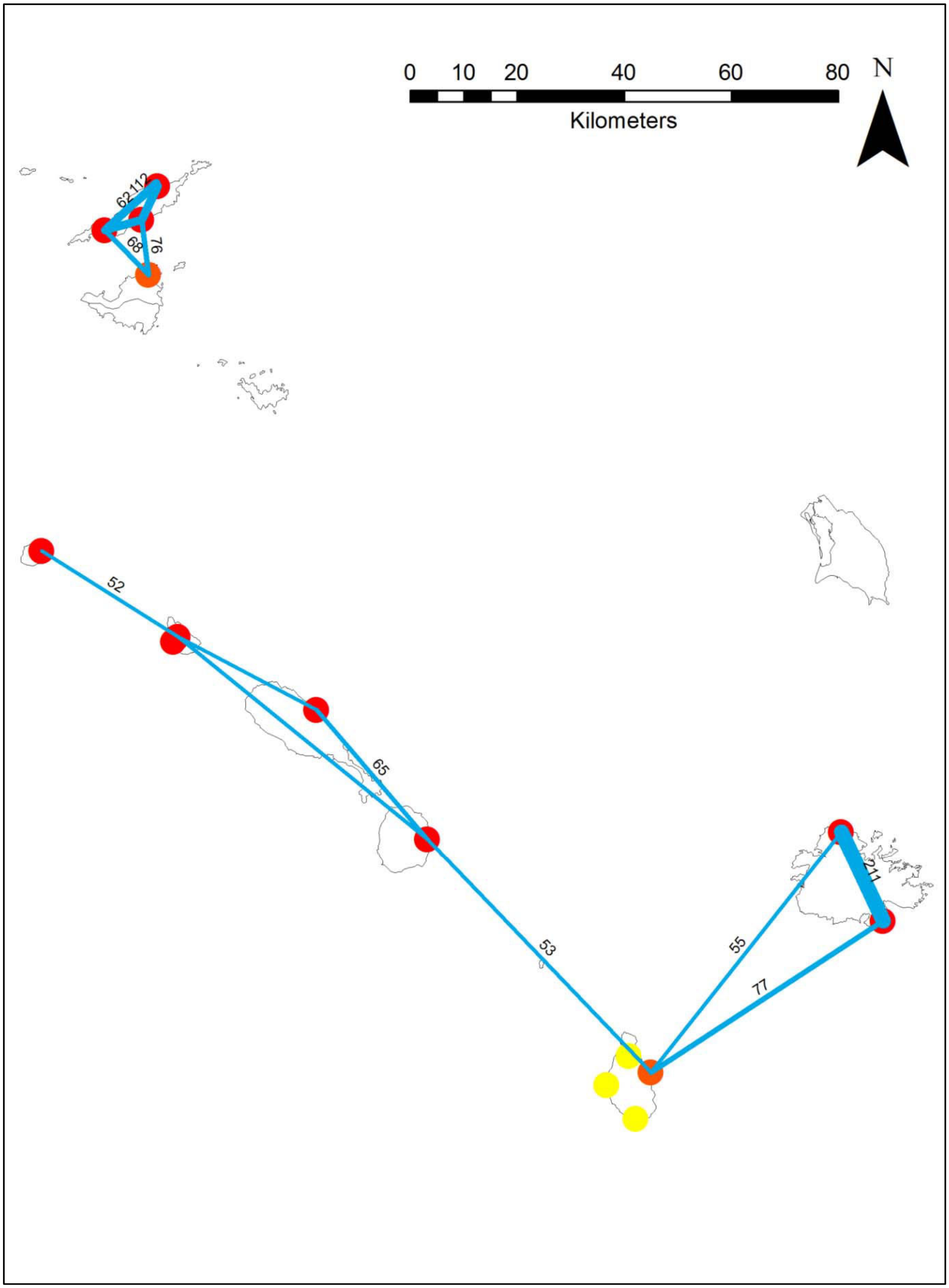


Figure 5.17. Interaction network for the Early Ceramic II with I_{ij} >50.

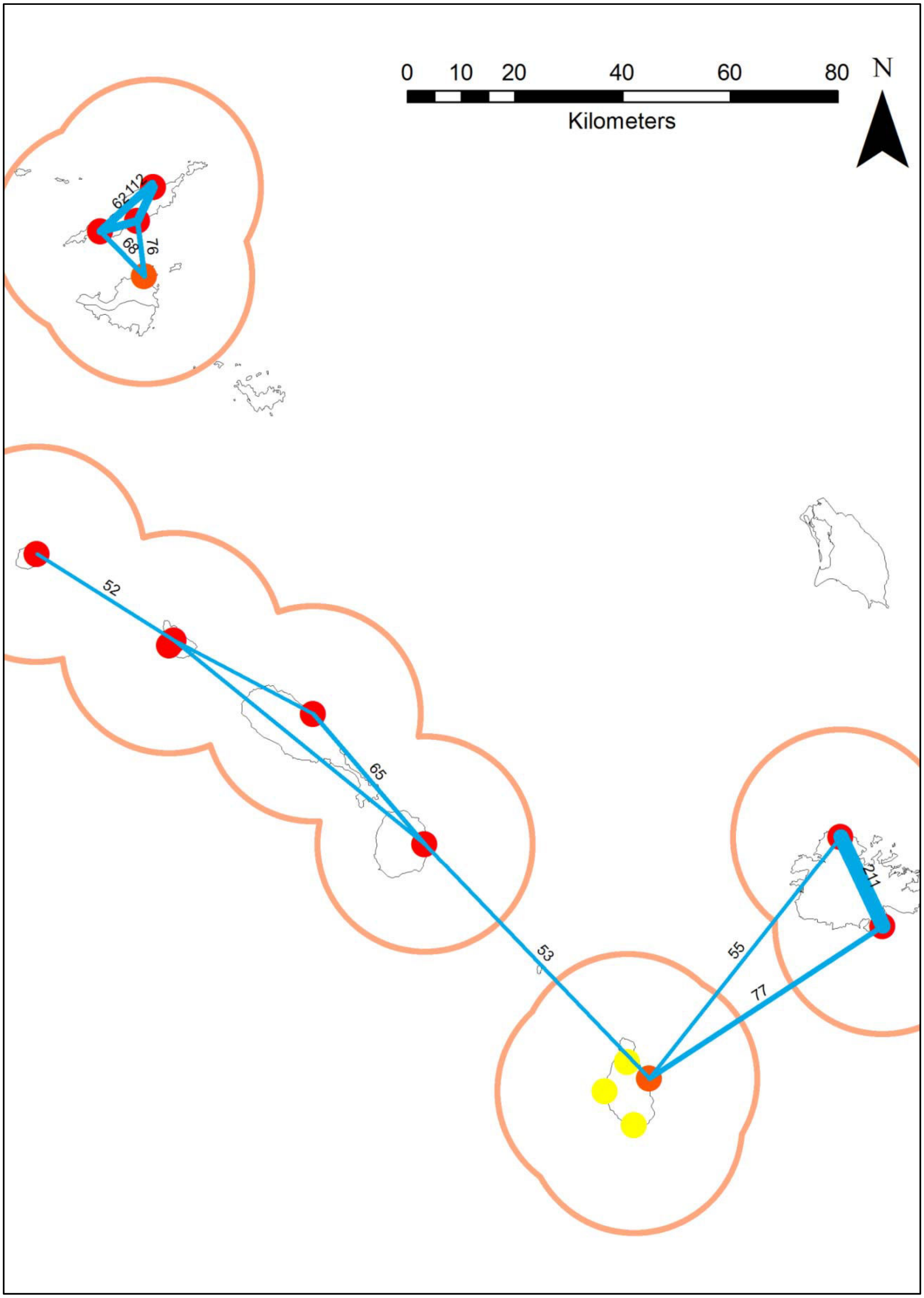


Figure 5.18. Interaction network for the Early Ceramic II with I_{ij} >50 and possible daily ranges of canoe travel from major sites..

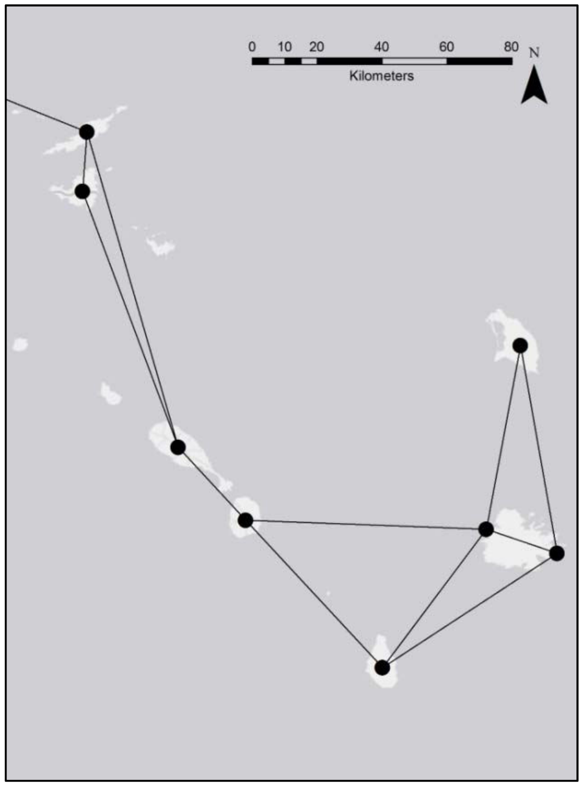


Figure 5.19. Proximal Point Analysis 1: hyper-connected.

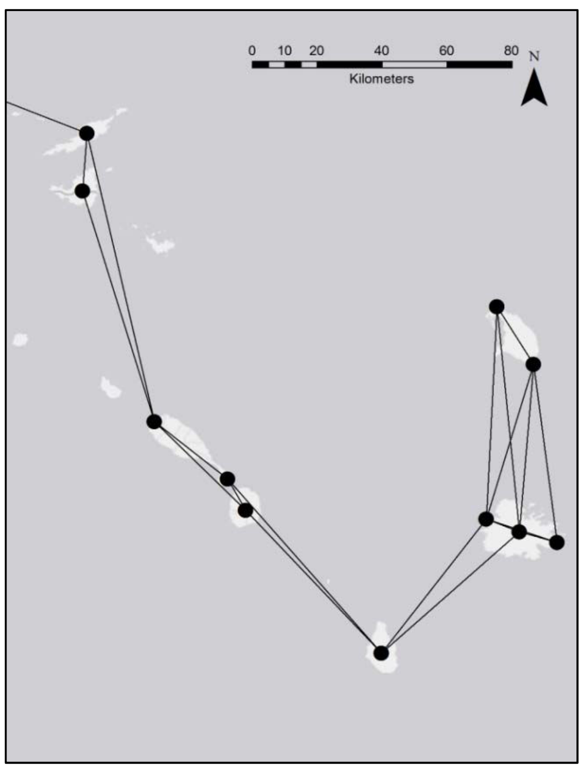


Figure 5.20. Proximal Point Analysis 2: Montserrat as a hub.

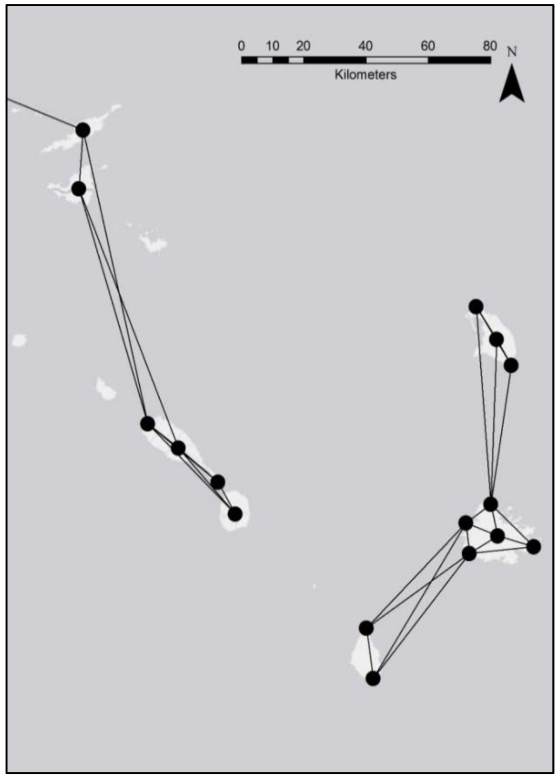


Figure 5.21. Proximal Point Analysis 3: decay of links between Montserrat and Nevis.

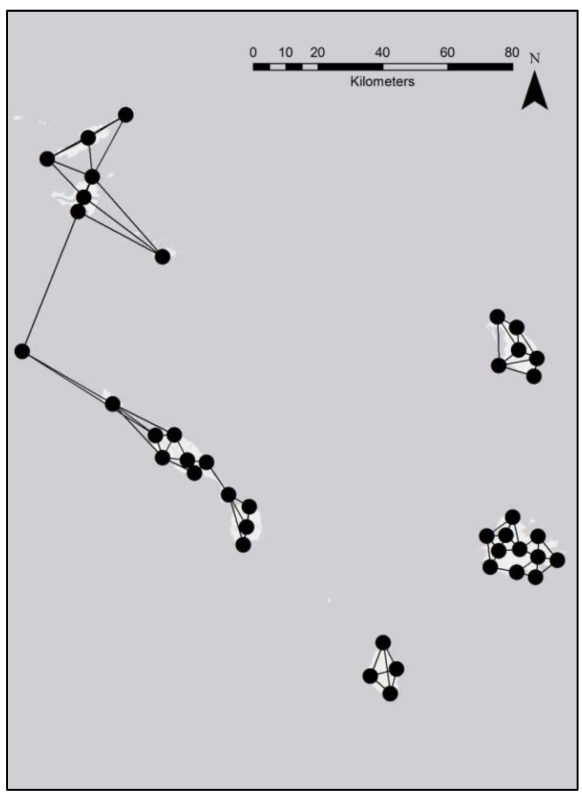


Figure 5.22. Proximal Point Analysis 3: hyper-insularity and the emergence of Saba as a hub.

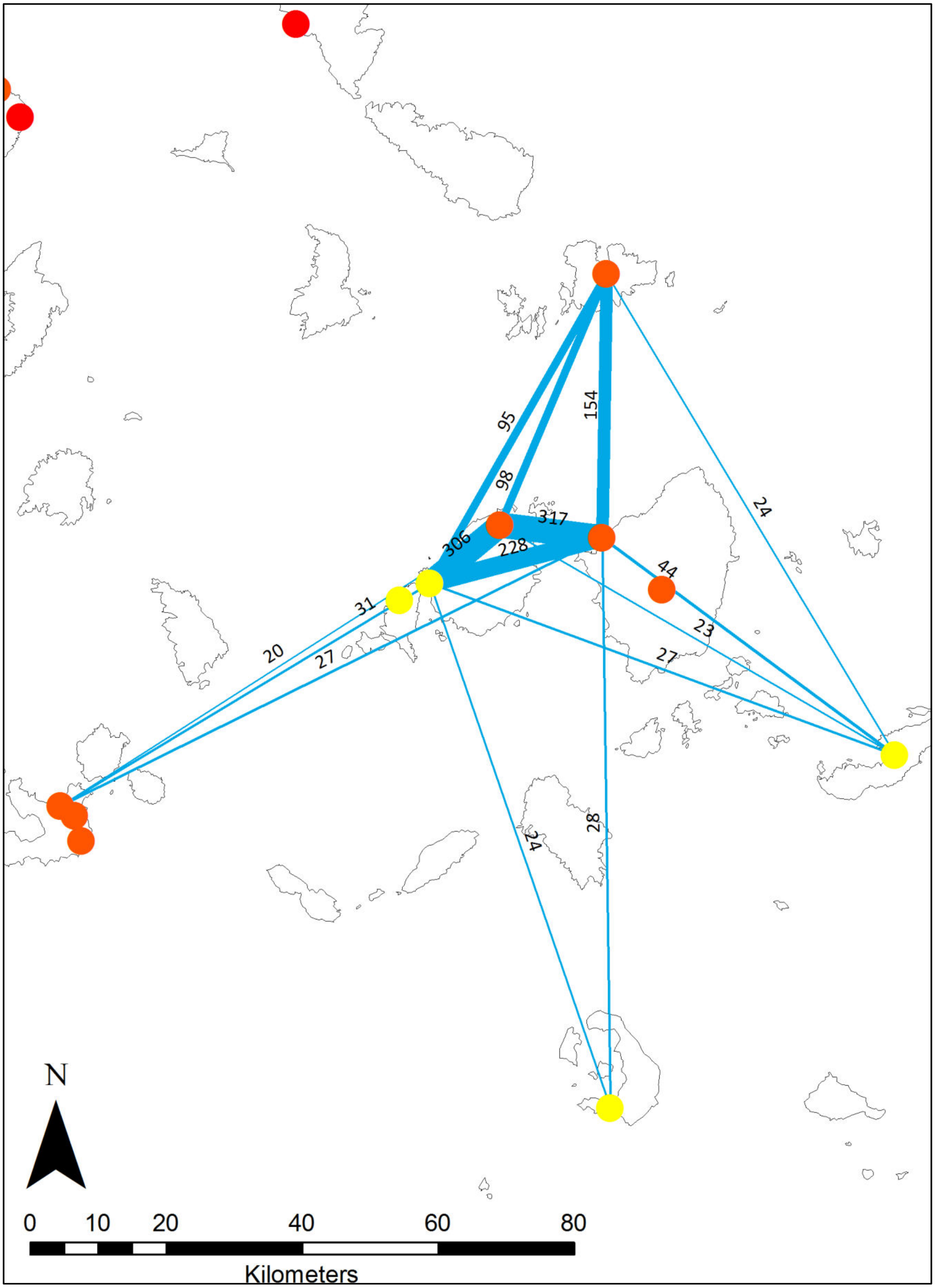


Figure 5.23. Interaction network for the Late Neolithic Cyclades with I_{ij} >20, connections indicated by blue lines weighted by value.

