only because he provided him with specimens of rare plants and animals from the North, but also since he without any preconceived opinion on systematics (he had not studied the subject at any university!) tested the usability of the Linnean system and reported on this to Linnaeus. To my knowledge the frankness of their discussion is unparallelled in the Linnean correspondence. It is obvious that they trusted each other and valued the observations and opinions of the other highly. Linnaeus most nobly praised Gunnerus in several of the letters, most obviously in a letter from March 1764 (fig.4 above). What a pity that they never met!

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Bumblebees – changing fortunes

Linnaeus' bumblebees[1] are amongst the oldest surviving bumblebees in Europe and his collection has a number of familiar species. In this world of diminishing species the collection is an increasingly important reference for species that are declining, becoming extinct or changing populations through climate change or man-made factors.

His bumblebees are part of three boxes of Hymenoptera (Boxes 33, 34 and 35) of mixed genera, curated by Mike Fitton, assessed by M.C. Day[2] and more recently by Paul Williams at The Natural History Museum.

Of particular interest to me is the paucity of *Bombus* species in the tropics,[3] for the genus is more typical of the Northern Hemisphere whilst exploitation of tropical habitats is much reduced or absent in some places such as

Boxes 33 (above) and 34 (right) of Linnaeus' Hymenoptera.

Africa. So I was interested to note the presence of a large insect labelled '*brasilianorum*' in Box 35 (left) that had lost its bronze lustre.

This is almost certainly a species of the *Xylocopa*, or Carpenter bee that is called *Xylocopa brasilianorum* (Linnaeus), i.e. not a bumblebee.[4] Xylocopids are known as important pollinators of passion flowers in Brazil, and the range of *X. brasilianorum* (Linnaeus) is north to California, for it is represented there as the Valley Carpenter Bee, *X. brasilianorum varipuncta* Patton.[5] It would seem from its name that *brasilianorum* would therefore exist from Brazil, northwards through Central America into south-western USA.

Finding bumblebees in the Brazilian rainforests and other tropical habitats[6] is usually unsuccessful these days (like chancing on jaguars or anacondas), but just occasionally a large hymenopteran is seen in a clearing for a brief moment without any chance of getting close. There is a high probability that many of the large bumblebees seen are actually Carpenter Bees belonging to the *Xylocopa* genus. The amount of fallen timber in Amazonia is always unbelievable, and is replenished every few months so this is a paradise for both coleoptera and hymenoptera.

Anecdotal evidence that xylocopids prefer warmer climates also comes from southern France. In the warm Mediterranean of the Cévennes (Gard) there are usually many more xylocopids on the wing than bumblebees and recent records indicate that they are making a foothold in southern England.[7] And a new bumblebee species has been added to the UK list in 2000 namely *B. hypnorum* (no common name). Global warming may have provided the opportunity for bumblebees to extend their ranges alongside increased fortunes of flowering plants.

Linnaeus's bumblebees therefore represent an important reference collection of insects, fixed in time to the late 18th century, many of which are continuing to experience declining populations. Distribution is therefore not only determined by the vagaries of the weather, now it is likely to be influenced by man.

Declines

The declines had already started in the late 20th century when the Kent bumblebee enthusiast, F.W.L. Sladen recorded *B. distinguendus* (the Great Yellow Humble-bee) becoming rare in the London area;[8] now it is restricted to the north of Scotland.[9]

According to Natural England (formerly English Nature) there has been a 70% decline in some bumblebees in Britain since the 1970s, with only six out of the UK species found easily.[10] Three UK species are now extinct and nine are threatened.[11]

When Prys-Jones and Sarah Corbet's book on bumblebees came out in 1991,[12] only 6 of the 9 non-cuckoo species listed were widespread and abundant, the rest either having not been seen for many years, were 'declining' or 'status unknown'.

Ted Benton in his New Naturalist *Bumblebees* book[13] has provided an agreeable overview of the status of Britain's bumblebees, and Paul Williams and Mike Edwards have provided an overview of the declines of bumblebees in the UK and worldwide.[14,15]

The UK probably does more for bumblebee conservation than any other country. Bumblebees are coming back to field margins that have been left for wildflowers under, for instance Defra's Countryside Stewardship Scheme, and Syngenta launched Operation Bumblebee to promote bumblebees on farmland, let alone a lot of work done by wildlife trusts on non-statutory wildlife sites.

The colour-matching of ragwort and bumblebee is remarkable.

Conservation

Bumblebees are indicators of a healthy and biodiverse environment. By bringing back the appropriate nectar sources bumblebees may thrive, but it's a delicate ecological balance for bumblebees, regulated by the availability of appropriate nectar sources for their particular length of tongue (for they have different length tongues for specific flowers). With global warming plant distribution can vary, which may be to the bumblebees advantage or not.

Recent research in the UK, the Netherlands and Germany concluded that overall bee diversity fell by almost 80% in these countries in the last 25 years up to 2006.[16] It was also found that plants that depend on pollination by bees are disappearing too. This is not a surprise since Charles Darwin predicted very much the same; he thought that if ever humble-bees became extinct or very rare in England that heart's ease

(*Viola tricolor*) and red clover (*Trifolium pratense*) would become very rare or disappear entirely.[17] I am not sure that these two wildflowers had disappeared synchronously with the bumblebees as they are still found along Kentish waysides.

