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How many species are there on Earth?

蒋志刚[2]

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How many species are there on Earth?

地球上有多少物种?

蒋志刚[①②]

① 中国科学院动物研究所, 北京 100101;
② 中国科学院大学, 北京 100049
E-mail: jiangzg@ioz.ac.cn

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摘要 地球陆地与海洋生境中有多少物种? 半个世纪以来, 生物学家对这一问题进行了研究, 不同研究者用不同方法得到的物种估计数不同, 估计地球物种总数在50万~1亿. 直到今天, 生物学家没有一个确切的地球物种数目. 但是, 有些生物类群的种数较为确定, 如植物、淡水鱼类、两栖类、爬行类、鸟类和哺乳类. 为什么地球物种数目测不准? 究其原因, 是因为物种定义的差异、系统分类方法的不同、分类学家的标准不同、不同类群研究深度的差异, 所以绝大部分种仍是未知, 加之物种的生境千差万别, 所以, 我们无法获得地球物种总数. 即使有一天人们能够对地球上所有生境中的所有生物类群进行深入分类学研究, 然而, 当研究不同类群、甚至研究相同类群的分类学家无法统一划分物种标准时, 学术界仍将不可能就地球物种总数达成共识. 然而, 这并不妨碍我们估计推测地球物种总数.

关键词 物种, 物种概念, 生境, 分类学, 生物多样性

物种是一群表型、基因型与其他生物群体有显著差别的生物个体, 不论人们是否已经发现了这些差别, 同种个体构成了一个在生态时间尺度中相对稳定的基因库. 物种是生物进化的基本单元, 是生态系统的基本功能单元. 然而, 地球上有多少物种? 自从理论生态学家May[1]提出这一问题以来, 一直困扰着生物学家们. 因为这一问题是生物多样性科学的基础问题[2].

尽管随着新种的不断被发现, 全球植物与脊椎动物种数还在增加, 但是全球植物与脊椎动物已经大致确定. 植物分类学家对全球植物种数有不同的估计数, 如Govaerts[3], Bramwell[4]指出全球植物种数约422000种; 而Thorne[5]估计约260000种; Palmer等人[6]估计约268000种; Thorne和Reveal[7]则指出全球植物种数约253300种; Prance等人[8]、Miller[9]、Jackson和Miller[10]以及全球植物名录(The Plant List, TPL, www.theplantlist.org)报道全球植物种数约300000种. TPL(2013)将全球植物种数更新为约350699种[11]. 过去二、三十年中植物分类学家在热带地区开展了大量野外采集及分类研究, 发现描述和订正了许多物种. 此外, 以英美两国植物学家为主并联合各国专家共同建立的全球植物名录[10], 对摸清全球植物物种数量起到了重要作用. 目前多数植物分类学者认为全球植物种数在30~35万种[11,12], 包括苔藓1.6万种、蕨类1.3万种、裸子植物1000种、有花植物26万种. FishData (www.fishbase.org, 2016)报道全球有33200多种鱼类被描述, 其中14000多种为淡水鱼类. 美国自然历史博物馆(American Musuem of Natural History) (2016) 记录全球有7493种两栖动物(www.research.amnh.org), 截至2015年8月, Reptile Data

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Base 收录了10272种爬行动物(www.iucnredlist.org), BirdLife International (2016)报道全球有10426种鸟类[13]. Wilson和Reeder[14]报道全球有5436种哺乳动物. 近年来, 人们发现了一些新种, IUCN (2016)报道全球有5515种哺乳动物(www.iucnredlist.org).