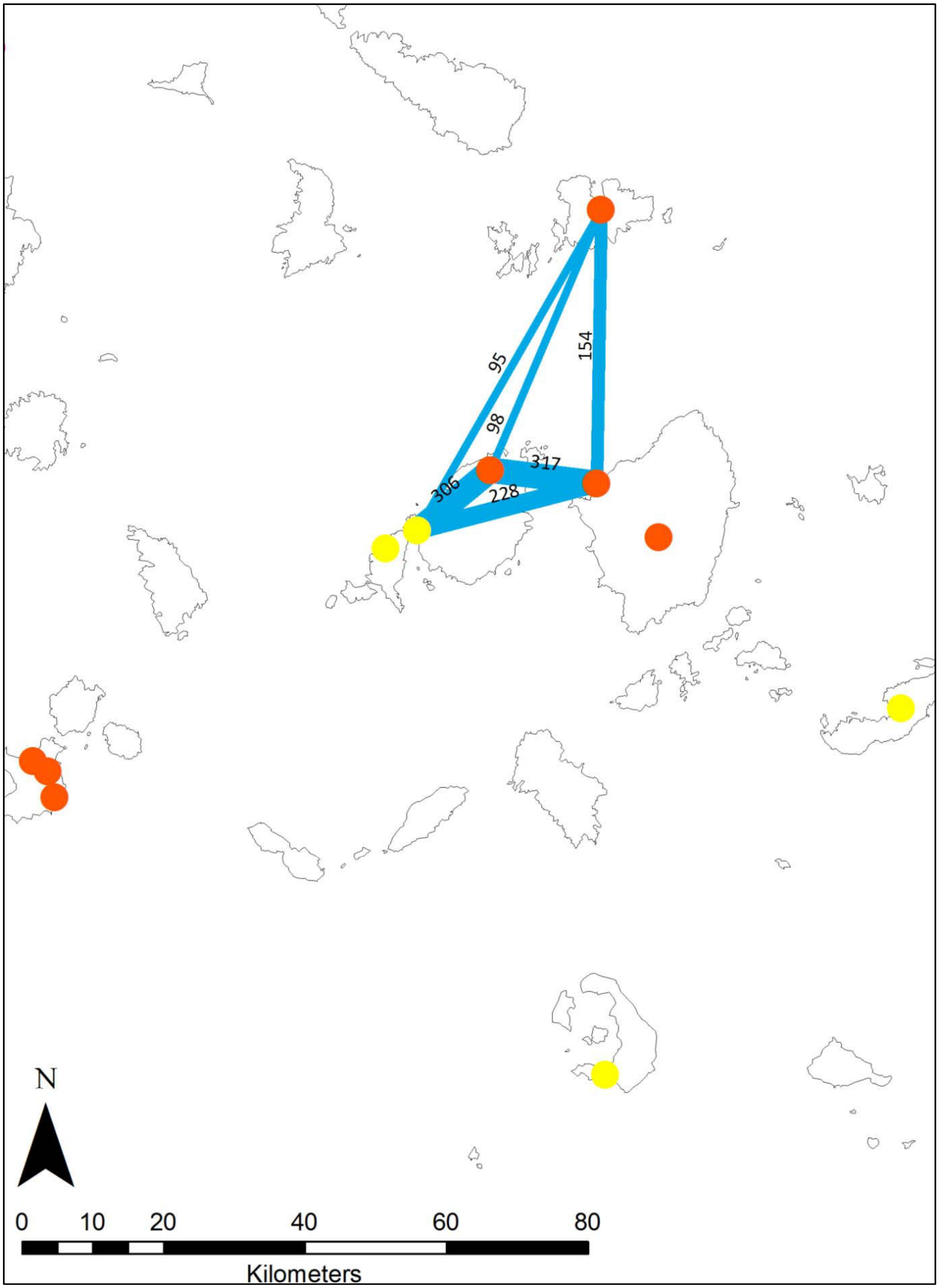


Figure 5.24. Interaction network for the Late Neolithic Cyclades with I_{ij} >50.

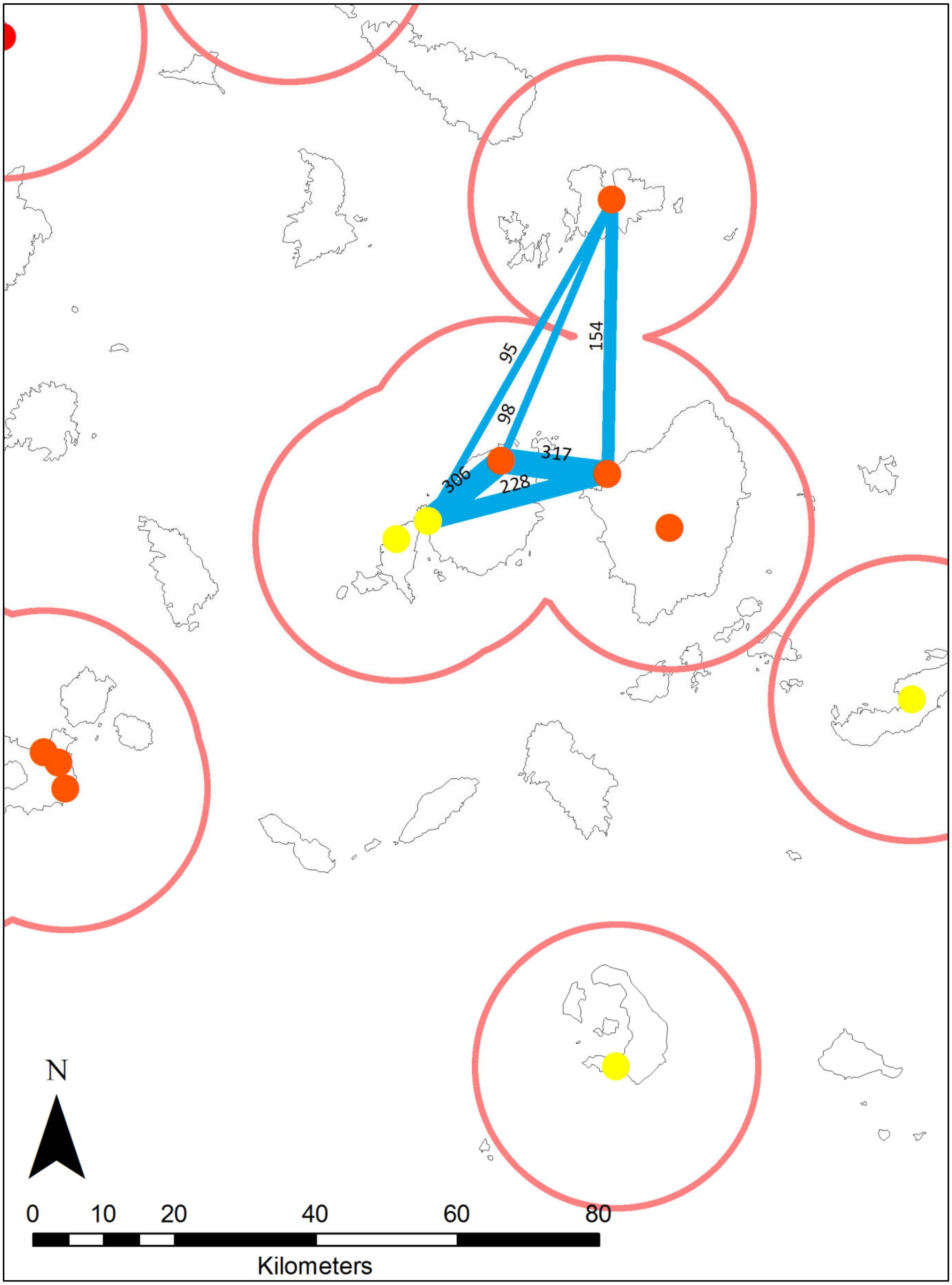


Figure 5.25. Interaction network for the Late Neolithic with I_{ij} >50 with daily travel canoe ranges from major sites indicated.

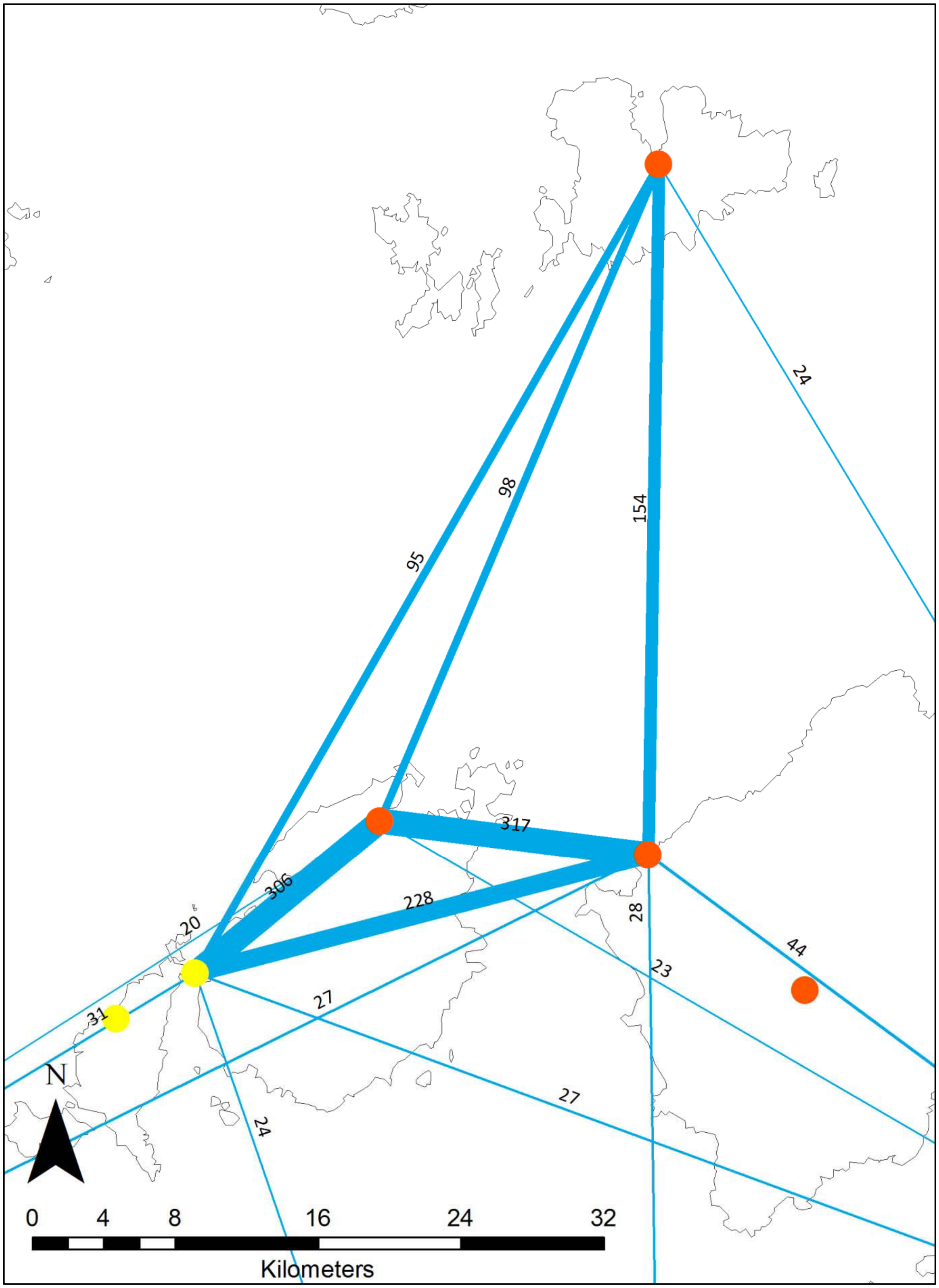


Figure 5.26. Interaction network for the Late Neolithic with I_{ij} >20; close-up of the Naxos-Paros hub.

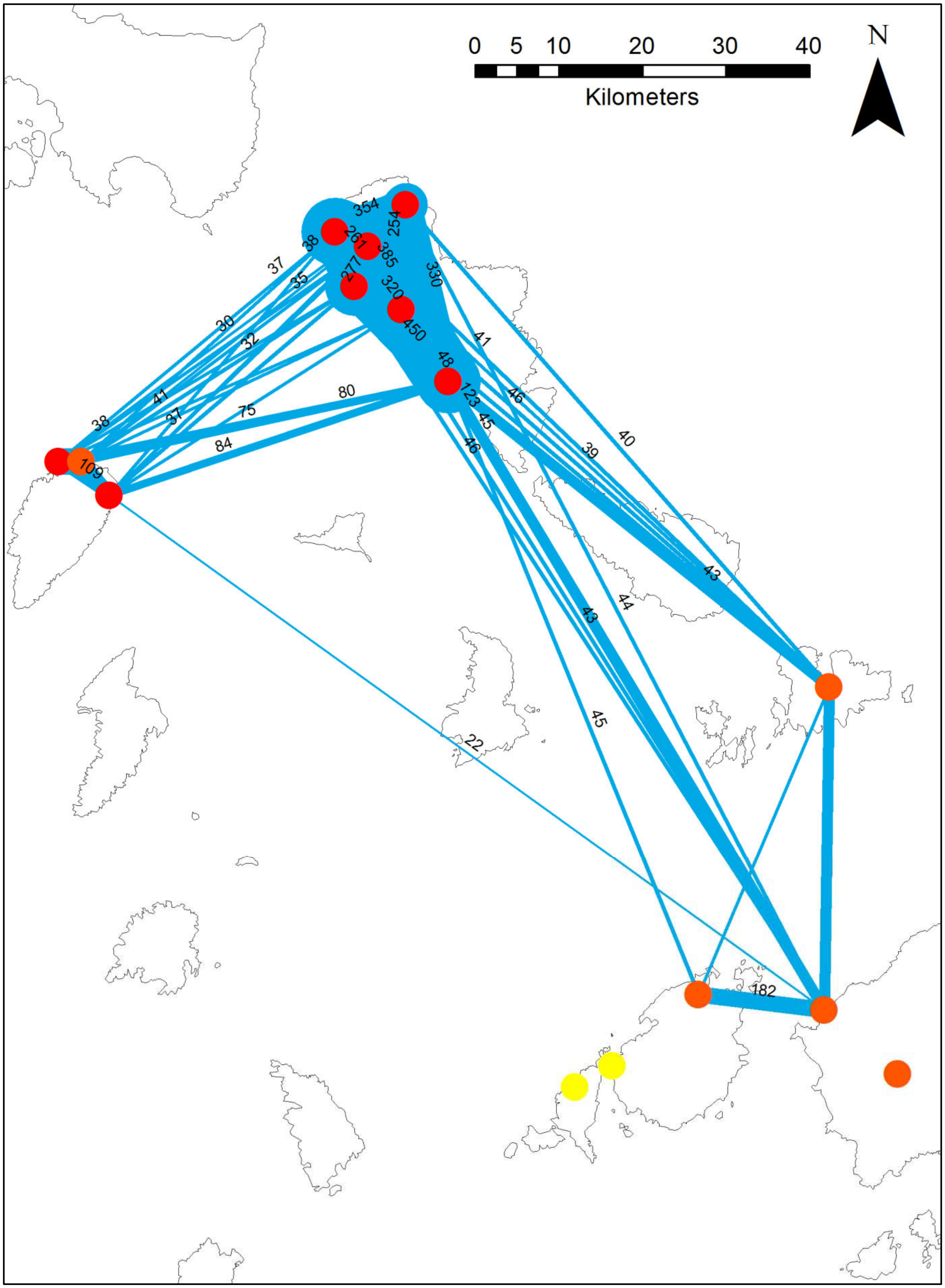


Figure 5.27. Interaction network for the Final Neolithic with I_{ij} >20.

