movement co-ordination in Polish populations, from 2 to more than 80 years of age. *Studies in Human Ecology* 7:189–203.

SZEMIK, M. 1986. Changes in somatic development of inhabitants of two neighboring villages in Kurpie region (Poland) between 1961–1981. *Studies in Human Ecology* 7:65–93.

WILLIAMS, G. R. 1931. *Maya-Spanish crosses in Yucatán.* Papers of the Peabody Museum of American Archaeology and Ethnology 13(1).

WOLAŃSKI, N. 1962. *Kinetics and dynamics of growth and differentiation of body proportions in children and youth.* Warszawa: PZWL.

———. 1966. Environmental modification of human form and function. *Annals of the New York Academy of Sciences* 134: 826–40.

———. 1973. Tables of basic data. *Studies of Human Ecology* 1: 197–226.

———. 1987 "Data for control of child growth (biological reference systems—Warszawa 1981)," in *Ocena rozwoju dziecka w zdrowiu i chorobie.* Edited by N. Wolański and R. Kozioł, pp. 359–413. Wrocław: Ossolineum.

———. 1990. Human population as bioindicator of environmental conditions (Environmental factors in biological status of the population of Poland). *Studies in Human Ecology* 9:295–321.

———. 1994. La familia como microambiente para el desarrollo de los niños: Estudios en la población de Mérida y Progreso, 1993 (Resultados preliminares). Final technical report, CONACyT ref. no. 1324-S9206, Mérida, Mexico, CINVESTAV.

WOLAŃSKI, N., AND A. LASOTA. 1964. Physical development of countryside children and youth aged 2 to 20 years as compared with the development of town youth of the same age. *Zeitschrift für Morphologie und Anthropologie* 54:272–92.

WOLAŃSKI, N., AND A. SINIARSKA. 1997. Body proportions in populations of Yucatan (Abstract). *American Journal of Human Biology* 9(1):144.

———. 2000. "Differences in body proportions between Yucatecan and Polish populations: Genes or living conditions?" in *Latvijas Vesturnieki*, pp. 166–92. Riga: Latvijas Vestures Instituta Apgads.

WOLAŃSKI, N., A. SINIARSKA, AND M. SZEMIK. 1982. "Polskie badania populacyjne," in *Ekologia populacji ludzkich.* Edited by N. Wolański and A. Siniarska, pp. 721–38. Wrocław: Ossolineum.

Ceramic Age Seafaring and Interaction Potential in the Antilles: A Computer Simulation[1]

RICHARD T. CALLAGHAN
Department of Archaeology, University of Calgary, Calgary, Alberta, Canada T2N 1N4. 5 x 00

1. Funding for this work was provided by a University of Calgary Research Services Pilot Grant and a Social Sciences and Humanities Research Council of Canada Research Grant. Donna Fremont of the University of Calgary, Computer Science Department, carried out the computer programming. I thank the Belizeans and Venezuelans who helped to construct rafts and test canoes, especially Morris Lesley of Sand Hill, Belize, and the Ye'Kwana people of the village of Esmeralda, Venezuela.

Computer simulations of ancient maritime voyaging patterns have shed light on a number of issues regarding the movements of prehistoric and historic peoples. The first simulation of this kind was designed by Levison, Ward, and Webb (1973) to investigate Polynesian dispersal. The technique was later used to determine which of the Bahamas Islands is likely to have been the first on which Columbus landed (Fuson 1987). Probably the most complex of these simulations are those of Geoffrey Irwin and his colleagues (Irwin 1989, 1990, 1992; Irwin, Bickler, and Quirke 1990), focused on exploration, colonization, and settlement patterns in Polynesia. A handful of other such works have been conducted elsewhere. This study uses computer simulations of the maritime environment and performance characteristics of aboriginal watercraft to investigate whether technology or the environment would have influenced patterns of human movement among the islands of the Antilles or between the islands and the South American mainland in the Ceramic Age, beginning in the first few centuries B.C. (fig. 1). Two models are tested: chance discovery through unintentional drift voyages (people lost at sea) and directed voyages (intentional exploration).