1 地球上物种的估测数

人们提出了很多方法估计地球上的物种数目. May[1]提出利用生物体型大小分布估计地球物种数目, 他估计地球上有1~5千万种动物. Raven[15]利用物种纬度梯度丰度估计地球上有3~5百万种大型生物. Grassle和Maciolek[16]根据物种-面积关系估计地球的深海海床上有1千万物种. 根据真菌与维管植物的比率约为6∶1, 而世界上已经发现了27万种维管植物, Hawksworth[17]估计地球上有160万种真菌. Erwin[18]根据热带已知有5万种树, 假定甲虫种数是数目种数的5倍, 树冠中的节肢动物中40%为甲虫, 而树冠的物种数是地面的2倍, 于是热带估计有3千万种节肢动物. Hodkinson和Casson[19]假设地球上7.5%~10%的物种是半翅目, 而62.5%的半翅目昆虫是未知的, 他们估计地球上的昆虫数目为184~257万种. Mora等人[20]根据物种分布曲线, 外推全球有19800种海洋鱼类. Bebber等人[21]估计地球上生活着11997种鸟类. Joppa等人[22]根据研究者-物种曲线外推, 估计有待发现的有花植物比例为13%~18%. 根据不同分类专家估计, 地球上有500万种昆虫[23], 20万种海洋生物[24]. Mora等人[25]发现物种在种以上分类阶元中遵从一种恒定的可预测模式, 根据这种模式, 他们估计地球上约有870±130万种生物, 其中220±18万种生活在海洋中, 86%的陆上生物和91%的海洋生物有待发现. 然而, 有关生物种数目的估计缺乏严格检验. Hinchliffa等人[26]将分类与系统发生整合到反映物种进化关系的“生命之树”之中, 他们发现“生命之树”有230万个现生端点. 尽管半个世纪前人们即开始估计地球物种总数, 估计物种数目的方法越来越复杂, 我们对生物多样性的了解也越来越深入, 但是, 目前各种物种总数目估计仍不一致, 人们对地球物种总数估计值并没有收敛于一个值[27].

2 为什么地球上的物种总数测不准?

科学家们对地球上有多少物种这一问题仍没有答案. 原因来自于以下几方面.

2.1 物种定义的不同

物种是一个颇有争议的概念. 从达尔文时代开始, 物种的概念一直在演化. 生物学界仍没有一致的物种定义.

生物分类的意见分歧来源于种的概念[28]. 生物以种存在. 种是生命科学的基石, 是生物多样性的基本单位, 是生物分类的基本阶元, 是一个可以随时间而变化的个体集合, 是真实的存在, 是生物进化的基本单元, 是生态系统的基本功能单元. 然而, 从柏拉图和亚里士多德的模式种概念、达尔文的唯名论种概念(达尔文说“物种这个名词, 我认为完全是为了方便起见, 任意用来表示一群相互密切类似的个体的”[29]), 到群体种概念(生物种是一些具有形态和遗传相似性的种群组成, 种内个体的相似性大于种间个体的相似性). 表型种概念(生物种是表型上能识别的生物个体的集合)、生态种概念(物种是生态系统的功能单元, 每个物种占据一个生态位)、时间种概念(当一个物种的后代随着时间的演化, 其表型的差异足以区别与其祖先区别时, 一个新的时间种即形成了)、分支种概念: (以生物进化每个分支事件, 即两个线系的衍征产生, 作为物种的识别标准), 物种的概念也在演化[30~34]. Maydan总结了25种进化种概念, 发现这些概念之间有交叉、甚至有包含关系[33]. 笔者综合唯名种、模式种和Maydan总结的进化种概念绘制了图1.

2.2 系统分类方法

过去分类学家多应用形态特征分类. 后来, 出现了数值分类方法和支序分类方法. 现代分子生物学技术的飞速发展, 打开了一扇认识生物起源分化的新窗口, 为分类学提供了新的手段. Apagow[35]发现, 对7例相同哺乳动物类群使用系统发育种概念发现了24个物种, 比应用非系统发育种(Phylogenetic species, 亦称系谱种)概念发现的14个物种, 多71%. 在他综述的91例涵盖所有生物类群的研究中, 使用系统发育种概念发现的物种数目比使用非系统发育种概念发现的平均多121%. 随着系统发育种概念的广泛被接受与应用, 可以期待会在今后的研究中人们会报道更多的新种.

