

VI RESEARCH CONTRIBUTIONS

INTRODUCTION

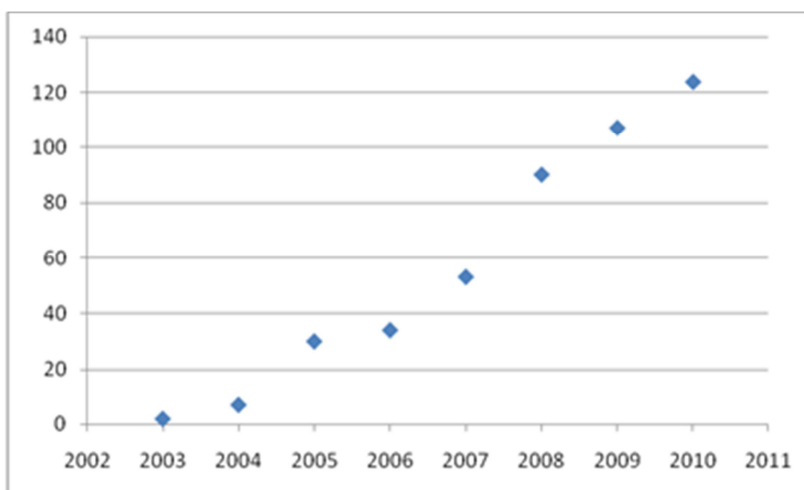
Since its introduction in 2003, most publications employing DNA barcoding were about DNA barcoding itself. Indeed, the number of publications using the term “DNA barcoding” or “DNA barcode” in the title has climbed steadily over the years (see Figure VI-1). However, these publications are being dwarfed by those that are simply using DNA barcoding as a tool, without explicit mention in the title or abstract. For example, according to Google Scholar there have been 103 articles published with “DNA Barcode” or “DNA Barcoding” in the title in 2010, however, there are 921 publications that use the term elsewhere in the body of the article but not necessarily in the title. This speaks volumes about the acceptance of DNA barcoding as a legitimate and useful tool within the scientific community.

As noted in the analysis below, a large proportion of DNA barcoding-related publications come from iBOL-related researchers. However, many have not been acknowledged as such. Recognizing the need for a stronger publication policy, iBOL’s Executive Director recently proposed the following:

This work was supported by funding to the International Barcode of Life Project (iBOL) through the Canadian Centre for DNA Barcoding, from the Ontario Genomics Institute, Genome Canada, the Ontario Ministry of Research and Innovation, and the Natural Sciences and Engineering Research Council of Canada.

This phraseology is currently being recommended on a case-by-case basis but will be formalized and communicated to the iBOL Membership in the Spring of 2011.

Figure VI-1: The number of scientific publications having the phrase “DNA Barcoding” or “DNA Barcode” in the title, 2003-2010, according to Google Scholar



PUBLICATIONS DIRECTLY ARISING FROM THE ICI

The publications below acknowledge Genome Canada as a source of funding for the research. Articles in bold are included in full in Appendix V.

1. Birstein VJ, Desalle R, Doukakis P, Hanner R, Ruban GI, Wong E (2009) Testing taxonomic boundaries and the limit of DNA barcoding in the Siberian sturgeon, *Acipenser baerii*. Mitochondrial DNA 20: 110-118.
2. Campagna L, Lijtmaer DA, Kerr KCR, Barreira AS, Hebert PDN, Lougheed SC, Tubaro PL (2010) DNA barcodes provide new evidence of a recent radiation in the genus *Sporophila* (Aves: Passeriformes). Molecular Ecology Resources 10: 449-458.

