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The *International Encyclopaedia of Primatology* (IEP) is comprehensive in many senses. It was edited by 15 people, who were joined by >415 contributors, who together cover 485 articles. To aid navigation, these articles are organised into 16 topics, listed here to illustrate the scope of the themes addressed: anatomy and locomotion, apes, behavioural ecology, captivity, cognition, conservation, disease, ethnoprimateology, field methods, genetics/endocrinology, history of primatology, Neotropical primates, Old World monkeys, primate evolution, prosimians, and sexuality and reproduction. The IEP can also be searched by article alphabetically, and each article is available as an abstract, html and pdf. Most articles are cross-referenced to other relevant articles in the encyclopaedia and are generally supported by 3–15 references with another 1–6 listed for further reading. There are electronic links (to abstracts, sometimes the full article, and citation information) for many of the references.

Together we have reviewed approximately 335 articles, 69% of the contents. Our comments by theme are given below.

Anatomy and Locomotion

This theme consists of a collection of mostly very short technical articles (2–3 pages), which in the majority provide clear, useful descriptions of various parts of primate anatomy (for example, “Bipedalism,” “Prehensile Tail,” “Cheek Pouches,” “Ischial Callosities”). In several articles, authors highlight the importance of anatomy in interpreting the fossil record and review their topic within a broader mammalian context as well as within a comparative primate one. The “Form/Function Framework” article nicely illustrates this contextual approach. The “Positional Behavior” article in this theme was unusual in being long (14 pages) and nicely illustrated with simple line drawings. These simple figures clearly demonstrate what is referred to in the text. Indeed, it would have been nice to see more figures/illustrations in this theme to show some of the anatomy being described. An article on “Urban Macaques” is an anomaly and would be more appropriately placed in the Ethnoprimateology theme.

Apes

Overall, this theme of 17 articles is disappointing – 20 of the 26 (soon to be 27) species of ape have been almost completely ignored. The small apes are not mentioned at all in “Ape Diets” and “Ape Field Studies” – even orangutans are given short shrift in the latter. Moreover, “Ape Field Studies” contains factual errors and several typos (and omits at least 1 site of note: Ugalla in Tanzania). There is a tendency for information to be outdated already and patchy in places; for example, “Ape Language” lacks more recent studies and there is no reference to gestural communication. This is also a theme of extremes, where 20 species of small ape are described in only 1.5 pages of space, while bonobos are covered twice – as a lengthy individual entry, and in “Chimpanzee and Bonobo” (which are not cross-referenced). This is particularly baffling, because there are only 3 other single species entries in the entire IEP (*Callimico*, Daubentoniidae and Gelada). There is also a lack of consistency in information provided in each entry: for example, the “Orangutan” article provides a nice overview of the conservation threats facing the genus but lacks information on their behavioural ecology, while the reverse is true for the Hylobatidae.

The lead author of “Gorilla” is a graduate student whose inexperience has produced a text that is not of a standard one would hope for in an “international” reference volume, with errors in the text and the table. The map in this entry shows that western gorillas are no longer found in the Democratic Republic of Congo, but it is listed as part of their geographic range, despite having been officially removed from the western gorilla’s habitat countries in 2008 [IUCN 2008 Red List of Threatened Species]. The Democratic Republic of Congo is also listed as a western gorilla range country in “Hominidae.” On a more positive note, the articles integrating evolutionary theory (for example, “Hominins,” “Hominoidea” and “Demonic Male Theory”) are well written and nuanced, providing excellent detail and an overview of the relevant research.

