The newsletter of the Society of Australian Systematic Biologists

Banksia

Banksia: The newsletter of the SASB

http://www.sasb.org.au

Issue 10 (March 2014)

Contents

photo credit: Lyn Cook

In this issue

Welcome to a new look Banksia

The 2013 general meeting of the SASB saw a change in editorial team for the newsletter, with the Cook lab at The University of Queensland taking on the role for the next two years. The new team would like to take this opportunity, on behalf of the Society, to thank Sam Brown for the tremendous contribution he made in starting the newsletter back in 2008 and for producing it about twice a year until August 2013.

Thanks to Sam Brown (pictured) for editing Banksia over the past 5 years.

In this issue, we introduce the new SASB committee and have a statement by incoming President Andy Austin. We have reports from several recent conferences (SASB, IBS ECR) and lab group meetings. Bob Mesibov provides Part I of a two-part series on using and reporting latitudes and longitudes, and this is followed by a review by Mike Crisp of a recently released GPS/two-way radio.

We finish off the issue with a systematics-themed crossword.

We welcome contributions from members and are keen to have reports on field trips and conferences, reviews of books, papers and software, and other news that might be of interest to members. We have typeset "Banksia" using the iBooks Author App and this allows us to add different types of media to the newsletter – so movies and interactive items are also encouraged. Please send contributions to Lyn Cook at l.cook@uq.edu.au.

You will already have noticed that SASB now also has an "E-alert" email newsletter for more urgent matters. Please email E-alert editor Rebecca Dew (The University of Adelaide) if you have any information on jobs, conferences, recent publications or other items with upcoming deadlines about which you would like to advise SASB members (rebecca.rmd@hotmail.com).

Cheers,

Lyn Cook & team

Layout and graphic design by Andy Wang

Report on SASB meeting in Sydney

by Simon Tierney

Attendees of “Systematics Without Borders”, Sydney, 2013 photo credit: Malcolm Ricketts

Conference Report: Systematics Without Borders, Sydney, 2013

The combined conferences of the Society of Australian Systematic Biologists (SASB), theInvertebrate Biodiversity & Conservation Conference (IBCC) and the Australasian Systematic Botany Society (ASBS) ran successfully during the first week of December 2013, on the picturesque grounds of The University of Sydney. Whilst checking into College accommodation, reception staff inquired as to what “*Systematics Without Borders”* actually meant. After a tangential and not entirely informative quip involving a reference to *Médecins sans Frontières*, the response detailed that while we may not be *real* doctors, as a collective, we certainly deal with *real* questions and use convergent scientific toolkits to explore life from a comparative evolutionary perspective. The inquisitors’ appeared satisfied and may have even feigned a modicum of interest: in any case, this did seem a pertinent distillation of the reason for convening.

Symposia consisted of investigations on a diverse array of organisms from aquatic, terrestrial, tropical, temperate, arid, and Antarctic ecosystems. Research projects continue to combine traditional alpha taxonomy and ecology with molecular genetic markers to resolve phylogenetic relationships, and, while Sanger sequencing is still a useful tool, a number of presentations provided results derived from high-throughput sequencing platforms. Such data sets are arguably a game changer in terms of the scope of questions that can be addressed and also gave a glimpse of the phylogenomic research horizon. A notable exemplar was a transcriptomic sequencing approach that addressed unresolved phylogenetic issues of land snails, incorporating upwards of 500 nuclear genes across 60-odd species, enthusiastically presented by Luisa Teasdale (The University of Melbourne & Museum Victoria). Luisa deservedly received the SASB award for Best Talk of the conference. The Best Poster prize was given to Rebecca Dew (Flinders University), for reminding us that evolutionary studies are best grounded by a robust taxo-

nomic and phylogenetic base, with her research on an as-yet undescribed assemblage of social bees. We were also fortunate to witness three highly informative and enjoyable keynote presentations from Craig Moritz (The Australian National University), Phil Garnock-Jones (University of Wellington) and Lyn Cook (The University of Queensland), all of whom provided valued insights on their latest research directives in tropical phylogeography, botanic reproduction and insect phylogenetics respectively.

Other non *de rigueur* highlights of the conference included an improvised 'call to arms' from Robyn Williams (The Science Show - ABC Radio National), imploring us to communicate our scientific stories to the broader community for mutual benefit; and a welcomely unrestrained stand-up comedy routine from Dieter Hochuli (The University of Sydney), which convincingly upstaged the otherwise decent-enough catering, hospitality and mural-art enjoyed at the Conference Dinner.

I would like to take this opportunity on behalf of all SASB members and conference attendees to sincerely thank the organising committee for a highly successful and well-run event:

Shane Ahyong *Co-Chair* (Australian Museum)
Peter Weston *Co-Chair* (Royal Botanic Gardens & Domain Trust)
Nerida Wilson *Co-Chair* (Australian Museum)
Pauline Markwell *Sponsorship Officer* (Royal Botanic Gardens & Domain Trust)
Dan Faith (Australian Museum)
Murray Henwood (The University of Sydney)
Frank Koehler (Australian Museum)
Andrew Mitchell (Australian Museum)
Nathalie Nagalingum (Royal Botanic Gardens)
Chris Reid (Australian Museum)
Karen Wilson (National Herbarium)

The next SASB meeting is earmarked for December 2015 and will be held in Western Australia, most likely Perth – see separate article in this issue by Mark Harvey.

Hope to see you there.
Simon Tierney

Conference accommodation: Women's College @ The University of Sydney

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The minutes of the 2013 SASB general meeting can be downloaded from http://www.sasb.org.au/history.html

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Meet the SASB committee

President

Andy Austin (The University of Adelaide)

Deputy-Director, Australian Centre for Evolutionary Biology & Biodiversity, UA. His major research interests focus on the biology, systematics and molecular phylogenetics of parasitic wasps, the evolution of host-parasitoid interactions, and the biodiversity and phylogeography of groundwater arthropods.

Vice President

Penny Mills (The University of Queensland)

Penny is a PhD candidate in the School of Biological Sciences at The University of Queensland. She is studying chromosomal evolution and the systematics of gall inducing scale insects in the *Apiomorpha minor* species complex. She is particularly interested in cryptic species and dolphins.

