## Supplementary material

# Evaluating the progress and needs of taxonomy since the Convention on Biological Diversity: going beyond the rate of species description

Elise Tancoigne<sup>A,B,D</sup> and Guillaume Ollivier<sup>C</sup>

<sup>A</sup>Institut de Systématique, Evolution, Biodiversité, ISYEB – UMR 7205 CNRS MNHN UPMC EPHE, Muséum National d'Histoire Naturelle, 25 Rue Cuvier, F-75005 Paris, France.

<sup>B</sup>INRA, UMR Lisis, IFRIS, Université Marne-la-Vallée, Cité Descartes, Champs-sur-Marne, 5 Boulevard Descartes, F-77454 Marne-la-Vallée Cedex 02, France.

<sup>c</sup>INRA, UR0767 Ecodéveloppement, PACA Research Centre, Site Agroparc, CS40509, F-84914 Avignon Cedex 9, France.

<sup>D</sup>Corresponding author. Present address: University of Geneva, Boulevard Carl Vogt 66, CH-1205 Geneva, Switzerland. Email: <a href="mailto:elise.tancoigne@unige.ch">elise.tancoigne@unige.ch</a>

## List of quantitative assessments of taxonomy (1992–2012, n = 84)

Documents analysed in our corpus (n = 67)

GTI reports

SBSTTA (1999); Herbert *et al.* (2001); Delanay and Associates (2002); Klopper *et al.* (2002); Shashikyan and Simonyan (2002); Wilson *et al.* (2002); Shimura (2003); Sattout (2004); Haas and Haeuser (2005, 2007); Taylor (2006); Anon. (2007); Oteng-Yeboah *et al.* (2007); Petřík (2007); W. Bogdanowicz, unpubl. data, 2004; T. Bourgoin, unpubl. data, 2004; F. Haas, unpubl. data, 2004; T. Nikolić, unpubl. data, 2004; A. Silfvergrip, unpubl. data, 2004.

### Governmental studies

Burnett *et al.* (1995); Shostak (1997); Tillier and De Wever (2000); Taylor and Hamer (2001); Götzl *et al.* (2003); Lewinsohn (2003); Australian Government Department of the Environment, Water, Heritage and the Arts (2006); Marques and Lamas (2006); Hall (2008); House of Lords, Science and Technology Committee (2008); Ng (2008); National Science and Technology Council, Committee on Science, Interagency Working Group on Scientific Collections (2009); Boxshall and Self (2011); Gerard *et al.* (2011); Lohrmann *et al.* (2012).

Scientific studies

Parnell (1993); Robles *et al.* (1996); Simonetti (1997); Green (1998); Sigogneau and Barriel (1998); Winston and Metzger (1998); Eggleton (1999); Herbert (2001); Hopkins and Freckleton (2002); Michán and Llorente (2002); Michán Aguirre and Morrone (2002); Michán Aguirre *et al.* (2004); Calabuig *et al.* (2003); Michán and Llorente Bousquets (2003, 2010); Cribb (2004); Löbl and Leschen (2005); Bouchet and Duarte (2006); Costello *et al.* (2006); McCallum and McCallum (2006); Agnarsson and Kuntner (2007); Pallini and

Matiello Fadini (2007); Michán *et al.* (2008); Smith *et al.* (2008); O'Dogherty *et al.* (2009); Packer *et al.* (2009); Rodrigues *et al.* (2010); Joppa *et al.* (2011); Tancoigne *et al.* (2011); Bacher (2012); Fontaine *et al.* (2012); Hamer (2012); R. Geeta, A. Levy, J. M. Hoch and M. Mark, unpubl. data, 2003.

*Missing documents* (n = 17)

Schminke (1994, 1996); Hawksworth (1995); Simonetti *et al.* (1995); Visher (1995); Anon. (2004, 2005); Blackmore (1996); Ziegler *et al.* (1997); Asociación Colombiano De Herbarios (1999); Torres-Contreras (2001); Gleich *et al.* (2002); Herrera (2002); Gast and Krieger Rincón (2003); Legakis and Emblow (2003); Nangulah and Zeidler (2004); Office of the Inspector General (2009).

### References

Agnarsson I, Kuntner M (2007) Taxonomy in a changing world: seeking solutions for a science in crisis. *Systematic Biology* **56**(3), 531–539. doi:10.1080/10635150701424546

Anon. (2004) Actes (vol 1 et 2) Premier Atelier International de NAFRINET, 23-24 October 2003, Rabat, Morocco.