This association of bee and flower exemplifies the essence of Darwinian evolution, and accounts for the fragility of populations in a changing environment. If a species is so highly specialised, without any useful means of adaptation to a changing world it has long-term success stacked against it. The intimate and uncanny mutual association of bumblebees with wildflowers is enough, one would have thought, to satisfy any evolutionary sceptic.

The degree of specialisation can therefore be a hindrance for long term evolutionary success especially if there is little chance of effecting realistic adaptation in a world of fragmentation of habitats and decline of foodplants. The winners will always be the species that are not fettered by specialisms, whether by scarcity of particular food sources or peculiarities in way of life. This is true for bees as for butterflies, and many other animals.

There will always be a range of insects that will prosper with little fluctuation in population in a changing environment, and others that will fall by the wayside and have declining populations. In butterflies the winners will be species whose larvae feed on the relatively ubiquitous Graminae, Cruciferae or Urticaceae, and in bumblebees there will be a hard core of species that are enormously successful because they have a good range range of common nectar sources. As Benton remarked, the abundant Common Carder-bee, *B. pascuorum* is a highly adaptable insect. The usefulness of the UK's 15 million gardens cannot be under-estimated in providing nectar sources for bumblebees.

Bumblebees are starting, very slowly, to be recognised as important biodiversity indicators on development sites. Both Buglife[18] and BCCT have joined forces to highlight the plight of bumblebees (amongst many other invertebrates) on the Thurrock Marshes in the Thames Gateway where a suite of Red Data Book and Biodiversity Action Plan (BAP) species are present. *B. humilis* (the Brown-banded Carder Bumblebee) and *B. ruderarius* (the Red-shanked Bumblebee) are present there, and their populations continued to decline.

Five bumblebee species are protected as Priority BAP species in the UK.[19] Of these just one species is represented in Linnaeus' boxes, namely *B. sylvarum* (two specimens in Box 34, bearing the label 'Lecotype, *Apis sylvarum*, det. M.C. Day.').

Linnaeus probably did not anticipate that the fortunes of bumblebees would change in his lifetime or that his collections would record the past so well. And Sladen probably did not realise that populations would retract so much when he was out in his rick collecting bumblebee nests during the best time of the year – at hay-making time. Too much has changed since then. The waysides and woodlands are different. But the decline has been dramatic in the last few decades and one hopes it is not too late to be reversed with some creative conservation and land management.

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John Feltwell would like to thank Gina Douglas for archival information and for facilitating access to the collection; the images of Boxes 33, 34 and 35 are reproduced courtesy of The Linnean Society of London. George Else helpfully advised about the xylocopids.

ENDNOTES

1. Not all the insects in these boxes have a provenance from Linnaeus, as it is known that James Edward Smith, the Founder of The Linnean Society added various specimens to the collection.
2. Day, M.C. 1979. The species of hymenoptera described by Linnaeus in the genera *Sphex*, *Chrysis*, *Vespa*, *Apis* and *Mutilla*. *Biological Journal of the Linnean Society* 12: 45-84.
3. Williams, Paul http://www.nhm.ac.uk/research-curation/projects/bombus/ where 118 species are known from the Palaearctic region compared to 11 in the East Neotropical Region containing the Amazon basin.
4. Almost identical specimens can be seen on Google Images. http://images.google.co.uk/images?
5. http://www.entomology.ucr.edu The subspecies is described as having a preference to partially decayed live oaks, deciduous oak, pepper trees (*Schinus molle*), eucalyptus and in the Spanish bayonet, *Yucca whipplei*.
6. typically in the Atlantic Rainforest at Cacheiros, Rio Janeiro State, Brazil. see www.regua.co.uk – a nature reserve of 6740ha in the Trés Picos National Park.
7. Feltwell, J. 2006 *Bumblebees*. Battle, Wildlife Matters.
8. Sladen, F.W.L. 1892. *The Humble-Bee, its life history of all the British species of Bombus and Psithyrus including The Humble Bee*. Reprinted by Logaston Press, 1989.
9. Prys-Jones, O.E. & Corbet, S.A. 1991. *Bumblebees*. Richmond, Richmond Publishing Co Ltd..
10. *Help save the Bumblebee…get more buzz from the countryside.* English Nature, 2006. Leaflet
11. The Bumblebee Conservation Trust. http://www.bumblebeeconservationtrust.co.uk/
12. Edwards, M. & Williams, P., 2004. Where have all the bumblebees gone, and could they ever return? British Wildlife June 2004 p. 305-312.
13. Benton, T. 2006. Bumblebees. The New Naturalist Library. London, Collins
14. Williams, *ibid*
15. Edwards, M. & Williams, P., 2004. Where have all the bumblebees gone, and could they ever return? *British Wildlife* June 2004 p. 305-312.
16. Wild bees and the flowers they pollinate are disappearing together. Press Release dated July 21, 2006. The University of Reading regarding paper in Science of 21 July 2006. http://www.nerc.ac.uk/press/releases/2006/bees.asp
17. Darwin, C.R. 1859. *Origin of Species by means of natural selection or the preservation of favoured races in the struggle for life.* London, John Murray.
18. http://www.buglife.co.uk The Invertebrate Conservation Trust.
19. http://www.ukbap.org.uk *B. distinguendus, humilis, ruderatus, subterraneus, sylvarum.*