Secretary

Andrew Thornhill (Australian Tropical Herbarium)

Andrew completed his PhD at the ANU in Mike Crisp's lab in 2011. His project studied the pollen morphology of the Myrtaceae and used a combination of palynology, phylogenetics and paleobotany to create a dated molecular phylogeny. Andrew is now based at the Australian Tropical Herbarium in Cairns.

Treasurer

Simon Tierney (The University of Adelaide)

Simon is an evolutionary ecologist with a research focus on transitions in behavioural environments, namely the entry into new photic niches and the evolution of sociality. He is currently a postdoc at The University of Adelaide investigating the loss of vision among subterranean water beetles, using high-throughput sequencing to explore the selective pressures operating on eye-related genes. His previous studies have focused on facultatively social bees that provide insights into how social organisation and parasitism arose. Some social bees are unusual in that they only fly in dim light, and this led to an interest in insect vision. See: http://www.adelaide.edu.au/directory/simon.tierney

Webmaster

Bob Mesibov

Since migrating to Tasmania in 1973 I have worked (in chronological order!) as an apple picker, mine assayer, high school teacher, forester, basketmaker, forest ecology/zoology/forest management consultant and museum-based zoologist. Now retired, I live in Penguin and work on millipedes and other litter invertebrates. See:
http://www.qvmag.tas.gov.au/qvmag/index.php?c=153

Assistant Treasurer

Steve Cooper (South Australian Museum)

Steve's research uses genetic data to study the evolution and diversity of Australian fauna. He has a strong focus on invertebrates living in subterranean and ground-water habitats of arid Australia. See:

http://www.samuseum.sa.gov.au/about/staff/prof-steve-cooper

Councillor

Andrew Mitchell (Australian Museum)

In Andrew's words: "I first became interested in insects after visiting my local museum which had thousands of diverse bugs on display – the ultimate jigsaw puzzle! I now use both DNA-based and morphology-based methods to investigate evolutionary relationships in insects, particularly cutworm moths and their relatives (Noctuoidea). I am also an enthusiastic "DNA barcoder" applying this technique to taxonomy, pest identification and ecology". See:
http://australianmuseum.net.au/staff/andrew-mitchell/

Councillor

Lyn Cook (The University of Queensland)

Lyn uses phylogenies, traits and distributions to try to understand the origins, diversification and distributions of organisms, especially plants and insects in Australia. See:

http://www.biology.uq.edu.au/staff/lyn-cook
http://www.lyncook.org/Lyn_Cook/Welcome.html

Councillor

Nerida Wilson (Western Australian Museum)

Nerida is a marine molecular biologist, who received her BSc from University of Melbourne, and BSc (Hons) and PhD at University of Queensland (2004). After postdoc-ing in the USA for some years, she returned to the Australian Museum, and is currently working at the Western Australian Museum. She thinks sea slugs are amazing, closely followed by crinoids, various marine invertebrates, and the odd fish. See: http://www.biodiversitymarine.com

Councillor

Michael Rix (The University of Adelaide)

"I am interested in the taxonomy, systematics and evolutionary biology of spiders, arachnids and other terrestrial invertebrates. I am also interested in phylogenetics and cladistic theory, and in the application of molecular techniques to systematics and evolutionary biology. My recent research has focused on southern-temperate and Australasian micro-spiders in the superfamilies Palpimanoidea and Araneoidea, and I am currently studying the systematics of the Australian trapdoor spiders of the family Idiopidae."

Councillor

Shane Ahyong (Australian Museum)

Shane is a Senior Research Scientist and Manager of the Department of Marine Invertebrates at the Australian Museum, Sydney, Australia. Prior to joining the Australian Museum in 2010, he was manager of the Marine Biodiversity and Biosecurity Group and the Marine Invasives Taxonomic Service at the National Institute of Water and Atmospheric Research, Wellington, New Zealand (NIWA). He has published widely on the systematics and phylogeny of marine crustaceans worldwide, especially Decapoda and Stomatopoda. He is President of The Crustacean Society, a contributing editor to the World Register of Marine Species (WoRMS), and an associate editor of the journals, Invertebrate Systematics, Nauplius and Zootaxa. Ongoing research interests include invertebrate systematics, phylogenetic methods integrating morphological and molecular data, comparative morphology and biological invasions.

President's Report

Message from the new President

I am very pleased and honoured to take over the reins of SASB for the next two years. The Society has come a long way since its inception, and is now a firmly established entity in the promotion of systematics in Australia. The Society has continued to run its biannual conferences, the last one held in December in Sydney which I think arguably has been our most successful yet – congratulation to the organising committee. The next conference has now been decided and will be held in Perth in the second half of 2015 (see stories below).

This is the second time I have been President of the Society, the first being as SASB's inaugural President in 1997-98.

Since then the activities of the Society have grown consistently. The introduction of our newsletter in 2008 under the editorship of Sam Brown was a highly successful initiative, and his efforts in this regard have been a great contribution to the Society. Lyn Cook and Co. at The University of Queensland have taken over the production of BANKSIA for the next two years and for this we are very grateful. The other important development that has occurred in recent years is the student bursaries program that has helped a number of PhD students get to the biannual conference. This initiative was most recently organised by our past president, Steve Cooper, and members of the SASB Council, and for this and the hard work of the Council in guiding the Society through the last two years, I would like to thank them on behalf of the Society.

There are a number of challenges that SASB will face in the coming years, most important of which is the vexing issue of membership fees. This has been discussed at the two AGMs prior to Sydney last December, and both times there was strong support expressed for the need to charge membership fees. There are several reasons for doing this, the most important of which are 1) our current bank balance is rather small and leaves the Society exposed financially if any of our future conference or other initiatives run at a substantial loss, and 2) we do not have sufficient funds to develop a more effective program to support student activities and other initiatives the Society may wish to embark on. Basically, to be more successful the Society needs to have an income stream. The Executive has had some discussions about membership fees and, although not decided, we would like to introduce a moderate fee in 2014 for employed members but still keep membership free for students. If anyone has any thoughts on this issue, I would be pleased to hear from them.

