R. V. Heraclitus: Scientific Collaborations, Accomplishments and Publications

The Institute of Ecotechnics

The RVH was built by members of the Institute of Ecotechnics (IE) in 1975-76 in Oakland, California. IE is an organization founded in 1973 which works on the harmonious integration of technics and ecology (www.ecotechnics.edu). IE has two branches with the same organization and sets of directors and operates as a U.S. non-profit organization and a U.K. charity organization.

The Institute consults to a series of biomic demonstration field projects. These include:

Synergia Ranch, a 130 acre (50 ha) property in semi-arid temperate grassland in New Mexico (www.synergiaranch.com) begun in 1969.

Birdwood Downs, a 1700 acre (680 ha) property in the tropical savannah biome in the Kimberley region of northwest Western Australia (www.birdwooddowns.com) which started in 1978.

The Les Marronniers a 17 acre (7 ha) organic farm and conference center, just outside Aix-en-Provence, France in the Mediterranean biome.

The October Gallery in the anthropogenic world city biome in London, begun in 1978 (www.octobergallery.uk.com).

Las Casas de la Selva, a 1000 acre (400 ha) sustainable timber project in the tropical forest of Puerto Rico (www.eyeontherainforest.org) begun in 1983.

IE's most high-profile project was serving as overall scientific consultant to the Biosphere 2 experiment, which pioneered a new type of laboratory for studying the gobal ecology and testing sustainable methods of integrating people, technics, farming within a diversity of mini-biomes (www.biospherics.com).

Since 1973, I.E. has organized and hosted some 25 international conferences bringing together cutting-edge scientists, artists, thinkers, managers and explorers from a wide variety of cultures and disciplines to consider topics of broad global concern.

The Institute was motivated to build the RVH since the Earth is 2/3 water and sea-peoples and cultures have been a crucial element in global ecology and historical development.

All the I.E. consulted projects emphasize an approach where people of all backgrounds can engage in “hands-on”, real-time projects on the ecological frontiers where emerging solutions can be found and where conventional approaches have generally failed.

The RVH is now owned and operated by Ecotechnics Maritime, a UK limited company.

Research history of the RVH

The Resarch Vessel Heraclitus (RVH) enables scientific exploration at a fraction of the cost of conventional research vessels. This is due in part because the RVH crew participates in the exploration science activities, learning whatever is necessary to contribute to the scientific work. Other contributing factors to its far lower operating costs are that a portion of the crew are volunteers and the ship uses its sails, rather than engines, whenever possible.

The following pages provide a brief overview of the ship’s research, collaborations, achievements and publications

1. Meteorological Observations

Beginning in 1978 before the first Atlantic Ocean crossing by the RVH, the ship signed a cooperative agreement with the National Oceanographic and Atmospheric Agency (NOAA) to collect weather, wind, cloud, temperature and rainfall data during its voyages. These data added to the information available through land-based weather stations and were especially valuable in that the RVH often sailed through seldom visited seas and docked at quite remote locations around the world.

2. Amazon Expedition, 1980-1982

Prof. Richard Evans Schultes of Harvard University at the I.E. Jungle Conference held in 1979 in Penang, Malayasia urged the R.V. Heraclitus (RVH) to go to the Amazon to continue the exploration of its wealth of plant resources and native knowledge of how to use the plants. Prof. Schultes is considered the father of modern ethnobotany and one of the world’s experts on Amazonia flora.

Prof. Laurent Rivier, Department of Plant Biology and Physiology, University of Lausanne, Switzerland and Prof. Bo Holmstedt, Professor of Toxicology at the Karolinska Institute, Sweden,. helped design and outfit the phytochemical laboratory aboard RVH while it was in Marseille, France on its way to the Amazon so that fresh plant samples and extracts could be tested for phytochemical activity.

Figure 1. Expedition Chief, Captain Robert Hahn in the on-board phytochemical laboratory during the Amazon Expedition.

During the expedition, ethnobotanists Dr. Wade Davis, Harvard University (now Explorer in Residence at the National Geographical Society), Terrence McKenna and Dr. Dennis McKenna, senior research scientist for the Natural Health Products Research Group at the British Columbia Institute of Technology (Canada) joined the RVH for studies of plant medicines and cultures. Dennis McKenna was then a Ph.D. student and included this Amazon work in his dissertation.