The evidence for a northern South American origin of the earliest ceramic-producing horticulturists in the Antilles is very clear (Rouse 1992:71–104; cf. Haviser 1997). These peoples, termed Saladoid, appear to have moved rapidly through the Antilles as far as eastern Hispaniola in the second half of the 1st millennium B.C. (Rouse 1986:39; 1992:79–80). In passing through the Lesser Antilles they initially occupied the northeast coasts of the high islands, presumably preferring those locations because they were the most heavily forested parts of the islands and resembled their original home on the mainland (Rouse 1992:9). As Rouse points out, these are the windward sides of the islands, and their settlement would indicate that the Saladoid peoples had a good command of seamanship. This group or some of its variants gave rise around A.D. 600 (p. 92) to the Ostionoid peoples, who then moved west into eastern Cuba. Eventually, the Ostionoid peoples gave rise to the Taíno groups encountered by Columbus (pp. 72–73).

Two dugout canoe designs were evaluated in this study. One is based on the Stargate canoe (fig. 2), recovered in the Bahamas by Stephanie Schwabe and the late Rob Palmer. This canoe is remarkably similar to canoes still being used by the Ye'Kwana and other native groups on the Orinoco River of Venezuela today (Callaghan and Schwabe n.d.). The other (fig. 3) is a platform-style canoe found widely today around the Caribbean mainland and similar to those depicted in the early Spanish chronicles of the islands (Callaghan 1993). Canoes of the two styles were analyzed in Venezuela and Belize respectively to determine their performance characteristics, including speed, leeway, carrying capacity, and stability. These characteristics were also analyzed using naval architecture programs. The data were then used in a simulation model of the Caribbean environment. The environmental factors considered were winds, currents, gale and hur-

FIG. 1. *The Caribbean region, showing staging area for voyages.*

ricane frequencies, and sea-swell conditions, and the data on these factors were taken from pilot charts and sailing directions compiled by the U.S. Navy and other agencies. The computer program employed for the analysis has been described elsewhere (Callaghan 1999).

One of the most important questions to be asked in applying the model is whether the data presented in the pilot charts for the study area, compiled since the early 19th century, are representative of the time period of interest here. The most important climatic factor affecting the model is surface wind circulation during the period from approximately 2,500 B.P. and 500 B.P. Surface winds not only affect vessels directly but also are the primary determinants of surface current direction. Therefore the question is whether surface wind circulation for the period differed significantly from present conditions.

According to Clarke's (1989:44) summary of weather patterns in the area today, the Caribbean lies within the wind belt known as the Northeast Trades. With the exception of disturbances from tropical cyclones, the weather is quite stable. The prevailing winds are easterly and usually steadiest in the south of the region during the period between December and May. Summer and fall are warmer and more humid than winter and spring. Cloud cover and rainfall increase, as does thunderstorm activity, and winds are often lighter and more variable. Tropical cyclones are most likely in summer and fall. The northern limit of the Northeast Trades is 28° N lat. and is reached between July and September. At this time, the strongest and steadiest winds pass through the middle of the region; near the northern limit they tend to be more variable. The limit shifts south to about 24° N between February and April. On average the winds blow 11–15 knots from the east-northeast. The northern Lesser Antilles experience the steadiest winds in the summer months; for the more southern islands and the coast of South America winds are steadiest in winter because of the southern shift of the central portion of the trade wind belt. The Bahamas are geographically outside of the Caribbean region but during the Ceramic Age were culturally within it. The northern Bahamas, north of 24° N, are beyond the trade winds in winter, and at this time they experience lighter winds that are more variable in direction and occasional strong winds from the north. The wind shifts east to southeast in the summer with the return of the trades.