Behavioural Ecology

This is the largest theme, containing 78 articles, most of which are well written and well researched. The vast majority of the articles are succinct and follow a standard format, being some 2–3 pages in length. However, 1 or 2 entries drift into personal opinion and away from research evidence (notably the entry on “Aggression”) or fall below the generally high standard (for example, “Habitat Use”). Inevitably, some topics are denser than others and require longer articles (for example, “Ecological Morphology,” “Environmental Seasonality” and “Foraging Strategies”). Overall, the chapter provides an excellent theoretical background for such a highly diverse and complex topic (for example, the theme covers large topics such as “Behavioral Flexibility,” “Dominance,” “Environmental Seasonality,” “Foraging Strategies” and “Niche Partitioning”), and the majority of the entries are written with authority and skill. This is thus a very strong theme and will provide an excellent reference aid to any level primatologist. However, the inclusion of a stand-alone article on “Madagascar” with an overview of its endemic lemurs (which contains some factual inaccuracies) seems strangely out of place.

Captivity

The 24 articles in this theme cover the major aspects of captive care (diet, enrichment, veterinary care) as well as legislation, the 3 Rs (replacement, reduction, refinement), and zoos and visitor effects. Overall, the standard of articles is very good, and they provide sound introductions to the topic (see, for example, “Captive Care Legislation,” “The Three Rs,” “Visitor Effects”). The “Zoos” article is limited as it is rather short and very US-based – disappointing in an international encyclopaedia (indeed several articles are like this, e.g., “Animal Welfare Act”). Surprisingly it does not cross-reference “Ex situ Primate Conservation.” The “Diet and Nutrition” article provides a very good technical overview – but is not really related to captivity. It is unclear why the “Max Planck Institute” article has been classed under captivity, since it overwhelmingly describes fieldwork on African great apes.

Cognition

This theme of 11 articles is largely very good, providing an overview of different facets of cognition. Several authors produced nicely balanced articles (for example, the eloquent discussions on the pros and cons of “Nonhuman Primate Personhood”) and developed interesting questions about the future for their field, suggesting potential avenues of research (for example, in “Collective Decision Making” and “Communication”). The “Culture,” “Learning” and “Primate Brain Evolution” articles are well rounded and well grounded in evolutionary theory, and also well referenced. However, in most sections, it would have been good to see more on novel techniques, field-based experiments and the new technologies that are being used to understand primate cognition. There are some excellent articles by experts in their field (for example “Imitation,” “Nonhuman Primate Personhood”). However, as with other themes, the articles are patchy (some great, some not), and a bit outdated in places. The style changes depending on writer and topic, which is a bit disruptive for the reader – it might have been advisable for the editors to be a little stricter on formatting!

Conservation

This is obviously a critical theme to cover, and a good place to start would be the article on the “IUCN Red List,” which clearly sets out just how much trouble primates are in – connected to habitat loss and hunting. Several articles cover aspects linked to habitat loss – see especially the excellent “Deforestation,” as well as “Logging.” A series of articles looks at different aspects of primate habitat (“Habitat Conservation,” “Habitat Fragmentation,” “Habitat Restoration,” “Hunting and Habitat Degradation”). There is of course some overlap but the message re loss of habitat is loud and clear – for example from 1980 to 2000 tropical forests were the main source of new agricultural land – and 55% of it replaced intact forest. Since most primates are forest-dwellers, the consequences are obvious. It is good to see “Human Population Growth, Poverty” covered, linked to “Urbanization,” as well as consideration of “Primate Conservation and Human Livelihoods,” which gives an overview and links to various articles in the Ethnoprimatology theme (e.g., “Ecotourism,” “Crop Raiding”). This theme of 26 articles is rather different from others in that it tends to contain much longer articles (“Primate Conservation Education” has >60 references – completely out of kilter with the rest of the IEP), although “Buffer Cropping” is only 2 pages.

