www.coml.org

***Embargo: 5 pm US Eastern Time / 9 pm GMT**, Tuesday 23 August 2011*

**Contacts: Mr. Terry Collins,** +1-416-878-8712; +1-416-538-8712; tc@tca.tc
**Ms. Darlene Trew Crist,** +1-401-295-1356; +1-401-952-7692; darlene.crist@cox.net

***Media Resources** (downloadable at http://www.soc.hawaii.edu/mora/PressRoom.html; username: mora_species, password: 7ey9 ): High-resolution **still images**, the **full paper** being published by PLoS Biology, and the accompanying **commentary by Lord Robert May of Oxford**. **Audio sound bites** for radio (in English and Spanish, with transcripts) may be downloaded at http://bit.ly/ovfqKw*

# *How Many Species on Earth? 8.7 Million*

***Most precise estimate ever is based on novel, validated analytical technique;***
***Yet to be discovered, described, catalogued: 91% of marine species, 86% of species overall***

Eight million, seven hundred thousand species (give or take 1.3 million).

That is a new, estimated total number of species on Earth -- the most precise calculation ever offered -- with 6.5 million species found on land and 2.2 million (about 25 percent of the total) dwelling in the ocean depths.

Announced today by Census of Marine Life scientists, the figure is based on an innovative, validated analytical technique that dramatically narrows the range of previous estimates. Until now, the number of species on Earth was said to fall somewhere between 3 million and 100 million.

Furthermore, the study, published today by *PLoS Biology*, says a staggering 86% of all species on land and 91% of those in the seas have yet to be discovered, described and catalogued.

Says lead author Camilo Mora of the University of Hawaii (formerly of Dalhousie University in Halifax, Canada, where the research was done): “The question of how many species exist has intrigued scientists for centuries and the answer, coupled with research by others into species’ distribution and abundance, is particularly important now because a host of human activities and

influences are accelerating the rate of extinctions. Many species may vanish before we even know of their existence, of their unique niche and function in ecosystems, and of their potential contribution to improved human well-being."

**"**This work deduces the most basic number needed to describe our living biosphere," says co-author Boris Worm of Dalhousie University. "If we did not know -- even by an order of magnitude (1 million? 10 million? 100 million?) -- the number of people in a nation, how would we plan for the future?"

"It is the same with biodiversity. Humanity has committed itself to saving species from extinction, but until now we have had little real idea of even how many there are."

Dr. Worm notes that the recently-updated Red List issued by the International Union for the Conservation of Nature assessed 59,508 species, of which 19,625 are classified as threatened. This means the IUCN Red List, the most sophisticated ongoing study of its kind, monitors less than 1% of world species.

The research is published alongside a commentary by Lord Robert May of Oxford, past-president of the UK's Royal Society, who praises the researchers' "imaginative new approach."

"It is a remarkable testament to humanity's narcissism that we know the number of books in the US Library of Congress on 1 February 2011 was 22,194,656, but cannot tell you -- to within an order-of-magnitude -- how many distinct species of plants and animals we share our world with," Lord May writes.

**"**(W)e increasingly recognise that such knowledge is important for full understanding of the ecological and evolutionary processes which created, and which are struggling to maintain, the diverse biological riches we are heir to. Such biodiversity is much more than beauty and wonder, important though that is. It also underpins ecosystem services that -- although not counted in conventional GDP -- humanity is dependent upon."

**Drawing conclusions from 253 years of taxonomy since Linnaeus**

Swedish scientist Carl Linnaeus created and published in 1758 the system still used to formally name and describe species. In the 253 years since, about 1.2 million species -- roughly 1 million on land and 250,000 in the oceans -- have been described and entered into central databases (roughly 700,000 more are thought to have been described but have yet to reach the central databases).

To now, the best approximation of Earth's species total was based on the educated guesses and opinions of experts, who variously pegged the figure in a range from 3 to 100 million -- wildly differing numbers questioned because there is no way to validate them.

Drs. Mora and Worm, together with Dalhousie colleagues Derek P. Tittensor, Sina Adl and Alastair G.B. Simpson, refined the estimated species total to 8.7 million by identifying numerical patterns within the taxonomic classification system (which groups forms of life in a pyramid-like hierarchy, ranked upwards from species to genus, family, order, class, phylum, kingdom and domain).

Analysing the taxonomic clustering of the 1.2 million species today in the Catalogue of Life and the World Register of Marine Species, the researchers discovered reliable numerical relationships between the more complete higher taxonomic levels and the species level.

Says Dr. Adl: "We discovered that, using numbers from the higher taxonomic groups, we can predict the number of species. The approach accurately predicted the number of species in several well-studied groups such as mammals, fishes and birds, providing confidence in the method."