3. Clarkston, B.E. & Saunders, G.W. 2010. A comparison of two DNA barcode markers for species discrimination in the red algal family Kallymeniaceae (Gigartinales) with a description of *Euthora timburtonii*. *Botany* 88: 119-131.
4. Ekrem T, Stur E, Hebert PDN (2010) Females do count: Documenting Chironomidae (Diptera) species diversity using DNA barcoding. *Organisms Diversity & Evolution* 10: 397-408.
5. Fazekas, A.J., P.R. Kesanakurti, K.S. Burgess, D.M. Percy, S.W. Graham, S.C.H. Barrett, S.G. Newmaster, M. Hajibabaei and B.C. Husband. 2009. Are plant species inherently harder to discriminate than animal species using DNA barcoding markers? *Molecular Ecology Resources* 9(Supp. 1): 130–139 doi: 10.1111/j.1755-0998.2009.02652.x.
6. Fazekas AJ, Steeves R, Newmaster SG, Hollingsworth PM (2010) Stopping the stutter: Improvements in sequence quality from regions with mononucleotide repeats can increase the usefulness of non-coding regions for DNA barcoding. *Taxon* 59: 694-697.
7. Floyd R, Lima J, deWaard J, Humble L, Hanner R (2010) Common goals: policy implications of DNA barcoding as a protocol for identification of arthropod pests. *Biological Invasions* 12: 2947-2954.
8. Footitt RG, Maw HEL, Pike KS, Miller RH (2010) The identity of *Pentalonia nigronervosa* Coquerel and *P. caladii* van der Goot (Hemiptera: Aphididae) based on molecular and morphometric analysis. *Zootaxa*: 25-38.
9. Geraci, C. J., Zhou, X., Morse, J. C., & Kjer, K. M. (2010). Defining the genus *Hydropsyche* (Trichoptera:Hydropsychidae) based on DNA and morphological evidence. *Journal of the North American Benthological Society*, 29(3), 918-933.
10. Hajibabaei M, Singer GAC (2009) Googling DNA sequences on the World Wide Web. *Bmc Bioinformatics* 10.
11. Hebert PDN, deWaard JR, Landry JF (2010) DNA barcodes for 1/1000 of the animal kingdom. *Biology Letters* 6: 359-362.
12. Hollingsworth PM, Forrest LL, Spouge JL, Hajibabaei M, Ratnasingham S, van der Bank M, Chase MW, Cowan RS, Erickson DL, Fazekas AJ, Graham SW, James KE, Kim KJ, Kress WJ, Schneider H, van AlphenStahl J, Barrett SCH, van den Berg C, Bogarin D, Burgess KS, Cameron KM, Carine M, Chacon J, Clark A, Clarkson JJ, Conrad F, Devey DS, Ford CS, Hedderson TAJ, Hollingsworth ML, Husband BC, Kelly LJ, Kesanakurti PR, Kim JS, Kim YD, Lahaye R, Lee HL, Long DG, Madrinan S, Maurin O, Meusnier I, Newmaster SG, Park CW, Percy DM, Petersen G, Richardson JE, Salazar GA, Savolainen V, Seberg O, Wilkinson MJ, Yi DK, Little DP, Grp CPW (2009) A DNA barcode for land plants. *Proceedings of the National Academy of Sciences of the United States of America* 106: 12794-12797.
13. Hunt, B., Strugnell, J., Bednarsek, N., Linse, K., Nelson, R. J., Pakhomov, E., Seibel, B., Steinke, D., & Wurzberg, L. (2010). Poles Apart: The "Bipolar" Pteropod Species *Limacina helicina* Is Genetically Distinct Between the Arctic and Antarctic Oceans. *PLoS ONE*, 5(3), e9835.
14. James, S. W., Porco, D., Decaëns, T., Richard, B., Rougerie, R., & Erse'us, C. (2010). DNA Barcoding Reveals Cryptic Diversity in *Lumbricus terrestris* L., 1758 (Clitellata): Resurrection of *L. herculeus* (Savigny, 1826). *PLoS ONE*, 5(12), e15629.
15. Kerr KCR, Birks SM, Kalyakin MV, Red'kin YA, Koblik EA, Hebert PDN (2009) Filling the gap - COI barcode resolution in eastern Palearctic birds. *Frontiers in Zoology* 6.
16. Le Gall L, Saunders GW (2010) DNA Barcoding is a Powerful Tool to Uncover Algal diversity: a Case Study of the Phylloporaceae (Gigartinales, Rhodophyta) in the Canadian Flora. *Journal of Phycology* 46: 374-389.
17. Li YW, Zhou X, Feng G, Hu HY, Niu LM, Hebert PDN, Huang DW (2010) COI and ITS2 sequences delimit species, reveal cryptic taxa and host specificity of fig-associated *Sycophila* (Hymenoptera, Eurytomidae). *Molecular Ecology Resources* 10: 31-40.
18. Lukhtanov VA, Sourakov A, Zakharov EV, Hebert PDN (2009) DNA barcoding Central Asian butterflies: increasing geographical dimension does not significantly reduce the success of species identification. *Molecular Ecology Resources* 9: 1302-1310.
19. Newmaster, S.G and S. Ragupathy. 2009. Testing Plant Barcoding in a Sister Species Complex of Pantropical Acacias (Mimosoideae, Fabaceae) *Molecular Ecology Resources* 9 (Suppl. 1),164–171 (doi: 10.1111/j.1755-0998.2009.02641.x)
20. 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-Revue Canadienne De Zoologie* 87: 1097-1110.

