Chagos News

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Cover image © Anne Sheppard

Editorial

Anne Sheppard, Editor, CCT trustee

As will be seen from a couple of articles in this issue, the news from the reefs of the Chagos Archipelago after two consecutive years of unusually high sea temperatures in the Indian Ocean, and bleaching is very bad.

The present widespread mortality of the corals has set back the recovery that followed the 1998 Indian Ocean wide mortality event.

Coral cover has been an up and down ride since the elation of what was hoped was going to be a good recovery in 2006, but by April this year coral cover was seen to be as low as during the immediate aftermath of the earlier destruction.

This highlights the continuing unique importance of the Chagos Archipelago as a natural laboratory to monitor the effect of these recurring warming episodes on coral reefs worldwide.

The fact that there are no other impacts on these reefs, other than those related to climate change, makes them almost unique. Added to this is the fact that there are coral cover data on these reefs from 1978 to present, and detailed temperature data from 2006 to present, due to the ongoing work and papers by Sheppard & Sheppard and Turner & Roche.

It is vital that this work continues so that we can understand the processes that these reefs are going through.

This can help researchers to understand and perhaps pick apart the different impacts on other reefs globally, and help to make informed decisions to give reefs all the help that we can to perhaps survive this global catastrophic period.

We had always hoped that the Chagos Archipelago's remote and un-impacted position might save it, but the fact that this is not the case is worrying.

CCT Chair, Prof Charles Sheppard, who has carried out more research on these atolls than anyone else and over a very long period, is unsurprisingly, very dismayed by the recent data, even though his 2003 paper in the journal *Nature* predicted that recurrent episodes of warming would occur around about this time with increasing frequency.

He commented "Our work shows that the rate of increasing frequency will perhaps exceed the ability of corals to reproduce in the next decade".

We hope that the crucial ongoing monitoring of the reefs will continue. It needs to.

Director's Report

Helen Pitman, CCT Director

It's been a great year for CCT and we are very much looking forward to 2017, which will see an expedition to survey the many islands found in the Chagos Archipealgo and starts off with our event at London Zoo!

Discover the extraordinary natural history of the Chagos Archipelago on Saturday January 21st 2017.

Presentations will include Professor John Turner giving us an overview of the natural history of the Chagos Archipelago. Professor Nick Graham reveals the fascinating relationship between seabirds and fish productivity and Dr David Jacoby will take us underwater to find out how movement and social networks inform shark conservation.

But that's not all! We'll have Nigel Wenban-Smith there to discuss his new book on the history of the Chagos Archipelago, Professor Charles Sheppard showcasing our new *Corals of Chagos* website and you can even visit the Chagos reef tank with Rachel Jones, team leader at the London Zoo aquarium.

It should be a fantastic day so register today, as places are limited!

New trustee joins CCT

I am also very happy to announce that Claudia Narania, a Connect Chagos graduate, is joining the CCT board of trustees. Claudia is passionate about the culture and conservation of her ancestors' home in the Chagos Archipelago.

She completed the Environmental Training Course in 2014, successfully applied for a bursary to fund advanced training in 2015 and joined a scientific expedition to the Chagos Archipelago.

Earlier this year Claudia was sponsored by CCT to attend the Big Ocean Think Tank. The aim of the meeting was to explore the social, cultural, political, institutional, and economic considerations and needs of the human dimension in these important marine areas.

Claudia was on the scientific expedition to learn about the Chagos Archipelago and the fauna and flora it supports and hopes to draw

"I was proudly representing the Chagos Archipelago and was amazed at how many people knew about Chagos and the Chagossian's history."

Claudia Narania, Connect Chagos graduate and new CCT trustee © Anne Sheppard

upon the knowledge gained to educate the Chagossian Community and the public at large.

“Imagine a world surrounded with unclean water, think about climate change and the impacts on the ocean and on the environment. The ocean belongs to us all. It is vital that we work together to ensure a better future for this planet. “

Conserving the Chagos Archipelago

Preparations for the Darwin Initiative funded Chagos Atoll Restoration Expedition are well underway.

The Royal Botanical Gardens Kew team has been preparing for the expedition by compiling available imagery, maps and data to enable vegetation mapping.

Resources compiled have been added to a Geographic Information System (GIS) by the Spatial Analysis team at Kew to enable the generation of vegetation maps.

Over at the Zoological Society of London the team has been developing a comprehensive species list of the terrestrial invertebrates found in the Chagos Archipelago. So far 444 species have been identified as living on these islands.

As always the CCT is grateful for your support and we hope that together we can continue to have a positive impact on the Chagos Archipelago. We hope to see many of you in January!

Sand, sea and sky

London Zoo on Saturday January 21st 2017

Discover the extraordinary natural history of the Chagos Archipelago

Presentations include:

Professor John Turner - The natural history of the Chagos Archipelago

Professor Nick Graham - From wind to fin: seabirds enhance fish productivity on Chagossian reefs

Dr David Jacoby - Connecting Chagos: how movement and social networks inform shark conservation

Plus more!

Visit London Zoo’s Chagos reef tank with aquarium team leader Rachel Jones

Talk with Nigel Wenban-Smith, the author of Chagos: A History

Dive deep amongst the Corals of Chagos with Professor Charles Sheppard

Limited places so register today! http://bit.ly/2c4HYrk or email events@chagos-trust.org

Nigel Wenban-Smith

Jonathan Hunt, CCT trustee

An important new book, Chagos: A History, succeeds in filling 549 pages with fascinating and well-written material including tables, illustrations, helpful explanatory notes and accurate indices.

It may not be everyone's idea of a page-turner, but the narrative rewards attentive readers with many nuggets of interest, without losing coherence.

It is expressed at a steady pace covering 200 years of life as lived in this somewhat forlorn Indian Ocean archipelago. Three EEEs neatly sum it up: Exploration, Exploitation and Expulsion.

Author Nigel Wenban-Smith conducted much of the research along with his collaborator, Dr Marina Carter. He was a career diplomat who spent much of his time in African postings and on the African desks of the Foreign & Commonwealth Office.

Before joining, he spent six months explaining democracy to remote villages in the Cameroons, and took his civil service exams in a hot mud hut.

In grander style he worked in Mobutu's Congo, consumed whisky with Idi Amin in Uganda and invited Hastings Banda to mend his ways in Malawi, where he served as High Commissioner. In Whitehall, various other autocracies kept him entertained. So given the need for diplomatic skills in relatively newly independent countries, why did he choose Chagos?

Wenban-Smith confesses he was largely "unaware of the Chagos, until I suddenly found myself in charge of its civil administration in 1982, as Commissioner of BIOT".

"I don't think anyone from the FCO had actually visited for at least eight years," he recalls. "A claim for additional compensation

Nigel Wenban-Smith
Author of *Chagos: A History*
© Juliette Parizy

for the ‘Ilois’ [island inhabitants or workforce] was pending and my boss’s request for comments was the first document I saw in my new job.”

Wenban-Smith managed to pay three visits, “by the simple expedient of writing a new line ‘Annual visit by Commissioner’ in the Territory’s draft budget. No-one noticed or objected!”

On the first trip he was driven by road all over Diego Garcia and also flown low over the whole Archipelago.

On the second, he was taken by ship around the islands, landing on six of them. Here, he surveys the prospect of braving the sharks to rejoin the inflatable which will take him from Eagle Island, before visiting Peros and observing the jungle’s encroaching greenery.

A more vivid memory was of Danger Island. “Our rigid inflatable’s engine cut out in surf at Danger Island and we were dumped unceremoniously ashore. It was a wonderful introduction to absolutely unflustered seabird life.”

Hello Darlings!