When applied to all five known eukaryote* kingdoms of life on Earth, the approach predicted:

1) **~7.77 million species of animals** (of which 953,434 have been described and cataloged)
2) **~298,000 species of plants** (of which 215,644 have been described and cataloged)
3) **~611,000 species of fungi** (moulds, mushrooms) (of which 43,271 have been described and cataloged)
4) **~36,400 species of protozoa** (single-cell organisms with animal-like behavior, eg. movement, of which 8,118 have been described and cataloged)
5) **~27,500 species of chromists** (including, eg. brown algae, diatoms, water moulds, of which 13,033 have been described and cataloged)

Total: 8.74 million eukaryote species on Earth.
(* Notes: Organisms in the eukaryote domain have cells containing complex structures enclosed within membranes. The study looked only at forms of life accorded, or potentially accorded, the status of "species" by scientists. Not included: certain micro-organisms and virus "types", for example, which could be highly numerous.)

Within the 8.74 million total is an estimated 2.2 million (plus or minus 180,000) marine species of all kinds, about 250,000 (11%) of which have been described and catalogued. When it formally concluded in October 2010, the Census of Marine Life offered a conservative estimate of 1 million+ species in the seas.

"Like astronomers, marine scientists are using sophisticated new tools and techniques to peer into places never seen before," says Australian Ian Poiner, Chair of the Census' Scientific Steering Committee. "During the 10-year Census, hundreds of marine explorers had the unique human experience and privilege of encountering and naming animals new to science. We may clearly enjoy the Age of Discovery for many years to come."

“The immense effort entering all known species in taxonomic databases such as the Catalogue of Life and the World Register of Marine Species makes our analysis possible,” says co-author Derek Tittensor, who also works with Microsoft Research and the UN Environment Programme’s World Conservation Monitoring Centre. “As these databases grow and improve, our method can be refined and updated to provide an even more precise estimate.”

“We have only begun to uncover the tremendous variety of life around us,” says co-author Alastair Simpson. “The richest environments for prospecting new species are thought to be coral reefs, seafloor mud and moist tropical soils. But smaller life forms are not well known anywhere. Some unknown species are living in our own backyards -- literally.”

“Awaiting our discovery are a half million fungi and moulds whose relatives gave humanity bread and cheese,” says Jesse Ausubel, Vice-President of the Alfred P. Sloan Foundation and co-founder of the Census of Marine Life. “For species discovery, the 21st century may be a fungal century!”

Mr. Ausubel notes the enigma of why so much diversity exists, saying the answer may lie in the notions that nature fills every niche, and that rare species are poised to benefit from a change of conditions.

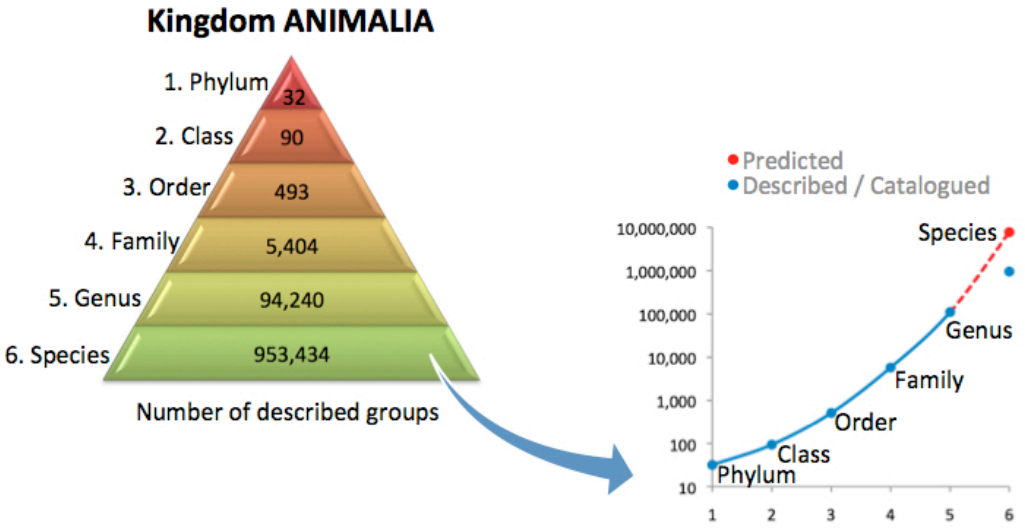
In his analysis, Lord May says the practical benefits of taxonomic discovery are many, citing the development in the 1970s of a new strain of rice based on a cross between conventional species and one discovered in the wild. The result: 30% more grain yield, followed by efforts ever since to protect all wild varieties of rice, “which obviously can only be done if we have the appropriate taxonomic knowledge.”

“Given the looming problems of feeding a still-growing world population, the potential benefits of ramping up such exploration are clear.”

Based on current costs and requirements, the study suggests that describing all remaining species using traditional approaches could require up to 1,200 years of work by more than 300,000 taxonomists at an approximate cost of $US 364 billion. Fortunately, new techniques such as DNA barcoding are radically reducing the cost and time involved in new species identification.