2.3 分类学家的物种标准

分类学研究是分歧较大的一门基础学科, 也是

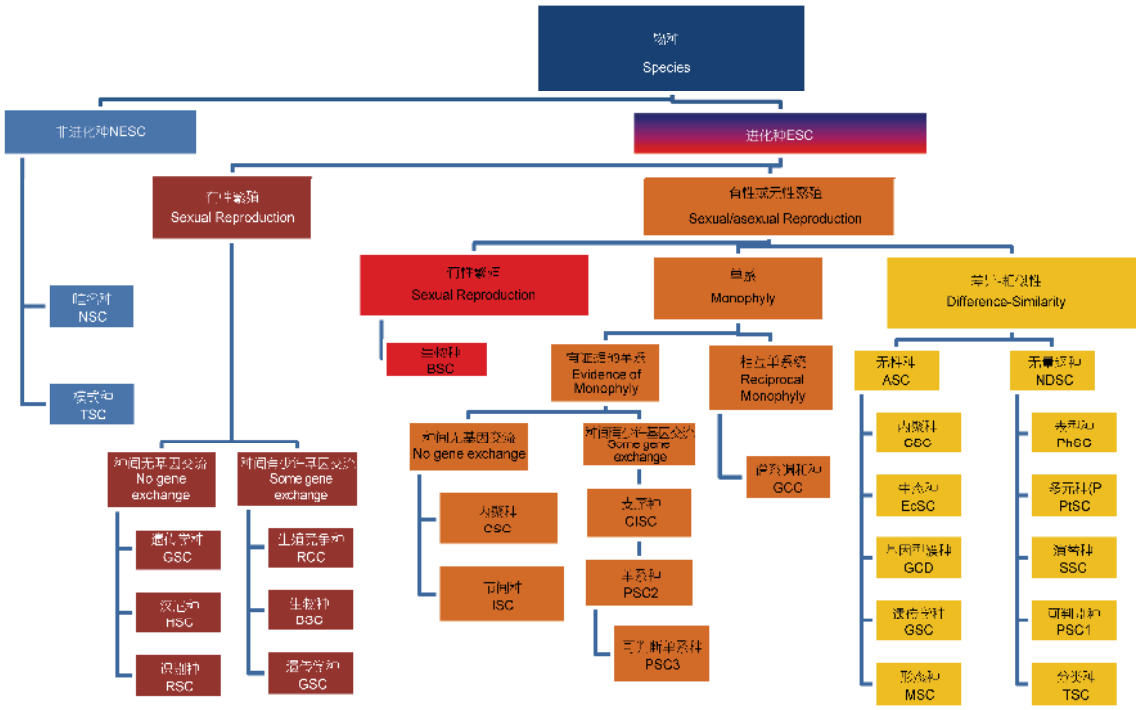

图 1 (网络版彩色)不同的物种概念及其相互关系(部分根据Mayden(1997)修改绘制)

Figure 1 (Color online) Relationship among different species concepts (modified after mayden, 1997)

图中的物种概念及其缩写(Species concepts and their acronyms in the figure): 1. 无性种(Agamospecies, ASC); 2. 生物种(Biological Species, BSC); 3. 内聚种(Cohesion Species, CSC); 4. 支序种(Cladistic Species, CISC); 5. 生态种(Ecological Species, EcSC); 6. 进化种(Evolutionary Species, ESC); 7. 谱系调和种(Genealogical Concordance Species, GCC); 8. 遗传学种(Genetic Species, GSC); 9. 基因型簇种(Genotypic Cluster Definition Species, GCD); 10. 汉尼种(Hennigian Species, HSC); 11. 节间种(Internodal Species, ISC); 12. 形态种(Morphological Species, MSC); 13. 无量纲种(Non-dimensional Species, NDSC), 非进化种(Non-Evolutionary Species, NESC). 14. 唯名种(Nominal Species, NSC); 15. 表型种(Phenetic Species, PhSC); 16. 可判别种(Diagnosable Version Species, PSC1); 17. 单系种(Monophyly Version Species, PSC2); 18. 可判别单系种(Diagnosable and Monophyly Version Species, PSC3); 19. 多元种(Polythetic Species, PtSC); 20. 识别种 (Recognition Species, RSC); 21. 生殖竞争种(Reproductive Competition Species, RCC); 22. 演替种(Successional Species, SSC); 23. 分类种(Taxonomic Species, TSC); 24. 模式种(Type Species, TSC). 其中, 没有画出进化显著单元. Mayden(1997)认为进化显著单元与进化种是相似的概念