Hodell et al. (1991) present a high-resolution reconstruction of the Caribbean climate for the past 10,500 years based on $^{18}O/^{16}O$ ratios in ostracod shells from Haiti's Lake Miragoane. Variation in the ratios reflects changes in precipitation for the period. From about 2,400 B.P. to 1,500 B.P. the $^{18}O/^{16}O$ values and variation are very similar to those for the past 900 years (1991:fig. 2). The

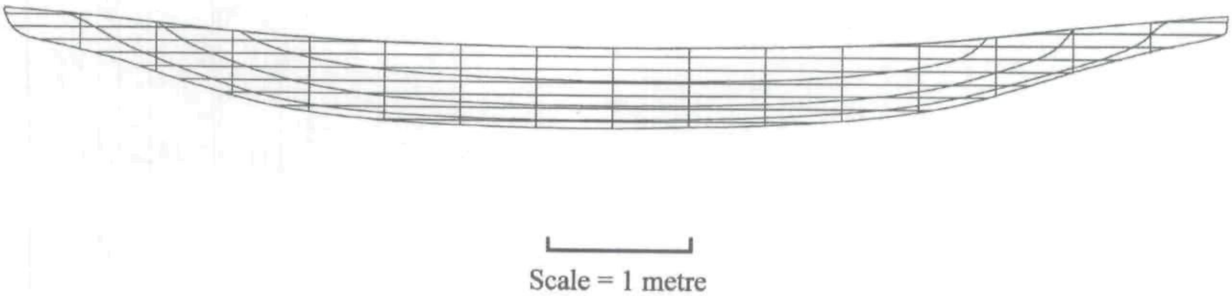

FIG. 2. *The Stargate canoe, South Andros Island, Bahamas.*

values indicate a drying trend for both periods (p. 792). For the intervening years from 1,500 to 900 B.P. the values indicate a brief wetter period but one not as wet as the early to mid-Holocene. While there is variation in rainfall for the period of interest here, 500 to 2,500 B.P., it does not approach the overall variation for the past 10,500 years. Hodell et al. note the correlation between precipitation anomalies and variation in the annual climatic cycle in the Caribbean region discussed above: "Enhancement of the annual cycle led to years of anomalously high precipitation, whereas a reduction led to a deficient rainy season" (p. 792). Thus reconstruction of variation in precipitation should be an accurate indicator of variation in the annual cycle.

The annual cycle is controlled by the summer displacement of the North Atlantic subtropical high by the northward movement of the Intertropical Convergence Zone and the reverse movement in winter. Hodell et al. compared their data with the changes in annual cycle intensity estimated from the seasonal insolation difference at the top of the atmosphere at 10° N between August and February and found the changes in the two records for their 10,500-year period to be similar. This reinforces the conclusion that while variations from present climatic conditions including surface wind patterns existed during the Caribbean Ceramic Age, they were not substantial. It also suggests a major mechanism for variation in both precipitation and the annual cycle in the form of "orbitally forced (Milankovitch) variations in solar insolation" (p. 792).

The field on which the simulation program operates is the Caribbean Sea, the Gulf of Mexico, and the surrounding mainland (U.S. Navy 1995). The area is divided into two-degree Marsden squares (two degrees of latitude by two degrees of longitude), with each square containing wind and current vectors as they have been recorded to occur for a particular month of the year. A separate field is used for each month. Any starting position can be chosen on the field. Positions 20 or 30 nautical miles off the coast were chosen in order to prevent all vessels from simply returning to the nearest coast.

The operator chooses a watercraft type and indicates its initial position. For each vessel type there are data on the speed that it can be paddled and the effect on it of various wind speeds. Vessels can be allowed either to drift before the wind or to be paddled in a specific direction. Each two-degree Marsden square contains eight wind vectors (cardinal and intercardinal points) and the percentage of the total number of observations in which the wind has blown from each direction. The percentage of observations in which calms are recorded is also given. The wind direction is chosen randomly by the program but is weighted to reflect actual observations. The effect of the chosen wind on a particular vessel is then added to the current vector for each two-degree square and the new position is calculated. If vessels are paddled in a specific direction, this needs to be added to the other vectors in order to obtain the new position. The duration over which the vectors affect the vessel between positions is 24 hours, following Levison, Ward, and Webb (1973:24–25). The procedure is repeated until the vessel either reaches an island (or any area designated as a success) or is forced back to the mainland (or off the field). Up to 1,000 runs from the same start can be simulated at a time.