Disease

This theme is generally excellent, technically detailed, but still clearly written. Just occasionally, the experts who provided these entries overlooked that we mere mortals are not familiar with some of the terms they use; however, the IEP makes a good attempt at providing definitions. One small niggle – the editors could have been up-to-date on Ebola terminology (previously but no longer known as Ebola haemorrhagic fever [CDC, 2017]) and might also have ensured consistency in the use of Ebola versus ebola. Unfortunately, the “Immunodeficiency” article claims that simian immunodeficiency virus is asymptomatic in African primates; however, it has been known since 2009 that in chimpanzees SIVcpz causes an AIDS-like illness that compromises their survival. This is corrected in the “Pathogen” article, but the 2 articles are not cross-referenced.

Ethnoprimatology

The 35 articles in this theme cover a breadth of complex issues, all of which can be difficult to describe in short papers. All the authors have done an excellent job of succinctly expressing the issues covered, and the section makes for an enticing introduction to a very important and

varied field of primatology (which includes, for example, “Primates in Mythology,” “Primates as Propaganda,” “Sacred Forests”). Some of the articles, such as “Bushmeat,” provide a good technical overview, but lack important details on the scale of wildlife extraction and the phenomenon of empty forests. Others, such as “Human-Animal Relations” and “Humans as Primate Predators,” cover more historical ground and ideology. The addition of methodologies in “Human-Animal Relations” is welcome, especially given that other topics (“Ecotourism” and “Mitigating Human-Nonhuman Primate Conflict”) seem almost to be a call to action for further research and well-designed conservation initiatives. There are some overlaps between articles – for example, “Primate Tourism” and “Ecotourism” – but this is unsurprising, and each contains enough distinct information to remain worthy of inclusion in the volume.

Field Methods

The 14 articles in this topic strike a balance between being both sufficiently detailed (some themes focus on complicated topics conceptually – “GPS/GIS,” “Home Range Estimation” and “Telemetry”) and being written in a succinct and an easy-to-follow style. Each of the articles is well condensed and summarised whilst still providing in-depth scientific information and description, with many articles also containing suitable figures and aids. The theme as a whole has been written with authority and clarity. Some authors have opted to write from a historical approach, outlining the genesis of the method itself, whereas others provide greater detail on the subject and focus more on its impact on wider primatology. Overall the articles in this theme are excellent; however, one quibble is the lack of a section on “Invasive Sampling: Genetic” as a complement to “Non-Invasive Sampling: Genetic,” as the former would cover myriad commonly practised, modern methodologies. Furthermore, with the nature of invasive work being more risky in general, it seems strange that an article on best practice and ethical guidelines is absent here. Such a topic could have improved the utility of the theme for working field biologists.

Genetics/Endocrine

This theme contains overwhelmingly genetic articles (only 4 of the 25 articles are on endocrinology – and these could probably have been categorised elsewhere). The standard of articles of both topics in this theme is high – with clear and informative explanations of techniques and hormone pathways. Most articles highlight how these techniques can be usefully applied to human and non-human primates (see for example “Landscape Genetics,” “Ancient DNA”), whereas others miss this link and are purely technical (“Genetic Drift”). Several give short (<2 pages) but useful overviews (“Karyotype,” “DNA Fingerprint”...). Given the rapid developments in genetics, many articles make predictions regarding future use and impact of next-generation sequencing for primatology. “Genetics of Primate Color Vision” is well explained but overlaps with “Color Vision of Primates” (in Primate Evolution) – although they are not reciprocally cross-referenced.

History of Primatology

This is one of the largest themes, with 72 articles, which are frustratingly patchy and of variable depth. On a positive note, 4 excellent articles describe the many facets of primate sanctuaries (philosophy, legislation, captive care, challenges, etc.), but it would have been so easy to include Africa, where sanctuaries formed an Alliance 15 years ago [Farmer 2002; PASA <https://www.pasaprimates.org>].

The histories of primatology are both informative and entertaining, and the IEP seems to be an appropriate vehicle for such information. The articles “Japan,” “North America” and “South America” are more detailed (up to 12 pages) than most entries under other themes; how-

ever, “Southeast Asia” is let down by a graduate student author who clearly had no depth of personal history to draw from. The history of European primatology is completely lacking (for example, no mention of Belgian and German explorers, the universities of Cambridge, Rennes-Paimpont, Strasbourg, or of the European primate societies – the Primate Society of Great Britain celebrated its 50th anniversary in 2017).