While this was impactful, he was unable to find much information available on the lives of the Ilois or the previous coconut economy; Sir Robert Scott’s Limuria, an important volume, had nothing to say about events after 1955.

But a conscientious commissioner searched deeper. He found a safe once used by a naval officer which contained a typewritten history of Diego Garcia, called Under Two Flags, compiled by a predecessor, who had been ordered to destroy every copy.

“Only a very closed mind could find it incendiary …” was his dismissive attitude to stupid and secretive commands. Indeed, he continued the search. “’Total destruction’ is rarely achieved, and I am now the proud owner of at least six copies. Thus was my interest in Chagos history first aroused.”

That interest grew and flourished. Like many diplomatic colleagues he continued to nurture an abiding interest in the lands and peoples he was sent to in the service of Her Majesty. Spells in Dublin, Brussels and Ottawa were better endowed with chandeliers and elegant cuisine, but luckily all provided both fascinating histories and wildernesses to explore. So why did he choose to write about Chagos?

“Well, for a start, there was less competition! And then my retirement pretty well coincided with the creation of Friends of the Chagos, CCT’s original name. Its founder, John Topp, who’d taken me around the islands, roped me in, before unloading the chairmanship onto me a few years later, with his conservation legacy increasingly secure, but Chagossian controversies becoming shriller by the day. “

I felt bound to venture into a different kind of unexplored world. Innocently, I thought it might take me three years to squeeze the islands’ history dry … Now, more than a decade later, here it is, with Marina Carter’s vital underpinning, drawn from her deep knowledge of Mauritian history and society. If

the book has balance, that is entirely due to her."

Drawing a parallel between the case of the banished Ilois and the people of the Dorset village of Tyneham, emptied of its inhabitants in 1916 to permit secret development of the tank, Wenban-Smith reminds us that now, a century later, it remains a restricted area. How much does he sympathise with the Ilois?

He is quick to point out that Chagossians was a term unknown until invented by an American in 1999. And to answer by saying: "Our book ends with the last islanders' departure in 1973. We think the dust needs to settle on the main current controversies before any attempt can be made to write of them as history.

"In the meanwhile, we think the earlier events, examined objectively, can help point to ways of enlarging Chagossians' understanding of what has led to their present situation and also, maybe, to help outsiders to consider what can most advance the well-being of Chagossians in the very changed circumstances of the 21st Century."

His early thoughts on researching the book were that he should focus on the memories of old people with direct experiences which might soon be lost, starting with the ex-servicemen among the Chagos 'Friends' who served on Diego Garcia during the last war.

"Those wartime contacts led me to the late Donald Taylor, whose cousin had commanded the first Mauritian military contingent; he knew much about the history of slavery in the Indian Ocean, and was a friend of two of the dedicatees, Paul Caboche and his sister Marcelle Lagesse.

"They possessed an amazing range of memories, documents and acquaintances in Mauritius. I made contact with Fernand Mandarin and began the long process of understanding the contribution which Chagossian exiles could make to understanding the plantation life of the islands.

"It is a great personal sorrow that he died after our book had already gone to press, too soon to see his own story in print. I also met Olivier Bancoult during a visit to Britain, but don't mention him for the simple reason that his own memories were limited and his main pre-occupations were primarily legal and political."

"Another important source of information was the late Richard Edis, one of my successors as Commissioner and author

The manager's house on Ile du Coin, Peros Banhos atoll

Middle Brother island on the Great Chagos Bank

of the lively book about Diego Garcia, Peak of Limuria. This drew my attention to Alan Thompson, the Royal Marine officer who installed Diego Garcia's shore battery in 1942.

"His wartime memoirs, Only the Sun Remembers, consist largely of lurid accounts - real or imagined – of serial seductions, unsuccessful only in the Chagos, where prickly heat seems to have cramped his style. His attitude to the local managers and workers (and Chagossiennes, who openly mocked him) was so appalling that I felt obliged to find a way of making amends."

By a happy chance, on his first visit to the Mauritius National Archives, Wenban-Smith found himself sitting next to Marina Carter. They quickly discovered the overlap between their respective areas of interest and decided to collaborate, especially in the role that Franco-Mauritians played in the Chagos story.

Paul Caboche, whose father had managed the Salomon island for many years, was able to direct Wenban-Smith towards several of the families concerned, while Marina drew his attention to Mauritian Heritage, Edward Duyker's study of the Lionnet family.

They played a major part in the commercial side of the islands' life. "I found myself answering questions put by French Mauritians wanting to know more about their ancestors having connections to the Chagos. That was very rewarding, though only a small part of those contacts found its way into the book."

But the book is full of explanatory notes relating to British and French archives, after Carter spent weeks and weeks delving into the various archives of mainland France, Reunion and Mauritius. She and Wenban-Smith both delved into the records of the British Library and the National Archives at Kew.

He found the 19th century files at Kew, with minimal indexing, huge size and a multiplicity of hard-to-read manuscript papers, "a challenge to muscles and eyesight alike! But the haystacks gradually revealed their 'needles' and allowed a narrative to develop."

Wenban-Smith assured me that there is no danger of his producing a sequel to the present volume.

He confessed, however, to having had at least one Sir Humphrey moment with a Minister involving the Chagos, but we must wait for someone else to look for files emerging from the dilatory operation of the 30-year rule before we find out about that. For the moment we can be content with an engaging, educational and entertaining book.

Iconic red-footed booby with chick

CCT 2017 Expedition

Rachel Jones, CCT trustee

The next CCT led expedition to the Chagos Archipelago, CAREX 2017, aims to study the terrestrial habitats, flora and fauna of the archipelago – a rare specifically terrestrial trip this time.

Led by Pete Carr of CCT, the expedition team includes botanists and GIS specialists from Royal Botanic Gardens Kew, invertebrate biologists from Zoological Society of London and rat eradication experts and bird specialists from the RSPB.

As well as surveying and mapping many of the islands of the region, the team will ultimately be producing a Terrestrial Action Plan (TAP) for the whole archipelago that will make recommendations on management, habitat restoration/rehabilitation, eradication and control of invasive alien species and, vitally, bio-security for the northern atolls in the future.

The terrestrial environments of the Chagos islands are so closely linked to that of the surrounding marine habitats that they form a seamless continuum.

Islands with no rats have thriving populations of nesting birds that produce nutrients in their guano that affects the productivity of surrounding reefs and even the deep waters beyond them. In turn the reefs themselves form the islands structure and the sand on their beaches.

However, there are big differences between the land and sea with implications for their management. Whereas no introduced species have been recorded in the marine environment of Chagos, the terrestrial environment is largely shaped by alien species and the historical activities of human beings.

On most islands, rats and coconut trees are the dominant species, crowding out and suppressing native flora and nesting birds. The original habitats have been so modified that the native hardwood forests, flowering plants and the flourishing bird communities they support cannot re-establish themselves without help.

Whereas there is little that can be done to 'improve' the marine environment other than limiting extractive activities like fishing, there is a great deal that can be done to help the terrestrial habitats return to a natural and healthy state by removing some of the invasive species and allowing the trees, birds and turtles to return again.

Detailing a plan for how to make this happen is part of what this expedition and subsequent action plan aims to do.

Terrestrial invertebrate survey by ZSL

A key part of CAREX 2017 is the terrestrial invertebrate survey being undertaken by the ZSL team of Paul Pearce-Kelly, Rachel Jones and Matt Robinson. Months of preparation have already gone into the survey long before the expedition even starts.

The ZSL team have been researching far and wide for any source of information on the invertebrate diversity of the archipelago including the 1905 Percy Sladen Trust Expedition, the Natural History Museum collection, the works of Barnett & Emms, Stoddart and Lunde, as well as incorporating the more recent observations of scientists working in the archipelago.