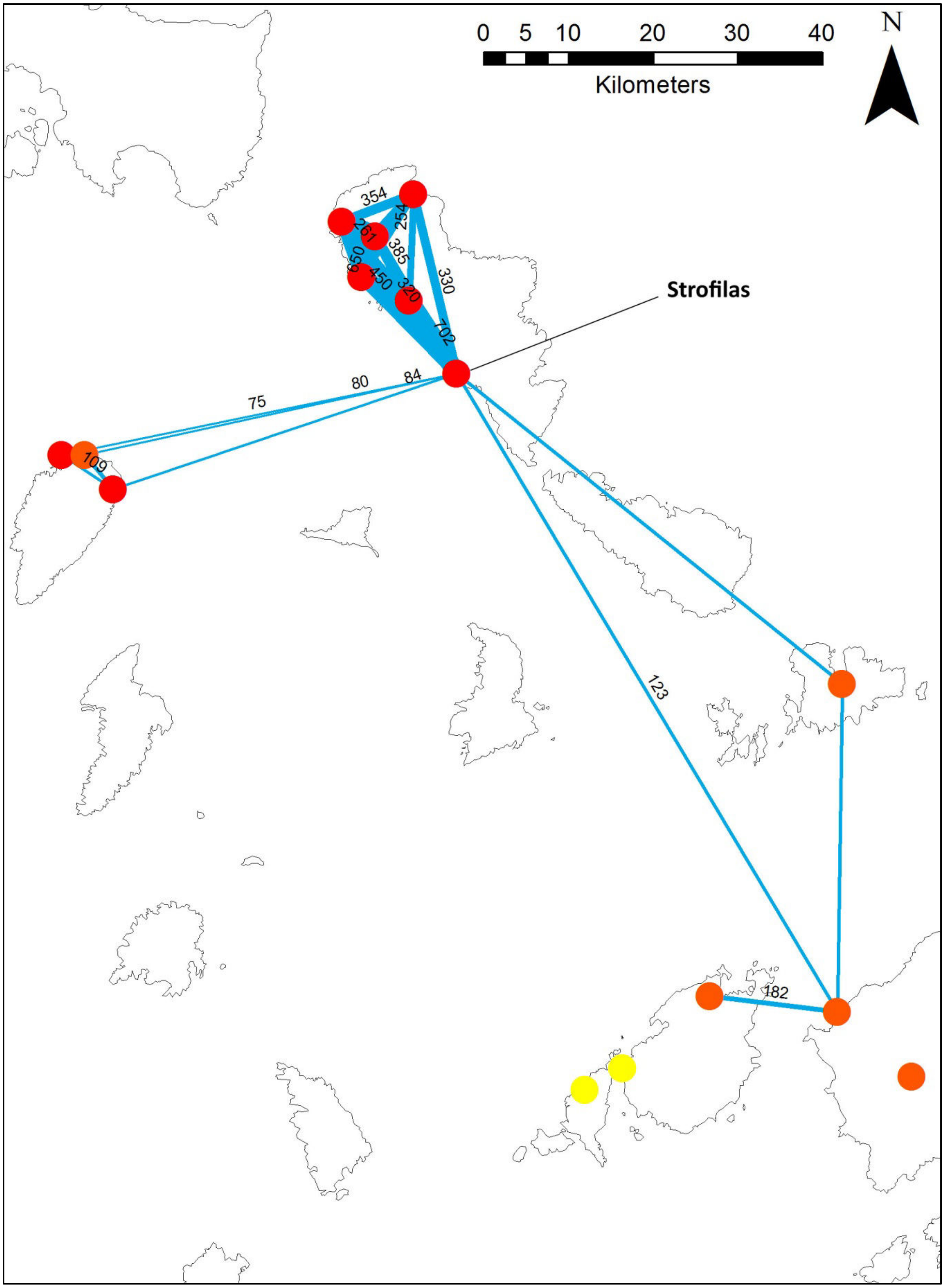


Figure 5.28. Interaction network for the Final Neolithic with I_{ij} >50. The central role of the large site at Strofilas is clear.

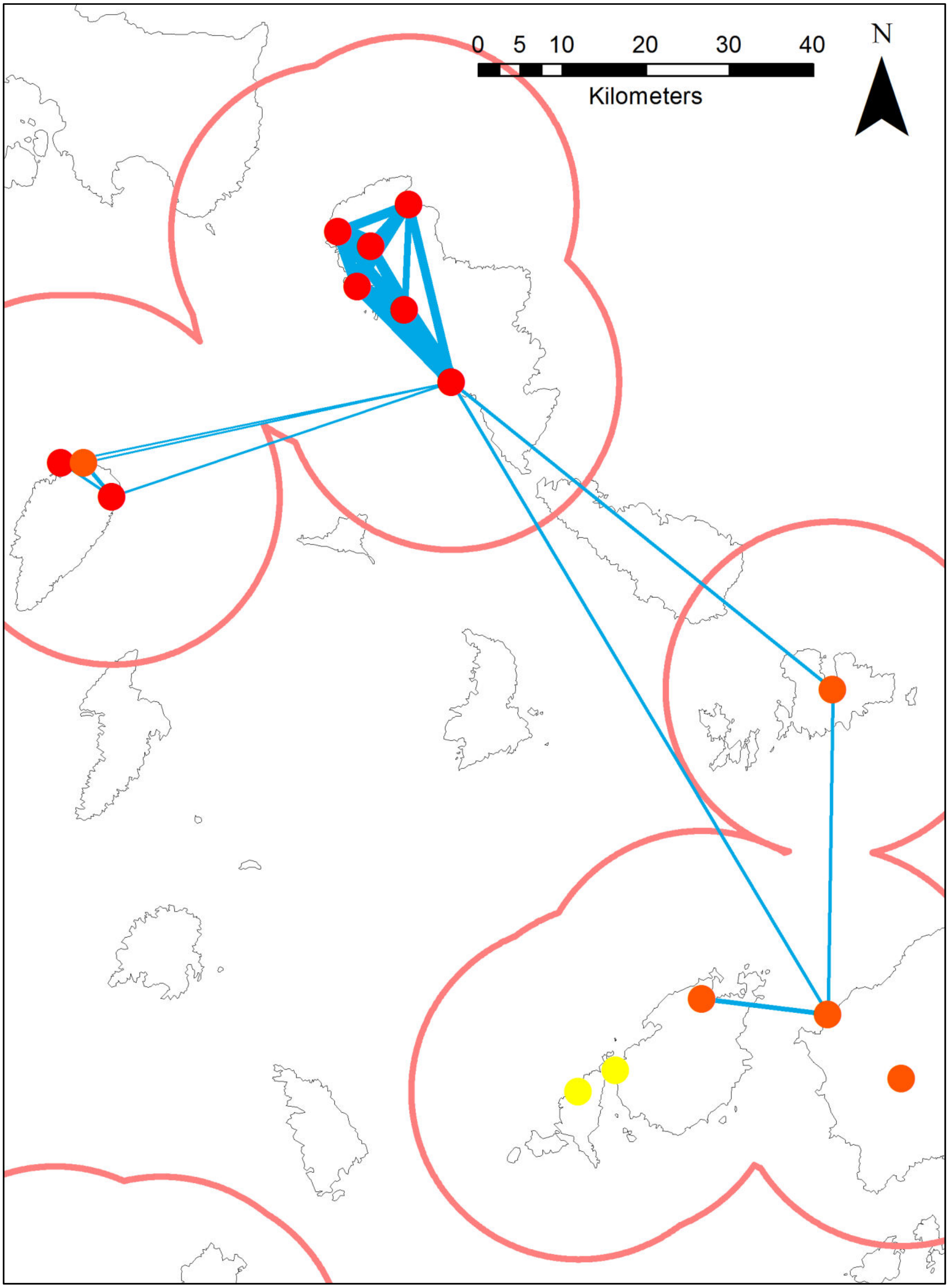


Figure 5.29. Interaction network for the Final Neolithic with I_{ij} >20 with daily canoe travel ranges indicated.

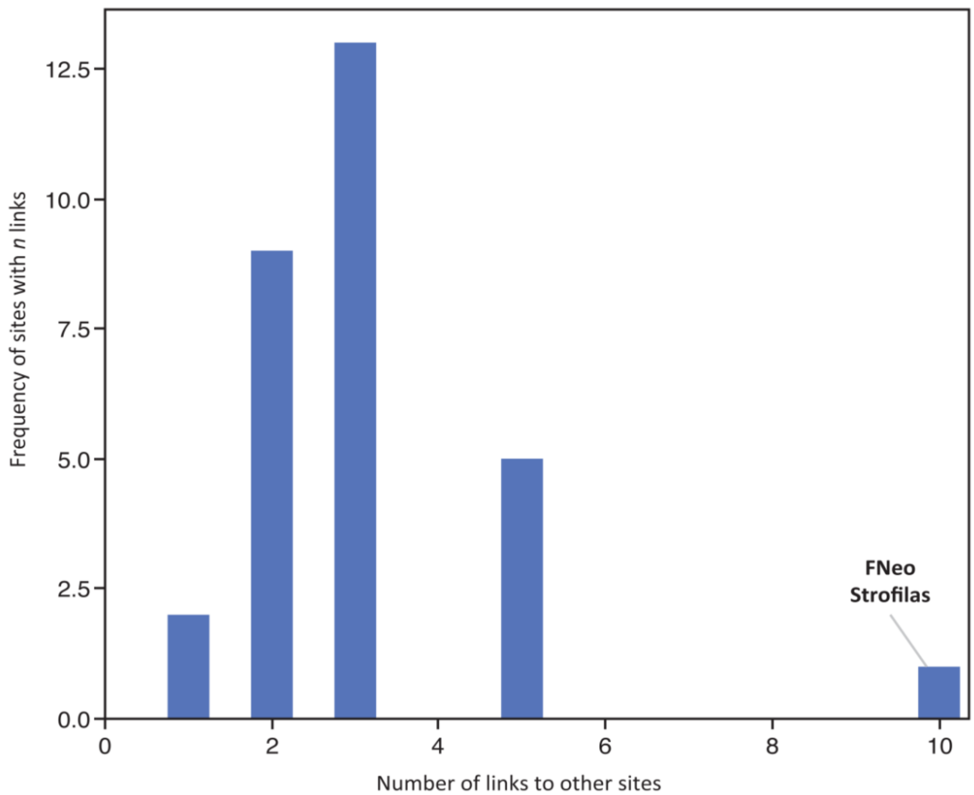


Figure 5.30. Frequency of sites with n connections in the network.

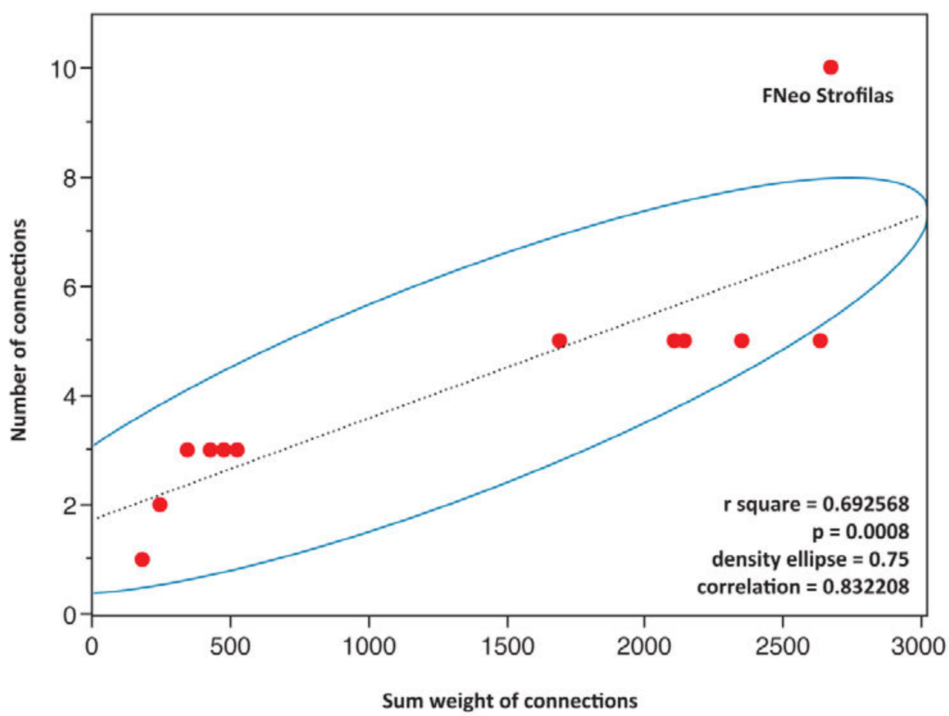


Figure 5.31. Number of network links plotted against total weight (summed I_{ij} values) of those links; Strofilas as hyper-connected by comparison to other sites.

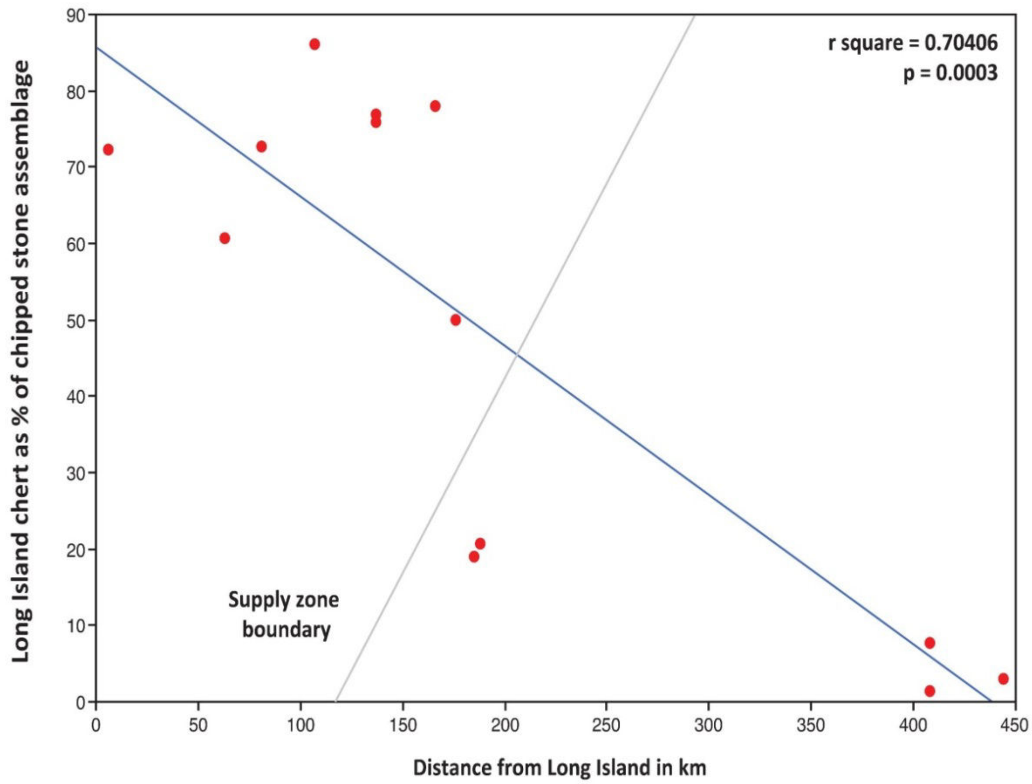


Figure 6.1. Distance decay outside the Long Island 'supply zone,' the area in which relative abudnance epxeriences exponential decay. Fit line in blue.

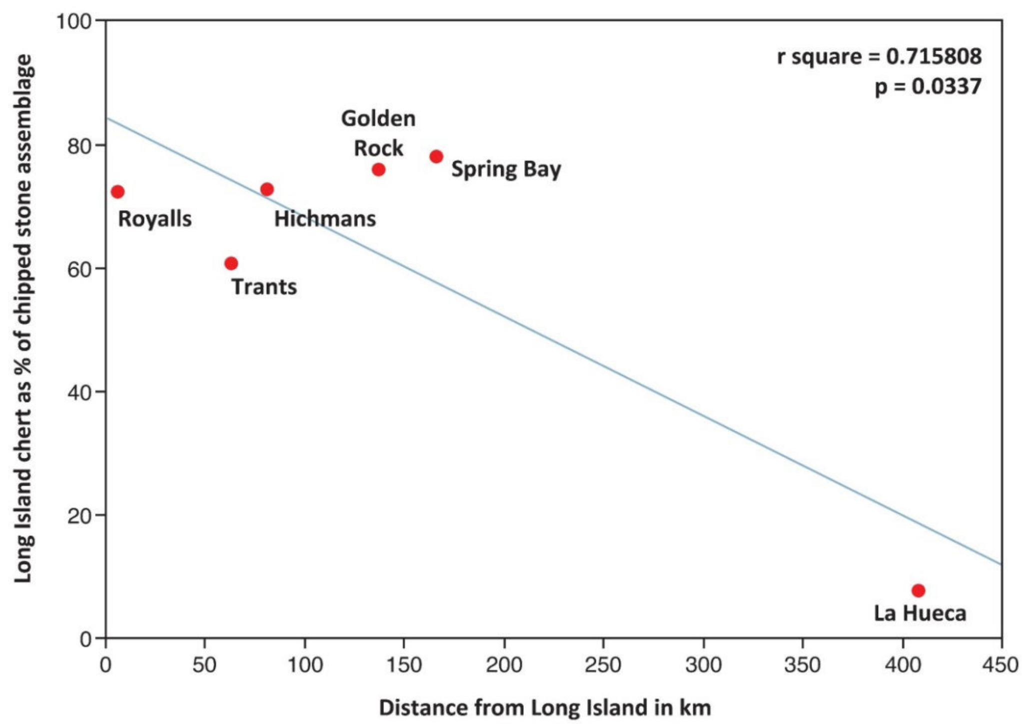


Figure 6.2. Distance decay in relative abundance of chert, Antigua to Vieques, with fit line.