21. Park DS, Suh SJ, Oh HW, Hebert PDN (2010) Recovery of the mitochondrial COI barcode region in diverse Hexapoda through tRNA-based primers. *Bmc Genomics* 11.
22. Pauls SU, Blahnik RJ, Zhou X, Wardwell CT, Holzenthal RW (2010) DNA barcode data confirm new species and reveal cryptic diversity in Chilean Smicridea (Smicridea) (Trichoptera:Hydropsychidae). *Journal of the North American Benthological Society* 29: 1058-1074.
23. Porco D, Rougerie R, Deharveng L, Hebert P (2010) Coupling non-destructive DNA extraction and voucher retrieval for small soft-bodied Arthropods in a high-throughput context: the example of Collembola. *Molecular Ecology Resources* 10: 942-945.
24. Ragupathy, S., S.G. Newmaster, B. Velusamy, M. Murugesan. 2009. DNA barcoding discriminates a new cryptic grass species revealed in an ethnobotany study by the hill tribes of the Western Ghats in southern India. *Molecular Ecology Resources* 9(Supp. I.): 172–180. (doi: 10.1111/j.1755-0998.2009.02642.x).
25. **Rasmussen RS, Morrissey MT, Hebert PDN (2009) DNA Barcoding of Commercially Important Salmon and Trout Species (*Oncorhynchus* and *Salmo*) from North America. *Journal of Agricultural and Food Chemistry* 57: 8379-8385.**
26. Richard B, Decaens T, Rougerie R, James SW, Porco D, Hebert PDN (2010) Re-integrating earthworm juveniles into soil biodiversity studies: species identification through DNA barcoding. *Molecular Ecology Resources* 10: 606-614.
27. Robinson EA, Blagoev GA, Hebert PDN, Adamowicz SJ (2009) Prospects for using DNA barcoding to identify spiders in species-rich genera. *Zookeys*: 27-46.
28. Rougerie R, Decaens T, Deharveng L, Porco D, James SW, Chang CH, Richard B, Potapov M, Suhardjono Y, Hebert PDN (2009) DNA barcodes for soil animal taxonomy. *Pesquisa Agropecuaria Brasileira* 44: 789-802.
29. Saunders GW, McDonald B (2010) DNA barcoding reveals multiple overlooked Australian species of the red algal order Rhodymeniales (Florideophyceae), with resurrection of *Halopeltis* J. Agardh and description of *Pseudohalopeltis* gen. nov. *Botany-Botanique* 88: 639-667.
30. Shokralla S, Singer GAC, Hajibabaei M (2010) Direct PCR amplification and sequencing of specimens' DNA from preservative ethanol. *Biotechniques* 48: 233-234.
31. Smith MA, Fisher BL (2009) Invasions, DNA barcodes, and rapid biodiversity assessment using ants of Mauritius. *Frontiers in Zoology* 6.
32. Sriwattanarothai N, Steinke D, Ruenwongsa P, Hanner R, Panijpan B (2010) Molecular and morphological evidence supports the species status of the Mahachai fighter *Betta* sp Mahachai and reveals new species of *Betta* from Thailand. *Journal of Fish Biology* 77: 414-424.
33. Steinke D, Zemplak TS, Boutillier JA, Hebert PDN (2009) DNA barcoding of Pacific Canada's fishes. *Marine Biology* 156: 2641-2647.
34. **Steinke D, Zemplak TS, Hebert PDN (2009) Barcoding Nemo: DNA-Based Identifications for the Ornamental Fish Trade. *Plos One* 4.**
35. Stoev, P., Akkari, N., Zapparoli, M., Porco, D., Enghoff, H., Edgecombe, G. D., Georgiev, T., & Penev, L. (2010). The centipede genus *Eupolybothrus* Verhoeff, 1907 (Chilopoda: Lithobiomorpha: Lithobiidae) in North Africa, a cybertaxonomic revision, with a key to all species in the genus and the first use of DNA barcoding for the group. *Zookeys*, 50, 29–77
36. Van Velzen R, Larsen TB, Bakker FT (2009) A new hidden species of the *Cymothoe caenis*-complex (Lepidoptera: Nymphalidae) from western Africa. *Zootaxa*: 53-63.
37. Victor BC, Hanner R, Shivji M, Hyde J, Caldow C (2009) Identification of the larval and juvenile stages of the Cubera Snapper, *Lutjanus cyanopterus*, using DNA barcoding. *Zootaxa*: 24-36.
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- deWaard JR, Mitchell A, Keena MA, Gopurenko D, Boykin LM, Armstrong KF, Pogue MG, Lima J, Floyd R, Hanner RH, Humble LM (2010) Towards a Global Barcode Library for Lymantria (Lepidoptera: Lymantriinae) Tussock Moths of Biosecurity Concern. *Plos One* 5.
39. Wilson, J. J. (2010). Assessing the value of DNA barcodes and other priority gene regions for molecular phylogenetics of Lepidoptera. *PLoS One*, 5(5), e10525.
40. Zhou X, Adamowicz SJ, Jacobus LM, DeWalt RE, Hebert PDN (2009) Towards a comprehensive barcode library for arctic life - Ephemeroptera, Plecoptera, and Trichoptera of Churchill, Manitoba, Canada. *Frontiers in Zoology* 6.