Finally, I hope you all have a happy and productive 2014.

Regards, Andy Austin

andy.austin@adelaide.edu.au

Next SASB meeting

an invitation from Mark Harvey

Swan River, Perth

photo credit: Mike Crisp

2015 SOCIETY OF AUSTRALIAN SYSTEMATIC BIOLOGISTS AND INVERTEBRATE BIODIVERSITY AND CONSERVATION CONFERENCE

The next meeting of the Society of Australian Systematic Biologists will be held in Perth 30 November – 4 December 2015. It will be held in conjunction with the Invertebrate Biodiversity and Conservation meeting.

We believe that Perth is an appealing venue to host this joint meeting. There has been a huge upsurge in systematic research in Western Australia in the last decade, with the discovery of many new plant species and short-range endemic invertebrate species, including many previously undocumented radiations of subterranean fauna. Some of these new species have raised significant conservation issues for government and industry. In addition, there will be opportunities to experience the unique and diverse biota of Western Australia first hand with one or more excursions.

The proposed dates for the conference are designed to coincide with the common university break. Please contact the chair of the organising committee, Mark Harvey at the Western Australian Museum for further details (mark.harvey@museum.wa.gov.au)

photo credit: Mike Crisp

Latitudes and longitudes: Part 1

by Bob Mesibov

photo credit: Bob Mesibov

Getting your locations right: Part 1

Ever since handheld GPS units became widely available, fieldworkers have been using them to locate their sampling sites. You push a button, the GPS displays and stores the lat/long (latitude and longitude), and Bob's your uncle. What could be simpler?

Alas, there's more to it than that, and if you don't understand the basics of spatial data you're likely to report your field locations incorrectly. This two-part article expands on a similar one I contributed to *Banksia* no. 2 in 2009. It's a guide to improving how you get and report locations.

Format

We'll look first at the formats most widely used for GPS lat/lon. As an example I'll use a location I visited recently near Walkerville in Victoria.

Decimal seconds format, e.g. **38°49'57.4"S 145°59'50.2"E**. Degrees are followed by the degree symbol, minutes by a single quote and seconds by a double quote. Seconds are in whole seconds plus decimal parts of seconds. Each decimal seconds figure is followed by the relevant hemisphere, i.e. N or S for latitude, E or W for longitude. This location could also be written **145°59'50.2"E 38°49'57.4"S**, because those trailing letters E and S make it clear which figure is for latitude and which is for longitude.

Decimal minutes format, e.g. **38°49.957'S 145°59.837'E**. Here whole degrees are given together with minutes and decimal parts of minutes. The decimal part simply comes from dividing the number of seconds by 60, which is the number of seconds in a full minute: 57.4/60 = 0.957, and 50.2/60 = 0.837.

Decimal degrees format, e.g. **-38.83261 145.99728**. No degree symbols here, no quote marks and no hemisphere code, just degrees and decimal parts of degrees, e.g. 38 + (49/60) + (57.4/3600) = 38.83261. By convention, latitudes north of the Equator in decimal degrees are positive, and

Tom Semple takes a GPS recording

south of the Equator negative. Longitudes east of Greenwich are positive, and west of Greenwich negative. Also by convention, latitude comes before longitude when reporting lat/long in decimal degrees.

All three formats are available in your GPS, so that you can easily convert your readings from one format to another by changing the GPS 'units' setting. You can also do the conversions with formulas, most easily in a spreadsheet. Watch out, however, where you put the minus sign when converting to decimal degrees. (-1)*(38 + (49/60) + (57.4/3600)) equals -38.83261, which is correct, but (-38) + (49/60) + (57.4/3600) equals -37.16739, which is wrong.

Formatting issues with lat/long are usually ambiguities rather than mistakes. Suppose you see **Brown Mtn, NSW, 36.36S 149.23E** on a label. Is that latitude meant to be **36.36°S**, or **36°36'S** (= **36.6°S**)? It's obviously not a good idea to use a full stop as a separator when writing lat/lon. If you don't want to use the degree symbol in your own records, **38d49m57.4sS 145d59m50.2sE** is unambiguous and **38-49-57.4S 145-59-50.2E** isn't bad, but neither would be acceptable in a publication. If you're storing degree-minute-second lat/lons in a spreadsheet, consider having six separate fields, one for each number. Separate fields also make spreadsheet calculations easier, too, like conversion to decimal degrees.

Another ambiguity can arise when leading zeroes are dropped. Degree-minute-second format conventionally uses leading zeroes, as in **42°03'47"S**. If you write **42°3'47"S**, you may indeed have meant 3 minutes, but a reader might wonder if that's a typo for **42°13'47"S** or **42°39'47"S** etc. Including the leading zero is easy to do and removes the doubts.

How well do you understand lat/long?

Try these three exercises. Answers on p. 13.

(1) Ayers Rock is at roughly **25°21'S 131°02'E**.

If you drew a line from Ayers Rock through the centre of the Earth, at what lat/long on the other side of the world would the line emerge?

(2) The International Prime Meridian was fixed by international agreement in 1884. It ran through the Royal Observatory in Greenwich, London at **51°28'38"N 00°00'00"**. A competing possibility was the Paris Observatory at **48°50'11"N 02°20'11"E**.

If the 1884 agreement had made the Paris Observatory the location of the Prime Meridian, what would be the latitude and longitude of the Melbourne Museum? The Museum's current location (main entrance) is **37°48'13"S 144°58'18"E**.

(3) The goal of the Degree Confluence Project (http://confluence.org) is to visit each of the whole-integer lat/long intersections on land in the world, and to take pictures at each of these 'confluence points' (CPs). The most recent CP visited (as of 11 December 2013) was **24°S 26°E** in Botswana. How many CPs are there in all, including the oceans?

Digression on distance

It's not widely appreciated that lat/long and distance are related. People think of locations as points and distances as lines. Nevertheless, a degree of latitude has a length, namely 111 km (approximately), anywhere in the world. It's the length of an arc segment that follows the Earth's curvature.