The Heraclitus crew collected approximately 350 plant species of ethnobotanical interest, and made approximately 1500 voucher specimens. Plant specimens collected during the expedition were donated to the herbaria of the University of Peru in Iquitos and Lima, the Missouri Botanical Garden (St. Louis, Missouri), the New York Botanical Garden, the Royal Botanical Gardens at Kew (U.K.) and the Institute of Ecotechnics herbarium (now donated to the Southern Cross University (Australia). A complete set of expedition plant voucher specimens were deposited in the Missouri Botanical Garden herbarium and added several new species to the Flora of Peru.

In 2014, the Institute of Ecotechnics Amazon collections located at the Ecotechnics project in Western Australia were moved to Southern Cross University (SCU) in Australia. The Ecotechnics collections are now available to researchers world-wide as part of the SCU online data base. Those Ecotechnics herbarium collections include 287 Peruvian species and Colombian collections of 11 species collected by Ecotechnics staff Tredwell and Hahn, and the plants

collected by two noted ethnobotanists who participated in the RVH Expedition: 118 species from Dr. Wade Davis and 101 species from Dr. Dennis McKenna.

Figure 2. Robyn Treadwell (right), Head of Plant Collections, and another crew member preparing plant voucher specimens in plant presses aboard the RV Heraclitus during the Amazon Expedition.

3. Ancient Boat-building cultures and techniques

During the early 1980s, RVH and the Institute of Ecotechnics arranged the collaboration of Dr. Balkrishna Tejam, University of Bombay, on Thor Heyerdahl's study of the expansion of the Middle Eastern reed boat culture to the Andaman Islands and other Indian ship-building centers. Ancient shipbuilding materials and techniques are still practiced in these islands off of India. These studies added to Heyerdahl's ground-breaking studies of the ancient sea-peoples and their roles in the interconnection and expansion of humans around the world.

Dr. Tejam and other colleagues at the University of Bombay operated a regional base of the Institute of Ecotechnics in India for a decade working on issues such as water and marine pollution and clean-up techniques.

4. The Around the Tropic World Expedition (ATWE), 1983-1986: Ocean Microbial Diversity

The Heraclitus collected ocean samples for Prof. Clair Folsome of the University of Hawaii, Manoa, during the Around the Tropical World expedition from 1983 to 1986 and the Circumnavigation of South America expedition to determine microbial biodiversity in marine

ecosystems. Prof. Folsome was one of the pioneers of materially closed ecospheres and a renowned microbiologist.

On this expedition there were also research studies into tropical architecture, botanical collections of medicinal plants and numerous diving expeditions on the Great Barrier Reef, in the Red Sea and throughout the Indian Ocean looking at ocean health and biodiversity.

A collaboration with Dr. Robert Raffauf, one of the foremost ethnopharmacological chemists in the world, at Northeastern University, Boston, MA, and a close colleague of Prof. Richard E. Schultes resulted in a next generation field kit for phytochemical analysis. Robert Hahn, Expedition Chief of the RVH during the ATWE contributed practical experience gained during the Amazon expedition's phytochemical laboratory in the development of the next test kit.