To date 487 species of terrestrial invertebrate have been identified as living on the islands, including 13 species of arachnid, 423 species of insect, 23 species of snail and a centipede.

However, over the last 100 years or so many species have been reclassified and renamed so a certain amount of detective work is required to match these animals to their modern day scientific names and classification.

Preparation for the expedition hasn't just involved scouring dusty tomes and specimen collections. The practical side of selecting the correct equipment necessary to sample species from at least 30 different orders of invertebrates, some of which will be aquatic, subterranean or airborne - depending on what part of their life-cycle they're in - requires extensive planning and experimentation.

To this end, much of the equipment was put through its paces on a recent field trip to Mongolia, a place with a surprisingly similar range of invertebrates (apart from the crabs!)

The next stage in the planning process is to finalise which of the islands to concentrate our efforts on. With such a diverse range of habitats (from near pristine to near coconut monoculture) as well as island size, this is no simple task.

This is where close collaboration with expedition colleagues from RBG Kew comes in.

The numbers and types of terrestrial invertebrates are closely tied to the range, diversity and health of plant communities. Using a combination of satellite imagery, mapping software and good old-fashioned local knowledge from our expedition leader, the Kew team have begun the laborious process of drawing up detailed vegetation maps for each island.

This in turn will help the invertebrate team narrow down locations that seem likely to harbour the most diversity or unusual locations that might hide as yet undescribed species.

There are still several months of planning to do before the expedition team gets underway so look out for future updates on CAREX in the New Year.

Terrestrial invertebrate database


CAREX team
© CCT/Helen Pitman

Chagos' Changing Face

Professor Charles Sheppard, CCT chair

Over several years we have published, in Chagos News and in science journals, a graph showing the total amount of coral covering the reefs of this archipelago, updated each time by adding to it the latest year's results.

We showed the collapse after the 1998 warming, the recovery and then various smaller oscillations which showed total coral cover bouncing up and down a little according to recent stormy conditions, disease outbreaks, further minor bleaching events, and so on.

I limited these graphs to results from ocean-facing reef slopes and excluded lagoon reefs. This is because, although we have information for them, it makes for a far more complicated story given the wider range of habitats that you find in lagoons compared with the reef slopes facing the ocean.

These show the total coral cover only. But, what kinds of corals are making up this cover, and does it matter? Well, yes, it does matter because there are about 300 species of stony coral in the Chagos Archipelago and different corals behave differently: some are dense, heavy, slow-growing, solid and apparently immovable, resistant to warming episodes and which we almost never see in a diseased state.

Others are fast-growing, spindly, do not survive a storm or are very susceptible to diseases - they may grow fast but they don't last long. All species will fit somewhere along this multi-dimensioned spectrum. So, while the total coral cover is enormously important, it is an average measure only, an average of all the species of corals, large and small. Much informative detail is not captured by a measure of total coral cover.

But we do have that detail of course. The video transects we have been collecting since 2006 are ideal for providing this information,

Figure 1. *Pavona varians*, the commonest coral in the Chagos Archipelago in terms of colony number, but it is a rather inconspicuous coral. Very important to reef growth and solidity. © Anne Sheppard

Figure 2. *Porites lutea* and *Porites lobata* are two huge, massive corals, conspicuous ad important for reef building
© Anne Sheppard

and some measures we have been taking from the earliest days were even published in 1980, in a paper describing the reefs during the 1970s, from the earliest days of scuba research in this archipelago. The following are some of our observations taken from our more recent recording sheets and from the video transects.

As with anything, the longer the time series we have the better and more informative it is, and our time series are now getting long enough to be very useful indeed.

The commonest coral in the Chagos Archipelago in terms of numbers of colonies will probably surprise most people. It is *Pavona varians*, which is usually small, brownish green and inconspicuous on ocean facing reefs, though it can get to a bigger size in lagoons. Figure 1 is a close up of it.

It is usually overlooked by divers and even by people doing surveys who are not coral specialists. If you try to collect a sample (and there are several now from the Chagos Archipelago in the Natural History Museum) you will see that it is extremely hard - thinly encrusting but very solid. In fact, we recorded it in the above mentioned paper in 1980 as being the commonest coral in the archipelago between eight and 25 m deep way back then too.

Although most colonies are very inconspicuous it could be said to be one of the main reef builders of the archipelago: the continued existence of the archipelago depends as much on this little species as on anything else, which is a salutary thought! Also common, not in terms of numbers but in terms of solidity and simple visual presence are a few species of the massive, mound forming coral of the genus *Porites* (Figure 2).

This too is a major reef builder, but for not quite the same reasons, it may be orders of magnitude less abundant than is the *Pavona*

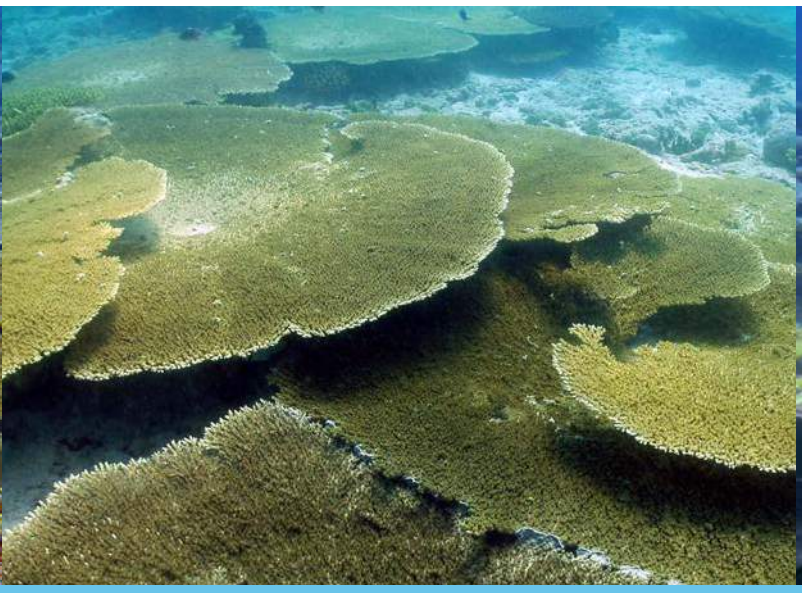


Figure 3. Table corals. There are several species but the fastest and commonest to colonise the reef after the 1998 warming was *Acropora cytherea*
© Anne Sheppard

Figure 4. and 5. After the table corals were at or near full size, they died in their millions, became toppled and ground down to rubble and sand, much lost to deep water
© Anne Sheppard

but its colonies are orders of magnitude bigger when adult. It lives for hundreds of years and its big colony size means that it provides a high proportion of the solidity of the reef. It is a major reef builder too and fortunately also happens to be relatively resistant to both bleaching in warm water and to diseases.

Now take the opposite extreme. These are the fast-growing and often transient species – I call them weed species although this is perhaps an unflattering term for corals which are important in many other ways.

The classic examples here are the table corals of which the most abundant is called *Acropora cytherea* (Figure 3). These deposit limestone in a much more porous form – think of Swiss cheese or Aero chocolate. Partly because of this structure of looser limestone crystals they grow very fast with each branch extending 10 cm per year, which is at least 10 times faster than the slow-growing species mentioned earlier.

Now think back to the major bleaching and mortality episodes in final years of the last century, when a huge proportion of all the corals on the reefs died because of the warming event at that time. Then, a lot of bare space became available all of a sudden.

Think too in terms of a newly cleared forest where bracken quickly colonises all the newly available space and will stay there until shaded out decades later by the slow recovery of the much slower growing trees. In the same way, these table *Acropora* quickly jumped in and occupied almost all of the reef between about 5 to 15 or 20 m deep.