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PUBLICATIONS INDIRECTLY ARISING FROM THE ICI

The articles below include at least one member of iBOL's Scientific Steering Committee as an author, but do not explicitly acknowledge the Project or Genome Canada.

1. Adamski D, Copeland RS, Miller SE, Darrow K, Hebert PDN, Luke Q (2010) A Review of African Blastobasinae (Lepidoptera: Gelechioidea: Coleophoridae), with New Taxa Reared from Native Fruits in Kenya. *Smithsonian Contributions to Zoology*: 1-63.
2. Azpurua J, De La Cruz D, Valderama A, Windsor D (2010) *Lutzomyia* Sand Fly Diversity and Rates of Infection by *Wolbachia* and an Exotic *Leishmania* Species on Barro Colorado Island, Panama. *Plos Neglected Tropical Diseases* 4.
3. Baldwin CC, Weigt LA, Smith DG, Mounts JH (2009) Reconciling Genetic Lineages with Species in Western Atlantic Coryphopterus (Teleostei: Gobiidae). *Smithsonian Contributions to the Marine Sciences: ISSN 0196-0768(print)|1943-0667X(electronic)*.
4. Bellemain E, Carlsen T, Brochmann C, Coissac E, Taberlet P, Kausserud H (2010) ITS as an environmental DNA barcode for fungi: an in silico approach reveals potential PCR biases. *Bmc Microbiology* 10.
5. Bucklin, A., Steinke, D., & Blanco-Bercial, L. (2010). DNA Barcoding of Marine Metazoa. *Annual Review of Marine Science*, 3(1)
6. Chen SL, Yao H, Han JP, Liu C, Song JY, Shi LC, Zhu YJ, Ma XY, Gao T, Pang XH, Luo K, Li Y, Li XW, Jia XC, Lin YL, Leon C (2010) Validation of the ITS2 Region as a Novel DNA Barcode for Identifying Medicinal Plant Species. *Plos One* 5.
7. Chung IH, Yoo HS, Eah JY, Yoon HK, Jung JW, Hwang SY, Kim CB (2010) A DNA Microarray for Identification of Selected Korean Birds Based on Mitochondrial Cytochrome c Oxidase I Gene Sequences. *Molecules and Cells* 30: 295-301.
8. Clayden, S.L. & Saunders, G.W. 2010. Recognition of *Rubrointrusa membranacea* gen. et comb. nov., *Rhodonematella subimmersa* gen. et comb. nov. (with a re-interpretation of the life history) and the Meiodiscaceae fam. nov. within the Palmariales (Rhodophyta). *Phycologia* 49: 283-300.
9. Costa FO, Carvalho GR (2010) New insights into molecular evolution: prospects from the Barcode of Life Initiative (BOLI). *Theory in Biosciences* 129: 149-157.
10. Costa FO, Henzler CM, Lunt DH, Whiteley NM, Rock J (2009) Probing marine Gammarus (Amphipoda) taxonomy with DNA barcodes. *Systematics and Biodiversity* 7: 365-379.
11. Craft KJ, Pauls SU, Darrow K, Miller SE, Hebert PDN, Helgen LE, Novotny V, Weiblen GD (2010) Population genetics of ecological communities with DNA barcodes: An example from New Guinea Lepidoptera. *Proceedings of the National Academy of Sciences of the United States of America* 107: 5041-5046.
12. Crawford AJ, Lips KR, Bermingham E (2010) Epidemic disease decimates amphibian abundance, species diversity, and evolutionary history in the highlands of central Panama. *Proceedings of the National Academy of Sciences of the United States of America* 107: 13777-13782.
13. Dunn MR, Szabo A, McVeagh MS, Smith PJ (2010) The diet of deepwater sharks and the benefits of using DNA identification of prey. *Deep-Sea Research Part I-Oceanographic Research Papers* 57: 923-930.
14. Eaton MJ, Meyers GL, Kolokotronis SO, Leslie MS, Martin AP, Amato G (2010) Barcoding bushmeat: molecular identification of Central African and South American harvested vertebrates. *Conservation Genetics* 11: 1389-1404.
15. Efe MA, Tavares ES, Baker AJ, Bonatto SL (2009) Multigene phylogeny and DNA barcoding indicate that the Sandwich tern complex (*Thalasseus sandvicensis*, Laridae, Sternini) comprises two species. *Molecular Phylogenetics and Evolution* 52: 263-267.
16. Evans KM, Chepurnov VA, Sluiman HJ, Thomas SJ, Spears BM, Mann DG (2009) Highly Differentiated Populations of the Freshwater Diatom *Sellaphora capitata* Suggest Limited Dispersal and Opportunities for Allopatric Speciation. *Protist* 160: 386-396.
17. Fazekas A.J., Steeves R., and Newmaster SG. 2010. Improving sequencing quality from PCR products containing long mononucleotide repeats. *Biotechniques* 48(4): 277-285.
18. Fernandez-Triana, J. (2010). Eight new species and an annotated checklist of Microgastrinae