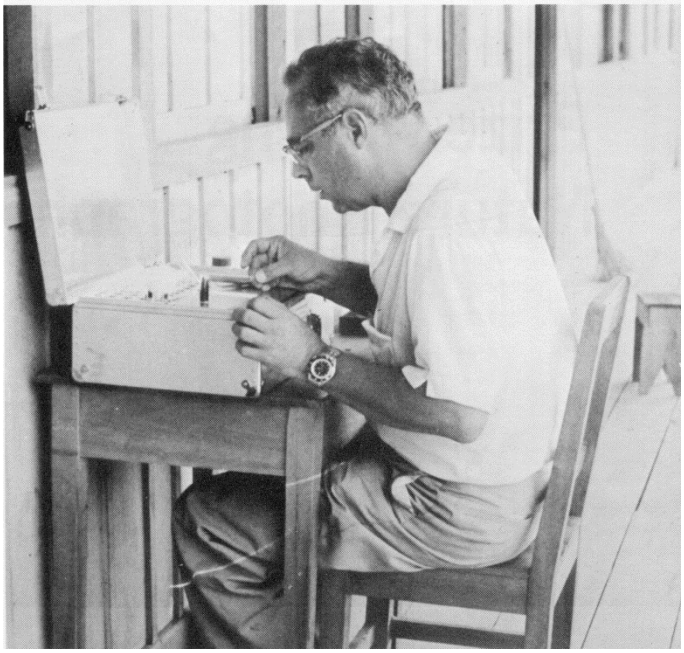

Figure 3. Dr. Robert Raffauf, Northeastern University, with the new field kit for testing phyto-activity in plants developed for the RVH Round the Tropic World Expedition.

5. Later RVH Expedition Plant collections

Plant samples from the Amazon expedition and from other voyages including specimens from the Peruvian and Colombian Amazon, as well as from Samoa, Vanuatu, New Zealand, Galapagos, Panama, Puerto Rico and Australia were curated by Robyn Treadwell, a Director of the Institute of Ecotechnics and housed in an herbarium at the Birdwood Downs project of the Institute in the Kimberley of West Australia. After Robyn's death in 2012, the herbarium collection was donated to the Medicinal Plant Herbarium at the Southern Cross University, in New South Wales, Australia.

6. Whale migration studies

In Sri Lanka during the Around the Tropic World expedition, studies of whale migration were carried out with Dr. Roger Payne of the World Wildlife Foundation, Abigail Alling (now with Biosphere Foundation) and local Sri Lankan scientists using the RVH.

7. The First Captive Dolphin Release to the Wild

In 1987 the RVH provided logistical and scientific support for a ground-breaking project of the Oceanic Research and Communication Alliance to re-introduce two captive dolphins to the wild. This was the first time that such a complex feat of reverse training had ever been undertaken with the full support of all relevant State and Federal authorities. The two Atlantic bottle-nose dolphins, 'Joe' and 'Rosie', had been captured five years previously for the neurophysiologist and cetacean specialist, John Lilly, MD, who had used the dolphins in his JANUS project (Joint Analogue and Numeric Understanding System), a series of experiments investigating dolphin to human communication using advanced signaling processors.

Joe and Rosie interacted and became familiar with a local pod of dolphins from within the safety of their oceanic pen, designed and constructed by the RVH crew, and were taught to catch their own fish again, and to fend for themselves. Both dolphins quickly regained fitness and were allowed to leave of their own free will. Dr. Rick Barry, famed for his work with dolphins during the TV show, My Friend Flicka, assisted with the dolphins. The two dolphins were later spotted caring for a new-born underscoring the success of their release. This project was the subject of a National Geographic film.

8. Circumnavigation of South America expedition (1987-1989)

Whale Population Genetic Studies

In collaboration with Dr. Steve O'Brien of the International Whaling Commission and the National Cancer Research Institute, genetic studies of Atlantic and Pacific whale populations were carried out. Tiny skin samples from behind the whales' dorsal fins were obtained from the ship's inflatable boats. The darts attached by cord to the crossbow were reeled back. Samples were stored in ship's freezer for genetic analysis to determine whether the two whale populations were distinct or interconnected.

During this three year expedition, the ship carried out a wild dolphin population survey. Other research included the continuing collaboration with NOAA (National Oceanographic and Atmospheric Administration) with the ship sending in weather reports from places which lacked meteorological stations to NOAA. Recording of humpback and sperm whale songs was done off of Ecuador.

9. Supporting Research for the Biosphere 2 Project (1988-1991)

Biospherian Crew Training

Part of the training for the crews of biospherians included stints aboard the RVH, giving invaluable experience in small group, real-time cooperation in challenging circumstances in tropical conditions.

Coral Reef Collections

The RVH collected hundreds of coral reef specimens and other marine life along the Yucatan coast of Mexico which helped create the biodiverse million gallon (four million litre) oceanic biome with living coral reef inside Biosphere 2. This remains the largest man-made coral reef ever made.