Two questions were asked of the simulation. The first question was how likely it was that the Saladoid peoples from South America would have discovered the Antilles by chance. Each of the two canoes was placed at different points along a 600-nautical-mile staging area off the coast of northern South America, and the simulation was run on the assumption that the vessels were allowed to drift. Although this may not seem a likely response to being lost at sea, it has the advantage of allowing the vessel to cover the maximum distance without expenditure of energy. In a storm situation there is often no other rational option. The simulation was run under weather conditions for each of four months—January, April, July, and October. The percentages of successful chance discoveries of the islands ranged from 0.3% under April conditions to 0.1% under October conditions. The higher success rates for April conditions have some sig-

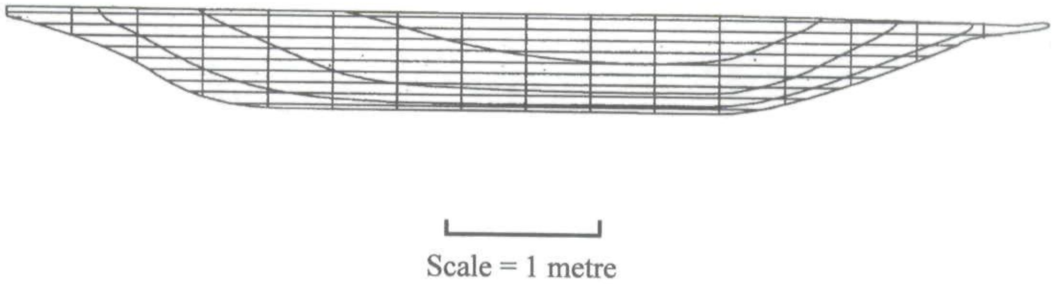

FIG. 3. *A platform-style canoe found widely around the Caribbean mainland and historically recorded in the islands.*

nificance in that April is the only month in which no hurricanes have ever been recorded (Clarke 1989:50).

Work in Polynesia has provided a means of estimating risk to the crew. Risk is determined by length of time at sea. Lengthy drift voyages in open boats due to shipwreck or other misfortune are well known for the Pacific Ocean under conditions similar to those of the Caribbean. The maximum recorded drift seems to be on the order of seven to eight months. Several recorded voyages covered distances of ca. 3,000 miles over a period of six to ten weeks, and a great number covered shorter distances (Howay 1944). Levison, Ward, and Webb (1973: 21) used the survival probabilities presented by McCance et al. (1956), based on 27,000 persons lost at sea, to represent the cumulative percentage of crew losses. From this I estimate that a successful drift voyage from the South American coast taking four to five weeks would have involved a probable crew loss of 10% to 12%—meaning that one or two crew members out of a total of eight to ten can be expected to have died en route.

A slight difference in the success rates of the two vessels is attributable to the difference in the effects of the wind on their different shapes. There was little difference in the success rates from various points along the coast. Although success rates were low, given the long stretch of coast from which success is possible and the long history of coastal adaptations in the region it seems probable that such drift voyages occurred.

Chance discovery of Grenada from a position off the north coast of Trinidad is not indicated by the simulation. The water gap between the continental islands of Trinidad/Tobago and Grenada is the only gap along the Lesser Antilles that cannot be seen across. It is possible, however, for an observer to see Trinidad and Grenada, Tobago and Grenada, or even all three islands from positions at sea. For Trinidad and Grenada there is a 25-nautical-mile overlap in their sighting distances, and for Tobago and Grenada there is a 15-nautical-mile overlap. There is also a 15-by-25-nautical-mile triangular area at sea from which all three islands can be observed given reasonable visibility. It at first appears that someone intentionally exploring for new land would not have had to leave sight of home (Trinidad or Tobago) in order to sight Grenada. However, for intentional discovery of Grenada from Trinidad explorers in a canoe would have had to steer a bearing considerably to the east of the target, and this would have virtually prevented their passing through the areas of mutual interisland visibility. Chance discovery still does not appear likely, as the areas of mutual visibility are relatively small and not on the drift voyage paths.