Even in the earliest days following the 1998 mortality when we counted juveniles we saw that by far the most abundant were of these 'weed' table corals. They grew quickly and, over the next 8 to 10 years, restored the total coral cover back to where it had been before.

Therefore, in terms of cover the reefs returned back to 'normal', but the species responsible for this recovery were quite different, being mostly this fast-growing species and a few similar relatives.

The colonies of these branching and table-shaped species, however, are relatively fragile. A clumsy diver knocking into one will break it and maybe knock it over. But the loss of one, or of even a thousand doesn't

Figure 4. and 5. After the table corals were at or near full size, they died in their millions, became toppled and ground down to rubble and sand, much lost to deep water
© Anne Sheppard

Figure 6. *Diploastrea heliopora*, a 'star' coral that formed huge colonies, was common especially in lagoons. It has not been seen since the warming
© Dr Doug Fenner

matter much in ecological terms in this huge archipelago - there were millions of them and they grow fast.

They do have an Achilles heel though - literally - which became evident after about 10 years. Then, the tables had reached 1 or even 2 m in diameter, still attached only by their stalk - the Achilles heel. This stalk erodes, making the table coral weaker and prone to toppling.

This is what we think happened just a few years ago when the huge, post mortality cohort which had reached their maximum, mature size and were about as large as they ever get, were hit by storms that appear to have damaged and removed them. They were toppled and turned, and broken up, by the millions.

We saw the results (Figures 4 and 5): total living coral was well down and total coral rubble was relatively higher. Much of the debris on these steep slopes ends up in very deep water but some does end up on the beach where it helps to build the island, so in this way too the species is very important.

However, during their life span, their importance lies not so much because they are reef builders directly but because they are tall - because they add the three-dimensional structure to the reef that is so important in the maintenance of its high biodiversity. They are paramount in quickly turning 2-D habitat space into 3-D space.

This is critical, especially in the early days after a major disaster as happened in 1998 and, we suspect has happened again in 2015.

We have documented many other changes with the corals too. The large, gloriously patterned coral *Diploastrea heliopora* (Figure 6) used to be common when we surveyed in 1996 and before.

It preferred lagoons and if any species could be thought to be solid and immovable it might have been this one. The photo is one from Fiji because in all our dives in the Chagos Archipelago since the 1998 warming it has not been seen at all, and we have certainly been looking for it.

There are confirmed specimens of it in the Natural History Museum collected from before though (Figure 7), so we were not dreaming

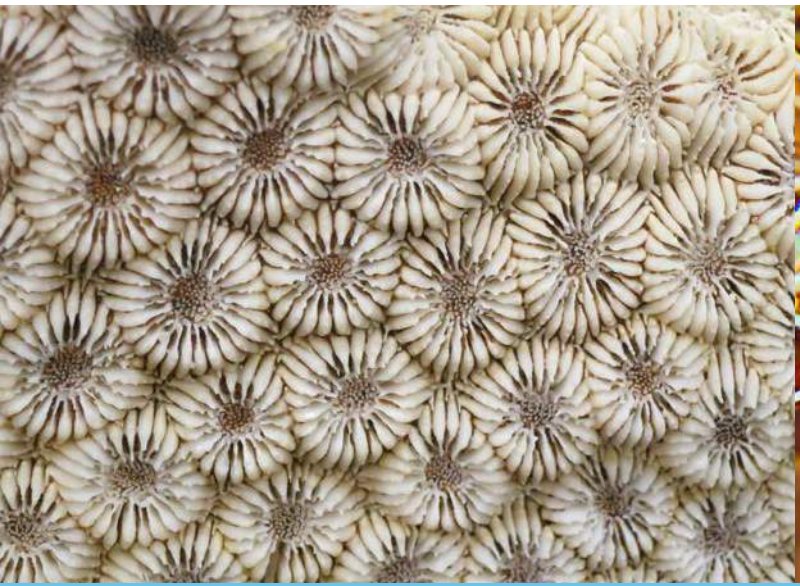


Figure 7. A sample of *Diploastrea heliopora* from the Chagos Archipelago, in the Natural History Museum, London, collected before the 1998 warming
© Anne Sheppard

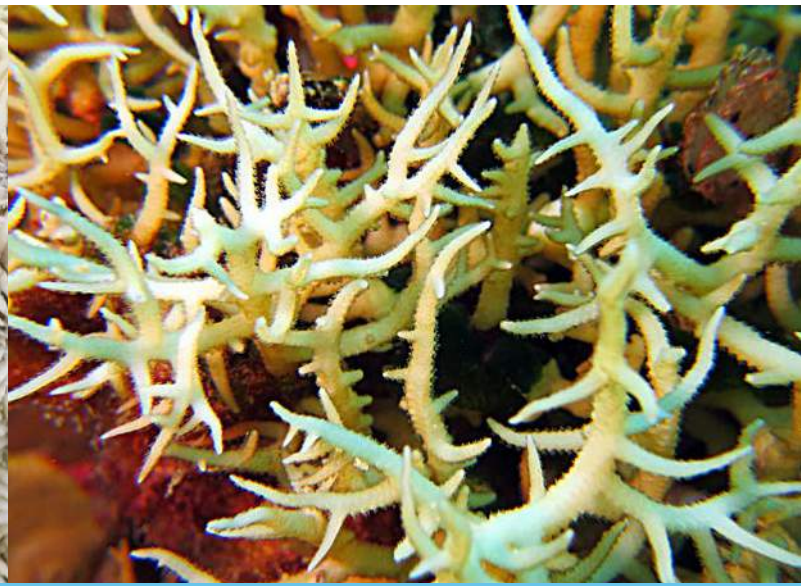


Figure 8. The finely branching *Seriatopora hystrix*, once common, then vanished for 15 years following the warming, now seen to have returned
© Anne Sheppard

that it used to be there! This massive reef and island builder seems to be one that has gone completely.

And there is a more complex picture emerging with many of the species, and many more years will likely see further changes – perhaps far more time than one human lifespan.

One change we are seeing is that of the finely branching *Seriatopora hystrix* (Figure 8). Formerly common in sheltered lagoons especially, it disappeared after 1998 for about the next 15 years. We thought it was another species that had become extinct in the archipelago. But then it appeared a few years ago and is now rapidly increasing in both abundance and in colony size.

In the Maldives it went extinct too, and apparently it still is absent there. Where did it come from? It seems possible that it reseeded from somewhere up-current – the Seychelles or East Africa seems likely. Perhaps other examples like this will emerge over the years.

Several other species that used to be common are now rare. We now have a situation whereby the identity of the total suite of species making up the coral community of this archipelago has changed.

The vast areas dominated by tables of a few years ago started to die off between 2010 and 2014 (Figure 9), the tables are now being replaced by a much higher diversity of those corals that take longer to grow but which are much more solid and (hopefully) durable (Figure 10). It is these that grow the reef.

They were very sparse from 1998 onwards but are returning, at least up to a year or two ago - preliminary results obtained by Dr Ronan Roche in early 2016 has shown that cover has again crashed to levels seen in 2001 – a double unhappy finding considering that measurement reflected damage done by warming in 2015 only, and any further damage added to by the warming in 2016 has not yet been recorded.

So it is likely that with present warming events the story will change again. We have been measuring the water temperature at many places and depths for years and our last set of records for up to 2015 we found that temperatures were consistently over 30^{o} C down to a depth of at least 25m deep, which is more than enough to cause considerable stress to the corals (Figure 11).

Undoubtedly some of the species that are now rare may increase their abundance and others

Figure 9. The ‘weed’ table corals that dominated for 10 years following the mass mortality…
© Anne Sheppard

Figure 10.… have now been replaced by a higher diversity of slower growing corals
© Anne Sheppard

will go – perhaps some already have gone. Different species respond differently to raised temperature.