Biosphere 2 Coral Reef and Ocean Research

During the two year closed system experiment of "Mission One" (1991-1993) the coral reef of Biosphere 2 became one of the most scientifically studied reefs in history because, for the first time, the interactions between the atmosphere and the coral reef could be precisely measured and monitored. Working with Dr. Chris Langley of the Scripps Institution of Oceanography, Prof. Supriya Chakrabarti at Boston University, and Prof. Phil Dustan of the College of Charleston, new remote sensing protocols were developed for remote sensing of Biosphere 2's coral reef using digital video cameras along selected transect lines to map the changes in health and vitality of the Biosphere 2 ecosystem. Drs. Robert Howarth and Roxanne Marino of Cornell University did marine chemistry studies of the Biosphere 2 ocean. In a survey after the end of the two-year closure experiment, Dr. Judy Lang of the Texas Memorial Museum documented 89 new coral species that formed while in the Biosphere 2 ocean coral reef. Dr. Don Spoon of Georgetown University investigated marine microbiota and discovered a species new to science in the Biosphere 2 ocean.

Later in the 1990s when Columbia University was managing Biosphere 2, seminal studies of the coral reef ecosystem were conducted. A series of papers on the impacts of elevated atmospheric CO2 and acidification of the Biosphere 2 ocean showed the devastating impact on coral reefs that will result from continued global climate change. Frank Press, former president of the National Academy of Sciences, described these interactions between atmosphere and ocean, taking advantage of the highly controllable mesocosm of Biosphere 2, as the "first unequivocal experimental confirmation of the human impact on the planet" (William C. Harris and Lisa J. Graumlich, "Biosphere 2: sustainable research for a sustainable planet", http://www.columbia.edu/cu/21stC/issue-4.1/harris.html)

10. Marsh studies

While based in Belize in the first part of the 1990s, the RVH conducted studies of coral reefs and marsh ecosystems. Its crew also aided Dr. Matt Finn, Georgetown University, in his dissertation research comparing phenology and ecology of the marsh biome in Biosphere 2 and the sites in the Florida Everglades where the plants, soils and other biota were collected by assisting in leaf litter studies.

Other studies included the offshore islands of Belize, expeditions to Lighthouse and Glovers Reefs, coral reef transects around Turneffe Atoll. Significant work was also done in collaboration with the Belize Fisheries Department.

11. Marine Bioluminescence

Dr. Josef Gitelson, Director of the Institute of Biophysics, Siberian Branch of the Russian Academy of Sciences, sailed with the RVH studying marine bioluminescence while the ship was based in Belize from 1990-1995.

12. Coral Reef Mapping and Health Studies (1996-2008)

The RV Heraclitus was leased for no-fee to the Planetary Coral Reef Foundation (a Division of the Biosphere Foundation) to facilitate studies of coral reefs in some of the world's least studied tropical oceanic regions. Working together, the research program pioneered the use of these same cutting-edge methods to monitor the health and vitality of coral reefs for over a decade during a series of coral reef expeditions of the ship from 1996-2006 in the Pacific and Indian Oceans. The RVH was the first Western ship to study the coral reefs off of Vietnam since the war, in collaboration of the Oceanographic Institute of the University of Nha Trang.

Indian Ocean / Red Sea	Date studied	**South East Asia**	Date Studied	**Melanesia and Australia**	Date Studied
Egypt - Hurgada	December 1995	Thailand - Ko_Phiphi	October 2001	Papua New Guinea - Milne Bay Region	March 2006
Oman - Daymaniyat	June 1996	Indonesia - Karang Kapot	January 2002	Australia - Low Isles	June 2006
Maldives - Addu_Atoll	December 1996	**Melanesia and Australia**		Australia - Lizard Island	July 2006
Seychelles - St Josephs	February 1997	Solomon Islands- Sagharughombe	June 2000	**East Pacific**	
Kenya - Kilifi	April 1997	Papua New	August	Mexico - Isla	March 2004