Anon. (2005) Mongolian and transboundary area biodiversity: natural resources, biodiversity and future ecological trends. In 'Mongolian and Transboundary Area Biodiversity: Natural Resources, Biodiversity and Future Ecological Trends', 2005, Ulaanbaatar, Mongolia.

Anon. (2007) Eléments de stratégie et plan d'action pour le renforcement des capacités dans le domaine de la taxonomie en République Centrafricaine. (Ministère des eaux, forêts, chasse et pêche chargé de l'environnement: République Centrafricaine)

Asociación Colombiano De Herbarios 1999. 'Agenda de Investigación en Sistemática/Biodiversidad Siglo XXI.' (Asociación Colombiano de Herbarios: Colombia)

Australian Government Department of the Environment, Water, Heritage and the Arts (2006) 'Survey of Australian Taxonomic Capacity.' (Australian Government Department of the Environment, Water, Heritage and the Arts: Canberra, ACT, Australia)

Bacher S (2012) Still not enough taxonomists: reply to Joppa *et al. Trends in Ecology & Evolution* **27**(2), 65–66. doi:10.1016/j.tree.2011.11.003

Blackmore S (1996) 'A Summary of UK Based Expertise in Systematic Biology.' (UK Systematics Forum)

Bouchet P, Duarte CM (2006) The magnitude of marine biodiversity. In 'The Exploration of Marine Biodiversity – Scientific and Technological Challenges'. pp. 33–64. (Fundación BBVA)

Boxshall G, Self D (2011) 'UK Taxonomy & Systematic Reviews – 2010.' (Natural Environment Research Council: London, UK)

Burnett J, Copp C, Harding PT (1995) Biological recording in the United Kingdom. Present practice and future development. Summary report. Department of the Environment, London, UK.

- Calabuig I, Dieguez C, Izquierdo I, Ramos M, Scharff N, Enghoff H 2003. ENHSIN users: scientific and wider. In 'ENHSIN: the European Natural History Specimen Information Network'. pp. 41–75. (Natural History Museum: London, UK)
- Costello MJ, Bouchet P, Emblow CS, Legakis A (2006) European marine biodiversity inventory and taxonomic resources: state of the art and gaps in knowledge. *Marine Ecology Progress Series* **316**, 257–268. doi:10.3354/meps316257
- Cribb TH (2004) Living on the edge: parasite taxonomy in Australia. *International Journal for Parasitology* **34**(2), 117–123. doi:10.1016/j.ijpara.2003.11.004
- Delanay and Associates (2002) 'Capacity Gap Analysis and Statement of Requirement.' (Federal Biosystematics Partnership: Ottawa, ON, Canada)
- Eggleton P (1999) Termite species description rates and the state of termite taxonomy. *Insectes Sociaux* **46**, 1–5. doi:10.1007/s000400050105
- Fontaine B, van Achterberg K, Alonso-Zarazaga MA, Araujo R, Asche M, Aspöck H, Aspöck U, Audisio P, Aukema B, Bailly N, Balsamo M, Bank RA, Belfiore C, Bogdanowicz W, Boxshall G, Burckhardt D, Chylarecki P, Deharveng L, Dubois A, Enghoff H, Fochetti R, Fontaine C, Gargominy O, Lopez MSG, Goujet D, Harvey MS, Heller K-G, van Helsdingen P, Hoch H, De Jong Y, Karsholt O, Los W, Magowski W, Massard JA, McInnes SJ, Mendes LF, Mey E, Michelsen V, Minelli A, Nafria JMN, van Nieukerken EJ, Pape T, De Prins W, Ramos M, Ricci C, Roselaar C, Rota E, Segers H, Timm T, van Tol J, Bouchet P (2012) New species in the Old World: Europe as a frontier in biodiversity exploration, a test bed for 21st century taxonomy. *PLoS One* 7(5), e36881. doi:10.1371/journal.pone.0036881
- Gast F, Krieger Rincón K (2003) 'Actualización Estado de la Investigación en Biodiversidad y de la Cooperación Científica y Técnica en Colombia.' (Instituto de Investigación de Recursos Biológicos Alexander von Humboldt: Bogotá, Colombia)
- Gerard F, Hamer M, Raath M (2011) Audit report of South Africa's natural science collections. Collecting now to preserve the future. Totem Media, Johannesburg, South Africa; and South African National Biodiversity Institute, Pretoria, South Africa.
- Gleich M, Maxeiner D, Miersch M, Nicolay F, Rendall S (2002) 'Life Counts: Cataloguing Life on Earth.' (Atlantic Monthly Press: New York, NY, USA)
- Götzl M, Abdel-Qader O, Ehrendorfer F, Geisler A (2003) 'The Austrian collections and databases on species diversity: an interdisciplinary study for the Global Biodiversity Information Facility.' (Federal Ministry of Education, Science and Culture: Vienna, Austria)
- Green SV (1998) The taxonomic impediment in orthopteran research and conservation. *Journal of Insect Conservation* **2**(3–4), 151–159. doi:10.1023/A:1009633811789
- Haas F, Haeuser C (2005) Taxonomists: an endangered species? In 'Abstracts of Poster Presentations at the 11th Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice of the Convention on Biological Diversity'. pp. 87–89. (Secretariat of the Convention on Biological Diversity: Montréal, QC, Canada)
- Haas F, Haeuser C (2007) How many taxonomists are there? *Nationale Kontaktstelle Deutschland*. Available at <a href="http://www.gti-kontaktstelle.de/taxonomy\_E.html">http://www.gti-kontaktstelle.de/taxonomy\_E.html</a> [Verified 12 October 2017]