The reviewers learned something from almost all of the profiles of individual primatologists, but we wonder if any criteria were used to select the individuals who are profiled? Surely all 7 recipients of the IPS Lifetime Achievement award [IPS, 2016] merit entries (3 – Box, Nishida and Oates – are not profiled, although their significant contributions to primatology were described at the time [e.g., Mitani et al., 2011; Yamagiwa, 2011]). What about Coimbra Filho, the Gautiers, Groves, McGrew, Martin, Thiago de Mello, Wrangham, to name but a few other glaring omissions? A whole book has been published in recognition of Groves’ reconfiguration of primate taxonomy [see Behie and Oxenham, 2015], but he too is not profiled. IPS officers or IUCN SSC PSG chairs would have helped identify authors to fill the gaps. The Editor-in-Chief admits that “the biographies are a mixed bag,” so would it have been better to omit biographies altogether? Last, it seems strange that only one book (*Primates in Perspective*) is singled out for an entry.

Neotropical Primates

This topic has 9 articles, divided phylogenetically. They are generally expert accounts, for example, the “Callitrichines” overview sets out the morphological, social and dietary differences between the 8 genera in this group, providing an excellent introduction to these small South American primates. However, despite their quality, there is variety in coverage and overlap – for example, the “Atelinae” article is an overview, yet does not cross-reference “*Brachyteles* (Muriqi)” or “Howler Monkey (*Alouatta*)” – instead directing the reader to “Long-Term Field Studies – Africa.” There is an article “Cebids (Cebinae)” which covers squirrel and capuchin monkeys – yet also an article on “Capuchin Monkeys.” Titi monkeys (Callicebinae) do not seem to be covered at all in this theme.

Old World Monkeys

Of the 12 articles in this theme, 9 cover primates and 3 are field sites. The primate articles present straightforward and very useful summaries of the broad taxonomy and characteristics of the various taxonomic groups. Several articles use tables (unusual in this encyclopaedia) to list the various species and their distributions. For example, the “African Colobines” and “Asian Colobines” articles set out the broad taxonomy of these folivores in tables. It is worth reading these articles together, as they provide a very useful introduction to this large group, and comparisons are highlighted. The “Macaque” article provides a useful at-a-glance summary of similarities and differences between the species, taking a huge amount of information and making it remarkably accessible, and the “Baboon” article also provides a succinct review. However, given the plethora of studies on these 2 taxonomic groups, it is incredible there are so few references and suggestions for further reading. But, overall this theme provides an excellent overview.

Primate Evolution

This theme contains articles on a wide range of subjects: specific fossils (“*Purgatorius*”), fossil sites (“Koobi Fora”), evolution of primate groups (for example “Evolution of Pliopithecoidae” and “Evolution of Modern Strepsirrhines”), to biogeography and climate change. The theme is detailed and meticulously researched. In general, it does justice to our understanding of this field, highlighting the uncertainties and grey areas in our current theories and understanding (for example, in “Origins of Primates – Debates and Controversies”). Several conceptually complex ar-

ticles, such as Encephalization, have considerable detail, but many of the articles could have been improved by the addition of figures – for example, in “Evolution of the Cercopithecidae.” The articles provide a good overview of the topic, and the majority are written with clarity and style. The inclusion of broader topics such as “Biogeography and Primate Biogeography” and “Plate Tectonics and Continental Drift” show the relevance of diverse topics to primatology and provide a “big picture” look at the range of major factors, including anthropogenic factors, that can influence primate populations over time.