A degree of longitude also has a length, but that length is dependent on latitude. It equals 111 km (approximately) times the cosine of the latitude:

City	Latitude	1 degree of latitude (km)	1 degree of longitude (km)
Darwin	12°27'S	111	108
Cairns	16°56'S	111	106
Brisbane	27°28'S	111	98
Perth	31°58'S	111	94
Sydney	33°52'S	111	92
Adelaide	34°56'S	111	91
Melbourne	37°49'S	111	88
Hobart	42°53'S	111	81

If 1 degree of latitude is 111 km, then 1 second of latitude is 111000/3600, or about 31 m, and at the latitude of Sydney, 1 second of longitude is 92000/3600, or about 26 m.

Those figures should give you a feeling for errors in GPS reading, which I'll discuss in the next section. For our Walkerville example, **38°49'57.4"S 145°59'50.2"E**, you can now see that reporting the lat/long to the nearest tenth of a second means to the nearest (roughly) 3 m, or an implied uncertainty of about ±1.5 m. The decimal-minutes location **38°49.957'S 145°59.837'E** to the nearest thousandth of a minute implies an uncertainty of about ±0.9 m, and the decimal degrees location **-38.83261 145.99728** to the nearest 0.00001 of a degree implies an uncertainty of ±0.5 m. How realistic are those uncertainties?

GPS error

They're not realistic. In fact, they're unbelievable. An ordinary handheld GPS unit just isn't that accurate.

A GPS unit is a radio receiver tuned to a particular set of orbiting satellites. It calculates its location on the Earth's surface from information contained in the satellite radio signals. This process involves unavoidable errors, and what you see on your GPS display is a fib which glosses over those errors.

To begin with, the reported location may not be *accurate*. In other words, the GPS might say you're at point A, but you're actually at point B some distance away. The accuracy of a GPS reading depends largely on satellite availability, and the more satellites the GPS can clearly 'see', the greater the accuracy. Also, the longer you leave the GPS to 'settle down' to a reading, the better.

You can watch that settling-down as a drop in what the GPS usually displays as its 'accuracy' (a misnomer). Under an open sky, the accuracy declaration might drop to less than 10 m in a minute or so. On a road through tall forest, the GPS might take 5-10 minutes to settle down, and then only with an accuracy declaration of 20-30 m. An accuracy declaration of 5 m is better than one of 10 m, which is better than one of 20 m. Be patient when taking GPS readings!

[Note: The accuracy declarations on GPS units are actually a little mysterious, and the manufacturers generally don't explain them. GPS enthusiasts have done tests which suggest that Garmin GPS 'accuracy' is a 50% error circle, meaning that 50% of all readings taken at a location will be inside a circle with that radius, and 50% will be outside. More on this below.]

Just like any other instrumental measurement, a GPS location can also vary from reading to reading, and a measure of the variation around the mean of a set of readings is the *precision* of the readings. In 2012 my 8-year-old Garmin eTrex® GPS unit got home-tested for precision. Twice a day for nearly a month I placed the eTrex at a particular spot in my backyard which sees mostly open sky. Readings were displayed to the nearest 1 metre (UTM) for convenience, and I allowed the eTrex to 'settle down' for at least a minute each time. Over 50 readings, the range of eastings (longitude's direction) was 12 m, and the range of northings (latitude's

direction) was 14 m. The standard deviations were 2.2 and 2.8 m, respectively, which is pretty good precision. Whether the mean position was *accurate* or not, I don't know – accuracy and precision are different things.

Manufacturers of GPS units often summarise the reliability of their measurements with an error probability. For example, the owner's manual for the Garmin GPSMap®62S, a popular and relatively accurate handheld GPS unit, says that 95% of readings will be within 10 m of the true position. (Conditions not specified by Garmin.) That can be understood as a circle 20 m in diameter, within which 95% of single, independent readings at the centre will be within 10 m of the centre's true location. My Garmin eTrex promises 15 m RMS, which means that 2/3rds of the readings will be within 15 m of the true position. (See *Further reading* below for more on GPS error).

See the problem? Even under good conditions – open sky, clear weather, GPS unit held up and well away from the body so you don't block satellite signals, letting the unit 'settle down' to a reading – an ordinary handheld GPS unit can only be relied on to locate your position ±10-15 m. But the display screen's figures imply an uncertainty of ±1.5 m (or less, depending on the format you selected).

What to do?

As a biological sampler you have three choices in dealing with the GPS error problem.

Ignore it. A lot of fieldworkers simply publish what the GPS screen says, e.g. **38°49'57.4"S 145°59'50.2"E**, without comment. If you do this, please add how you got the lat/lon, e.g. **38°49'57.4"S 145°59'50.2"E (GPS)**. That's code for *I know the lat/long really isn't that accurate, and you can mentally add at least ±10-15 m to the position estimate, now that you know how I got it*.

Specify an uncertainty. You do this by following the the Darwin Core biodiversity data standard, which says you can add an uncertainty to your location (note that Darwin Core prefers decimal degrees) by giving *The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location* (http://rs.tdwg.org/dwc/terms/index.htm#coordinateUncertaintyInMeters).

Note that this is an arbitrary point-radius uncertainty, *not* an error estimate. Your uncertainty will be based in part on the capability of your GPS unit (check its manual), in part on the accuracy declaration you get for your GPS reading, and in part on your assessment of the satellite reception conditions in the field. You're the best judge of what *smallest* means in *smallest circle*.

I'm pretty conservative, so under good conditions with my eTrex I routinely add an arbitrary ±25 m to my GPS locations. That specifies a circle 50 m in diameter around the lat/lon, within which I can reasonably expect the true sampling location was present. When my sampling location is a patch of bush rather than a point, I specify an appropriately bigger uncertainty, say ±50 m.

Getting back to Walkerville, **38°49'57.4"S 145°59'50.2"E ±25 m** would be one way I could report my GPS reading and its point-radius uncertainty. Again, that **±25 m** is *not* an error estimate, because there is simply no way to gather enough information for a single reading to understand how it was affected by satellite number, satellite position, weather, signal bounces off local objects, etc. If **38°49'57.4"S 145°59'50.2"E ±25 m** looks to you too much like an estimate with its error, you could report **38°49'57.4"S 145°59'50.2"E (coordinateUncertaintyInMeters = 25 m)**.