一门经验学科. 不同生物类群、不同分类学家对种的标准有不同认识, 对于一个种是否有效, 一个分类单元的分合, 往往仁者见仁、智者见智, 无法取得统一意见. 不仅不同类群分类学家的物种标准不同, 同一类群的分类学家的物种标准也不一致[36]. 中国啮类(Glires, 包括啮齿目和兔形目)是一个争议较多的类群[37]. 尽管在过去一段时间内分类学家强调生物种的概念, 但是在实践中以生殖隔离来区分物种, 常常是不可取的. 许多物种间隔离机制事实上是地理隔离, 当两个种的个体在自然界相遇时常常产生杂交. 然而, 若不以生殖隔离来区分物种, 物种的分类只能依靠专家的经验标准. 此外, 分类学家在研究中标新立异, 在实践中无法统一物种的标准, 是目前分类的意见分歧的根源. 一个类群往往合久必分, 分久必合, 于是, 物种数目一直在波动.

2.4 研究类群与地区的差异

分类学家们对一些类群已经深入开展研究, 而另一些类群缺乏研究; 例如, 对于哺乳类、鸟类、爬行类和两栖类等脊椎动物已经进行了深入的研究, 而有关线虫类研究却很少[38]. 此外, 一些物种的生境特殊, 如深海生物、寄生生物、土壤生物, 由于研究条件的限制, 人们还很难开展深入研究. Wilson等人[2]发现地区间生物多样性研究的不均衡. 2014年中全球发表了10036篇有关生物多样性保护的论文中, 有关生物多样性最丰富的厄瓜多尔、印度尼西亚、马达加斯加和秘鲁的论文仅比生物多样性相对贫乏、研究透彻的英国仅多4篇. 而厄瓜多尔有些地区每半

公顷土地上的昆虫数超过100000种, 比英国所有物种数还多. 他们还发现IUCN-濒危物种红色名录专家组成员中有44位来自美国, 39位来自英国, 而没有一位来自厄瓜多尔、印度尼西亚、马达加斯加和秘鲁[39].

3 我们能得到一个确定的地球物种总数吗?

对于种概念的讨论已经持续多年, 即使是在对生物遗传基础的分子机理已有相当认识的今天, 对于物种的定义仍存在争议[40]. 然而, 人们对地球物种总数的研究、对不同生物类群物种数目的研究一直热情不减[41~64].

多大的差异足以区别物种? 这将是一个没有答案的问题. 除非一个分类学家或者他的团队用同一方法在相对短的时间内(如一代人的时间内)研究了地球上所有生物. 显然, 这是不可能的. 一是一个人或一个团队不可能相对短的时间内完成所有的生物类群的分类研究, 二是同一种分类标准不可能适用于所有生物类群, 一个研究团队也不可能具备对所有生物的全面知识. 所以, 当物种的标准不一时, 分类学家无法统一划分物种时, 我们将永远不可能得到地球物种总数. 然而, 这并不妨碍我们对地区物种进行编目, 估计推测地球物种总数(www.catalogueoflife.org, www.marinespecies.org).