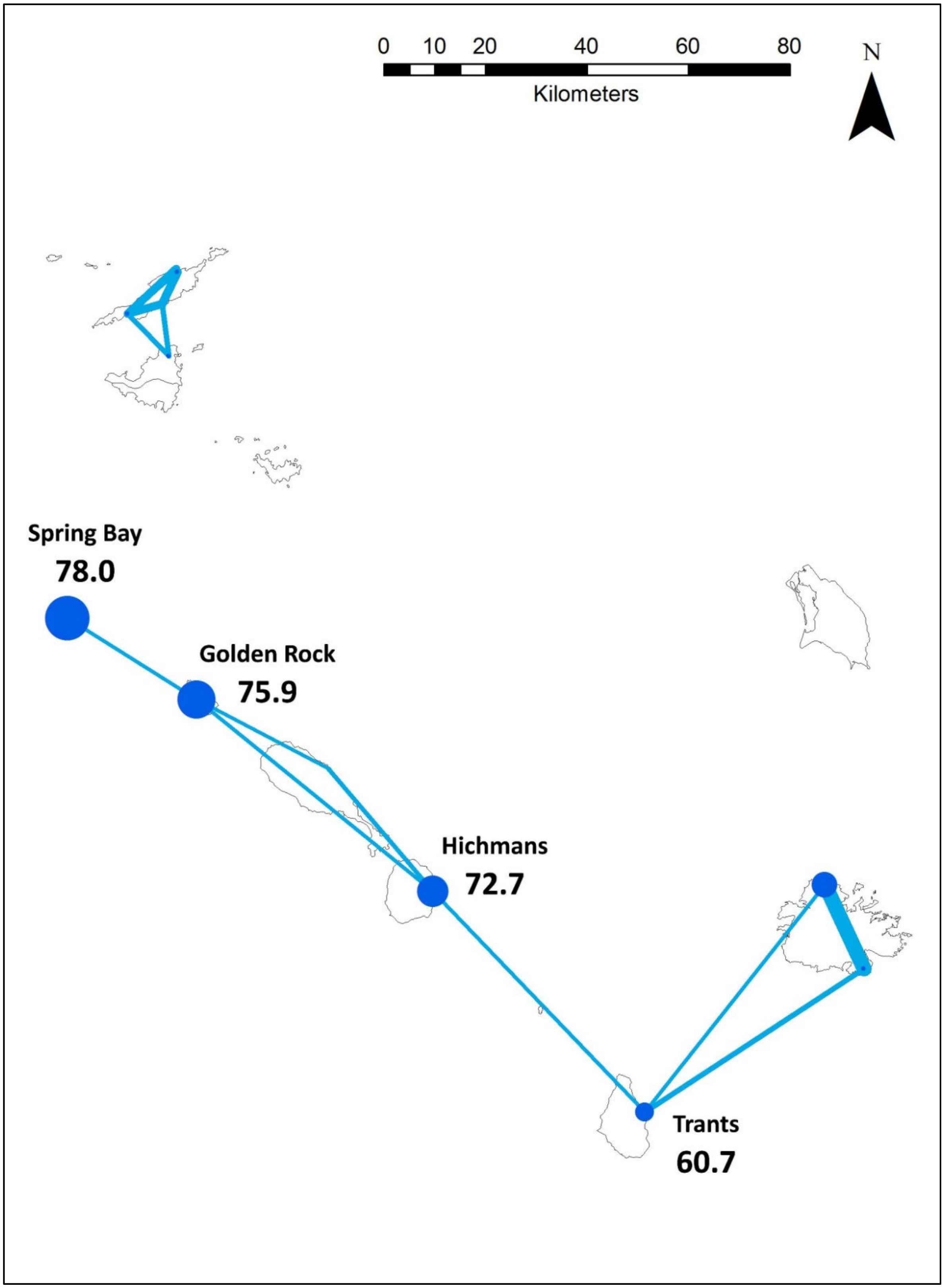


Figure 6.3. Increasing relative abundance of Long Island chert in percentages in a cline from Montserrat to Saba, with network (I_{ij} <50) indicated with blue lines.

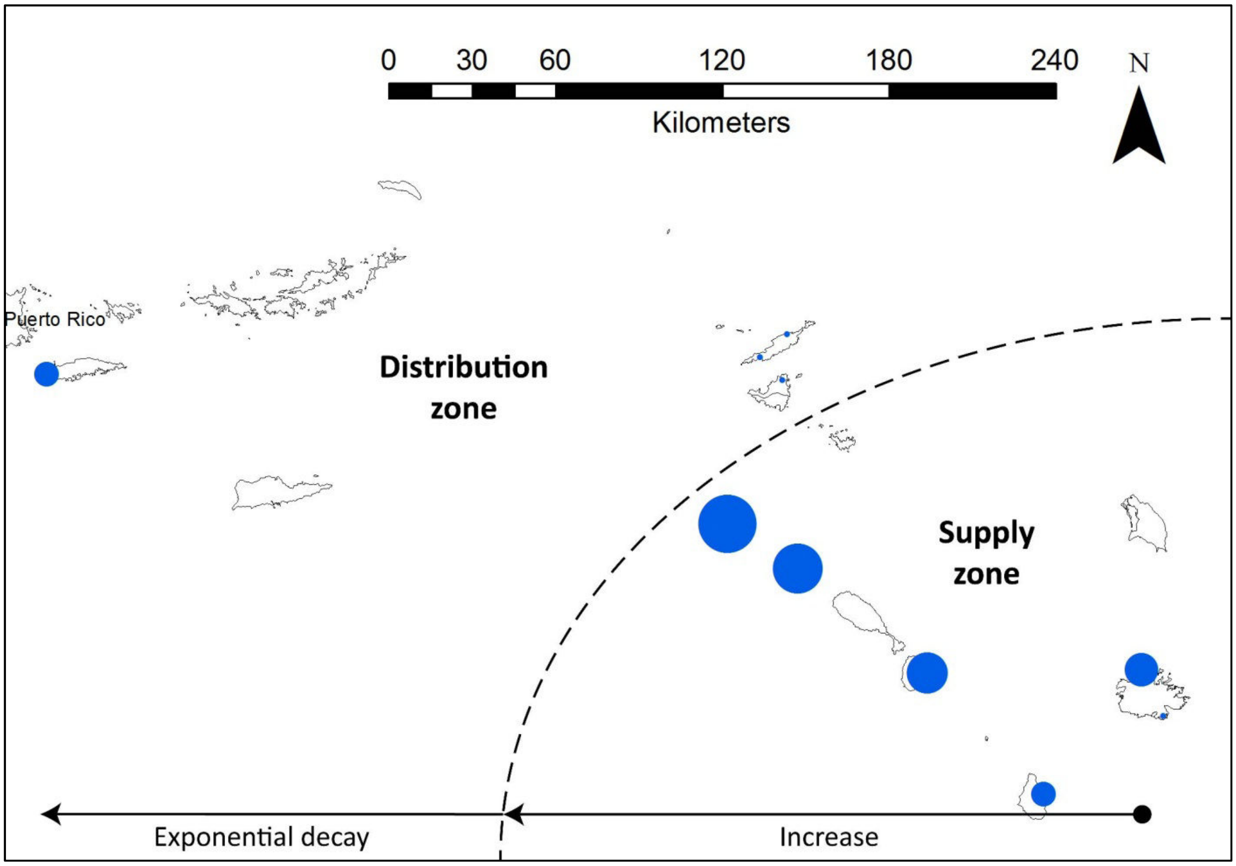


Figure 6.4. Exponential decay in relative abundance of Long Island chert beyond Saba, with weight of blue circles indicating relative abundance within each site assemblage.

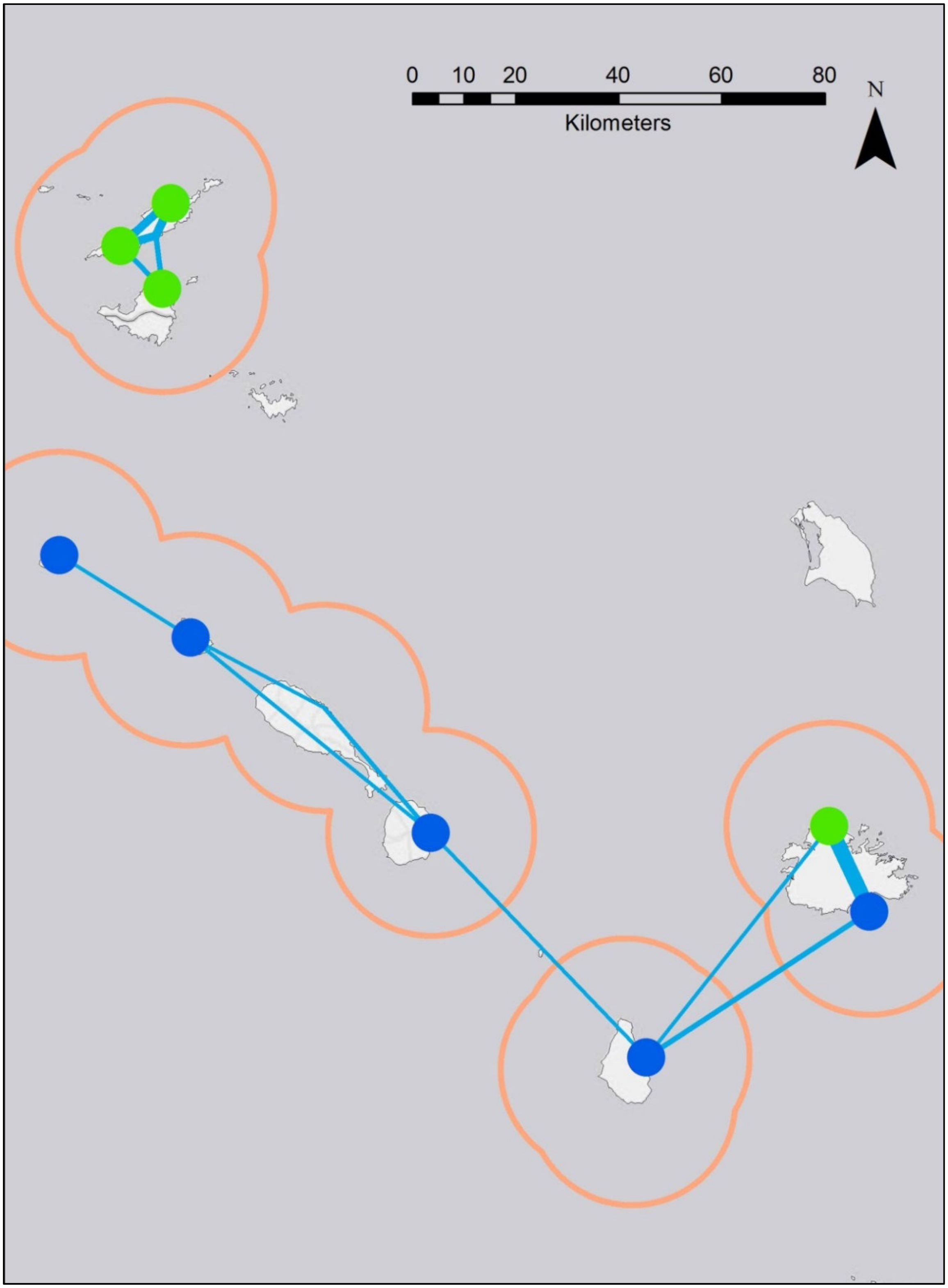


Figure 6.5. Plot of primary reduction sites (blue circles), with network at I_{ij} >50 in blue lines. Primary reduction sites in blue, sites with no evidence for primary reduction in green. Buffers at 20 km.

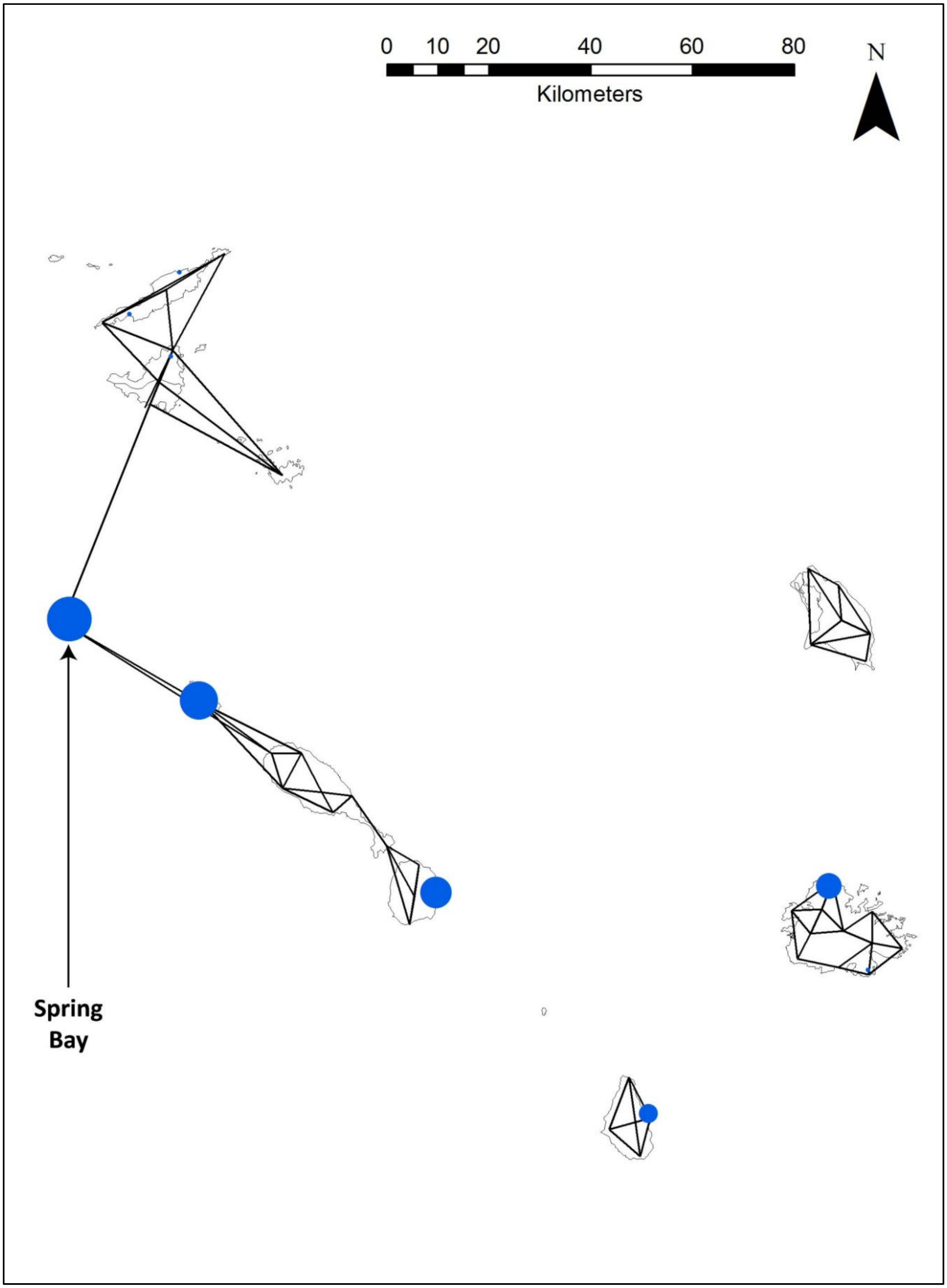


Figure 6.6. Proximal Point Analysis 4 (black lines) with blue symbols weighted for relative abundance of Long Island chert.

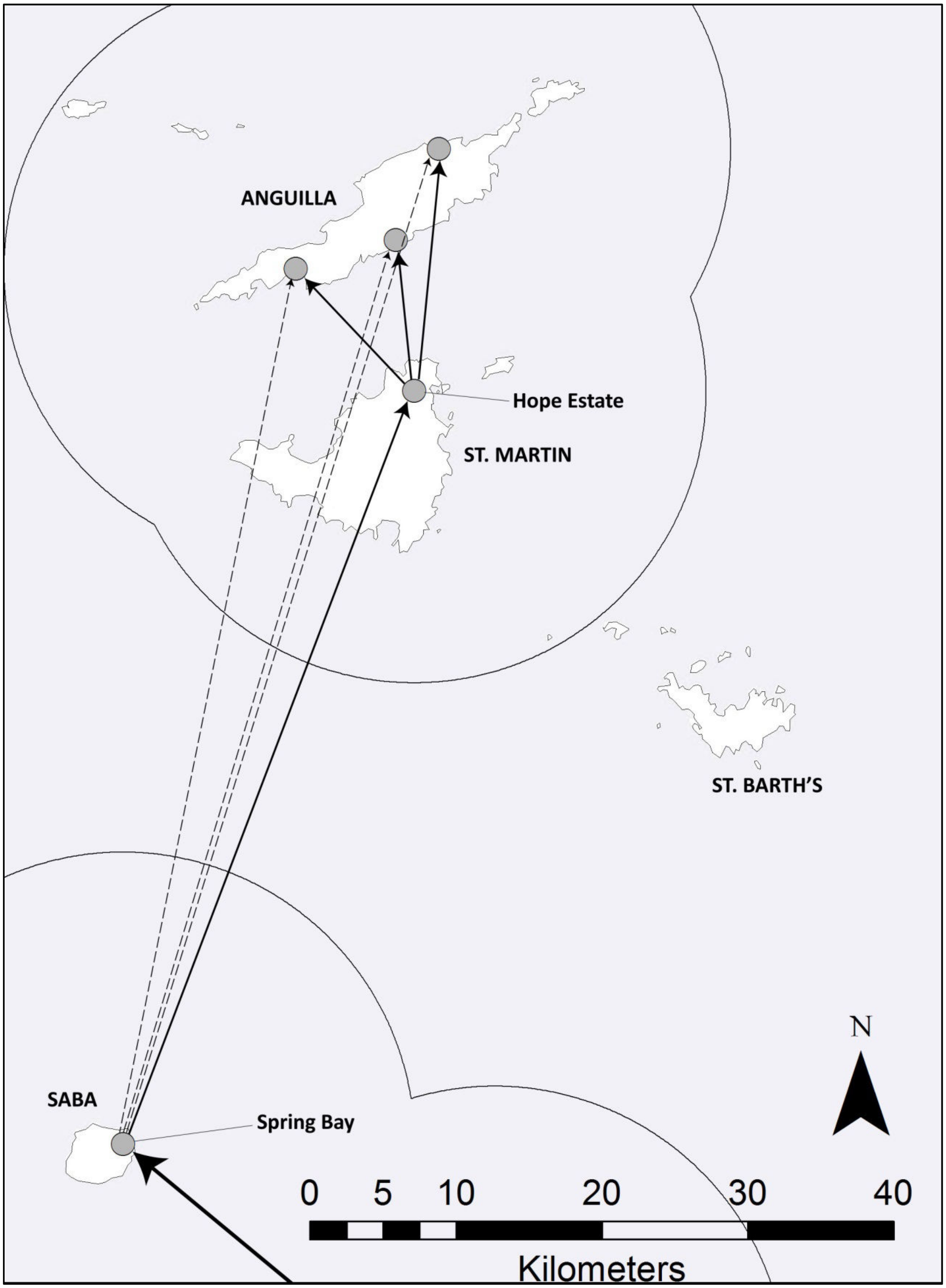


Figure 6.7. Models of exchange of Long Island chert between Saba and the Anguilla Bank in the Early Ceramic II period. Direct access by all sites in dashed lines; Hope Estate, St. Martin, mediating exchange in hard lines.