- (Hymenoptera, Braconidae) from Canada and Alaska. *ZooKeys*, 63, 1-53.
19. Footitt RG, Lowery DT, Maw HEL, Smirle MJ, Lushai G (2009) Identification, distribution, and molecular characterization of the apple aphids *Aphis pomi* and *Aphis spiraecola* (Hemiptera: Aphididae: Aphidinae). *Canadian Entomologist* 141: 478-495.
 20. Francis CM, Borisenko AV, Ivanova NV, Eger JL, Lim BK, Guillen-Servent A, Kruskop SV, Mackie I, Hebert PDN (2010) The Role of DNA Barcodes in Understanding and Conservation of Mammal Diversity in Southeast Asia. *Plos One* 5.
 21. Hausmann A, Hebert PDN, Mitchell A, Rougerie R, Sommerer M, Edwards T, Young CJ (2009) Revision of the Australian *Oenochroma vinaria* Guenee, 1858 species-complex (Lepidoptera: Geometridae, Oenochrominae): DNA barcoding reveals cryptic diversity and assesses status of type specimen without dissection. *Zootaxa*: 1-21.
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 23. Hogg ID, Smith BJ, Banks JC, Dewaard JR, Hebert PDN (2009) Testing use of mitochondrial COI sequences for the identification and phylogenetic analysis of New Zealand caddisflies (Trichoptera). *New Zealand Journal of Marine and Freshwater Research* 43: 1137-1146.
 24. Hubert N, Delrieu-Trottin E, Irisson JO, Meyer C, Planes S (2010) Identifying coral reef fish larvae through DNA barcoding: A test case with the families Acanthuridae and Holocentridae. *Molecular Phylogenetics and Evolution* 55: 1195-1203.
 25. Janzen DH (2010) Hope for Tropical Biodiversity through True Bioliteracy. *Biotropica* 42: 540-542.
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 27. Le Gall, L. & Saunders G.W. 2010. Establishment of a DNA-barcode library for the Nemaliales (Rhodophyta) from Canada and France uncovers overlooked diversity in the species *Nemalion helminthoides* (Velley) Batters. *Crypt. Algal.* 31: 403-421.
 28. Lee DH, Lee HJ, Lee YJ, Kang HM, Jeong OM, Kim MC, Kwon JS, Kwon JH, Kim CB, Lee JB, Park SY, Choi IS, Song CS (2010) DNA Barcoding Techniques for Avian Influenza Virus Surveillance in Migratory Bird Habitats. *Journal of Wildlife Diseases* 46: 649-654.
 29. Li FW, Kuo LY, Huang YM, Chiou WL, Wang CN (2010) Tissue-direct PCR, a rapid and extraction-free method for barcoding of ferns. *Molecular Ecology Resources* 10: 92-95.
 30. Li FW, Tan BC, Buchbender V, Moran RC, Rouhan G, Wang CN, Quandt D (2009) Identifying a mysterious aquatic fern gametophyte. *Plant Systematics and Evolution* 281: 77-86.
 31. Lim J, Kim SY, Kim S, Eo HS, Kim CB, Paek WK, Kim W, Bhak J (2009) BioBarcode: a general DNA barcoding database and server platform for Asian biodiversity resources. *Bmc Genomics* 10.
 32. Lowenstein JH, Amato G, Kolokotronis SO (2009) The Real *maccoyii*: Identifying Tuna Sushi with DNA Barcodes - Contrasting Characteristic Attributes and Genetic Distances. *Plos One* 4.
 33. Lowenstein JH, Burger J, Jeitner CW, Amato G, Kolokotronis SO, Gochfeld M (2010) DNA barcodes reveal species-specific mercury levels in tuna sushi that pose a health risk to consumers. *Biology Letters* 6: 692-695.