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参考文献

1 May R M. How many species are there on earth? Science, 1988, 241: 1441–1449
2 Wilson E O. The Diversity of Life. New York: W.W. Norton & Company, 1992. 424
3 Govaerts R. How many species of seed plants are there? Taxon, 2001, 50: 1085–1090
4 Bramwell D. How many plant species are there? PI Talk, 2002, 28: 32–34
5 Thorne R F. How many species of seed plants are there? Taxon, 2007, 51: 511–512
6 Palmer J D, Soltis D E, Chase M W. The plant tree of life: An overview and some points of view. Am J Bot, 2004, 91: 1437–1445
7 Thorne R F, Reveal J L. An updated classification of the class Magnoliopsida ("Angiospermae"). Bot Rev, 2007, 73: 67–181
8 Prance G T, Beentje H, Dransfield J, et al. The tropical flora remains under-collected. Ann Missouri Bot Garden, 2000, 87: 67–71
9 Miller J S. The discovery of medicines from plants: A current biological perspective. Econ Bot, 2011, 65: 396–407
10 Jackson W P, Miller J S. Developing a world flora online-a 2020 challenge to the world's botanists from the international community. Rodriguésia, 2015, 66: 939–946
11 Paton A J, Brummit N, Govaerts R, et al. Towards target 1 of the global strategy for plant conservation: A working list of all known plant species—progress and prospects. Taxon, 2008, 57: 1–10
12 Zhang L B, Gilbert M G. Comparison of classifications of ascular plants of China. Taxon, 2015, 64: 17–26
13 Christie D A, Elliott A, Fishpool L D C. HBW and Birdlife International Illustrated Checklist of the Birds of the World. Volume 1: Non-Passerines & Volume 2: Passerines. Lynx Edicions In Association With Birdlife International. Barcelona: Lynx Edicions, 2016
14 Wilson D E, Reeder D M. Mammal species of the world. In: A Taxonomic and Geographic Reference (3rd ed). New York: Johns Hopkins University Press, 2005. 2: 142
15 Raven P H. Disappearing species: A global tragedy. Futurist, 1985, 19: 8–14
16 Grassle J F, Maciolek N L. Deep-sea species richness: Regional and local diversity estimates from quantitative bottom samples. Am Nat,1992, 139: 313–341
17 Hawksworth D L. The fungal dimension of biodiversity: Magnitude, significance and conservation. Mycol Res, 1991, 95: 641–655
18 Erwin T L. Tropical forests: Their richness in Coleoptera and other arthropod species. Coleopter Bull, 1982, 36: 74–75
19 Hodkinson I D, Casson D. A lesser predilection for bugs: Hemiptera (Insecta) diversity in tropical forests. Biol J Linn Soc, 1991, 43: 101–119
20 Mora C, Tittensor D P, Myers R A. The completeness of taxonomic inventories for describing the global diversity and distribution of marine fishes. Proc Roy Soc B, 2008, 275: 149–155
21 Bebber D P, Marriott F H C, Gaston K J, et al. Predicting unknown species numbers using discovery curves. Proc Roy Soc B, 2007, 274: 1651–1658
22 Joppa L, Roberts D L, Pimm S L. How many species of flowering plants are there? Proc Roy Soc B, 2010, doi: 10.1098/rspb.2010.1004
23 Gaston K J, Williams P H. Mapping the world's species-the higher taxon approach. Biodiv Lett, 1993, 1: 2–8
24 Briggs J C, Snelgrove P. Marine species diversity. Bioscience, 1999, 49: 351–352