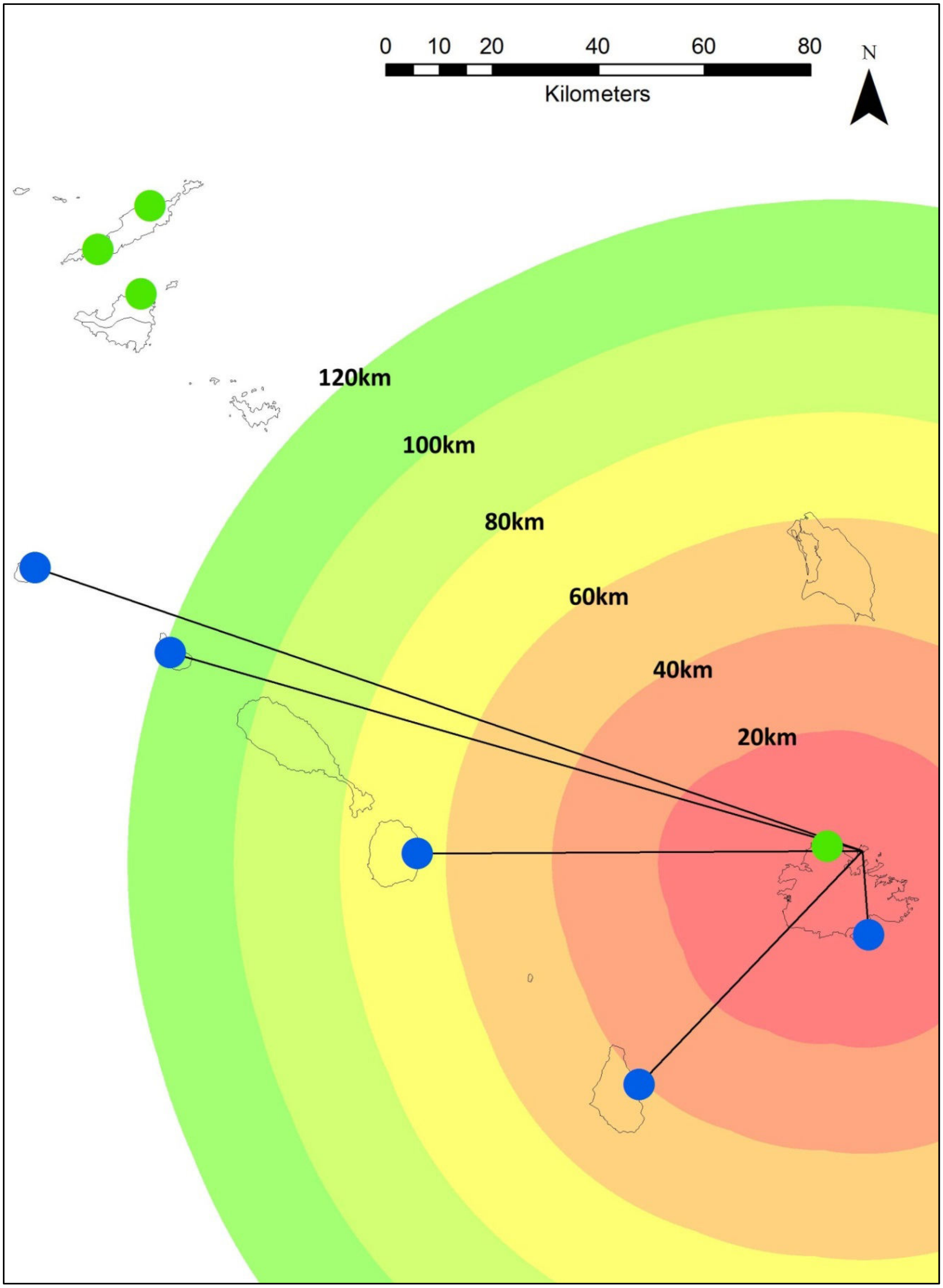


Figure 6.8. Direct access to Long Island in the Early Ceramic II. Sites with evidence for primary reduction in blue, sites with no such evidence in green. Distance buffers in 20 km unit divisions from Antigua.

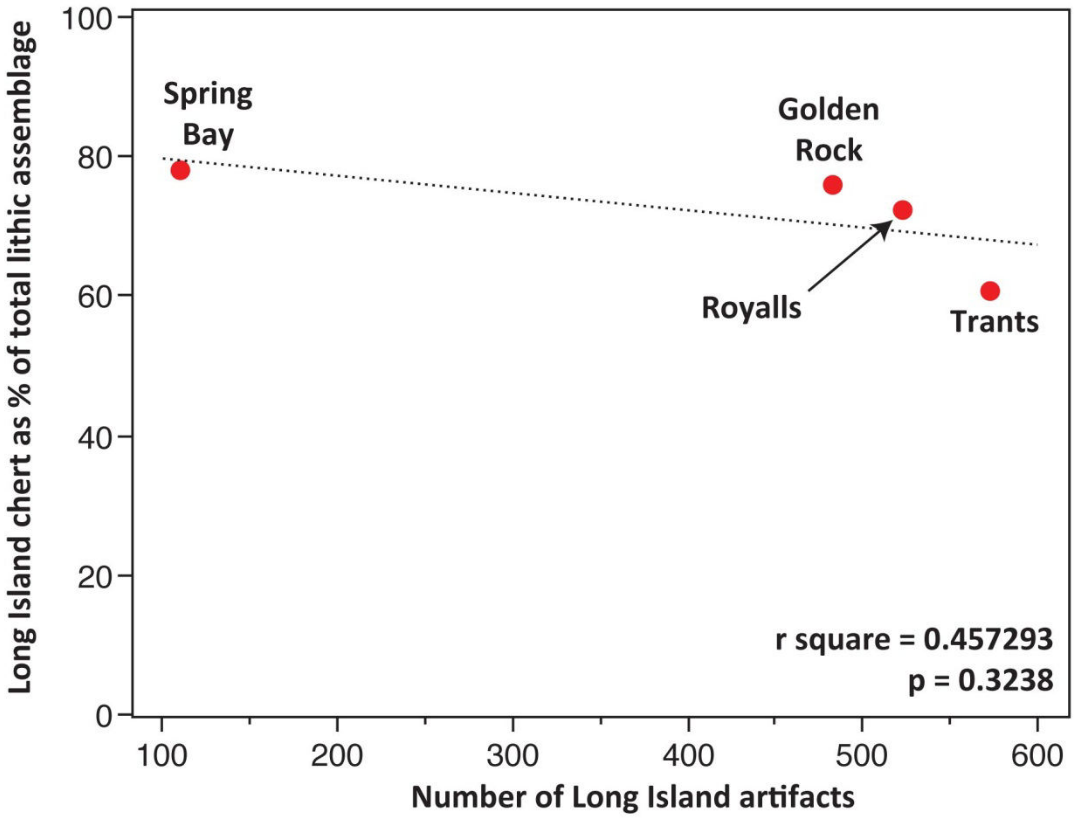


Figure 6.9. Total abundance of Long Island chert plotted against percentage of Long Island chert in chipped stone assemblages in the southern part of the Leeward Islands. Fit line indicated.

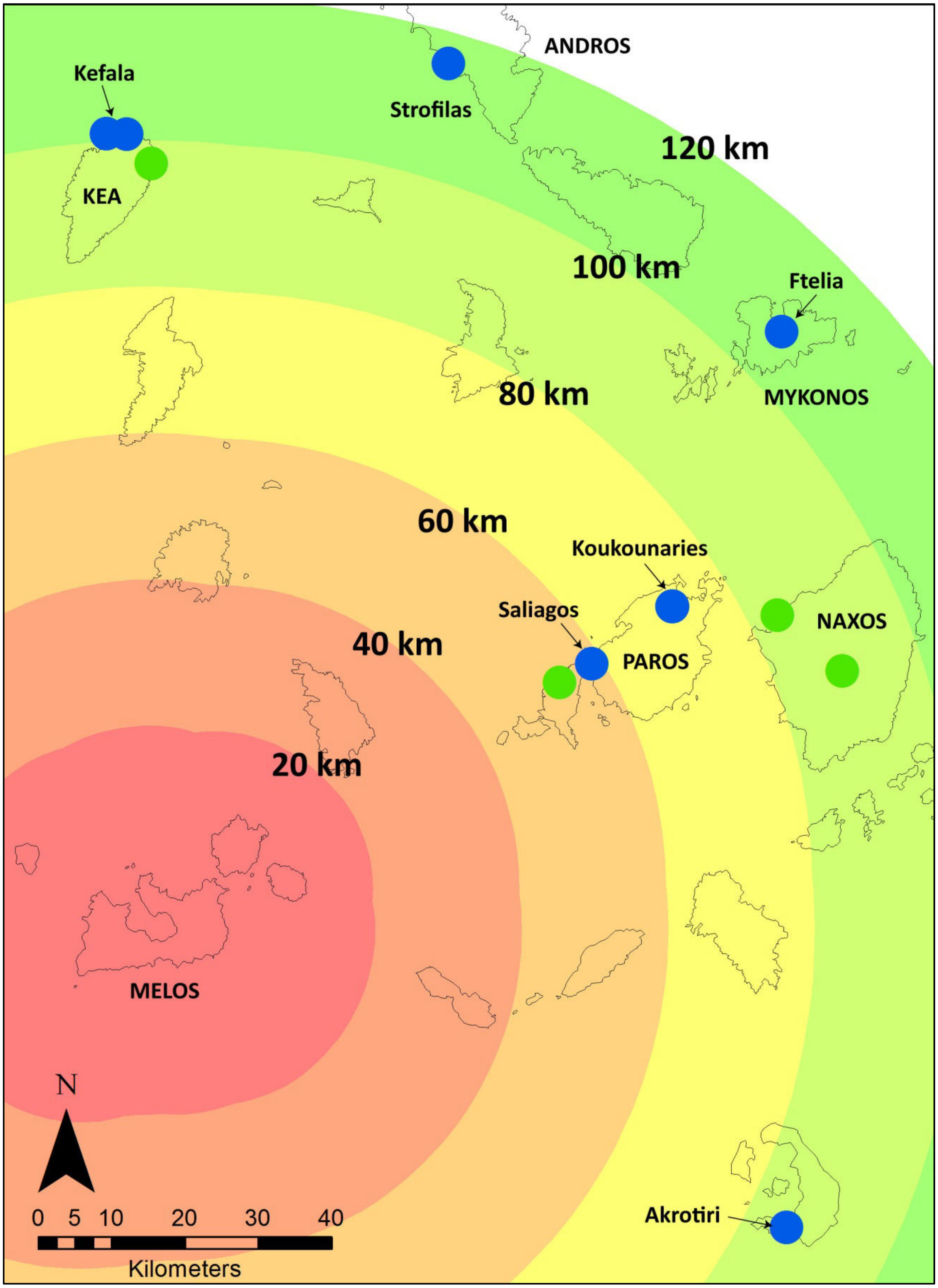


Figure 6.10. Primary reduction sites of Melian obsidian (blue circles) and sites with no evidence for primary reduction (green circles), Late-Final Neolithic. Distance buffers in 20 km unit divisions from Melos.

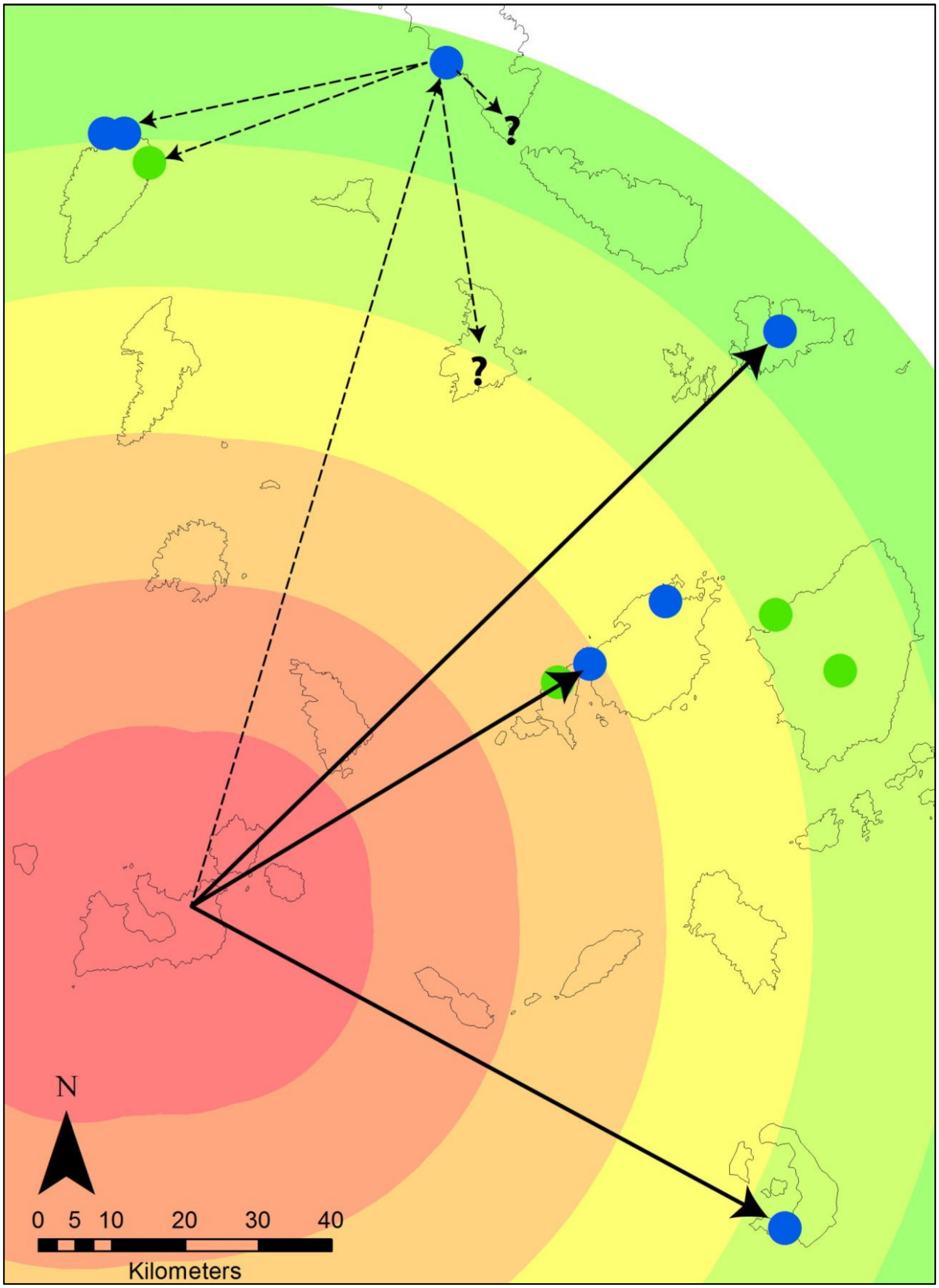


Figure 6.11. Two models of exchange of Melian obsidian: direct access in the Late Neolithic (solid lines) versus mediated access via tier 1 sites in the Final Neolithic (hashed lines). Primary reduction sites (blue circles) and sites with no evidence for primary reduction (green circles).