		Guinea - Kavieng	2000	Socorro	
South East Asia		Papua New Guinea - Kavieng	April 2002	**Polynesia**	
Indonesia - Enggano	January 1998	Solomon Islands- Sagharughombe	September 2002	French Polynesia - Rangiroa Atoll	May 2004
Indonesia - Lembongan	March 1998	Papua New Guinea - Kitava	January 2003	French Polynesia - Tahaa Island	June 2004
Indonesia - Banggai	December 1998	Fiji - Great Astrolabe Reef, Kadavu	May - June 2005	French Polynesia - Bora Bora Island	July 2004
Indonesia - Togian	February 1999	Fiji - Namena	June - July 2005	Cook Islands - Rarotonga Island	August 2004
Vietnam - Nha Trang	August 1999	Fiji - Mamanuka Group	July 2005	Cook Islands - Aitutaki Atoll	September 2004
Indonesia - Wakatobi	October 1999	Vanuatu - Eretoka (Hat) Island	August 2005	Tokelau - Atafu Atoll	September 2004
Indonesia - Lembongan	December 1999	Vanuatu - Maskelyne Islands	October 2005	Phoenix Islands	November - December 2004
Philippines - Starfish	December 2000	Vanuatu - Uri Island	November 2005	Tuvalu - Nukufetau Atoll	January - March 2005
Malaysia - Renggis	May 2001	Solomon Islands - Sagharughombe	January 2006		

Table 1. Coral reef study sites visited by PCRF/RVH (source: http://pcrf.org/science/sitelist.html)

Some of the findings were extremely surprising and alarming. For example, the Phoenix islands' coral reef communities had been cited as in extremely good health, an exemplar of a very remote from modern civilization pristine reef, just a few years before the RVH arrived to do its ecological survey. The expedition discovered a virtually completely devastated coral reef, probably due to a hotspot (with temperatures far higher than those in adjacent areas) caused by global warming. This finding was a grim forecast of what may lay ahead for coral reefs considered safely distant from other causes of degradation unless global climate change trends are changed.

A map produced by PCRF summarizing the findings of their extensive surveys, showed a majority of these oceans' reefs to be in danger, with greater than 50 threat. For more information on the methodologies used and results see http://www.science.pcrf.org

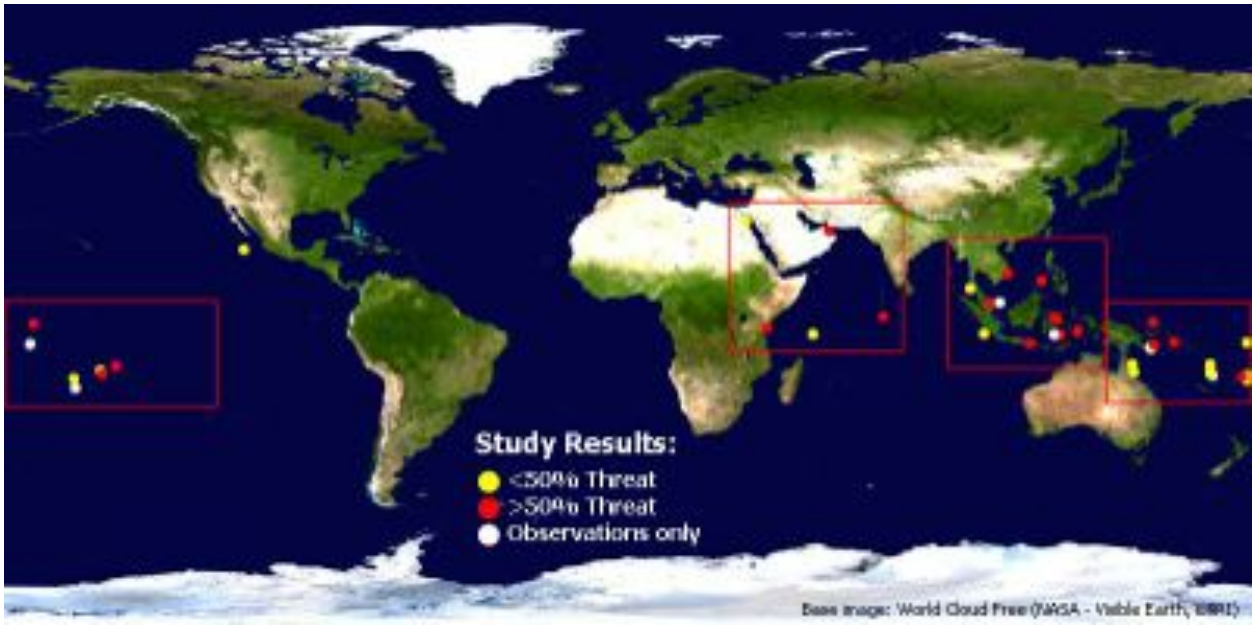

Figure 4. Summary chart of the coral reef findings arranged by reefs with more or less than half the coral colonies threatened (Source: http://pcrf.org/science/index.php).