25 Mora C, Tittensor D P, Adl S, et al. How many species are there on earth and in the ocean? PLoS Biol, 2011, 9: e1001127
26 Hinchliffa C E, Smitha S A, Allmanb J F, et al. Synthesis of phylogeny and taxonomy into a comprehensive tree of life. Proc Natl Acad Sci, 2012, 112: 12764–12769
27 Caley M J, Fisher R, Mengersen K. Global species richness estimates have not converged. Trends Ecology Evol, 2014, 29: 187–188
28 Mayden R L. A hierarchy of species concepts: The denouement in the saga of the species problem. In: Claridge M F, Dawah H A, Wilson M R, eds. Species: The Units of Biodiversity. London: Chapman & Hall, 1997. 381–424
29 Darwin C R. On the Origin of Species. Li H, trans. Beijing: Tsinghua University Press, 2012 [达尔文. 物种源始. 李虎, 译. 北京: 清华大学出版社, 2012]
30 Dobzhansky T. A critique of the species concept in biology. Philosophy Sci, 1935, 2: 344–355
31 Mayr E. Systematics and the Origin of Species from the Viewpoint of a Zoologist. New York: Columbia University Press, 1942
32 Hennig W. Phylogenetic Systematics. Davis D D, Zangerl R, trans. Urbana: University of Illinois Press, 1966
33 Cronquist A. Once again, what is a species? In: Knutson L V, ed. Biosystematics in Agriculture. Montclair N J: Alleheld Osmun, 1978. 3–20
34 Apagow P M, Bininda-Emonds O R P, Crandall K A, et al. The impact of species concept on biodiversity studies. Quart Rev Biol, 2004, 79: 161–179
35 Apagow P M. Species: Demarcation and diversity. In: Purvis A, Gittleman J L, Brooks T, eds. Phylogeny and Conservation. Cambridge: Cambridge University Press, 200. 19–56
36 Jiang Z G, Ma Y, Wu Y, et al. China's mammalian diversity (in Chinese). Biodiver Sci, 2015, 23: 351–365 [蒋志刚, 马勇, 吴毅, 等. 中国哺乳动物多样性. 生物多样性, 2015, 23: 351–365]
37 Ma Y, Yang Q S, Zhou L Z. Taxonomy and Geographic Distribution of Glires in China (in Chinese). In: Zheng Z M, Jiang Z K, Chen A G, eds. Conspectus of Glires. Shanghai: Shanghai Jiaotong University Press, 2008. 35–42 [马勇, 杨奇森, 周立志. 中国啮类的分类与地理分布. 见: 郑智民, 姜志宽, 陈安国, 主编. 啮齿动物学. 上海: 上海交通大学出版社, 2008. 35–42]
38 Cribb T H, Bray R A. Trematode families and genera: Have we found them all? Trend Parasitol, 2011, doi: 10.1016/j.pt.2010.12.008
39 Wilson K A, Auerbach N A, Sam K, et al. Conservation research is not happening where it is most needed. PLoS Biol, 2016, 14: e1002413
40 Jiang Z G, Ma K P. Principles in Conservation Biology (in Chinese). Beijing: Science Press, 2014. 2–6 [蒋志刚, 马克平. 保护生物学原理. 北京: 科学出版社, 2014. 2–6]
41 Erwin T L. Tropical forests: Their richness in Coleoptera and other arthropod species. Coleopter Bull, 1982, 36: 74–75
42 Erwin T L. Tropical forest canopies: The last biotic frontier. Bull Entomol Soc Am, 1983, 29: 14–19
43 Thomas C D. Fewer species. Nature, 1990, 347: 237
44 Erwin T L. How many species are there? Revisited Conserv Biol, 1991, 5: 1–4
45 Gaston K J. The magnitude of global insect species richness. Conserv Biol, 1991, 5: 183–196
46 Hawksworth D L. The fungal dimension of biodiversity: Magnitude, significance and conservation. Mycol Res, 1991, 95: 641–655
47 May R M. Bottoms up for the oceans. Nature, 1992, 357: 278–279
48 May R M. How many species inhabit the earth? Sci Am, 1992, 10: 18–24
49 Gaston K J, Williams P H. Mapping the world's species-the higher taxon approach. Biodiv Lett, 1993, 1: 2–8
50 Poore C B, Wilson G D F. Marine species richness. Nature, 1993, 361: 597–598
51 May R M. Marine species richness. Nature, 1993, 361: 598
52 Storks N. How many species are there? Biodiv Conserv, 1993, 2: 215–232
53 Hawksworth D L, Rossman A Y. Where are all the undescribed fungi? Phytopathology, 1997, 87: 888–891
54 Ricotta C, Ferrari M, Avena G. Using the scaling behaviour of higher taxa for the assessment of species richness. Biol Conserv, 2002, 107: 131–133
55 Lambshead P J D, Boucher G. Marine nematode deep-sea biodiversity-hyperdiverse or hype? J Biogeogr, 2003, 30: 475–485
56 Bouchet P. The magnitude of marine biodiversity. In: Duarte C M, ed. The Exploration of Marine Biodiversity: Scientific and Technological Challenges. Bilbao, Spain: Fundacion BBVA, 2006. 31–64
57 Zapata F, Robertson R. How many species of shore fishes are there in the Tropical Eastern Pacific? J Biogeogr, 2006, 34: 38–51
58 Adl S M, Leander B S, Simpson A G B, et al. Diversity, nomenclature, and taxonomy of protists. Syst Biol, 2007, 56: 684–689
59 Lopez-Garcia P, Moreira D. Tracking microbial biodiversity through molecular and genomic ecology. Res Microbiol, 2007, 159: 67–73
60 Mora C, Tittensor D P, Myers R A. The completeness of taxonomic inventories for describing the global diversity and distribution of marine fishes. Proc Roy Soc B, 2008, 275: 149–155
61 Chapman A D. Numbers of Living Species in Australia and the World. 2nd ed. Toowoomba: Australian Biodiversity Information Services, 2009
62 May R. Tropical arthropod species, more or less? Science, 2010, 329: 41–42
63 Hamilton A J, Basset Y, Benke K K, et al. Quantifying uncertainty in estimation of tropical arthropod species richness. Am Nat, 2010, 176: 90–95
64 Carbayo F, Marques A C. The costs of describing the entire animal kingdom. Trends Ecol Evol, 2011, 26: 154–155

How many species are there on Earth?