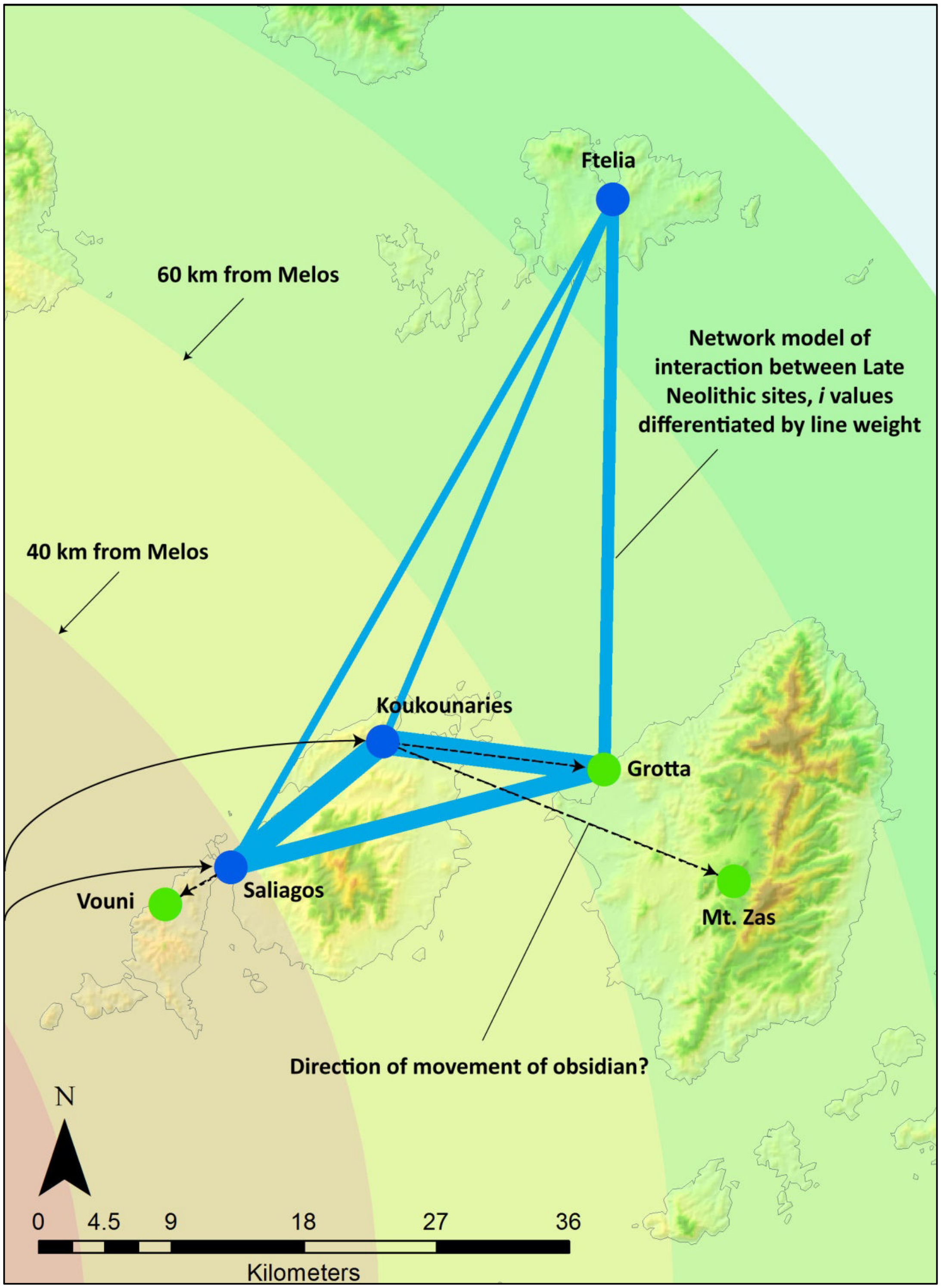
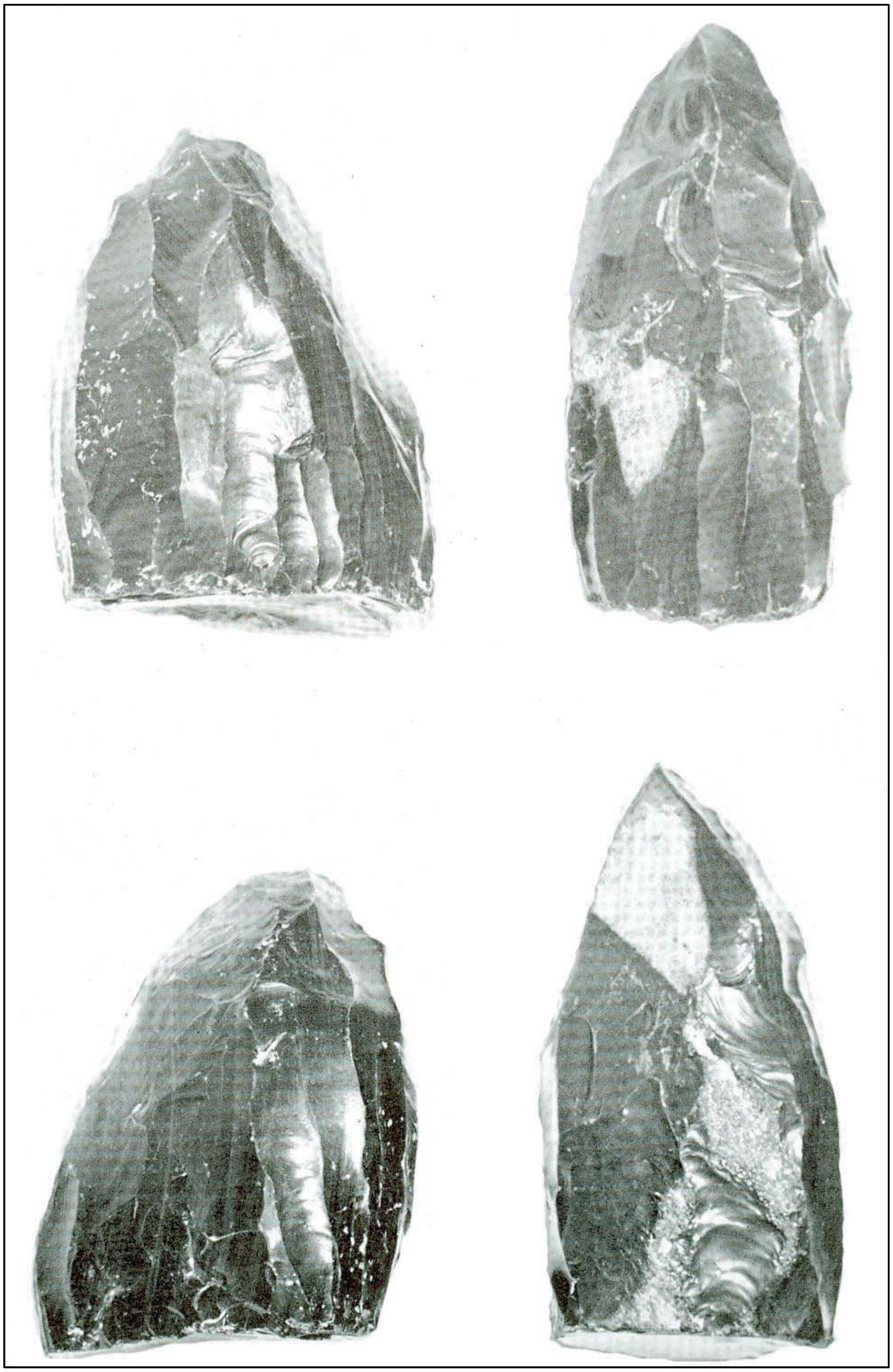


Figure 6.12. A possible model of the movement of obsidian in the Late Neolithic. Sites with direct access in blue, sites with no evidence for reduction sequences in green, overlaid on network model I_{ij}>50 and SRTM data. Grotta is likely to have also retained direct access to the Melian sources.



6.13. Two very large obsidian cores from Saliagos. After Evans and Renfrew 1968.

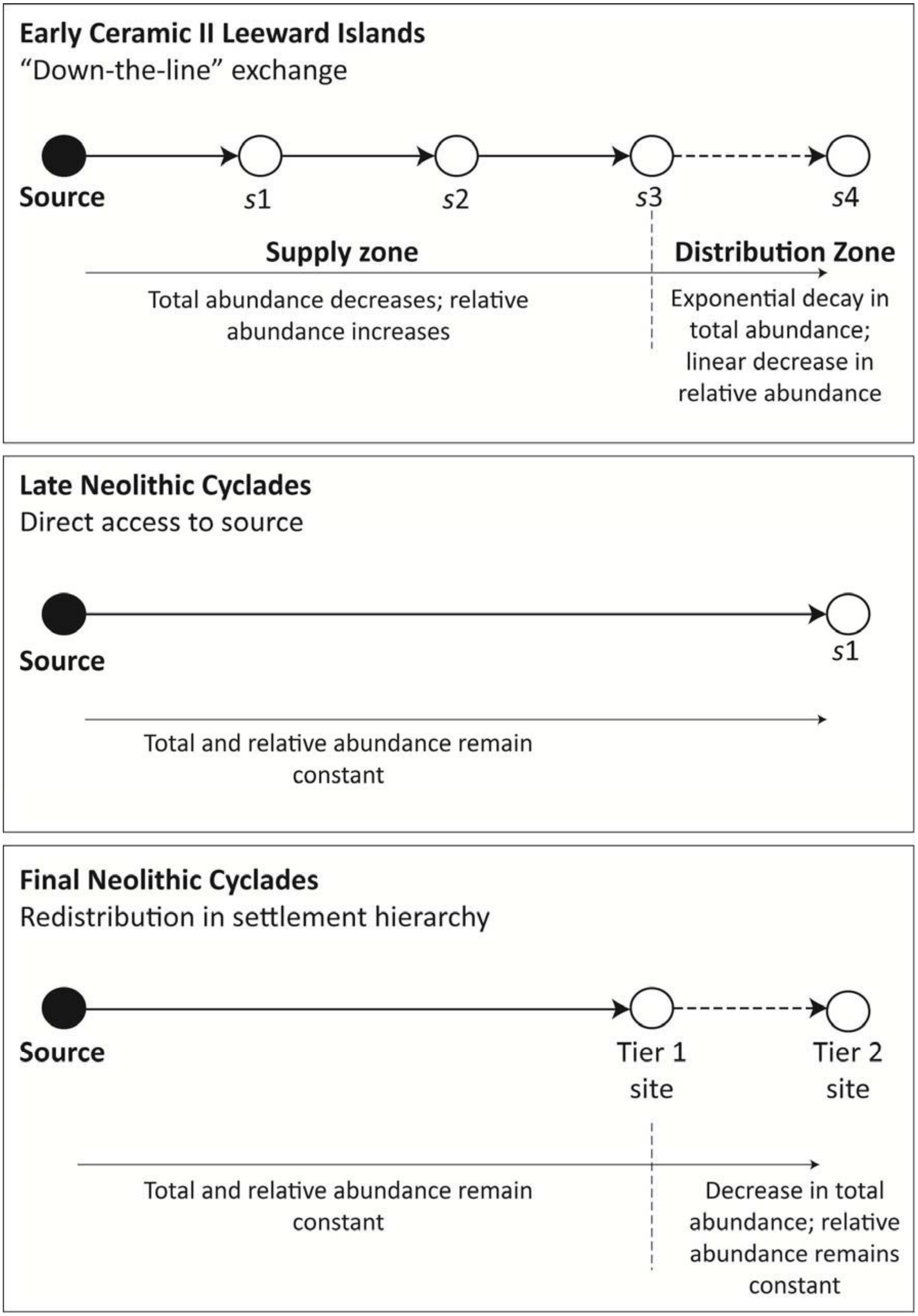


Figure 6.14. Three modes of acquistion of chipped stone tools in the Leeward Island and Cyclades.

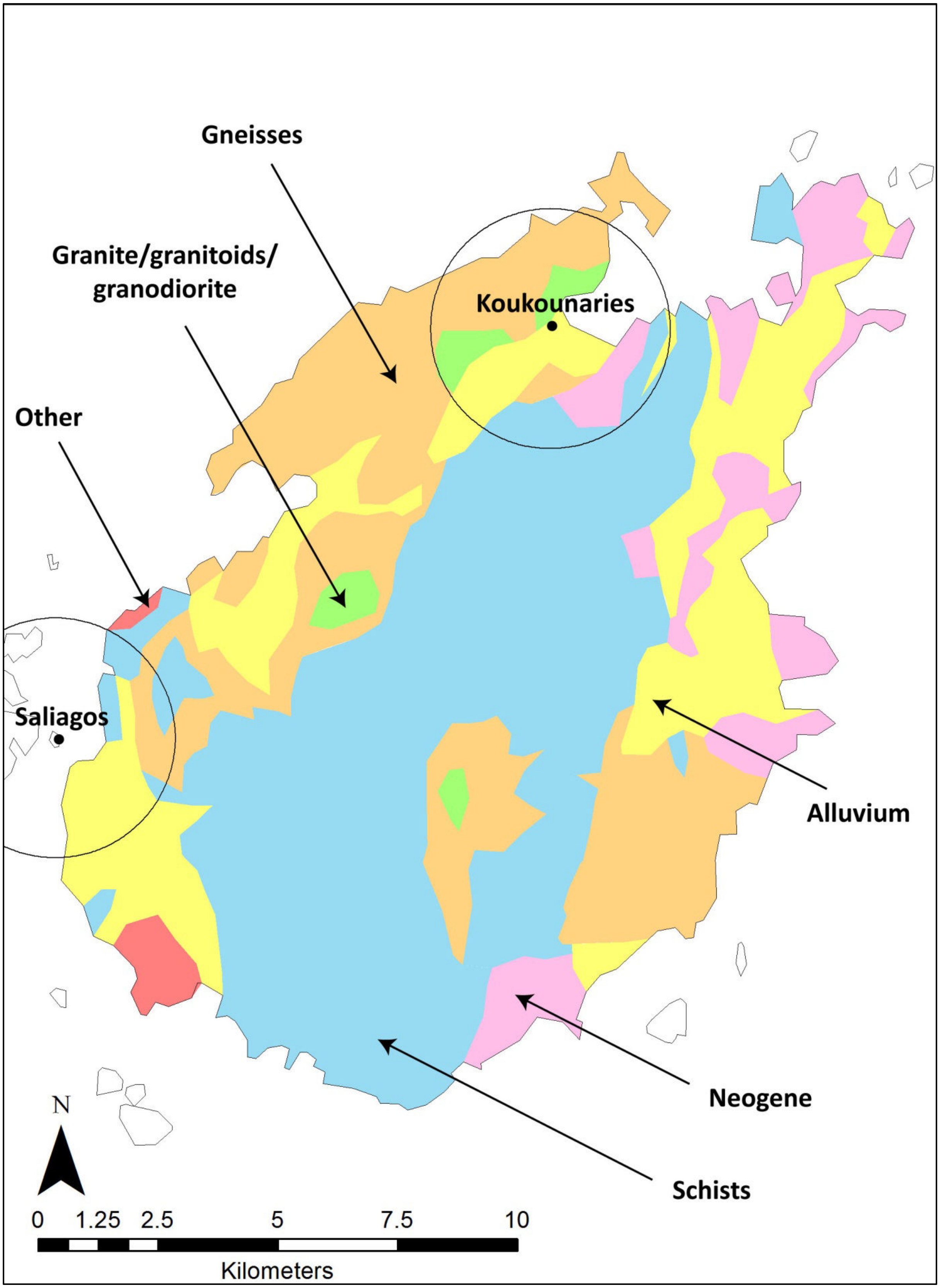


Figure 6.15. The geology of a Cycladic island: Paros (from Bargnesi *et al.* 2012).

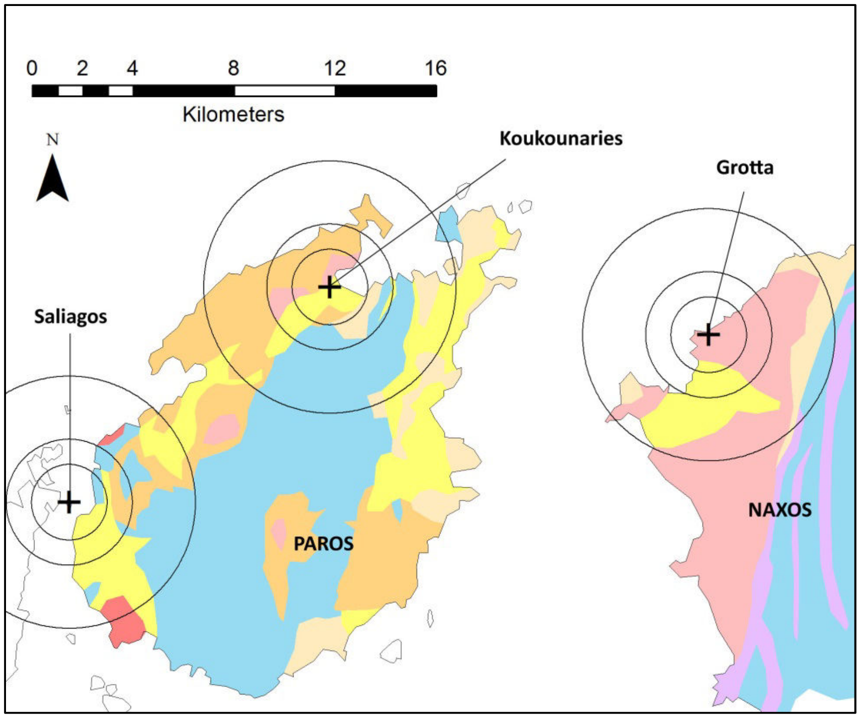


Figure 6.16. Site catchment zones on Paros and Naxos (from Bargnesi *et al.* 2012 and Feenstra 1996) with 1.5, 2.5., and 5.0 km radii from sites indicated.

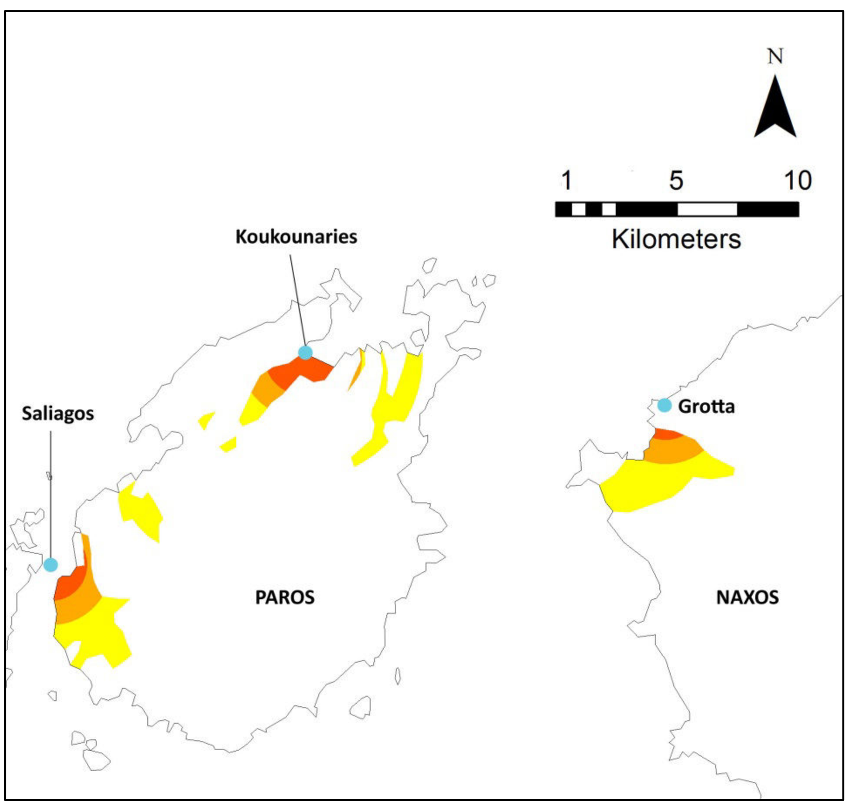


Figure 6.17. Alluvial surfaces graded (red-yellow) according to proximity to Late Neolithic sites.