- Hall K (Ed.) (2008) 'Proceedings of the National Taxonomy Forum', 3–4 October 2007, Sydney, NSW, Australia. (Federation of Australian Scientific and Technological Societies (FASTS) and Australian Biological Resources Study (ABRS): Sydney, NSW, Australia)
- Hamer M (2012) An assessment of zoological research collections in South Africa. South African Journal of Science **108**(11/12), 1090. doi:10.4102/sajs.v108i11/12.1090
- Hawksworth DL (1995) The resource base for biodiversity assessments. In 'Global Biodiversity Assessment'. pp. 549–605. (Cambridge University Press: New York, NY, USA)
- Herbert DG (2001) Museum natural science and the NRF: crisis times for practitioners of fundamental biodiversity science. *South African Journal of Science* **97**(5/6), 168–172.
- Herbert DG, Smith GF, Hamer M, Scholtz CH (2001) Taxonomy and systematics research in South Africa: vital research facing a crisis in capacity and resources. Report to the National Research Foundation and the Department of Arts, Culture, Science and Technology.
- Herrera A (2002) 'Desarrollo de la Capacidad Taxonómica en América Central: iniciativa mundial en taxonomiaconvenio sobre la diversidad biologica.' (CBD/SIDA/INBiol)
- Hopkins GW, Freckleton RP (2002) Declines in the numbers of amateur and professional taxonomists: implications for conservation. *Animal Conservation* **5**(3), 245–249. doi:10.1017/S1367943002002299
- House of Lords, Science and Technology Committee (2008) Systematics and Taxonomy: Follow-up. 5th report. House of Lords Science and Technology Committee, London, UK.
- Joppa LN, Roberts DL, Pimm SL (2011) The population ecology and social behaviour of taxonomists. *Trends in Ecology & Evolution* **26**(11), 551–553. doi:10.1016/j.tree.2011.07.010
- Klopper RR, Smith GF, Chikuni AC (2002) The global taxonomy initiative in Africa. *Taxon* **51**(1), 159–165. doi:10.2307/1554974
- Legakis A, Emblow CS (2003) The register of collections of European marine species: an overview. In 'The New Panorama of Animal Evolution'. pp. 603–609. (Pensoft: Sofia, Bulgaria)
- Lewinsohn TM (2003) 'Evaluation of the State of Knowledge on Biological Diversity in Brazil: Executive Summary.' (Ministry of the Environment: Brasília, Brazil)
- Löbl I, Leschen RAB (2005) Demography of coleopterists and their thoughts on DNA barcoding and the phylocode, with commentary. *Coleopterists Bulletin* **59**(3), 284–292. doi:10.1649/850.1
- Lohrmann V, Vohland K, Ohl M, Haeuser C (2012) 'Taxonomische Forschung in Deutschland eine Übersichtsstudie.' (Christoph Häuser Netzwerk-Forum zur Biodiversitätsforschung Deutschland (NeFo): Berlin, Germany)
- Marques AC, Lamas CJE (2006) Sistemática zoológica no Brasil: estado da arte, expectativas e sugestões de ações futuras. *Papéis Avulsos de Zoologia* **46**(3), 139–174.
- McCallum ML, McCallum J (2006) Publication trends of natural history and field studies in herpetology. *Herpetological Conservation and Biology* **1**, 62–67.