JIANG ZhiGang

[1] *Institute of Zoology, Chinese Academy of Sciences, Beijing 100101, China;*
[2] *University of Chinese Academy of Sciences, Beijing 100049, China*

How many species are there in the marine or terrestrial realms in the world? Biologists have tried to answer this question for the past half century. However, different estimations are made of the number of species, using different methods, estimates range from 500000 to 100000000 species on earth. There is no accurate estimate and the estimations of the total number of species on earth do not converge yet. However, the number of species of higher plants, freshwater fishes, amphibians, reptiles, birds and mammals are relatively clearly ascertained. Most botanists agree there are 30000000–3500000 plant species on earth. FishData (2016) reported 33200 fish species that have been scientifically described, of which 14000 are freshwater species. The American Museum of Natural History (2016) recorded 7493 amphibians in the world. Reptile Data Base (2016) recorded 10272 reptile species. BirdLife International (2016) reported 10426 bird species. Wilson and Reeder (2005) reported 5436 mammalian species in 2005. Adding the new species reported worldwide since then, IUCN (2016) reported there are 5515 mammalian species excluding domestic animals on earth. Why can we not get an accurate count of species number on earth? The reasons lie in differences in the definition of species, taxonomic methods, standards of species used by different taxonomists and the research scope and depth in different taxa or in different regions on earth. The species is a disputed concept, which has evolved since Darwin's time, yet we still cannot reach a universal definition of the concept. In the past, taxonomists used morphorlogical traits to classify species, later numerical taxonomic methods and cladisitic methods were used. Now molecular phylogeny is widely in use in taxonomy, and more phylogenetic species are discovered with this method. Taxonomy is an empirical science. Taxonomists study different goups, and even different taxonomists studying the same group may hold different opinions on the standard of species, reflecting that often taxonomists cannot reach agreement on whether a species is valid, whether to split a species or to lump several taxa into a single species. Taxonomists have done siginficant work on describing species in mammals, birds, reptiles and amphibians, but little work on, e.g., nematodes. Most biodiversity studies are concentrated in deveploped countries like USA and UK while the biodoversity-rich counrties like Ecuador, Indonesia, Madagascar and Peru are neglected. Most leading biologistss are working in academic institutions and universities located in developed countries, who dominate the conservation science policy making bodies such as IUCN/SSC specialist groups, Red List Committee and IUCN Endangered Species Redlist Techanical Working Group (Wilson et al. 2016). Thus, most species remain undescribed. If one day, people can carry out thorough studies on all taxa in all habitats on earth when taxonomists studying different taxa cannot standardize their definition of species, or even taxonomists studying the same taxa cannot standardize their definition of species, we still cannot get an accurate census of number of species on the earth. Nevertheless, it would be logic to estimate the number of species on the earth.

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蒋志刚

中国科学院动物研究所研究员，博士研究生导师. 1993 年获加拿大 Alberta 大学博士学位. 1994 年任中国科学院动物研究所保护生物学研究室主任、副研究员. 1995 年入选中国科学院“百人计划”. 1996 年入选人事部“百千万工程”并破格晋升研究员. 1997 年获国家杰出青年科学基金. 主要研究领域是保护生物学和行为生态学. 发表 300 余篇论文，著作 20 余部. 现任中国濒危物种科学委员会常务副主任，中国野生动物保护协会科技委员会主任，中国动物行为学会理事长，中国兽类学会副理事长，世界自然保护联盟/物种生存专家委员会(IUCN/SSC)专家，DIVERSITA 中国国家委员会委员，人与生物圈中国国家委员会委员，中国科学院生物多样性委员会委员，*Current Zoology*，《生物多样性》、《野生动物学报》副主编，*Biological Conservation*，*Oryx*，*PLoS One* 等刊物编委.