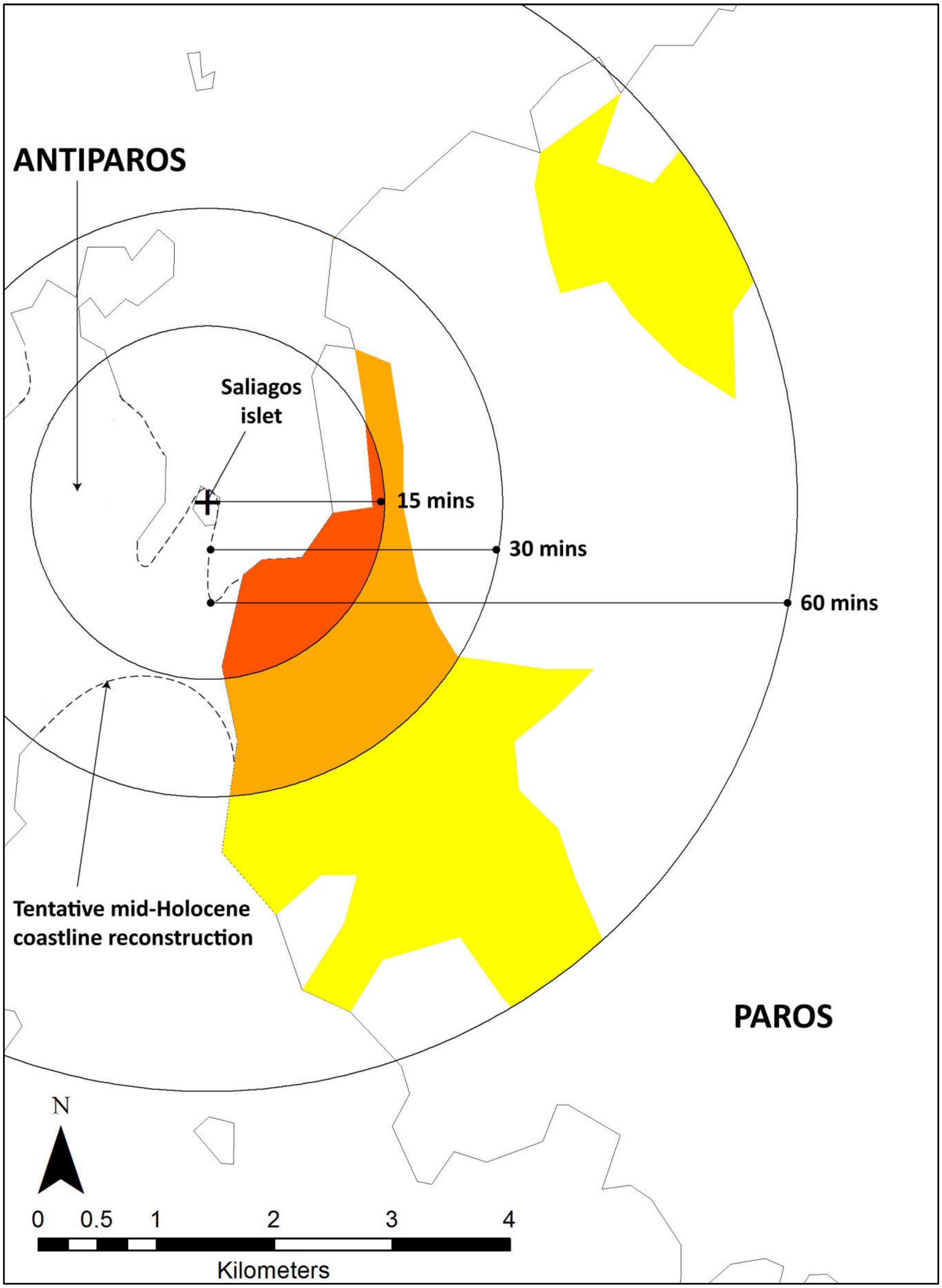


Figure 6.18. The alluvial hinterland of Saliagos with necessary access time for 1.5, 2.5, and 5.0 km radii.

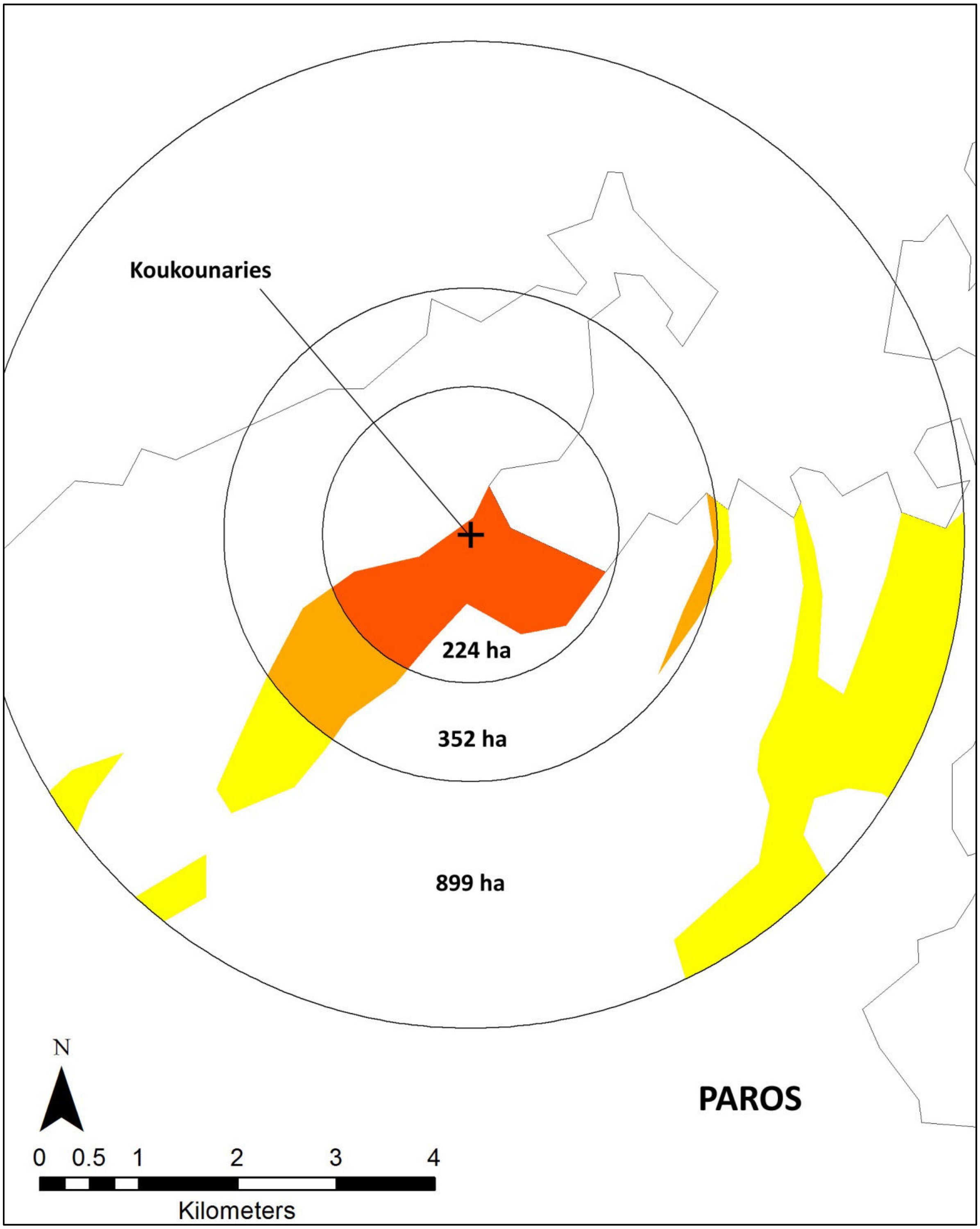


Figure 6.19. The alluvial hinterland of Koukounaries with total accessible areas for different cirum-site radii in hectares.

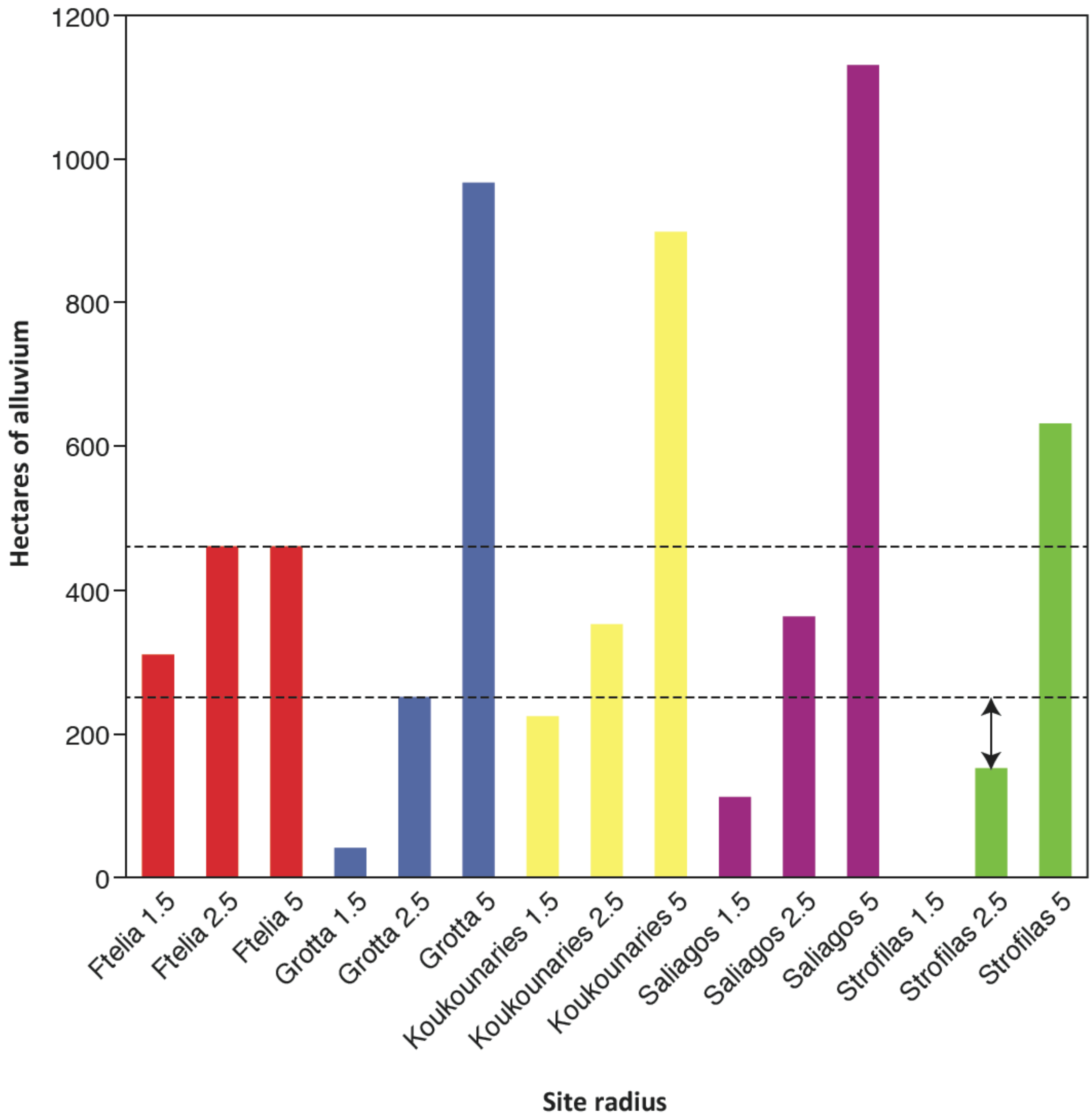


Figure 6.20. Total area in hectares of accessible alluvium at 1.5, 2.5, and 5.0 km radius. Dotted lines indicate zone delineated by total alluvial areas available within 2.5 km for the Late Neolithic sites, broadly capable of supprting populations of c. 200 individuals; Strofilas (in green) falls significantly below this zone.

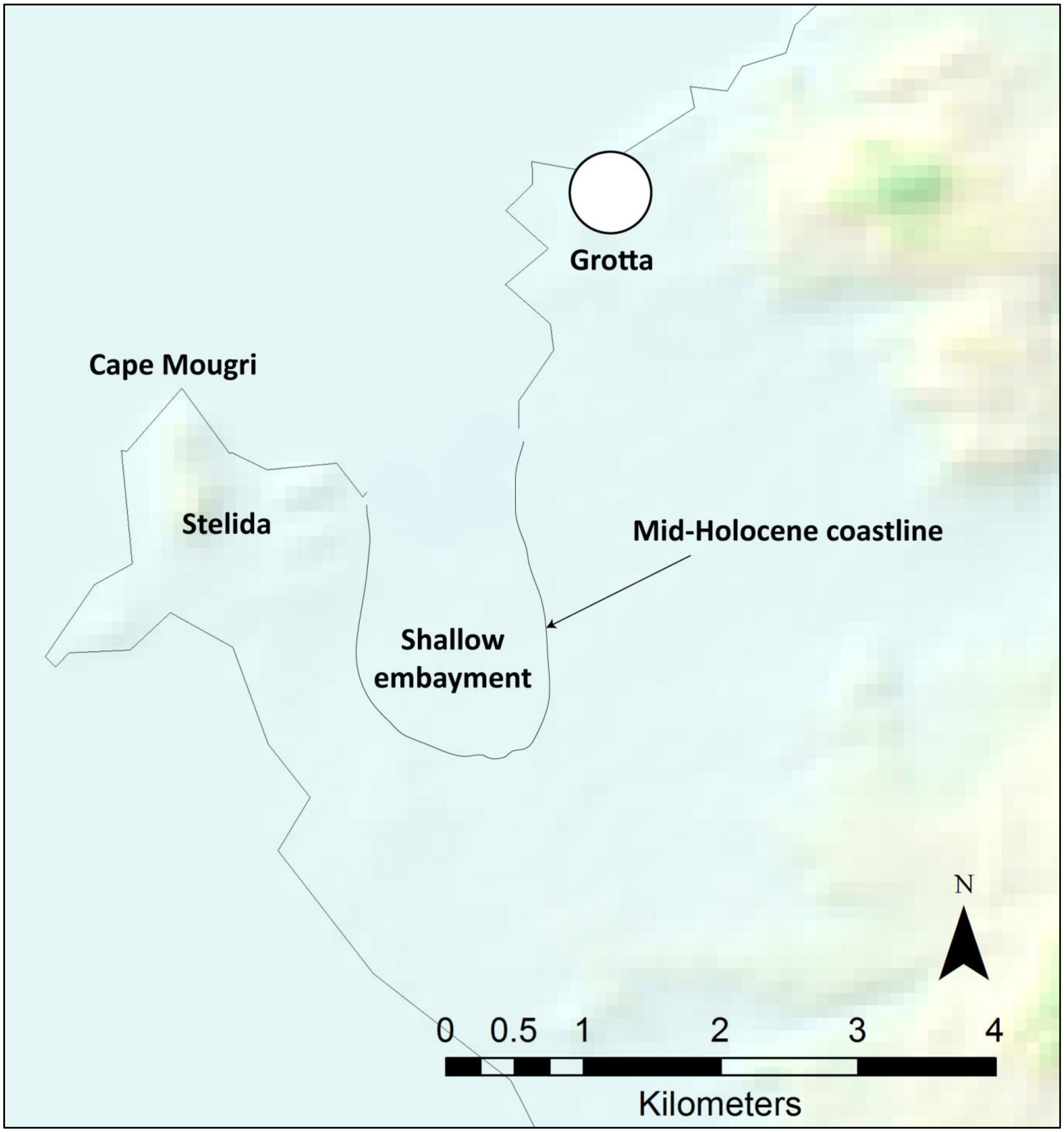


Figure 6.21. The early-mid Holocene embaymnt of northwestern Naxos (after Evelpidou *et al.* 2012).