- Michán L, Llorente JJ (2002) Hacia una historia de la Entomología en México. In 'Biodiversidad, Taxonomía y Biogeografía de Artrópodos en México'. (Eds J Llorente, JJ Morrone) pp. 3–52. (UNAM: Mexico)
- Michán L, Llorente Bousquets JE (2003) La taxonomía en méxico durante el siglo XX. *Publicaciones Especiales del Museo de Zoología* **12**, 1–229.
- Michán L, Llorente Bousquets J (2010) Bibliometría de la sistemática biológica sobre América Latina durante el siglo XX en tres bases de datos mundiales. *Revista de Biología Tropical* **58**(2), 531–545.
- Michán L, Russell JM, Sanchez Pereyra A, Llorens Cruset A, López Beltrán C (2008) Análisis de la sistemática actual en Latinoamérica. *Interciencia* **33**(10), 754–761.
- Michán Aguirre L, Morrone JJ (2002) Historia de la taxonomía de Coleoptera en México: Una primera aproximación. *Folia Entomologica Mexicana* **41**(1), 67–103.
- Michán Aguirre L, Llorente Bousquets J, Martínez AL, Castro DJ 2004. Breve historia de la Taxonomía de Lepidoptera en México durante el siglo XX. In 'Biodiversidad, Taxonomía y Biogeografía de Artrópodos en México'. pp. 5–42. (Facultad de Ciencias) Available at <a href="http://repositorio.fciencias.unam.mx:8080/xmlui/handle/11154/140047">http://repositorio.fciencias.unam.mx:8080/xmlui/handle/11154/140047</a> [Verified 3 November 2013]
- Nangulah S, Zeidler J (2004) 'National Biodiversity Professional Training Framework. Consultancy report for the Ministry of Environment and Tourism Philippines.' (Association of Systematic Biologists of the Philippines)
- National Science and Technology Council, Committee on Science, Interagency Working Group on Scientific Collections (2009) Scientific Collections: Mission-Critical Infrastructure of Federal Science Agencies. (Office of Science and Technology Policy: Washington, DC, USA)
- Ng FSP (2008) 'Natural History Museum Malaysia Planning and Development.' (United Nations Development Programme/Forest Research Institute: Malaysia)
- O'Dogherty L, De Wever P, Gorican S (2009) Historical perspective: 140 years of Mesozoic radiolarian taxonomy. *Geodiversitas* **31**(2), 357–369. doi:10.5252/g2009n2a5
- Office of the Inspector General (2009) 'Museum Collections: Accountability and Preservation.' (US Department of the Interior: Washington, DC, USA)
- Oteng-Yeboah A, Kwapong P, Cobblah MA, Smith R, Lyal CHC (2007) 'Taxonomic Needs Assessment for Ghana.' (CSIR/BioNET/NHM: Legon, Accra, Ghana)
- Packer L, Grixti JC, Roughley RE, Hanner R (2009) The status of taxonomy in Canada and the impact of DNA barcoding. Canadian Journal of Zoology 87(12), 1097–1110. doi:10.1139/Z09-100
- Pallini A, Matiello Fadini MA (2007) Demandas e perspectivas para a Acarologia no Brasil. *Neotropical Biological Conservation* **2**(3), 169–175.
- Parnell J (1993) Plant taxonomic research, with special reference to the tropics: problems and potential solutions. *Conservation Biology* **7**(4), 809–814. doi:10.1046/j.1523-1739.1993.740809.x
- Petřík P (2007) 'Global Assessment of Taxonomic Needs and Capacities.' (CBD National Reports: Průhonice, Czech Republic)