Prosimians

This theme, with only 7 articles, seems somewhat understated in comparison to others, especially given the substantial numbers of primate taxa that are Madagascan prosimians. It is curious that only an arbitrary selection of families (Daubentonidae and Megaladapidae) is covered in detail, whilst other large families, such as the Cheirogalaeidae, are almost entirely omitted. Many lineages go unmentioned, for example mouse lemurs (*Microcebus*). There is little discussion regarding the level of hidden or cryptic diversity being revealed in the nocturnal prosimians. Other than “Megaladapidae” and “Tarsiiformes” the articles were rather disappointing.

Sexuality and Reproduction

The 36 articles that make up this theme are for the most part extremely thorough and well referenced, representing some of the strongest sections of the IEP. Broad biological concepts are given functional and evolutionary significance, for example, when discussing “Consortship” or “Sperm Competition,” and brought to the level of individual species through clear examples from long-term fieldwork. Especially noteworthy are the discussions of “Alloparental Behavior,” “Paternal Care,” and different mating systems (“Monogamy,” “Promiscuous Mating”). The language is rather technical in places; however, the articles are readable and engaging, providing a good depth of knowledge, for example when discussing “Menstruation” and the “Ovarian Cycle.” As in other themes, there are major differences in length and formatting (the shortest article in this section, “Adolescent Sterility,” was 3 paragraphs with 1 reference), but this was less of an issue due to the high quality of the articles throughout.

Overall Comments

One would expect a high standard from such a hefty title, and what has been achieved is often excellent, but it is disappointingly mixed. Our initial assessment softened after reading the Editor-in-Chief’s introduction, which provides some explanation for the shortfalls, such as why some entries already seem dated in a 2017 publication. However, having undertaken a project of such potentially vast scope, the editors should be prepared for criticism.

While most articles are well written by a recognised expert of their field, a few seem to have been “delegated” to graduate students, whose texts lack depth. Moreover, there is considerable variation in the length of articles, the formatting style and the referencing, which could have been addressed by the numerous editors. There are some exceptionally long entries with >15 references (and one with 60), while the majority are limited to <6 plus “Further Reading,” although not all articles even provide further reading. As a reference volume, some types of error are unacceptable. For example, there are 2 cases of contradictory entries, both involving disease, and in each case only one of them is correct. The IEP has various typos and some strange words, which should have been picked up (for example, agnostic instead of agonistic). There are also some omissions: no tables were cited (for example in “Protected Areas”) and no titi monkeys in “New World Primates.”

Given the difficulty of describing a family or genus adequately in just a few pages, the IEP might have been better served if the purpose of the taxonomic entries had been primarily to provide links and suggestions for further reading. Standardising the level of taxonomy would also have helped (there are articles from species to family) and evened out the coverage, which is quite variable.

It was clearly hard to decide what to include or exclude and how to distribute articles between themes (we imagine there must have been a lot of discussion even to decide on themes). There is quite a bit of overlap between articles and even the cross-referencing is uneven and not always reciprocal, which is something the editors could have addressed.

That said, for the most part, the IEP is timely, and most themes are thorough compilations of current knowledge on an area of primatology. The IEP also includes descriptions of a number of technologies and methodologies and their application and relevance to primatology. It is strongest when taking broad concepts and applying them to the Primate order and when defining technical terms, or describing concepts, behaviour or morphology. Although technical in places, by and large it is pitched well for non-expert understanding.

While there is a necessary shallowness in some of the coverage (given the number and breadth of topics) and some overlap between articles, most cover the critical points for each area in an engaging and informative fashion, providing an excellent first resource for anyone wanting to know more about the field. Indeed, although some of the articles are limited as individual pieces, it is possible to get a more complete picture by using the linked articles. The encyclopaedia is a bit repetitive in places, but reads better as a whole, and is more thoughtful, better referenced and more reliable than Wikipedia. The IEP will be most useful for students wanting an overview of a topic with directions to further reading and, as such, is a valuable starting point for further work. However, its high price may put it out of reach of most individuals and many institutions.

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