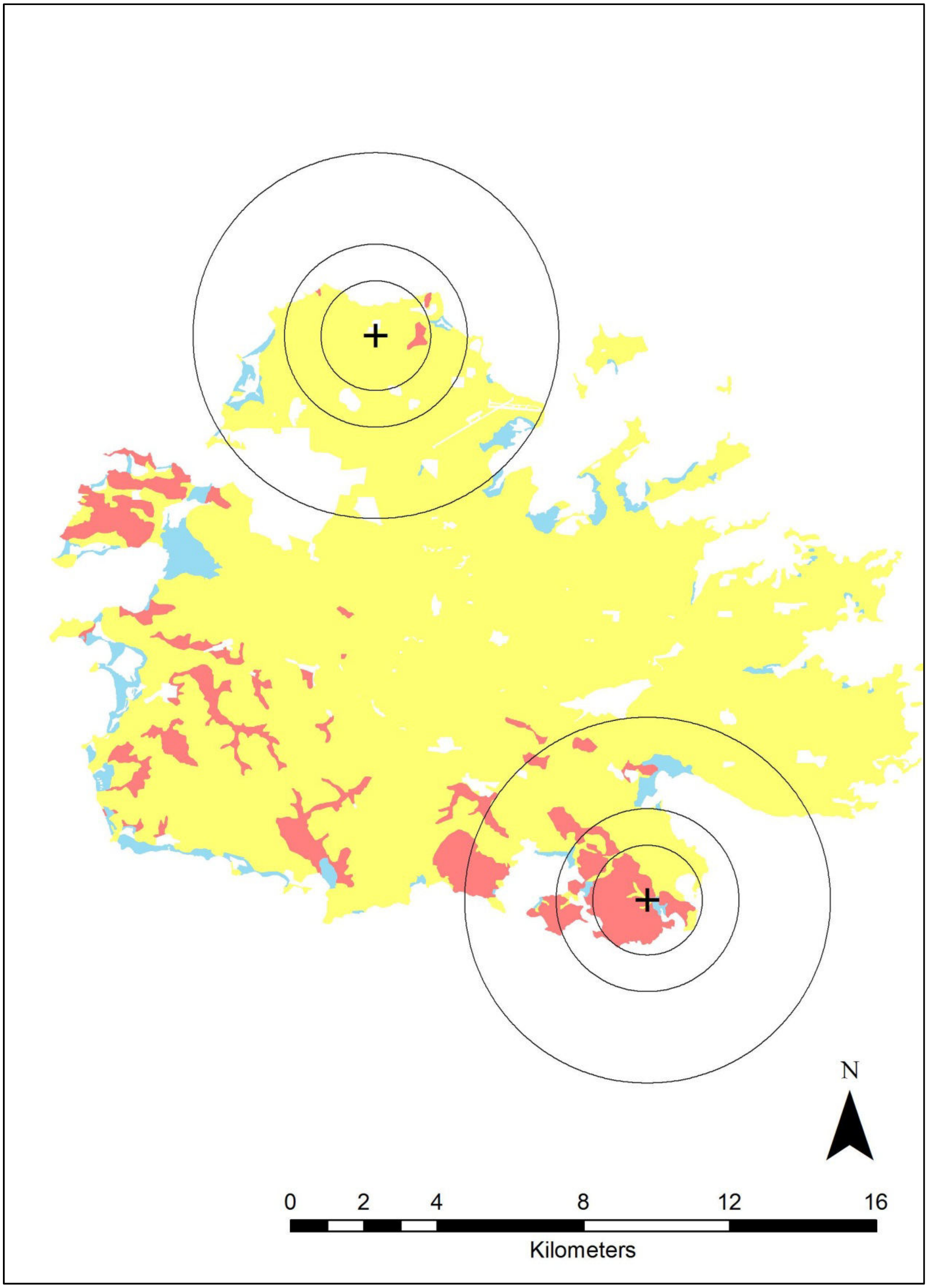


Figure 6.22. Antigua's pedological units. Clay-derived soils in yellow, loam and alluvium in red, coastal ecologies in blue. Note that the white polygons are urban centers, not lake features.

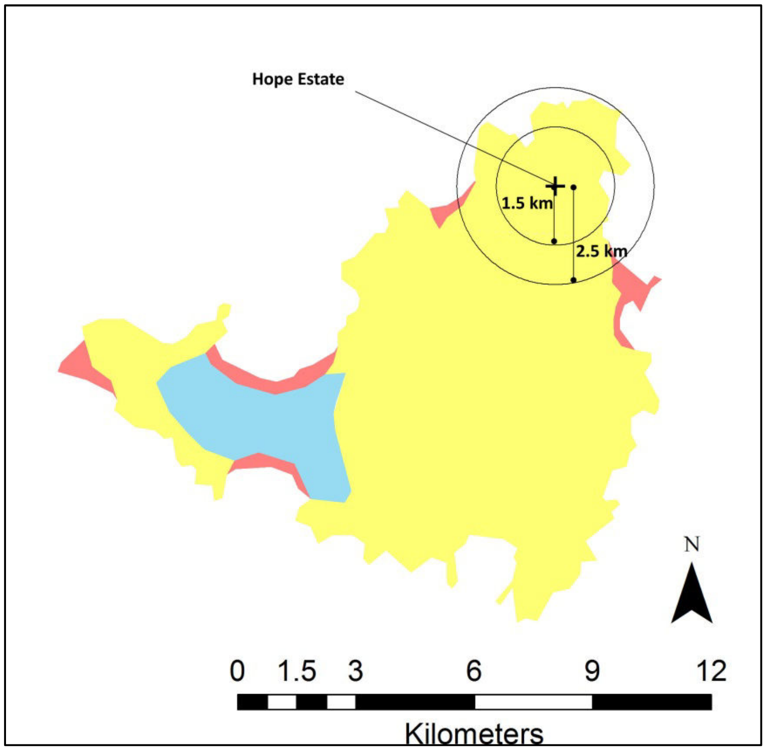


Figure 6.23. St. Martin’s pedological units. Clay-derived soils in yellow, loam and alluvium in red, coastal ecologies in blue. Circum-site radii indicated.

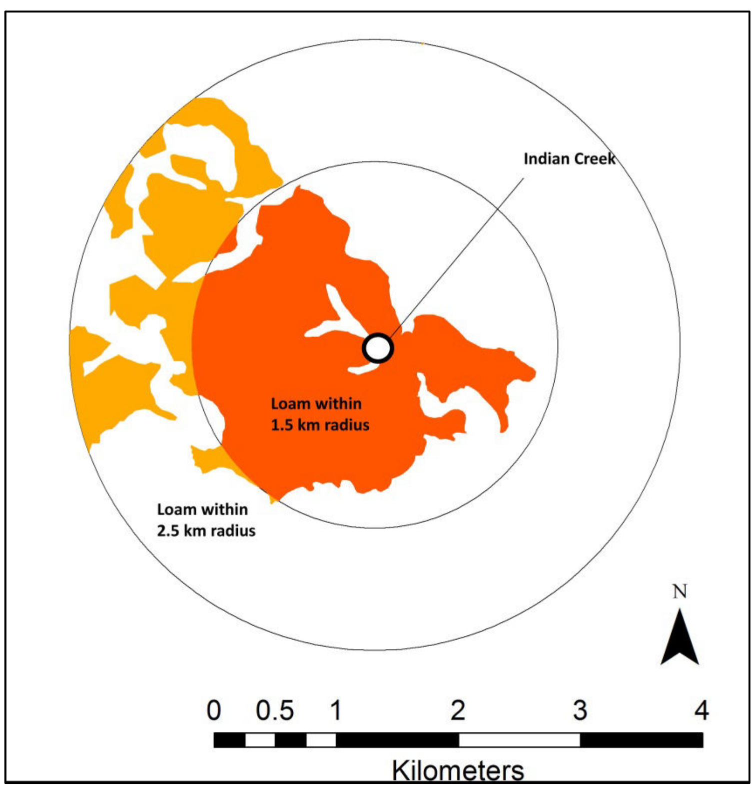


Figure 6.24. The alluvial hinterland of Indian Creek, Antigua. Circum-site radii indicated.

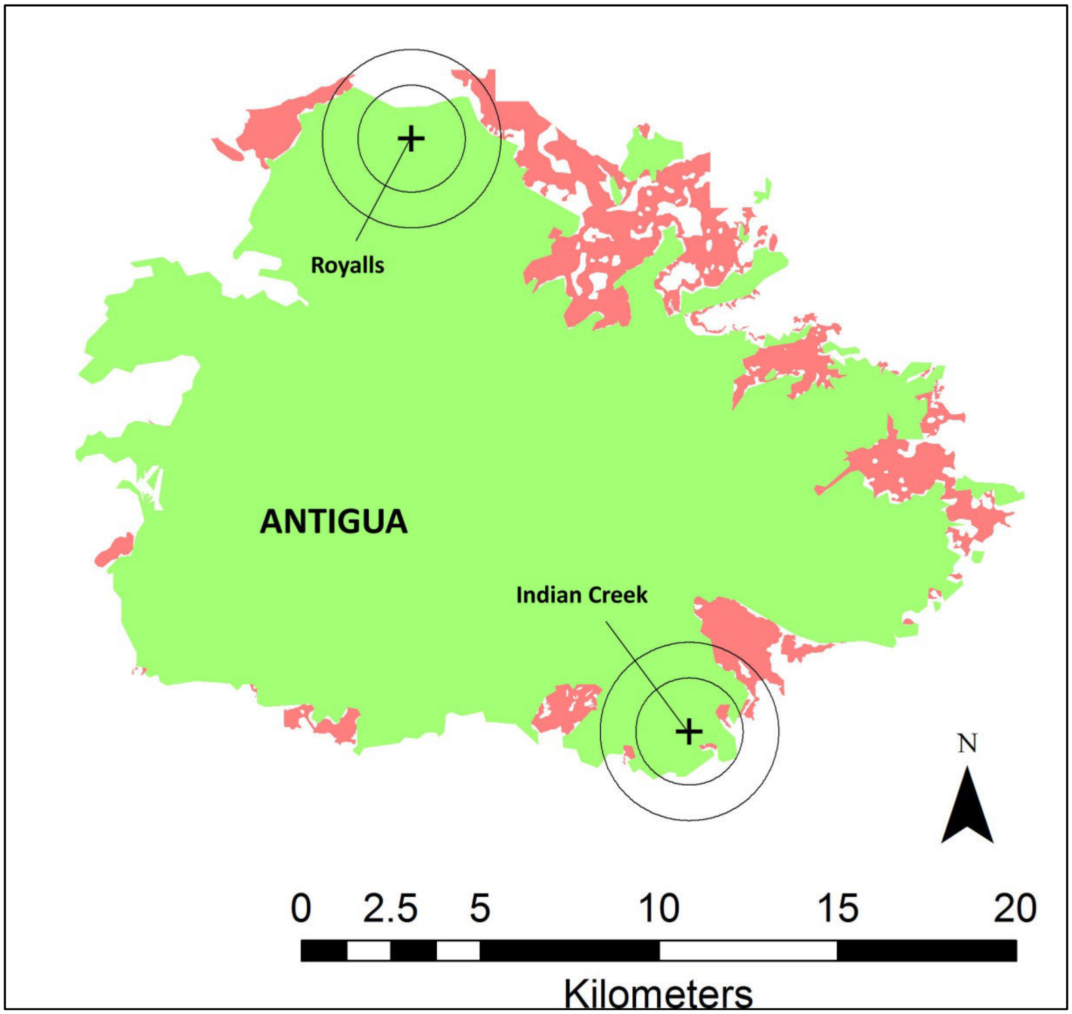


Figure 6.25. Sea-grass beds (red) around Antigua in relation to Indian Creek and Royalls. Radii at 1.5 and 2.5 km.

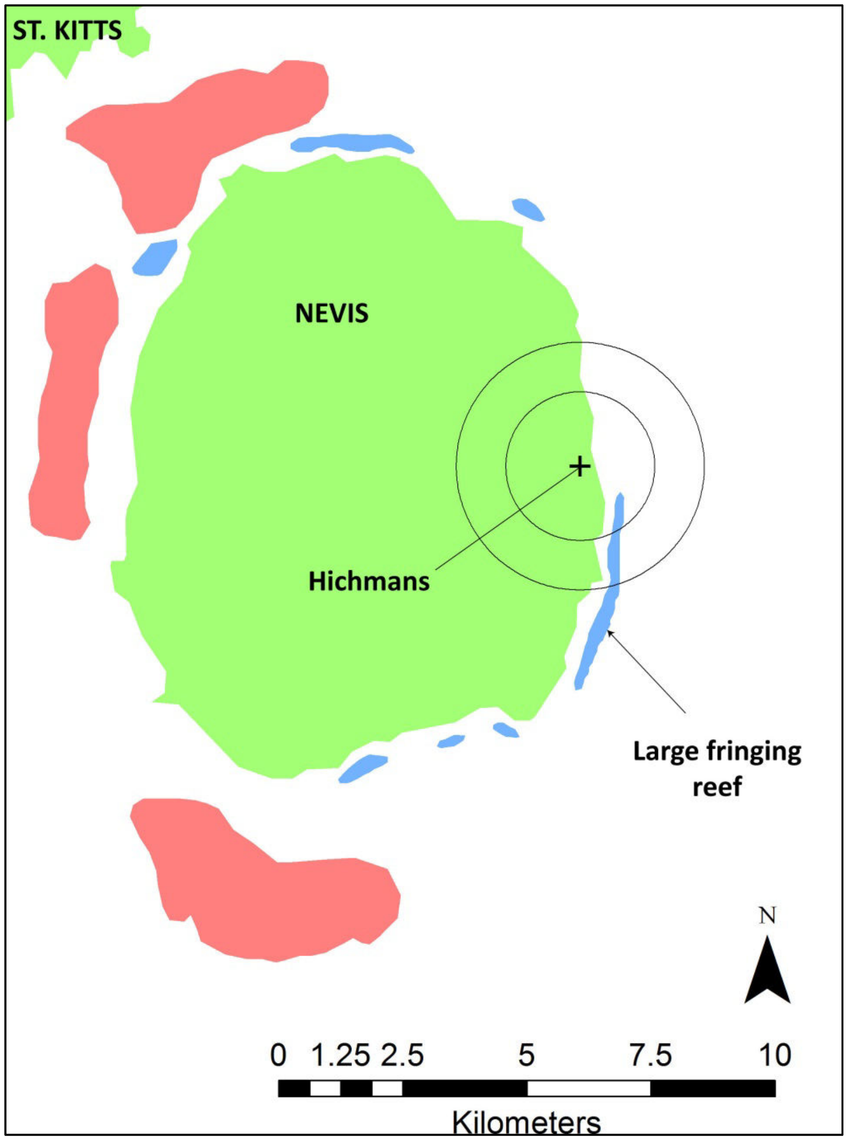


Figure 6.26. Sea-grass beds (red) and reefs (blue) around Nevis in relation to Hichmans. Radii at 1.5 and 2.5 km.

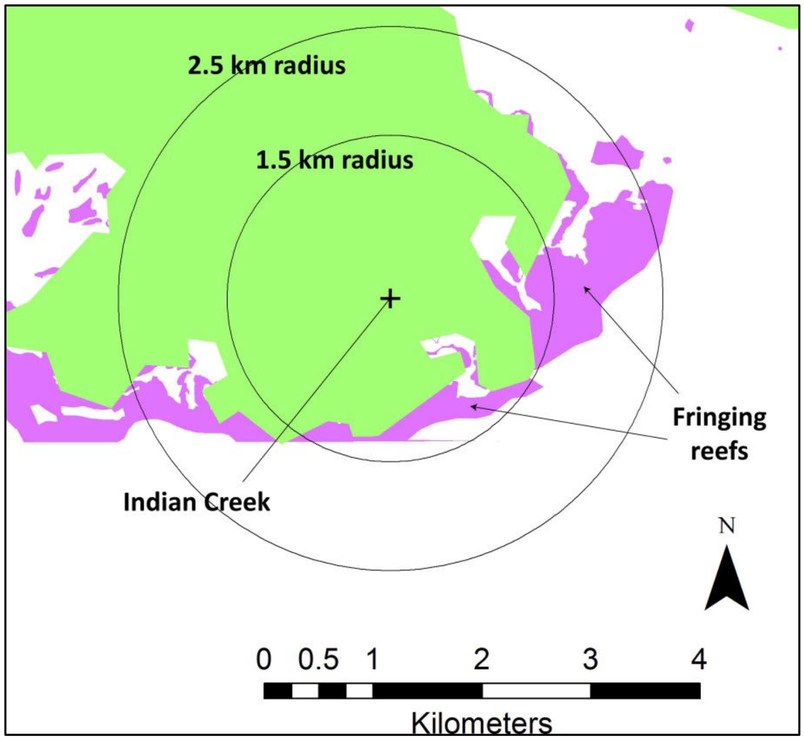


Figure 6.27. Fringing reefs (purple) near Indian Creek, Antigua.

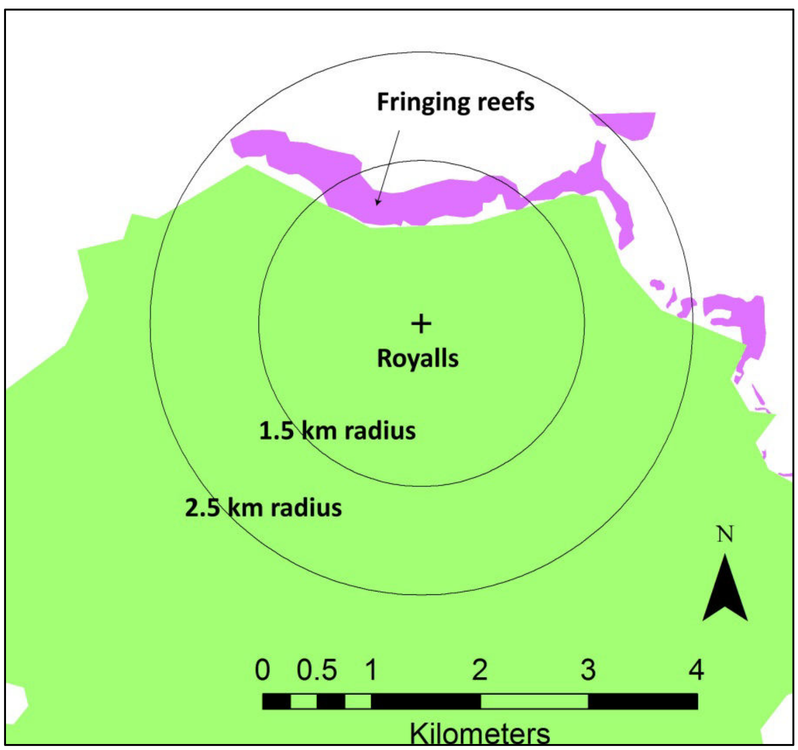


Figure 6.28. Fringing reefs (purple) near Royalls, Antigua.

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