 34. Mateos E, Cabrera C, Carranza S, Riutort M (2009) Molecular analysis of the diversity of terrestrial planarians (Platyhelminthes, Tricladida, Continenticola) in the Iberian Peninsula. *Zoologica Scripta* 38: 637-649.
 35. McDevit DC, Saunders GW (2010) A DNA barcode examination of the Laminariaceae (Phaeophyceae) in Canada reveals novel biogeographical and evolutionary insights. *Phycologia* 49: 235-248.
 36. Naro-Maciel E, Reid B, Fitzsimmons NN, Le M, Desalle R, Amato G (2010) DNA barcodes for globally threatened marine turtles: a registry approach to documenting biodiversity. *Molecular Ecology Resources* 10: 252-263.
 37. Newmaster, S.G. and S. Ragupathy. 2010. Ethnobotany Genomics - Discovery and Innovation in a New Era of Exploratory Research. *BioMed Journal of Ethnobiology and Ethnomedicine* 6:2: 1-11.
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 39. Newmaster, S.G and S. Ragupathy. 2009. Ethnobotany genomics – use of DNA barcoding to explore cryptic diversity in economically important plants. *Indian Journal of Science and Technology* Vol.2 No 5: 2-8.
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- DNA Barcoding Facilitates an Automated Identification Technology (AIT) System for Plants. *International Journal of Computer Applications in Technology* 35(1):50-60.
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 46. Quiroz-Vazquez P, Elias-Gutierrez M (2009) A New Species of the Freshwater Cladoceran Genus *Scapholeberis* Schoedler, 1858 (Cladocera: Anomopoda) from the Semidesert Northern Mexico, Highlighted by DNA Barcoding. *Zootaxa*: 50-64.
 47. Ragupathy, S. and S.G. Newmaster. 2010. DNA barcoding: Problems, progress and prospects. Special issue "Bioinformatics: An Agricultural Perspective". *Hortinformatics* 10: 89-94.
 48. Raupach MJ, Astrin JJ, Hannig K, Peters MK, Stoeckle MY, Wagele JW (2010) Molecular species identification of Central European ground beetles (Coleoptera: Carabidae) using nuclear rDNA expansion segments and DNA barcodes. *Frontiers in Zoology* 7.
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 50. Schneider, C.W., Lane, C.E. & Saunders, G.W. 2010. Notes on the marine algae of the Bermudas. 11. More additions to the benthic flora and a phylogenetic assessment of *Halymenia pseudofloresii* (Halymeniales, Rhodophyta) from its type locality. *Phycologia* 49: 154-168. (cover article)
 51. Sirovich L, Stoeckle MY, Zhang Y (2010) Structural Analysis of Biodiversity. *Plos One* 5.
 52. Soininen EM, Valentini A, Coissac E, Miquel C, Gielly L, Brochmann C, Brysting AK, Sonstebo JH, Ims RA, Yoccoz NG, Taberlet P (2009) Analysing diet of small herbivores: the efficiency of DNA barcoding coupled with high-throughput pyrosequencing for deciphering the composition of complex plant mixtures. *Frontiers in Zoology* 6.
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 59. Wang JF, Qiao GX (2009) DNA barcoding of genus *Toxoptera* Koch (Hemiptera: Aphididae): Identification and molecular phylogeny inferred from mitochondrial COI sequences. *Insect Science* 16: 475-484.