13. Paleoclimate research relevant to global warming issues using coral reef cores

During their stay in the Maldives the crew cored corals and conducted depth sounding of submerged coral reefs for off the northernmost island of the Maldives contributing to the research on long-term studies of past climates of Dr. Richard Fairbanks (Lamont-Dougherty Earth Observatory, Columbia University) and Chris Charles (Scripps Institution of Oceanography). These cores and others collected during the coral reef expeditions of PCRF/RVH provided information about climatic conditions and insights into patterns of climate change useful for global warming studies.

Coring was done at a number of other sites during the ten-year coral reef expeditions. In particular, such cores help understand the natural variability of the southwest El Nino and Monsoon climate systems, the thermal stability of the ocean's warm pools, and the hydrologic cycle. The coral coring of living and ancient submerged reefs also provides information on sea surface temperature and rainfall from past centuries.

14. “Wastewater Gardens”: Ecological systems for treating and recycling human waste

The development of “Wastewater Gardens” were originally inspired by concerns about protecting coastal marine environments, especially coral reefs, from eutrophication damage caused by the discharge of inadequately processed nutrient-rich human waste. Since the RVH

had collected the corals for Biosphere 2 off of Akumal, Quintana Roo, Mexico along the Yucatan coast, PCRF obtained grants which permitted the constructed of the first two WWG systems in 1997 as a demonstration of a low-cost and biodiverse approach to making constructed wetlands which could protect off-shore reefs from sewage pollution. WWGs evolved from the constructed wetlands that were used in Biosphere 2 for treating and re-using all the facility's wastewater. Mark Nelson, Chairman of the Institute of Ecotechnics and a former biospherian, used these systems for his dissertation research, working with the eminent systems ecologist Prof. H.T. Odum at the University of Florida.

In the succeeding decade and a half, over 150 WWG systems were implemented and researched in eleven countries worldwide: Mexico, Belize, Bali & Sulawesi, Indonesia, Queensland and West Australia, Australia, New Zealand, France, Spain, Portugal, Poland, the Bahamas, the Philippines, Algeria and the United States.

Figure 5. (left) One of first Wastewater Gardens systems in first year of operation in Akumal, Mexico, 1997; (right) the 2nd WWG system after 17 years of operation (photos: Gonzalo Arcila)

Figure 6. WWG systems: (left): Kuta/Leggian Bali, Indonesia; (right) Temacine, Algeria.

The WWG systems produced extremely good wastewater treatment without the use of imported technology or chemicals. The biodiverse systems grew luxuriantly and added to the landscape beauty where they were installed. The treated water was used for further greening through subsoil irrigation.

Parameter	**In Septic Tank mg/l**	**Discharge from WWG mg/l**	**Removal Percentage %**
BOD_5 Biochemical Oxygen Demand	145	17.6	87.9
Total Phosphorus	8.1	1.9	76.4
Total Nitrogen	47.6	10	79
TSS Total Suspended Solids	69.9	38.9	44.4
Coliform bacteria	4.9×10^6	2.2×10^3	99.8

Table 2. Water analysis and treatment levels achieved in the first two WWG systems installed at Akumal, Mexico to protect the nearby coral reef.

15. Oral History of the Sea Peoples of the Mediterranean

The oral history project carried out by the RVH during its Mediterranean expedition was done in collaboration with the Museu Valencia d'Etnologia (the Valencia Muse1um of Ethnology), Spain.

Over a hundred and fifty interviews with sailors, fishermen and port people in Morocco, Tunisia, Spain and France were conducted and archived. Publications and reports are in process. The project is working towards a museum exhibition called “The Gift”, about the reciprocity needed between human cultures and their biomic roots.