Round off your figures. If you prefer not to estimate a point-radius uncertainty for your GPS reading, but don't want your spatial data to have unbelievable implied accuracy, you can round off your lat/long to something realistic:

Whole seconds (e.g. **38°49'57"S 145°59'50"E**) implies an uncertainty of ca ±15 m, which is plausible for single, good-quality GPS readings

Decimal minutes to two places (e.g. **38°49.96'S 145°59.84'E**) implies an uncertainty of ca ±9 m, which is a little optimistic but more believable than keeping a third decimal place (ca ±0.9 m)

Decimal degrees to four places (e.g. **-38.8326 145.9973**) implies an uncertainty of ca ±5 m, even more optimistic but better than keeping a fifth decimal place (ca ±0.5 m)

Next issue...

Part 2 of this series will cover datums, Google Earth, locations in words, and GPS elevations. I'll finish here with two of my favourite wild exaggerations. The first is shown in the accompanying photo. I like to imagine someone in a big caravan, driving around the caravan park in ever-diminishing circles, trying to reach that absurdly exact location.

I found the second example in the Atlas of Living Australia. The lat/long in decimal degrees for a locality the collectors described in 1971 as 'ca 12 km SE of Millaa Millaa' is given as -17.6000003814697 145.699996948242. The vaguely worded Queensland locality has been located by ALA to the nearest 0.01 micron, possibly a world first in biodiversity data publishing.

Answers to lat/long exercises:

(1) **25°21'N 48°58'W**

(2) **37°48'13"S 142°38'07"E**. The Museum would be 2°20'11" closer to the Prime Meridian. Latitude wouldn't be different.

(3) 64442. A circle of latitude has 360 CPs. There are 90 integer circles of latitude north and south of the Equator, but the 90-degree ones - the North and South Poles - are one CP each, and the Equator (0 degrees latitude) is only counted once. The total is (2 * 89 * 360) + 2 [Poles] + 360 [Equator] = 64442.

Further reading:

Wikipedia has excellent pages on most of the topics in this article. There are also a range of websites dealing specifically with GPS error; two worth reading are http://www.radio-electronics.com/info/satellite/gps/accuracy-errors-precision.php and http://earthmeasurement.com/GPS_accuracy.html

Chapman, A.D. and Wieczorek, J. (eds) 2006. *Guide to best practices for georeferencing*. Global Biodiversity Information Facility, Copenhagen, 80 pp. [Available online at http://www.gbif.org/orc/?doc_id=1288]

Mesibov, R. 2012. Known unknowns, Google Earth, plate tectonics and Mt Bellenden Ker: some thoughts on locality data. *ZooKeys* 247: 61-67. [Available online at http://www.pensoft.net/journals/zookeys/article/4195/]

Rodríguez-Pérez, J., Álvarez, M. and Sanz-Ablanedo, E. 2007. Assessment of low-cost GPS receiver accuracy and precision in forest environments. *Journal of Surveying Engineering* 133(4): 159-167. [Available online as a 2006 conference paper at https://www.fig.net/pub/fig2006/papers/ps05_04/ps05_04_05_rodriguezperez_etal_0565.pdf]

Review of Garmin Rino GPS

by Mike Crisp

Tom Semple holds a Rino for display purposes.

Two ‘horns’ with twice the punch: the Garmin Rino 650 handheld GPS and two-way radio

Recently I bought a pair of these [details bottom*] and have already tested them in situations as widely separated as heathland in southern NSW and SE Queensland rainforests. They are amazing! As a hand-held GPS alone, it is the best I have used. And my basis for comparison is another, more expensive, Garmin unit, which at the time I bought it, was close to the top of the line in handhelds. The reason for buying a pair is that it is also a two-way UHF radio – ideal for keeping in touch with your companions in the bush.

Among the features of this device:

• Accuracy. Typically it reports an error of 3 m and the worst I have seen is 5 m.

• Speed. It finds its satellites very quickly and I seldom find myself hanging around, drumming my fingers and waiting for all the green bars to light up.

• Batteries. The rechargeable Li-ion batteries have an amazingly long life, even if you leave the device on for long periods while navigating. They have lasted me for several days’ field work. And there is a battery monitor that reports the percentage charge remaining.

• Sensitivity. It is almost as good under a rainforest canopy or heavy cloud as under a clear sky. And I was astonished to discover that it can see the sky through windows, even when positioned well inside a car or room.

• Compass. The built-in compass appears to be accurate and fast. The display (including a big, easy-to-see arrow) and response time are improved, making cross-country navigation to a waypoint much easier.

• Tip for using 'Where To?' to enter waypoints in advance. Don't choose the 'Coordinates' option because this only stores one waypoint at a time, deleting the previous coordinates when a new set is entered. Instead, make a waypoint at your current location, then edit and alter the name and coordinates using the waypoint manager. This allows you to store any number of waypoints in advance. This function has changed from my previous Garmin model.

Radio:

The device also has a built-in UHF radio with a range of up to 32 km (line of sight). This is why you buy them in pairs! You can communicate with any other UHF radio if the channels are synced. This includes in-vehicle or base radios. Best of all, the radio and GPS functions are integrated. If there are two of you in the field, each carrying a Rino, you can talk using the radio AND also can see the position of the other Rino(s) on the GPS map. Recently I was in the field with a colleague and we became separated in dense bush. When I returned to the vehicle, I called my colleague on the radio but no response. Their radio was switched off and they were lost in a dense thicket – they hadn't way-pointed the vehicle before setting off – naughty!! However, their GPS was on and I could see them on my GPS map, about 150 m away. So I yelled, got a response, and was able to direct my friend back to the road.