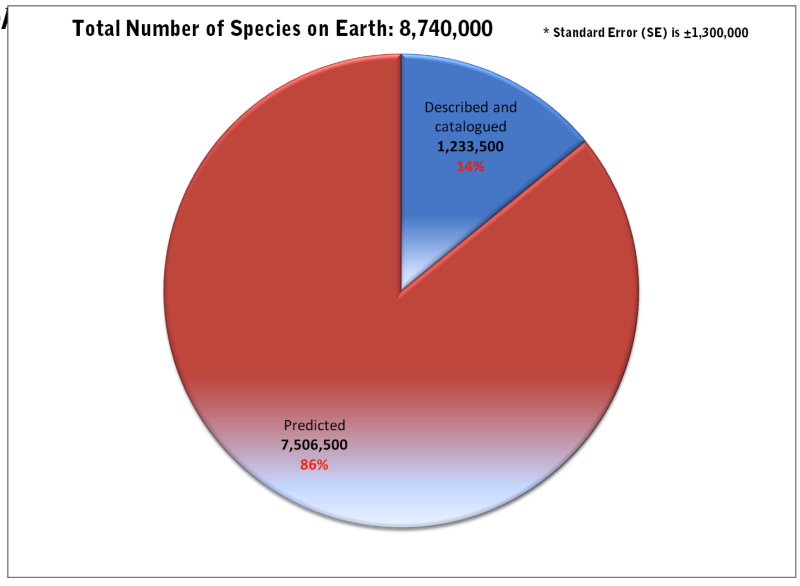
Concludes Dr. Mora: “With the clock of extinction now ticking faster for many species, I believe speeding the inventory of Earth’s species merits high scientific and societal priority. Renewed interest in further exploration and taxonomy could allow us to fully answer this most basic question: What lives on Earth?”

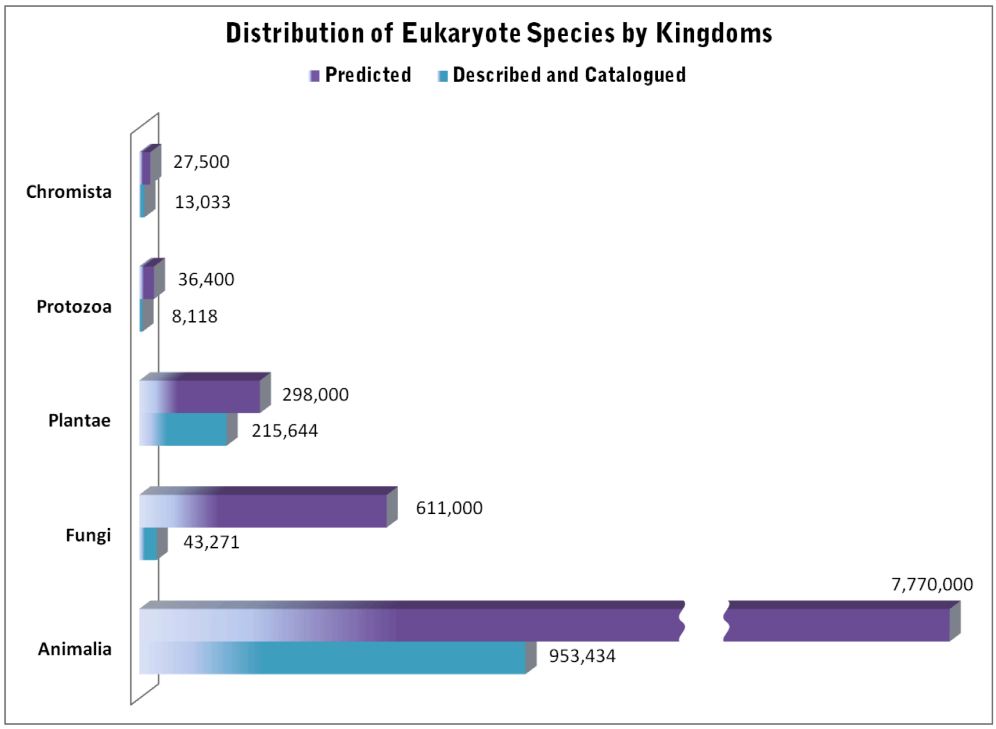
* * * * *




The description of a new species requires its classification within the Linnaean system of classification adopted some 250 years ago. This is a hierarchical system in which lower taxonomic groups belong to higher ones. For instance, a specific species is grouped with other species of similar characteristics within a given genus, which in turn is grouped with other genera of similar characteristics within a given family, which in turn is grouped with other families of similar characteristics within an specific order and so on. In this hierarchical system there are more groups at lower taxonomic levels than at higher ones and while the later ones are almost fully discovered, the earlier ones (i.e. species) remain for the most part to be found. The pattern that has been discovered suggest that the better known number of higher taxonomic groups allows to estimate the less well known number of lower groups, including the number of entities at the level of species.

***Example: The innovative analytical model plots data from higher taxonomic levels on an exponential grapl***






*Yet to be discovered and catalogued, scientists estimate, are between 74,000 and 90,000 plant species, some of which may help increase world food production. This wild rice,* Oryza officinalis*, photographed in the Philippines, inherently resists pests and diseases and tolerates extreme environmental conditions. The genes of such species are used to improve cultivated rice varieties. Photo credit required: "Part of the image collection of the International Rice Research Institute (www.irri.org)"*