During its voyages, the search for the origins of human cultures and the history of the sea peoples of the world have been an ongoing activity of the RVH. This work is cited by John P. Allen, the inventor of Biosphere 2, Chairman of PCRF during its collaboration with the RVH on coral studies as inspiration for his pioneering work on the "ethnosphere".

Selected Scientific Publications resulting from R.V. Heraclitus work

Allen, J.P.(2003). Ethnospherics: Origin of Human Cultures, Their Subjugation by the Technosphere, The Beginning of an Ethnosphere, and Steps Needed to Complete the Ethnosphere. *Ethics in Science and Environmental Politics (ESEP),* l 7-24, published 30 April 2003. http://www.esep.de/articles/esep/2003/E29.pdf

Allen, J.P. 1991. *Biosphere 2: The Human Experiment.* Viking/Penguin Books, 1991.

Allen, J.P., Nelson, M., and Snyder, T.P., Institute of Ecotechnics, *The Environmentalist*, 4 (1984): 205-218.

Alling, A. (1986). Records of odontocetes in the northern Indian Ocean(1981-1982) and off the coast of Sri Lanka(1982-1984). *Journal of the Bombay Natural History Society, Bombay* 83(2), 376-394.

Alling, A. 1997. Pulsing Planet Earth: The Planetary Coral Reef Project. *Explorers Journal*. Fall, 1997.

Alling, A. and P. Dustan. 1996. Coral Reef Ecosystem of Biosphere 2. *4th International Conference on Closed Ecological Systems. Linnean Society*, UK.

Alling, A., Dorsey, E. M., & Gordon, J. C. D. (1991). Blue whales (Balaenoptera musculus) off the northeast coast of Sri Lanka: distribution, feeding and individual identification. *UNEP Marine Mammal Technical Report*, 3, 247-258.

Alling, A., Doherty, O., Logan, H., Feldman, L., & Dustan, P. (2007). Catastrophic coral mortality in the remote central Pacific Ocean: Kiribati, Phoenix islands. *Atoll Research Bulletin*, *551*, 1-19.

Baker, C. S., Perry, A., Bannister, J. L., Weinrich, M. T., Abernethy, R. B., Calambokidis, J., ... & Vasquez, O. (1993). Abundant mitochondrial DNA variation and world-wide population structure in humpback whales. *Proceedings of the National Academy of Sciences*, 90(17), 8239-8243.

Charles, C. D., Hunter, D. E., & Fairbanks, R. G. (1997). Interaction between the ENSO and the Asian monsoon in a coral record of tropical climate. *Science*, *277*(5328), 925-928.

Dustan, P., S. Chakrabarti, and A. Alling. 2000. Mapping and Monitoring the Health and Vitality of Coral Reefs from Satellite: A Biospheric Approach. *Life Support and Biosphere Science*, Vol 7: 149-159.

Finn, M. 1996. *Comparison of mangrove forest structure and function in a mesocosm and Florida*. Ph.D. dissertation, Georgetown University, Washington D.C.

Finn, M., Kangas, P., & Adey, W. (1999). Mangrove ecosystem development in Biosphere 2. *Ecological Engineering*, 13(1), 173-178.

Goeke, R. F. (2004, November). The Coral Reef Satellite Mission. In *Remote Sensing* (pp. 107-115). International Society for Optics and Photonics.

Hahn, R. 1997. R/V Heraclitus: Ship of Discovery, *The Explorers Journal*, Fall 1997, vol. 75, number 3

Harris, W.C. and L. J. Graumlich, "Biosphere 2: sustainable research for a sustainable planet", http://www.columbia.edu/cu/21stC/issue-4.1/harris.html

Ippers, Linda. 2004. *Environmentally Influenced Structural, Morphological and Biological Interactions on a Coral Reef in Milne Bay Province, Papua New Guinea*. Master's thesis in Environmental Engineering at Bingen University, Germany.

Langdon, C., T. Takahashi, C. Sweeney, D. Chipman, J. Goddard, F. Marubini, H. Aceves, H. Barnett, and M.J. Atkinson. 2000. Effect of calcium carbonate saturation state on the calcification rate of an experimental coral reef. *Global Biogeochemical Cycles* 14(2):639–654.