We hope to be able to see this succession because we have the necessary fairly long time series of observation and video to base the study on. We can see that up to the current warm water condition at least, the low diversity, high cover situation (always a vulnerable ecological state for any ecosystem) slowly changed to one where diversity of species grew.

We hope that the set-back caused by the very recent warming will also recover - the consequences for the survival of the islands themselves is literally at stake given too many warming incidents.

Using the video transects which are archived at Bangor University with Professor John Turner we can return to investigate the changes that have occurred and, more importantly, what the consequences may be.

Every one event that causes losses in total coral cover reduces the calcification needed to keep this archipelago above water. We know that bioerosion and erosion by waves continues whether or not the corals are thriving - sponges in particular bore into the coral continuously (Figure 12) and coral is a relatively soft form of limestone, which is fairly vulnerable to erosion.

Many other species burrow away too. Yet overall, on a healthy reef, growth marginally outstrips erosion - it has to be thus or the reef would not be there! But with reef and coral growth being continuously damaged the balance becomes more precarious.

We have measured all this and more over many years and we hope to get the funding to continue to do so in the future! By the end of 2016, Anne Sheppard, myself and Dr Doug Fenner hope to have completed *Corals of Chagos* a part of CCT's Chagos Information Portal (ChIP), which is documenting the approximately 300 species of stony and reef building corals of the Chagos Archipelago.

This is not only a taxonomic database but also includes some of the important characteristics as described above, for several species too.

Figure 11. A temperature logger being replaced
© Charles Sheppard

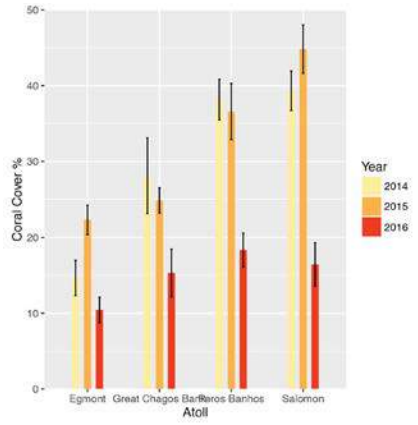
Figure 12. A dead coral extensively bored and hollowed out by the boring sponge *Cliona*. Each dark spot marks where the sponge starts its burrow
© Anne Sheppard

Chagos' Reef Slopes

Professor John Turner, CCT trustee

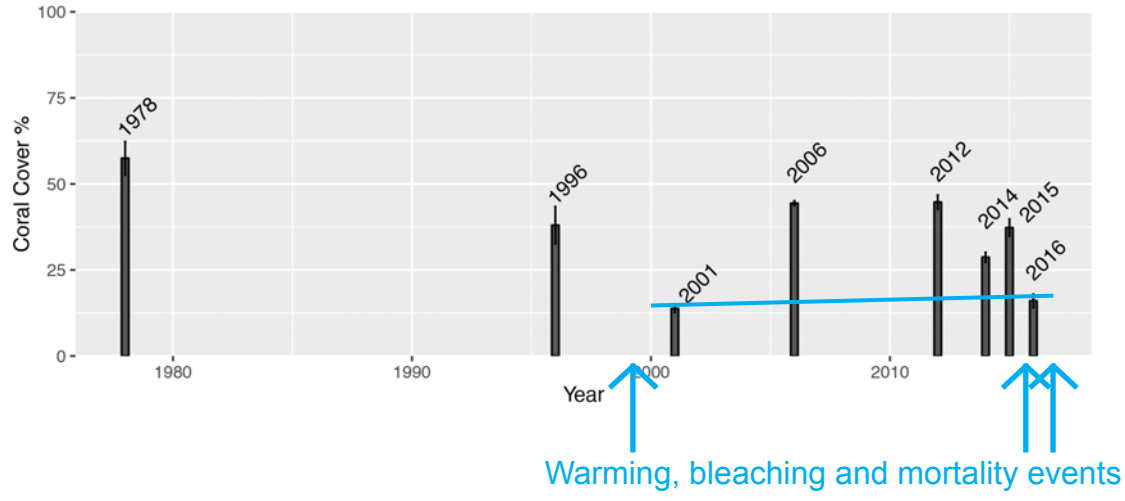
Some results on corals of Chagos reef slopes, taken from a presentation at Reef Conference UK at ZSL in November 2016.

The following are some extracts from a presentation given at ZSL in November 2016. The full set of data is currently being worked up. It shows some key findings, specifically, that the warming event of 2015 caused massive mortality of corals, to a level similar to that seen after the 1998 warming. The final slide shows also that coral disease, which is also exacerbated by warm water and coral stress, is likely to have had and important effect on this too.



Bad news: change in live coral cover by atoll 2015-2016

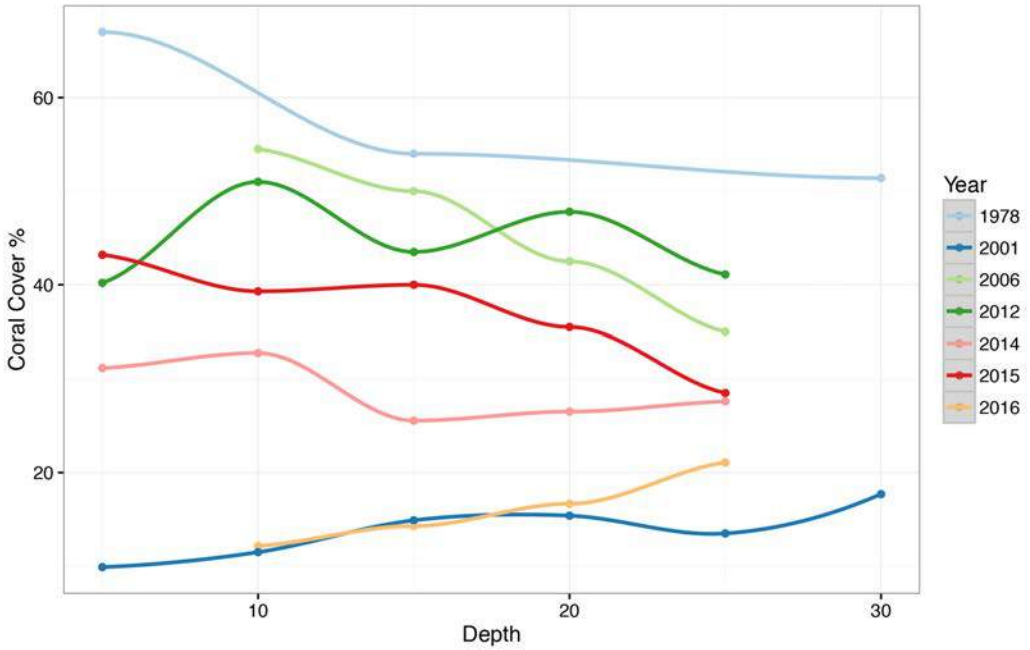
Figure 1: The change in live coral cover recorded by video surveys between 5m and 25m depth at a range of sites across 4 atolls between 2014 and 2015. The reduction in coral cover in 2016 results mostly from coral bleaching induced mortality in April-May 2015.