- Robles G, Correa M, Ocampo R (Eds) (1996) 'Situación de los herbarios de Centroamérica y el Caribe.' (Centro Agronómico Tropical de Investigación y Enseñanza, Tecnica: Turrialba, Costa Rica)
- Rodrigues ASL, Gray CL, Crowter BJ, Ewers RM, Stuart SN, Whitten T, Manica A (2010) A Global Assessment of Amphibian Taxonomic Effort and Expertise. *Bioscience* **60**(10), 798–806. doi:10.1525/bio.2010.60.10.6
- Sattout EJ (2004) Lebanon 2005 taxonomy report. National capacities & needs. American University of Beirut, Beirut, Lebanon.
- SBSTTA (1999) The Global Taxonomy Initiative: recommendations from DIVERSITAS Element 3, including an assessment of present knowledge of key species groups. In 'DIVERSITAS/Systematics Agenda 2000 meeting', 1999. p. 34. (Technical Subsidiary Body on Scientific and Technologica Advice: ICSU, Paris, France) Available at <a href="https://www.cbd.int/doc/meetings/sbstta-04/information/sbstta-04-inf-06-en.pdf">https://www.cbd.int/doc/meetings/sbstta-04/information/sbstta-04-inf-06-en.pdf</a> [Verified 12 October 2017]
- Schminke HK (1994) Wiederaufbau von Forschung und Lehre in Zoosystematik eine nationale Aufgabe. *Spektrum der Wissenschaft* **9**, 114–116.
- Schminke HK (1996) Naturkundliche Sammlungen das vernachlässigte Erbe? *Spektrum der Wissenschaft* **1996**, 116–119.
- Shashikyan S, Simonyan G (2002) Assessment of priority capacity building needs for biodiversity. National report. CDB National Reports, Ministry of Nature Protection, Yerevan, Armenia.
- Shimura J (2003) 'Global Taxonomy Initiative in Asia. Research Report from the National Institute for Environmental Studies.' (National Institute for Environmental Studies: Tsukuba, Ibaraki, Japan)
- Shostak AW (1997) Results of surveys of taxonomic expertise in parasitology in Canada and of interest in national faunal projects on parasites in Canada. *Taxonomic Survey and Gap Analysis*. Available at <a href="http://www.biology.ualberta.ca/parasites/ParSec/texten/modgap.html">http://www.biology.ualberta.ca/parasites/ParSec/texten/modgap.html</a> [Verified 12 October 2017]
- Sigogneau A, Barriel V (1998) Positions de la France en Systématique caractérisées par quelques indicateurs bibliométriques. *Biosystema* **16**, 27–36.
- Simonetti JA (1997) Biodiversity and a taxonomy of Chilean taxonomists. *Biodiversity and Conservation* **6**(4), 633–637. doi:10.1023/A:1018345631406
- Simonetti JA, Arroyo TK, Spotorno AE, Lozada E (1995) 'Diversidad biologica de Chile.' (Comision Nacional de Investigacion Cientifica y Tecnologica)
- Smith GF, Buys M, Walters M, Herbert DG, Hamer M (2008) Taxonomic research in South Africa: the state of the discipline. *South African Journal of Science* **140**(7–8), 254–256.
- Tancoigne E, Bole C, Sigogneau A, Dubois A (2011) Insights from Zootaxa on potential trends in zoological taxonomy. Frontiers in Zoology 8, 5. doi:10.1186/1742-9994-8-5
- Taylor A (2006) 'United Kingdom Taxonomic Needs Assessment.' (NHM/defra: London, UK)
- Taylor PJ, Hamer M (2001) A report on the South African zoological collections audit 1998. *South African Museums Association Bulletin* **25**(2), 5–20.

- Tillier S, De Wever P (2000) Systématique : ordonner la diversité du vivant Rapport sur la science et la technologie n°11. Editions Tec & Doc. Rapport sur la science et la technologie: Paris, France)
- Torres-Contreras H (2001) Antecedentes biológicos de hormigas presentes en Chile publicados en revistas científicas nacionales y extranjeras durante el siglo XX. *Revista Chilena de Historia Natural* **74**, 653–668. doi:10.4067/S0716-078X2001000300011
- Visher L (Ed.) (1995) Taxonomy in crisis? A report on a national workshop held in Canberra, 18 October 1995. (Australian Biological Resources Study: Canberra, ACT, Australia)
- Wilson KL, Cresswell I, Lyal CHC, Shimura J (Eds) (2002) Building capacity: Bangladesh to Bali and beyond. Preliminary report of first Global Taxonomy Initiative Workshop in Asia', September 2002, Putrajaya, Malaysia. pp. 1–54. Available at <a href="https://www.cbd.int/doc/meetings/sbstta/sbstta-09/information/sbstta-09-inf-17-en.pdf">https://www.cbd.int/doc/meetings/sbstta/sbstta-09/information/sbstta-09-inf-17-en.pdf</a> [Verified 12 October 2017]
- Winston JE, Metzger KL (1998) Trends in taxonomy revealed by the published literature. *Bioscience* **48**, 125–128. doi:10.2307/1313138
- Ziegler W, Bode HJ, Mollenhauer D, Peters DS, Schminke HK, Trepl L, Türkay M, Zizka G, Zwölfer H (1997) Biodiversitätsforschung: Ihre Bedeutung für Wissenschaft, Anwendung und Ausbildung. Fakten, Argumente und Perspektiven. *Kleine Senckenberg Reihe* **26**, 1–68.