Langdon, C., W.S. Broecker, D.E. Hammond, E. Glenn, K. Fitzsimmons, S.G. Nelson, T.H. Peng, I. Hajdas, and G. Bonani. 2003. Effect of elevated CO2 on the community metabolism of an experimental coral reef. *Global Biogeochemical Cycles* 17(1):1011, doi:1010.1029/2002GB001941.

McKenna, Dennis, 1984. *Monoamine oxidase inhibitors in Amazonian hallucinogenic plants: ethnobotanical, phytochemical, and pharmacological investigations*, Ph.D. Dissertation, University of British Columbia (Canada).

Muñoz-Matutano, G., Serra, EP, Anguiano, EA, Gay, MA, & Ferri, JG (2013).Disseminating scientific culture in the city. Cultural Association "Pirates of Science".*AUSART* , *1* (1).

Nelson, M. 2014. *The Wastewater Gardener: Preserving the Planet One Flush at a Time*, Synergetic Press, Santa Fe, NM.

Nelson, M., 1998. *Limestone mesocosm for recycling saline wastewater in coastal Yucatan*, Mexico, Ph.D. dissertation, Dept. of Environmental Engineering Sciences, University of Florida, Gainesville, pp. 329

Nelson, M., 1998. Wetland systems for bioregenerative reclamation of wastewater -- from closed systems to developing countries, *Life Support and Biosphere Science*, 5(3): 357-369.

Nelson, M., R. Tredwell, A. Czech, G. Depuy, M. Suraja and F. Cattin, Worldwide Applications of Wastewater Gardens and Ecoscaping: Decentralised Systems which Transform Sewage from Problem to Productive, Sustainable Resource International Conference on Decentralised Water and Wastewater Systems, in: *Decentralised Water and Wastewater Systems : International Conference, Fremantle, Western Australia, 10-12 July 2006*, pp. 63-73, edited by Kuruvilla Mathew, Stewart Dallas, Goen Ho*, IWA Publications*, London, 2008

Nelson, M., Odum, H.T., Brown, M.T., and A. Alling, Living off the land: resource efficiency of wetland wastewater treatment, invited paper presented at COSPAR conference, Warsaw, Poland, July, 2000, *Advances in Space Research* vol 27(9): 1546-1556, 2001.

Nelson, M., Finn, M, Wilson, C., Zabel, B., van Thillo, M., Hawes, P., and R. Fernandez, 1999. Bioregenerative recycle of wastewater in Biosphere 2 using a created wetland: two year results, *J. Ecological Engineering* 13: 189-197.

Nelson, M., T. Burgess, A. Alling N. Alvarez-Romo, W. Dempster, R. Walford, and J.P. Allen. 1993. Using a closed ecological system to study Earth's biosphere: Initial results from Biosphere 2. *BioScience* 43(4): 225-236.

Obesekara, N., R. Gunaratne, R. Hahn , 1985. Report of Sightings of Marine Mammals on the South East Coast of Sri Lanka", Session paper, 1985 International Whale Conference, UK.

Olds, K., P. Dustan, A. Alling. 2008. Eight years of coral reef data from Melanesia and Southeast Asia: Vitality, percent cover, reef cover and effects of earthquake**.** Poster prepared for the *International Coral Reef Symposium*, Florida. http://www.pcrf.org/pdf/ICRSKatie08.pdf

Raffauf, R. "Plant Screening: A Chemical Field Test Kit," *Journal of Ethnopharmacology,* vol. 32/1-3, 1991.

Sagan, D. (1987). Biosphere 2: meeting ground for ecology and technology. *Environmentalist*, 7(4) 271-281.

Schuyler, Q., Dustan, P., & Dobson, E. (2006, June). Remote sensing of coral reef community change on a remote coral atoll: Karang Kapota, Indonesia. In *Proceedings of 10th international coral reef symposium*, Okinawa, Japan (Vol. 28, pp. 1763-1770).

Spoon D.M, Hogan C.J., Chapman, G.B. Ultrastructure of a primitive, multinucleate, marine, cyanobacteriophagous ameba (Euhyperamoeba biospherica, n.sp.) and its possible significance in the evolution of lower eukaryotes. *Invertebrate Biology* 114.3 (1995): 189-201.