Another possibility for detecting Grenada from Trinidad or Tobago is the use of clouds as land indicators. Stationary cumulus clouds can form over high islands such as Grenada and indicate their location. Burch (1986: 197) states that stationary cumulus clouds form at all latitudes but may be obscured by lower clouds. Such clouds when developed into cumulonimbus clouds can reach heights of more than 50,000 feet in the tropics (Admiralty Hydrographic Department 1941:50). Even a stationary cloud with an upper height of 7,300 feet would make Grenada detectable from the coast of Trinidad. The question remains whether the first Ceramic Age explorers would have had the opportunity to learn about this effect in their initial forays north, particularly as such clouds are most useful for navigation before midday (Burch 1986:197). Further, these explorers would still have had to become familiar with the wind and current patterns to steer the correct bearing.

The majority of the earliest Early Ceramic Age dates are north of the Guadeloupe Passage, the Fond Brulé site on Martinique being the only exception (Haviser 1997). Although the pattern may be a sampling bias, it does fit with a chance discovery of the Greater Antilles and Northern Lesser Antilles before the islands of the Southern Lesser Antilles. This raises the possibility that the settlement of the islands by Saladoid peoples was not a simple south-to-north progression.

The second question was whether movement along the island chain was so constrained by technology and the environment that it had to be conducted in "stepping-stone" fashion or whether travel between the South American mainland and the northern islands was possible. To investigate this question the two canoes were again placed along the staging area off the north coast of South America with weather conditions for January, April, July, and October. Now, rather than being allowed to drift, the canoes were paddled by their occupants (eight per canoe) in shifts of four, eight hours at a time. The speeds used were calculated from tests in the field, naval architecture programs (Callaghan 1999), and the human-endurance data provided by Horvath and Finney (1976). With regard to navigation skill the only assumption was that the occupants directed the canoe northward. Success in this series of experiments was defined by simply reaching the islands of the Greater Antilles from the same mainland area as in the previous series of experiments. A range of paddled speeds from 3.4 knots to 2.0 knots was employed. All voyages were successful under these stipulations, with only slight variations of landing sites despite variation of speed. Vessels ended up variously in an area from eastern Puerto Rico to western Hispaniola within five to six days. For intentional voyages from all areas the probability of crew loss was less than 1%, which does not translate into a fatality. Return voyages from north to south did not indicate any significant differences; in both directions winds and currents are moving across the path of the vessels.

Applying the results presented here to the Saladoid period, it appears likely that direct crossings of the Caribbean Sea were undertaken either between the mainland and islands like Puerto Rico or between any islands of the Lesser Antilles not adjacent to one another. Once the locations of the Greater Antilles were known, direct contact was possible between the Venezuelan mainland and islands such as Puerto Rico as some researchers have suggested (Chanlatte Baik and Narganes Stordes 1989, Rodríguez and Rivera 1991, Zucchi 1984). Movement within the Lesser Antilles need not have followed a stepping-stone-like pattern. Only modest navigation skill would have been required, and even moderate-sized canoes could have made a direct crossing in five to six days.

A direct route between Venezuela and Puerto Rico may not at first seem advantageous. It would, however, have been only about two-thirds the distance involved in following the curve of the Lesser Antilles island chain. Moreover, the channels between the Lesser Antilles often have currents of 3 knots, and therefore voyagers following the Lesser Antilles would have encountered crosscurrents three to four times the strength of those encountered in a direct crossing. The bottleneck effect on waves that had built up while crossing the Atlantic would also have made crossing the channels less desirable for small vessels than passing to the west (Stone and Hays 1991:224). Finally, the deep valleys and high land of some of the Lesser Antilles, for example, Dominica, produce heavy squalls that are a danger to vessels (Defense Mapping Agency 1985:152).