Accessories:

• Digital maps. A not very detailed world map is built in to the device but you should also get the 'Garmin TOPO Australia-NZ DVD 4' maps*. These can be used to navigate on both city and country roads, though instructions to turn are communicated by beeps, rather than in American English. Beware: some of the road information in these maps is out of date, especially for remote and minor roads. Last weekend, in trying to negotiate the maze of tracks in Barakula State Forest near Chinchilla in Queensland, we discovered that the roads on our GPS map didn't exist, while the actual roads weren't in the GPS map. We think that the problem is that the GPS map shows gazetted roads, which can often bear little relation to the roads that are subsequently made.

• Alkaline battery pack*. Very useful if you get caught with flat rechargeable batteries and (damn!) you left the charger home and/or don't have a power source available.

* Availability and prices as at 2 March 2014. The Rino GPS 650 is available from Johnny Appleseed <http://www.ja-gps.com.au/> at $560 (plus postage) for a single unit. Garmin TOPO Australia-NZ DVD 4' maps = $199. Alkaline battery pack = $39. Package deal: all the above in a single box, with Oz-NZ maps installed in the unit = $743 plus shipping (saves $55).

Report on IBS in Canberra

by Lisa Pope, Alicia Toon and Jude Keyes

photo credit: Peter Cowman

Session attendees at the IBS Early (and not so early) Career Researchers conference, Canberra, 2014.

This year's International Biogeography Society's early career conference kick-started 2014 by bringing together early career and experienced biogeography researchers to present their latest research and offer networking opportunities. It was held at the ANU in Canberra in January, jointly supported by IBS, the ANU Centre for Macroevolution and Macroecology and the ANU-CSIRO Centre for Biodiversity Analysis.

The week started with a day of workshops including BioGeoBEARS – run by Nicholas Matzke. This workshop started with a great general overview of biogeography and discussed the major philosophical split between vicariance versus dispersal. He showed that programs such as LAGRANGE don't allow founder events, so it is perhaps not surprising that it favours vicariance as the main mechanism for speciation, and showed how his new R package BioGeoBEARS [http://cran.r-project.org/package=BioGeoBEARS], allows you to be more explicit about what hypotheses you are testing.

The themes of the conference were species distribution modeling, advances in phylogenetics for biogeography and biodiversity turnover across spatial scales. The focus was on broad scales and multiple species, examining multiple factors to explain observed patterns – and ideally moving away from explaining patterns towards predicting them.

Traditional ideas from ecology about the spatial and temporal turnover of species are being broadened in a biogeographic context to include consideration of phylogenetic and genetic divergence. Theoretically, this is very straightforward: we simply replace species with alleles or lineages as our

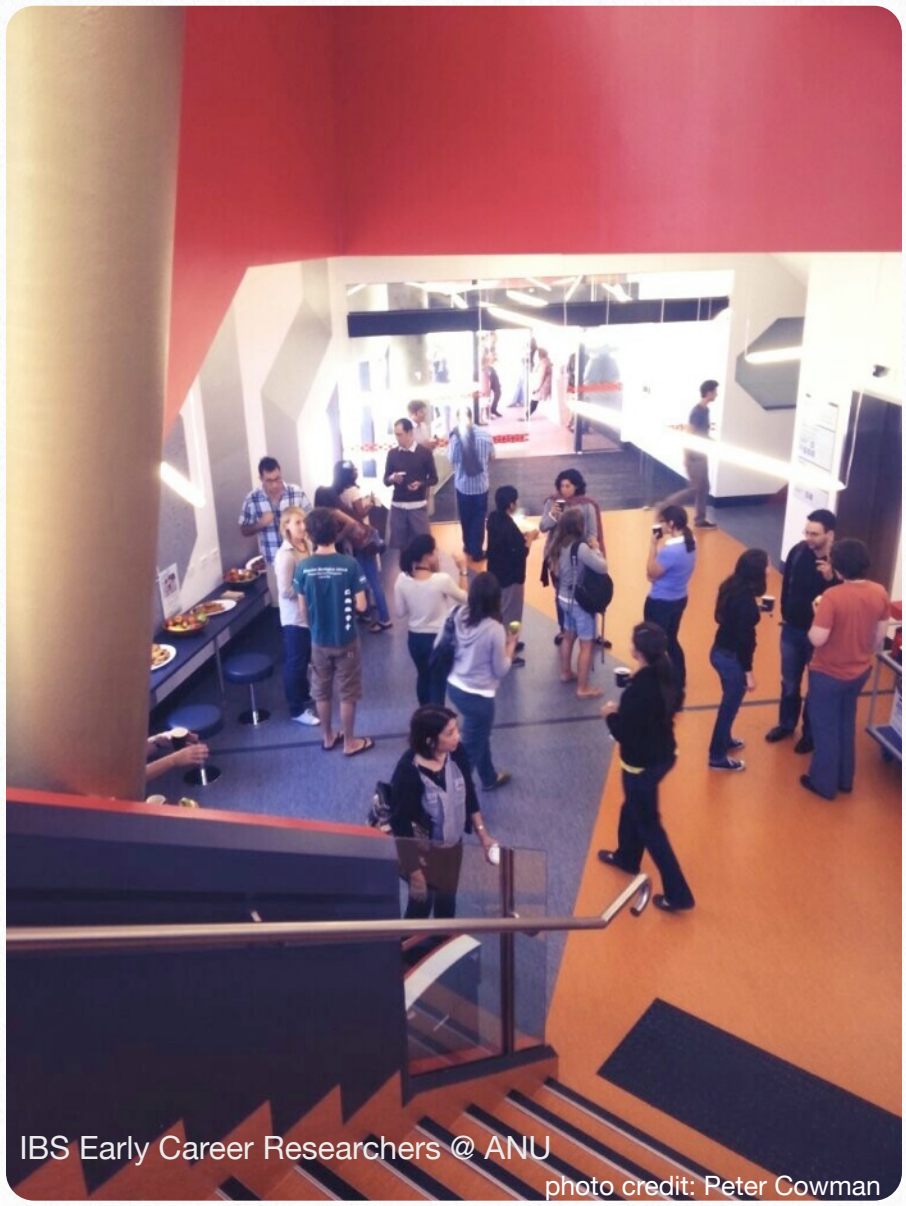
Some of the organisers of the IBS Canberra conference

photo credit: Peter Cowman

units of measurement. It's great to see the full taxonomic scale of the problem being addressed by biogeographers. The conference offered great insight into the new software being developed to handle this expansion. We heard from several speakers using BIODIVERSE [http://code.google.com/p/biodiverse/], open-source software written by Laffan, Lubarsky and Rosauer in 2010.