Data Release

A more thorough description of iBOL data release to GenBank can be found in Section IV, part 3.1.2. However, in brief, routine data release to GenBank began in January 2010, and proceeded quarterly thereafter. As noted in the iBOL Data Release Policy (Appendix VI), data release occurs in two phases. In the first, all information in BOLD (aside from images and taxonomic details lower than Order level) are transferred to GenBank. The next step in data release, "Phase II", occurs when the data owner is prepared to publish the detailed taxonomy developed in the BOLD workbench. It must be acknowledged that the Phase I of the data release plan took much longer than anticipated. Differences in the QA/QC processes at both ends of the pipeline caused a multitude of difficulties. For example, the nation boundary definitions used by BOLD are different than those used by GenBank. Especially in specimens sampled from coastal waters, this would frequently create an apparent conflict between GPS coordinates and country name. The situation was such that as of June 30, 2010, no iBOL records were publicly visible at GenBank (Table VI.1). However, after a great deal of work by programmers at BOLD and GenBank, we are happy to report that data release is now proceeding smoothly (Table VI.2), and in January 2011 the rate of data release moved from quarterly to monthly instalments.

Now that "Phase I" data release is working well, BOLD and GenBank are preparing to implement the "Phase II" data release. A project plan will be distributed in February 2011 for implementation of this step.

In the tables to follow, it is important to note that discrepancies may exist between these statistics and those reported elsewhere in this document (Section IV and Appendix VIII). There are two sources for this discrepancy. First, each record is assigned to a single iBOL Working Group. However, as depicted in Appendix VIII, many records could rightly be placed in more than one working group. For example, bats are vertebrates (WG1.1), but many are pollinators (WG1.6), and of course all are terrestrial organisms (WG1.9). The assignments are made algorithmically, but after receiving feedback from collaborators the assignment algorithm was changed. Another source of discrepancy is what is meant as a "new" species. BOLD contains a large number of records that have not been publicly released, so something that is not new to BOLD may, in fact, still be new to the public sphere. Therefore, a discrepancy exists between the number of species that are "new to GenBank" versus those that are "new to BOLD". The tables below report "new to BOLD", but in any event we wish to emphasize that regardless of how the numbers are sliced, the accomplishments of the project are clear: as of the end of 2010, the **iBOL Project is responsible for generating DNA barcodes from more than 325,000 individual organisms representing more than 75,000 species**. Even though many of these species have been barcoded previously, broadening the genetic and geographic sampling of those species contributes to better science.

Table VI.1: Data release statistics as of June 30th, 2010

Working Group	CUMULATIVE TOTALS As of June 30, 2010			
	Total BIN Objective	Total public in BOLD	Total transferred to GenBank	Total public in GenBank ^a
WG1.1 - Vertebrates	1,500	1,444	1,444	0
WG1.2 - Land plants	2,500	0 ^b	0	0
WG1.3 - Fungi	100	0 ^c	0	0
WG1.4 - Parasites, Pathogens, & Vectors	120	119	119	0
WG1.5 - Agricultural and Forestry Pests	1,000	2,819	2,819	0
WG1.6 - Pollinators	2,000	1,004	1,004	0
WG1.7 - Freshwater Bio- surveillance	1,500	1,617	1,617	0
WG1.8 - Marine Bio- surveillance	4,000	509	509	0
WG1.9 - Terrestrial Bio- surveillance	6,280	15,582	15,582	0
WG1.10 - Polar Bio- surveillance	1,000	779	779	0
Total	20,000	23,873	23,873	0