Decadal trends in coral cover on Chagos reefs
(Visual data by Sheppard 1978- 2012 and Video data 2006-2016)

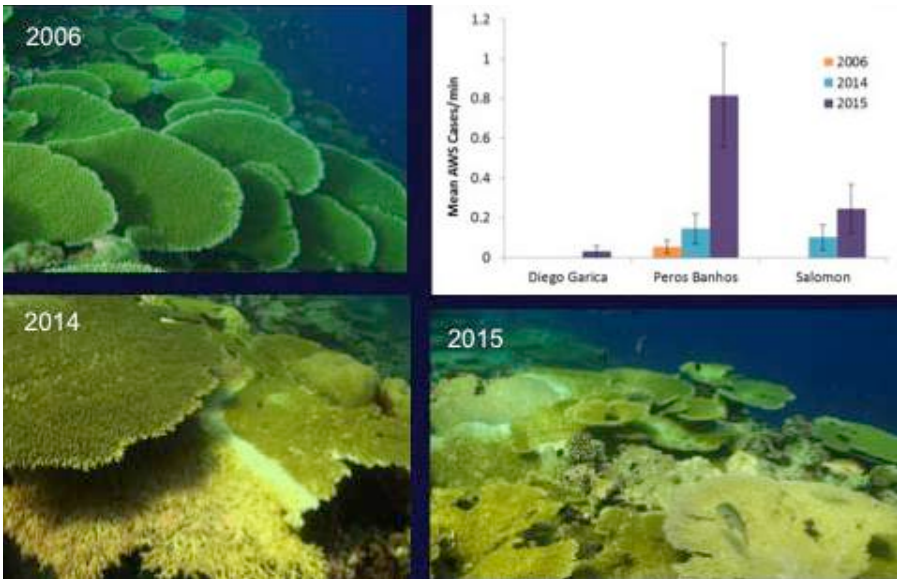
Figure 2: Decadal trends in the coral cover on Chagos reefs. 1978, 1996, 2001 and 2012 data from Sheppard & Sheppard visual assessments, and 2006, 2014, 2015 and 2016 from video surveys by Turner & Roche.

Bleaching events occurred in 1997/98, April- May 2015 and again in April-May 2016, although the impact of the latter is not yet known. The reefs show similar levels of cover to those post the major 1997/98 bleaching event.



Can resilience be maintained in Chagos?

Figure 3: Data from video recorded across the depth range of 10-25m surveyed in March 2016 (post 2015 bleaching event but prior to 2016 bleaching event) (orange line) is superimposed on Sheppard & Sheppard visual assessments data of earlier years to show that coral cover, especially in shallow waters, has been set back to the levels observed in 2001, post the 1997/98 bleaching event.



Analysis of archival video

Figure 4: Coral disease (white syndrome) was observed affecting table corals (mostly *Acropora cytherea*) in 2014, with an increase in frequency especially at Peros Banhos atoll in 2015. Reanalysing archival video recorded in 2006 (when disease was not of concern) shows incidence then was very low, even on Peros Banhos reefs. This demonstrates the immense value of archival video records.

Saving The Oceans

Helen Pitman, CCT director

2016 was an outstanding year for our oceans. Over the last few months we've seen more ocean protected than ever before.

From the tropics to the Antarctic a diverse range of habitats and species will now stand a better chance of survival in the face of climate change and many other threats.

A tropical oasis

In August, US President Obama more than quadrupled the size of the Papahanaumokuakea Marine National Monument in the Northwestern Hawaiian Islands.

Originally designated as a marine monument by US President Bush a decade ago the expanded section of the monument will ban all commercial extraction activities, including fishing and future deep-sea mining and protect the world's oldest living animal — a black coral estimated to be 4,500 years old.

Spanning the ocean

At the Our Oceans conference in September UK Foreign Office Minister Sir Alan Duncan announce plans to double marine protected areas around the UK overseas territories.

The announcement included full protection for the Pitcairn Islands' marine areas in the south Pacific. Covering an area of over 800,000km^2 it is an important refuge for many species including 48 threatened species such as the Pitcairn angelfish.

In addition, the designation of partial protection around St Helena and the commitment to further protect ocean around Ascension by 2019 and Tristan da Cunha by 2020, will total around four million Km^2 of the south Atlantic Ocean to be protected.

Pitcairn Islands' fully protected marine area © Johnny Briggs/Pew Environmental Trust

Penguins hunting in the Ross Sea © John Weller

One million Km^2 will exclude commercial fishing, similar to the Chagos Marine Reserve, allowing marine life to thrive.

To help with implementation, management, surveillance and enforcement of these new protected areas the UK government also pledged £20 million over the next four years to overseas territories.

The announcement by the UK government is a very significant contribution towards achieving the UN target and we congratulate them on taking this lead.

On the high seas

A month later a monumental announcement was made by 24 countries and the European Union, who agreed to designate the Antarctic's Ross Sea as the first large scale marine protected area on the high seas. This came after years of negotiation within the Commission for the Conservation of Antarctic Marine Living Resources.

The high seas are international waters, meaning they are open-access common areas for everyone and are not covered by any laws.

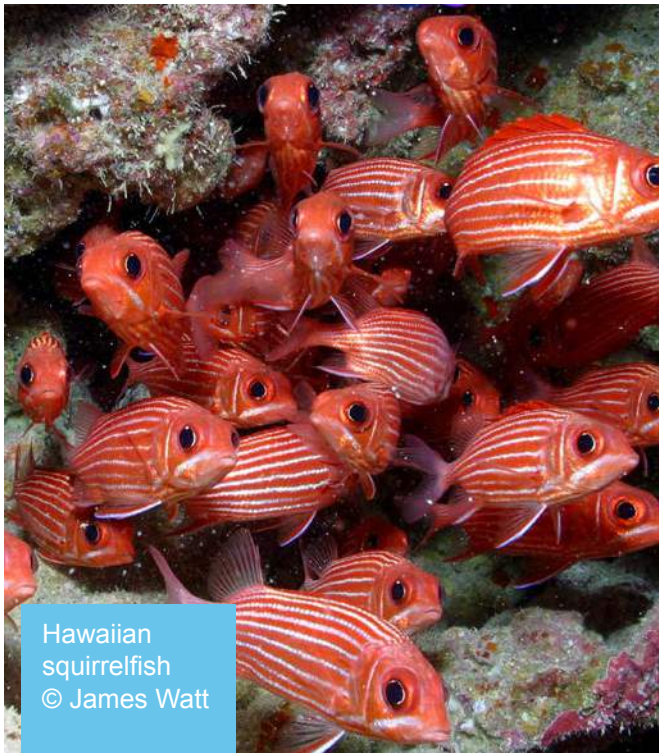
Found in the Southern Ocean the Ross Sea is home to a third of the world's Adelie penguins and Antarctic petrels and around 6% of the world's Antarctic minke whales. Its huge numbers of krill are an important food source for many for marine species.

The future

Although 2016 has been an outstanding year for our oceans with more protection granted than ever before there is still a way to go to.

A lot more will have to be done to achieve target 11 of the Convention on Biological Diversity's Aichi Targets that states *"by 2020 at least 17 per cent of terrestrial and inland water areas and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem service, are conserved though effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascape."*

But the achievements of this year have proven that with collaboration and political will great things can be accomplished.



Hawaiian squirrelfish © James Watt

2016 Expedition Scholar

Chagos Conservation Trust - US

Collaboration between CCT and CCT-US will see CCT-US' Expedition Scholarship fund an invasive plant specialist to join the Darwin Initiative funded Chagos Atoll Restoration Expedition in 2017.

Dr Martin Hamilton is a native of Cerulean, Kentucky where he studied at Western Kentucky University (WKU). Following a visit to Royal Botanical Gardens Kew, Martin successfully completed a Kew Diploma in Horticulture where he worked with CCT trustee Dr Colin Clubbe to survey threatened plant species in the wild and assist local conservationists with propagation in the US and British Virgin Islands. After finishing the diploma Martin continued working in the Kew Herbarium as the UK Overseas Territories Program Officer.

Over the next nine years, Martin worked closely with many other departments and international collaborators to protect, study and conserve the unique plants and habitats of the UK Overseas Territories.