To pick out some specific highlights: Osmar Luiz gave a fantastic talk linking fish adult traits to range size. Body size, schooling behavior and nocturnal activity explained range size to a much greater extent than pelagic larval duration. Giovanni Di Virgilio presented an amazing 2D animated sliding window analysis using BIODIVERSE. Hélène Morlon gave an inspiring plenary on theories underlying geographic patterns of species richness. She found that, rather than the number of species in a lineage constantly increasing (such that the number of species in a lineage is explained by mutation rate/age of clade), or reaching an upper maximum (perhaps due to ecological limits), the number of species in a clade increased and then decreased. This finding challenges the underlying assumptions of many biogeographic analyses. Matthew Fitzpatrick ended with a plenary that illustrated a way forward for phylogeography, contrasting patterns of neutral and 'selected' SNP loci in multiple species across a broad geographic scale. This could be an interesting avenue to examine both dispersal and adaptation to environmental change.

The international attendance was reflected in exciting research from countries around the world including New Zealand, central and southern America, India, China, Africa and Europe as well as studies on a global scale. Some of the parallels from international studies were insightful, such as the high endemicity and levels of cryptic species in herpetofauna from tropical savannas in the Cerrado in Brazil and northern Australia, which has largely been uncovered using a combination of old (Sanger) and new (next-generation) sequencing methods. This an exciting time for using molecular methods in biogeography and we are just now seeing the first studies presenting analyses using massive sequencing datasets. Analysis of such datasets present a challenge, however the message was clear that future studies will combine these sequence data with traditional morphological and trait analyses, and the latest species distributional modeling, to get a better understanding about past and present spatial patterns of diversity.



IBS Early Career Researchers @ ANU

photo credit: Peter Cowman

Report on BSCVII

by Penny Mills

Lunch spot in gully off Sandstone Drive.

BOOTSTRAP CAMP VII – KUNGALA, NSW

"Bootstrap Camp" is the title given to the annual lab retreat for the Cook Lab from The University of Queensland (UQ), the Crisp Lab from The Australian National University (ANU) and, since 2012, the Bruhl lab from the University of New England (UNE). In 2013, the seventh annual Bootstrap Camp (BSCVII) was held from 3 - 9 November at the Community Hall in Kungala, NSW. Twelve lab members attended: Jeremy Bruhl, Marg Stimpson, Chrissy Prychid, George Plunkett and Nan Thomas (Bruhl lab); Lyn Cook, Alicia Toon, Paul Lin, Ed Sacre and Penny Mills (Cook lab); Mike Crisp and Bo Choi (Crisp lab).

At BSCVII, most people brought camping gear and camped or swagged near the community hall, leaving room for the local bushfire brigade to gain access to the fire station which bordered the hall. Paul, from the Cook lab, set up "camp" in the community hall to avoid the creepy crawlies outside.

For the first night of BSCVII, we gathered at The Golden Dog Hotel at Glenreagh for a meal and to interact with the other labs. True to its name, there is a 4-metre high yellow dog statue beside the hotel.

The next few days of BSCVII consisted of a morning/mid-afternoon walk through the local bush, including visiting some of the national parks and nature reserves near Kungala to observe the native flora and fauna, afternoon talks (10–15 min per person), some spare time while 2 or 3 people from one of the lab groups prepared the evening meal, and one after-dinner talk with discussion.

Attendees of BSCVII. Back (L-R): Nan, Chrissy, Mike, Ed, George, Jeremy. Front (L-R): Marg, Alicia, Penny, Bo, Paul, Lyn.

The talks covered topics ranging from morphological analyses to host interactions, molecular phylogenetics, molecular dating, DNA extraction protocols for difficult organisms, and systematics. The range of organisms included sedges, *Banksia*, *Melaleuca*, *Triodia*, the swamp foxtail grass *Cenchrus purpurascens*, eucalypts, and native and invasive scale insects.

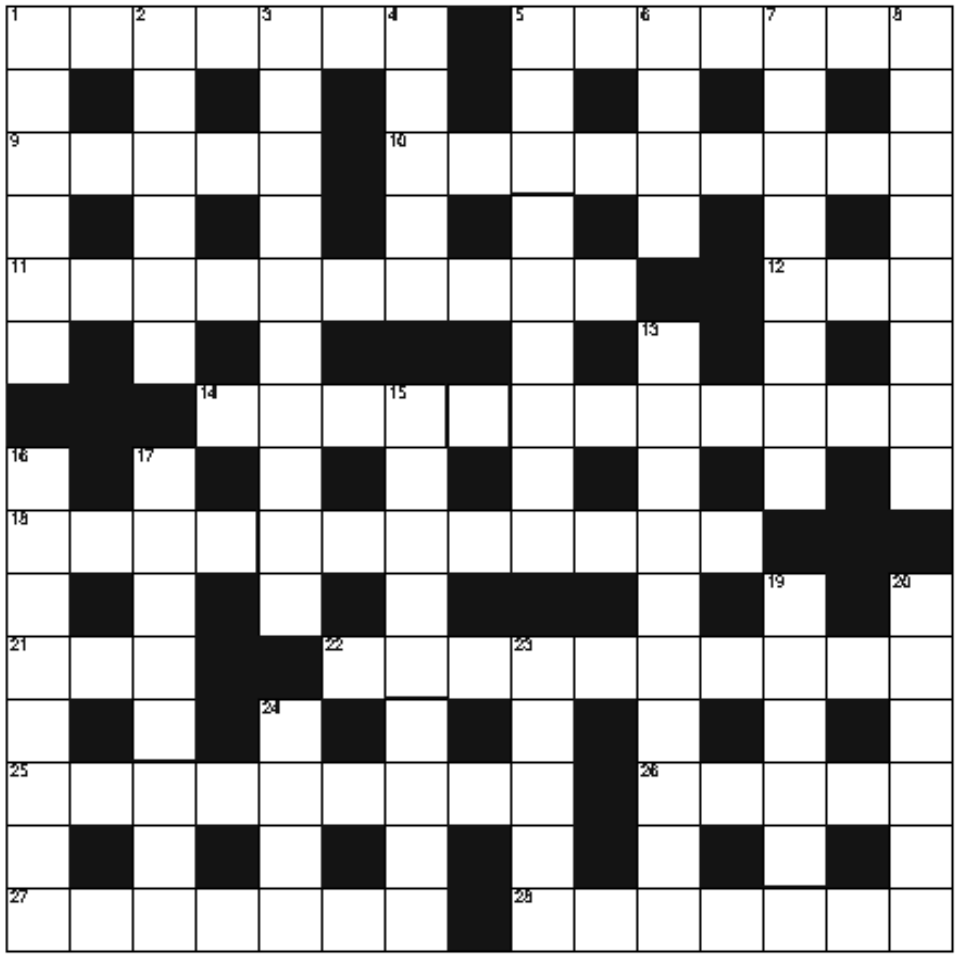
On the last full day of BSCVII, an unscheduled power outage "forced" most lab attendees to one of the Woolgoolga beaches for a swim and some down-time before returning to the community hall for technological talks and computer program demonstrations. The last night of BSCVII saw attendees treated to a concert by Marg and other local musicians, and the singing of the "Bootstrap Camp VII song" written by Marg and Chrissy.