Another factor in direct crossing between the mainland and Puerto Rico or Hispaniola that should be noted is the formation of altocumulus lenticularis or mountain wave clouds (Burch 1986:197) on the south coast of Puerto Rico. These are highly distinctive, sharply defined lenticular clouds that form when moist air passes over mountains (Admiralty Hydrographic Department 1941: 230). Cumulus clouds form on the mountaintops, and lenticular clouds break off and drift out to sea. As the northeast winds pass over islands like Puerto Rico these clouds move southward into the Caribbean. They can maintain their very distinctive shape for long distances, and I have observed them 240 nautical miles from the mountain ranges that formed them. Under these conditions voyagers would have had a clear indication of land for half of the distance from Venezuela to Puerto Rico.

Overall, a direct route would have been shorter, safer, and easier than a route along the Lesser Antilles. If voyages were made in April, there would have been little danger of encountering tropical storms in the open sea. The expected loss of crew over a five-to-six-day period would have been less than 1%. Finally, for the Taíno toward the end of the prehistoric period a direct route may have had the advantage of avoiding islands of the Lesser Antilles occupied by the reputedly hostile Island Caribs. Neither the environment nor the available seafaring technology would have forced people to travel along any particular route. Any pattern that may emerge from the analysis of lapidary materials (see, e.g., Ball 1941; Chanlatte Baik 1983; Cody 1991*a*, *b*, *c*; Rodríguez 1991; Watters and Scaglion 1994; Watters 1997; Murphy et al. 2000) will be due to social, political, and economic factors.

References Cited

ADMIRALTY HYDROGRAPHIC DEPARTMENT. 1941. *Admiralty weather manual.* London: H.M. Stationery Office.

BALL, S. H. 1941. The mining of gems and ornamental stones by American Indians. *Smithsonian Institution, Bureau of American Ethnology Bulletin 128, Anthropological Papers* 13: 1–77.

BURCH, DAVID. 1986. *Emergency navigation.* Camden: International Marine.

CALLAGHAN, R. T. 1993. "Passages to the Greater Antilles: An analysis of watercraft and the marine environment," in *Proceedings of the Fourteenth Congress of the International Association for Caribbean Archaeology, Christ Church, Barbados, 1991.* Edited by A. Cummins and P. King, pp. 33–39. Martinique.

———. 1999. Computer simulations of ancient voyaging. *The Northern Mariner/Le Marin du nord* 9(2):11–22.

CALLAGHAN, R. T., AND STEPHANIE J. SCHWABE. n.d. "Watercraft of the islands," in *Proceedings of the Eighteenth International Congress for Caribbean Archaeology, Grenada, 1999.* In press.

CHANLATTE BAIK, L. A. 1983. *Catálogo arqueológica de Vieques.* Río Piedras: Museo de Antropologia, Historia y Arte, Universidad de Puerto Rico.

CHANLATTE BAIK, L. A., AND Y. M. NARGANES STORDE. 1989. La nueva arqueología de Puerto Rico (Su proyección en Las Antilles). *Museo del Hombre Dominicano Boletín* 16 (22): 9–63.

CLARKE, JAMES. 1989. *Atlantic pilot atlas.* Camden: International Marine.

CODY, A. K. 1991*a*. *Prehistoric patterns of exchange in the Lesser Antilles: Materials, models, and preliminary observations.* Ann Arbor: UMI.

———. 1991*b*. "Distribution of exotic stone artifacts through the Lesser Antilles: Their implications for prehistoric interaction and exchange," in *Proceedings of the Fourteenth Congress of the International Association for Caribbean Archaeology, Barbados, 1991*. Edited by A. Cummins and P. King, pp. 204–26.

———. 1991*c*. "From the site of Pearls, Grenada: Exotic lithics and radiocarbon dates," in *Proceedings of the Thirteenth Congress of the International Association for Caribbean Archaeology, Curaçao, 1990*. Edited by E. N. Ayubi and J. B. Haviser, pp. 589–604. Reports of the Archaeological-Anthropological Institute of the Netherlands Antilles 9.

DEFENSE MAPPING AGENCY HYDROGRAPHIC/TOPOGRAPHIC CENTER. 1985. *Sailing directions for the Caribbean Sea.* Vol. 1. Washington, D.C.