It was during this time that Martin first started to study and collaborate on the flora of the British Indian Ocean Territory (BIOT) working with the late Commander John Topp.

The two collaborators produced a checklist of the plants of BIOT in 2009, based on the holdings of Kew and the collections and field notes of Commander Topp. Martin undertook remote sensing work of BIOT during the preparations for the 2010 Chagos Expedition that saw Colin visit the archipelago to collect botanical data using a GIS and data collection system that Martin developed.

Martin embarked on a PhD at Birkbeck, University of London and since completing this has been the Research Leader for the UK Overseas Territories team at Kew, within the newly formed Conservation Science Department.

"I am looking forward to working with an international group of dedicated specialists in one of the most unique areas of our planet and input into an ambitious and much needed action plan to preserve one of the jewels in the British crown!"

Dr Hamilton with *Varronia rupicola* on Anegada, British Virgin Islands

His on-going field projects are mostly focused in the Caribbean; however, he is actively involved in projects across the UK's overseas territories.

The support provided by CCT-US will enable him to participate in the Chagos Atoll Restoration Expedition.

CCT-US partners to fund Chagos turtle research

CCT-US has partnered with the Loggerhead Marinelife Center to expand their expedition scholarship.

The scholarship is an annual initiative that funds a US scientist to join a Chagos Archipelago expedition.

LMC is a premier non-profit education and conservation facility based in Juno Beach, Florida and its mission is to promote conservation of ocean ecosystems and focuses on threatened and endangered sea turtles.

To advance both missions, the two organizations will fundraise jointly to finance a scientist to conduct turtle research in the Chagos Archipelago in 2017.

LMC's President and CEO, Jack Lighton, and Sam Purkis, Chair and Co-Founder of CCT-US announced the partnership, during LMC's Circle of 100 Spring Dinner.

"The CCT-US looks forward to updating the Chagos Archipelago community about this exciting partnership as it develops, and extends particular thanks to the generous donors who presently support its Expedition Scholarship Program" said Professor Sam Purkis, Chair and Co-Founder of CCT-US.

The CCT-US Expedition Scholarship Program is kindly funded by the Ric and Suzanne Kayne Foundation, Schnormeier Family Fund, Honorable Otho Eyster and Carol Garner Fund, The Max and Victoria Dreyfus Foundation and the CCT-US members.

I'm Not Dead!

Professor Les Kaufman, Boston University Marine Program

In Monty Python and the Holy Grail, Scene 2, a moribund medieval man who is nonetheless getting better is loaded by his caregiver against his will onto a passing cart led by a guy whose job it is to gather the fruits of death.

When the poor fellow protests profoundly "I'm not dead!" a negotiation ensues between cartman and caregiver. As a favor to the caregiver, the cartman dispatches the unfortunate to make him definitively dead, upon which his corpse is summarily loaded onto the cart with the others.

Obviously this scene, like most of the Monty Python canon, is meant to be humorously thought provoking. In a similar vein, *Outside* magazine's online site recently published a satirical obituary for the Great Barrier Reef, the point being to underscore the dismal trajectory of the world's greatest coral reef system so that something might be done about this and quickly. It was a satirical obituary.

A lot of people didn't get the satire part, or did and didn't think it was particularly funny. Evidently a good many coral reef lovers are worried that a premature death sentence for the world's coral reefs will have the same effect as the cartman's bludgeon.

Now that a tsunami of comments savaging the author of this tongue-in-cheek blog seems finally to have faded to foam, we should reflect on what that little episode was truly all about.

The GBR really has suffered calamity but most of it remains dominated by living hard corals, coralline algae, and coral reef fishes and invertebrates, and so is still recognizable as a coral reef system. Just a very sick one.

Imagine a person with gangrene, whose foot is rapidly heading south. His head still looks pretty good and will for at least a little while longer. The important thing is that something can still be done about it and the person could yet survive and thrive, even if needs be, sans foot. Can something still be done about the world's coral reefs? This is a very important question because if not, we have many other things to worry about.

If yes, we have a gigantic caregiving role on our plate that we may well have caused, but we certainly hadn't asked for. No wonder the caregiver was glad to get the cartman's violent favor.

So what about the blog was actually true, and what of it could perhaps have been dangerously misleading?

Well, coral reefs are threatened globally by anthropogenic climate change, which includes ocean warming - triggering mass bleaching events, coral disease pandemics and killer cyclonic storms; and ocean acidification that compromises corals ability to repair, regenerate, and repopulate episodically devastated reef environments. Climate change is an anthropogenic ill on the scale of our entire planet.

You might be inclined to think that anything

Biscayne National Park

done to combat the effects of climate change on a local scale is pissing into the wind.

Except, this is hardly the whole story. It is going to take us a few centuries to bring runaway climate change under control even with the effort heavily front-end loaded: right now through the next couple of decades is absolutely critical.

Coral reefs are going to have to somehow survive this 'climate hiatus' if they are to thrive once more in more or less their current forms. That's going to take a lot of help, on a very local level. And it'll be hard.

Forget climate change for a moment. Coral reefs are locally besieged by overfishing, limestone mining, military oceanscaping, coastal development, and by virulent and voluminous runoff from land loaded with sediments, nutrients, trash, toxins and pathogens.

We do all this stuff. We could, for example, consider not doing it?

If we are to judge from the current situation in Biscayne National Park just south of Miami, then the answer might be "not likely".

Given the dire condition of the Florida reefs in general, the National Park Service found prudence dictating that everything possible should be done to intensively steward the part of the reef tract that had landed on their watch, in the BNP.

This recently rich stretch of patch reefs is strategically located just north of the Florida Keys, linking the Keys reefs with a northern reach of coral communities that stretch all the way up to West Palm Beach. In warming seas such a corridor to cooler waters could be critical.

NPS staff planned on placing the park's entire coral reef habitat into a marine reserve to shield it from physical damage from the hurling of traps, nets, lines and anchors on this beloved fishing ground. Small park, tiny reserve, potentially very big payoff.

As a compromise with extractive use, the planned reserve was shrunk approximately to between one quarter and one third of the park's coral reef habitat, or only about 6% of the park's total area.

Note that after years of heated discussion among marine scientists a consensus recommendation has emerged: if you are really serious about maintaining the health of any marine ecosystem, you need to effectively shield about 30% of it from direct impacts, as a marine reserve.

Biscayne National Park

This is a judgment call, but one no weaker than your doctor's insistence that you'd better stop smoking or risk a high likelihood of dying from lung cancer or emphysema.

The coral reef itself comprises a small proportion of an ecological landscape that includes seagrass, mangrove forest, and other habitats that help to nurture and support the reef and the goods that it provides us. 6% isn't 30%.

Not surprisingly, some of the fishermen who use the park are opposed to there being a no-fishing zone anywhere. Their argument is quite interesting: the reef's poor condition is due to climate change; about which nothing can be done at a local level. Since the coral reef - which is essential fish habitat - will not respond to local stewardship, then must we not accept that we've simply lost that habitat and manage the fishery as if it were never there?

Some kind of fishery could still be sustainable. It just would not be a coral reef any more, and the target species would no longer be those that require a coral reef habitat.

Snappers and groupers aren't the only things that require a coral reef habitat. Coral reefs have evolved to break the waves. Reef crest corals like the endangered and majestic elkhorn coral are surfers, and their lives are one long ride.

By virtue of corals' millennial service on the front line just off the beach, we humans have expensive coastal real estate. Also, somewhere around one quarter of all marine organisms are coral reef citizens: no reef, no citizens.

But who cares about them? You might be surprised. In this country, causing species to go extinct, even locally extinct, is illegal. It is also strongly frowned upon everywhere else on this planet.