I would like to thank Marg from the Bruhl lab who did most of the organising for BSCVII and for everyone who came and made this year's BSC another successful one.

One of the highlights of the week was a guided walk around Marg Stimpson's property at Kungala and seeing *Blandfordia* in bloom.

Systematics Crossword 1

By Cecidomyiidae



SIMPLE

Across

1. If you have matched sequences against GenBank, you've probably done this (7).
5 and **25** . What you get if you calculate the number of DNA substitutional differences between specimens (7,9).
9. Generation time is a species-level _____ (5).
10. Vulnerable residents of Christmas Island (4,5).
11. Folivorous (4,6).
12. Scanning electron microscopy (3).
14. This is an occasional mutation in decapods – could happen to 10 across (6,6).
18. If you remove blue hues from a white spectrum, you would shift colours in this direction (2,6,4).
21. A criterion used to evaluate differences in likelihood scores (3).
22. Two lineages that are each other's closest relative (6,4).
25. See 5 across (9).
26. Collective noun for a group of baboons (5).
27. A demersal fish is a bottom-_____ (7).
28. Used to vigorously scrub and clean a dirty beaker (7).

Down

1 and **6**. Reduction of genetic diversity through a founder event (6, 4).
2. Genus name for pineapple (6).
3. If you want to find the molar mass of Carbon, you would find the atomic mass of Carbon in the periodic table, and this is equal __ ___ _____ mass in grams per mole (2, 3, 5).
4. Town in the Netherlands famous for its blue and white pottery (5).
5. Early-established biotechnology company – has url of www.gene.com (9).
6. See **1** down.
7. Name of a line along which you take regular ecological samples (8).
8. Soft fine wool from a goat (8).
13. A fraction in which the numerator is not an exact multiple of the denominator (5,5).
15. Characteristic of a dobsonfly that might also be found in 10 across (3,6)?
16. DNA is double-_____ (8).
17. Termite colonies have individuals with different specialized morphologies, but cockroaches are _____ (8).
19. Process of giving birth in mammals (6).
20. ABI prism software for analyzing microsats: gene_____ (6).
23. The waxy covers of scale insects (5).
24. Post-anal extension of the backbone in vertebrates (4).

CRYPTIC

Across

1. Used search tool and blew up violently (7).
5 and **25** . Lengths which depend on the model of evolution (7,9).
9. Sounds like a platter characteristic (5).
10. Abundant Christmas Island residents require last of soil and sideways movements (9).
11. Folivory in the meadow where Hymenoptera have been exempted from carnivory (4-6).
12. Search engine marketing focuses on the detail (1,1,1).
14. Military manoeuvre possibly undertaken by 10 across (6,6)?
18. When 4 loses blue, this shift occurs in its colour wheel (2,6,4).
21. Australian Institute of Conveyancing to estimate lost information (1,1,1).
22. Nun taking you and me from tree – a common ancestor is shared (6,4).
25. See 5 across.
26. Portuguese city rearranges itself to form a military body (5).
27. Resident takes last of land to hesitate after bore (7).
28. Washer not needing the last of recourse (7).

DOWN

1 and **6**. Founder effect can contribute to courageous cervical arrangement (6, 4).
2. *Musa* fruit beheaded to create another fruiting genus (6).
3. Looking for wisdom? If so, where in the mouth one would go (2,3,5).
4. Famous for Blue and Orange, escaped up before tea (5).
5. Early-established biotechnology company using information, dash and technology (9).
6. See **1** down.
7. I left the train to the cult to take a sample (8).
8. It takes fee simple to acquire goat hair (8).
13. Stirred oration with no beginning or end to produce non-integral proportion (5,5).
15. Characteristic of dobsonfly might also be found in 10 across (3,6)?
16. DNA is typically left aground after the first half of 14 across (8).
17. Unlike termites, cockroaches are not about off set.
19. Workplace belongs to us – where we work.
20. Used to describe the occupation of early explorers, but now used to describe the occupation of biotechnology workers (6).
23. Organ loses me to become insect covers (5).
24. Feel ill after dinner to get result in Monte Carlo (4).

Solutions in next issue of Banksia

About the Society


photo credit: Lyn Cook

The Society

The Society of Australian Systematic Biologists is open to all people who use the science of biological systematics as a basis for the study and understanding of nature. The Society is a non-profit inter-disciplinary organisation whose purposes are to promote the scientific study of biological systematics and to disseminate scientific and educational information related to its fields of interest.

Membership

Membership is free. Details are available on the society website (http://www.sasb.org.au/contacts.html) and from the secretary.