Table VI.2: Data release statistics as of December 31st, 2010

Working Group	CUMULATIVE TOTALS As of December 31st, 2010			
	Total BIN Objective	Total public in BOLD	Total transferred to GenBank	Total public in GenBank
WG1.1 - Vertebrates	2,000	1,735	1,735	1,735
WG1.2 - Land plants	4,250	0	0	0
WG1.3 - Fungi	100	0	0	0
WG1.4 - Parasites, Pathogens, & Vectors	220	126	126	126
WG1.5 - Agricultural and Forestry Pests	2,750	3,697	3,697	3,697
WG1.6 - Pollinators	2,500	1,259	1,259	1,259
WG1.7 - Freshwater Bio- surveillance	2,250	1,947	1,947	1,947
WG1.8 - Marine Bio- surveillance	4,500	924	924	924
WG1.9 - Terrestrial Bio- surveillance	16,280	21,799	21,799	21,799
WG1.10 - Polar Bio- surveillance	1,600	1,331	1,331	1,331
Total	36,450	32,818	32,818	32,818

^a Although records were transferred to GenBank, they were placed in "hold up" (i.e., they were not publicly visible) until July 1st, 2010

^b Since no "BIN" algorithm exists for plant barcode markers, records were not transferred until a suitable substitute was determined. In July 2010 GenBank proposed that an alternative unique ID could be used in place of the "BIN" name.

^c A standard barcode marker has not yet been chosen by fungal researchers

Technology Transfer

IN PROGRESS			IN CIRCULATION		COMMERCIALISATION	
Disclosures	Provisional Patents	Patents filed	Copyrights	Published Patents	Commercial licenses in place	Number of companies formed

Commercial Potential

Although iBOL is predicated on the notion of open access and information sharing, we recognize the commercial potential for the data and technologies being developed. The DNA barcode databases (WG3.1 & 3.2) are very valuable resources, enabling industry and regulatory agencies to more easily and accurately identify disease-carrying agents (WG1.4) and other pests (WG1.5). In addition, there is quite a lot of interest in the arena of environmental barcoding (WG4.1), that will take advantage of the DNA barcode library developed by the freshwater (WG1.7), marine (WG1.8), and terrestrial (WG1.9) working groups. We are already aware of two companies in North America that perform DNA barcoding as a service, and we expect that this trend will increase in the near future.

As DNA barcoding as a service becomes commonplace, the natural technological evolution will be placing this power directly in the hands of the users. This is the goal of the mobile barcoding working group (WG4.2). Although there is much research and development to be done to make this dream a reality, in the past six months two large companies (Life Technologies and Bayer) have expressed interest in the development of such a device, based on their belief that there is a large market of potential users.

Additional Leverage

As the iBOL nodes continue to develop and organize, there have been numerous funding success stories. These will be tracked through continuous updating of Node Profiles (see Appendix VII for an example). Here, we outline a few highlights:

- The International Development Research Centre provided \$2 million to enable five developing nations (Argentina, Costa Rica, Kenya, Peru, and South Africa) to participate in iBOL. This model created a lot of excitement, and a “Donor’s meeting” is in the planning stages to get other international development agencies to adopt similar models
- The U.S. has committed \$6 million towards the barcoding of Moorea (WG2.1), and an additional \$1 million annually for DNA barcoding at the Smithsonian Institute has been requested for inclusion in the 2012 U.S. federal budget.
- Australia has raised \$32 million for the Atlas of Living Australia. An additional \$1.2 million was awarded to the NSW Department of Primary Industries for the DNA barcoding of economically-important insects
- In Mexico, Dirección de Redes awarded \$700,000 to ECOSUR, IBUNAM, and CIBNOR to establish a national laboratory for DNA barcoding, and an additional \$700,000 in operating grants. \$300,000 was awarded by Dirección General de Bioinformática to CONABIO for the establishment of a BOLD mirror site, Conacyt has committed \$5 million to fund Mexico’s participation in iBOL.
- The Indian Ministry of Agriculture has committed \$10 million to allow national participation in iBOL.
- Brazil’s Ministry of Science and Technology has recently awarded \$3 million in grants that are targeted at DNA barcoding work