There is a lot that we can and must do to shepherd coral reefs through the climate hiatus. During this interregnum our reefs may not look like they used to, but there's a chance for them to deliver value and to reiteratively lift themselves up from successive climate clobberings.

The odds are good that we can facilitate this happy outcome, but only if we do two things.

First, we stop crapping on reefs with local insults and policies that look like lunacy a mere year or two out.

Second, we support recovery in every way possible, even by farming and planting seed corals and their ecological allies back out on the reef should that be necessary. For it already is, and we already are. It's early days: we're just learning how.

So the next time the cartman chants "Bring out your dead" to the beat of wooden wheels on cobblestone, put the bludgeon away.

Care for the people and things that you yourself had a hand in making so sick, and fill the space between forehead and nose tip with thoughts of a longer-term future.

(The author thanks Dr. Anthony Janetos, Director of the Pardee Center, for reminding him of the mentioned scene from *Monty Python and the Holy Grail*.)

Les Kaufman is Professor of Biology at the Boston University Marine Program and Pardee Center for the Study of the Longer-Range Future.

Corals of Chagos

Professor Charles Sheppard, Chair, CCT

Our Chagos Information Portal, the project funded by the John Ellerman Foundation includes, as just one of its components, an online and well-illustrated Corals of Chagos.

The Natural History Museum in London is the repository of a large collection of coral specimens from the archipelago, mostly collected during the expeditions of the 1970s. On recent visits, 'collection' has mostly been by camera.

Charles Sheppard, Anne Sheppard and Doug Fenner from the USA (who was in fact a US-CCT funded scholar to the archipelago in 2014), are nearing completion of this major task.

Each of approximately 300 coral species are being catalogued, and the online version will have descriptions of all corals so far properly identified, along with numerous photographs, both underwater and close-up of specimens from the NHM repository.

About 2,000 photos in all have been assembled to date, both underwater portraits as well as close-up illustrations, selected and matched from a far larger total number.

These will soon be available in the Chagos Information Portal (ChIP) and the result will be available to view at the AGM meeting in mid January.

The Chagos Archipelago is a particularly important cross-roads for corals (and other groups) in the Indian Ocean, being called 'the Chagos Stricture' by J.E.N. Veron who is the world's leading coral taxonomist.

This work which has taken a couple of years and much original research will put the work online for all to use – it is increasingly important as this archipelago itself becomes more important in today's deteriorating environment for corals.

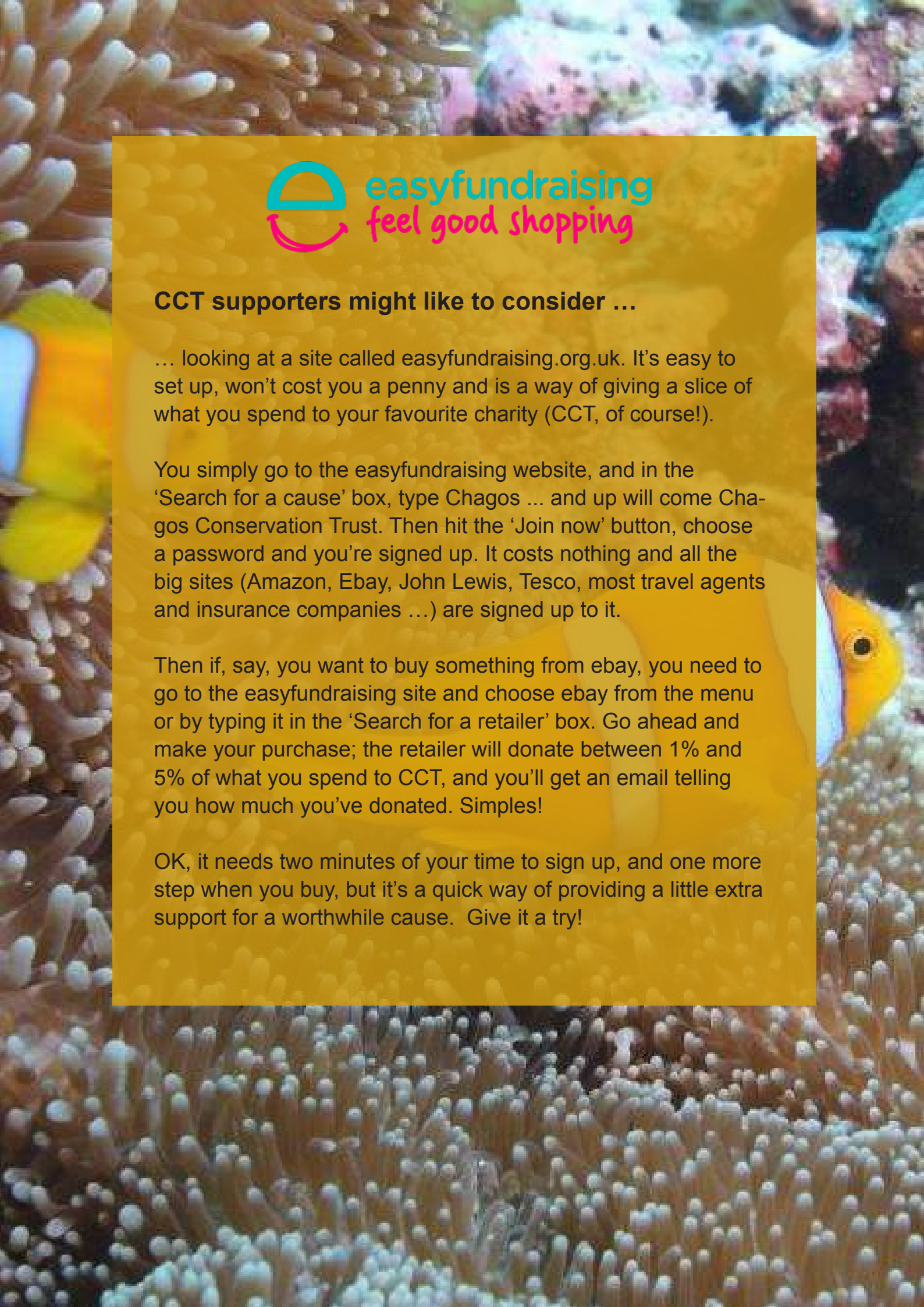
Lobophyllia diminuta skeleton
© Anne Sheppard

Acropora vermiculata, note the daytime extended polyps which are diagnostic of this species © Anne Sheppard

Acropora lutkeni, note the two sizes of coral calices © Anne Sheppard

Charles Sheppard and Doug Fenner with the Chagos collection at the NHM © Anne Sheppard

Anne Sheppard photographing corals for the ID guide © Doug Fenner



easyfundraising
feel good shopping

CCT supporters might like to consider …

… looking at a site called easyfundraising.org.uk. It's easy to set up, won't cost you a penny and is a way of giving a slice of what you spend to your favourite charity (CCT, of course!).

You simply go to the easyfundraising website, and in the 'Search for a cause' box, type Chagos ... and up will come Chagos Conservation Trust. Then hit the 'Join now' button, choose a password and you're signed up. It costs nothing and all the big sites (Amazon, Ebay, John Lewis, Tesco, most travel agents and insurance companies …) are signed up to it.

Then if, say, you want to buy something from ebay, you need to go to the easyfundraising site and choose ebay from the menu or by typing it in the 'Search for a retailer' box. Go ahead and make your purchase; the retailer will donate between 1% and 5% of what you spend to CCT, and you'll get an email telling you how much you've donated. Simples!

OK, it needs two minutes of your time to sign up, and one more step when you buy, but it's a quick way of providing a little extra support for a worthwhile cause. Give it a try!