FUSON, ROBERT H. 1987. *The log of Christopher Columbus.* Camden: International Marine.

HAVISER, J. B. 1997. "Settlement strategies in the Early Ceramic Age," in *The indigenous people of the Caribbean.* Edited by Samuel M. Wilson, pp. 57–69. Gainseville: University of Florida Press.

HODELL, DAVID A., JASON H. CURTIS, GLEN A. JONES, ANTONIA HIGUERA-GUNDY, MARK BRENNER, MICHAEL W. BINFORD, AND KATHLEEN T. DORSEY. 1991. Reconstruction of Caribbean climate change over the past 10,500 years. *Nature* 352:790–93.

HORVATH, S. M., AND B. R. FINNEY. 1976. "Paddling experiments and the question of Polynesian voyaging," in *Polynesian navigation and voyaging.* Edited by Ben R. Finney, pp. 47–54. Polynesian Society Memoir 39.

HOWAY, F. W. 1944. Some lengthy open-boat voyages in the Pacific Ocean. *American Neptune* 4:53–57.

IRWIN, GEOFFREY. 1989. Against, across, and down the wind. *Journal of the Polynesian Society* 98:167–206.

———. 1990. Human colonization and change in the remote Pacific. CURRENT ANTHROPOLOGY 31:90–94.

———. 1992. *The prehistoric exploration and colonization of the Pacific.* Cambridge: Cambridge University Press.

IRWIN, GEOFFREY, S. BICKLER, AND P. QUIRKE. 1990. Voyaging by canoe and computer. *Antiquity* 64:35–50.

LEVISON, M., R. G. WARD, AND J. W. WEBB. 1973. *The settlement of Polynesia: A computer simulation.* Minneapolis: University of Minnesota Press.

MC CANCE, R. A., C. C. UNGLEY, J. W. L. CROSFILL, AND E. M. WIDDOWSON. 1956. *The hazards to men lost at sea, 1940–44.* Medical Research Council [London] Special Report 291.

MURPHY, A. REG, DAVID J. HOZJAN, CHRISTY N. DE MILLE, AND ALFRED A. LEVINSON. 2000. Pre-Columbian gems and ornamental materials from Antigua, West Indies. *Gems and Gemology* 36:234–45.

RODRÍGUEZ, M. 1991. "Early trade networks in the Caribbean," in *Proceedings of the Fourteenth Congress of the International Association for Caribbean Archaeology.* Edited by Alissandra Cummins and Philippa King, pp. 306–14. St. Ann's Garrison: Barbados Museum and Historical Society.

RODRÍGUEZ, M., AND V. RIVERA. 1991. "Puerto Rico and the Caribbean Pre-Saladoid 'crosshatch connection,'" in *Proceedings of the Twelfth Congress of the International Association for Caribbean Archaeology.* Edited by Linda Sickler Robinson, pp. 45–51. Martinique.

ROUSE, I. 1986. *Migrations in prehistory: Inferring population movement from cultural remains.* New Haven: Yale University Press.

———. 1992. *The Tainos.* New Haven: Yale University Press.

STONE, WILLIAM T., AND ANNE M. HAYS. 1991. *A cruising guide to the Caribbean.* New York: Putnam.

U.S. NAVY. 1995. *Marine climatic atlas of the world.* Asheville: National Climatic Data Center.

WATTERS, D. R. 1997. "Maritime trade in the prehistoric Eastern Caribbean," in *The indigenous people of the Caribbean.* Edited by Samuel M. Wilson, pp. 88–99. Gainseville: University Press of Florida.

WATTERS, D. R., AND R. SCAGLION. 1994. Beads and pendants from Trants, Montserrat: Implications for the prehistoric lapidary industry of the Caribbean. *Annals of Carnegie Museum* 63:215–37.

ZUCCHI, A. 1984. "Nueva evidencia sobre la penetracíon de groupos Cerámicos a las Antillas Mayores," in *Relaciones prehispánicas de Venezuela.* Edited by Erika Wagner, pp. 35–50. Caracas: Acta Cientifíca Venozolana.