

Journal of Geek Studies

Vol. 5(2). 2018.



ISSN 2359-3024

Journal of Geek Studies

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Journal of Geek Studies

<http://jgeekstudies.wordpress.com/>

<http://jgeekstudies.org/>

ISSN: 2359-3024 (online).

Vol. 1 (2014) – present.

São Paulo, SP, Brazil.

1. Science; 2. Technology; 3. Geek Culture.

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Cover art: The distribution of known animal species in the World of Ice and Fire, from the article by Evangelos Vlachos (JGS vol. 5(2), pp. 01–17). See the full article for an extended explanation.



Zoological Nomenclature of Ice and Fire

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Valar gūrēñis — All men must learn

The diversity of the World of Ice and Fire (Westeros, Essos and the other continents combined) is remarkable. All kinds of species of animals and plants are known, including some mythical creatures. The purpose of this contribution is to provide a system of nomenclature for the most important animal species from the World of Ice and Fire. This new system is based on the High Valyrian language, and aims to provide a set of names that can be applied to the various species of life that survived, or even became extinct, in this world.

The World of Ice and Fire is a fictional world. Although most of the wild and domesticated animals are the same or similar to our own, there several animals that are unique to it. Also, more than one 'species' of humans survive in this world, now mostly isolated in remote islands like Ibben and the Sothoryos. The Common Tongue, spoken mainly in the Seven Kingdoms of Westeros, is given to us through the books in English; but this doesn't mean that it is English. Even if a direwolf is called a direwolf in the books, it

probably sounded differently in the Common Tongue.

Back to our world, following the pioneering work of C. Linnaeus in 1758 the need of a stable and universal system of biological nomenclature became necessary. Since then, a set of rules has been created, revised, used and applied to Zoological Nomenclature, forming the so-called *International Code of Zoological Nomenclature* (ICZN, or simply 'the Code'). The latest edition was published in 1999, and some parts of the Code have been recently (2012) amended to include names and acts published in electronic-only journals.

I will briefly present the main features of this system of nomenclature for those not entirely familiar with it. The backbone concept of nomenclature is the **binomen**: each species name is formed by two components, the genus name and the specific name; both are written in italics and the genus name is capitalized (e.g., *Homo sapiens*). The ICZN offers a graphical summary of the whole process of naming animal taxa¹, which is summarized in Box 1 below. The reader should, of course, consult the Code for further details.

¹ See the ICZN's website (<http://iczn.org>) for detailed information.

Box 1. Basic steps for naming taxa

1. The name must be contained in a published work (published *sensu* the ICZN);
2. The name must be available (*sensu* the ICZN);
3. The name must be properly formed, following the instructions of the ICZN.

Names that do not conform these rules are unavailable names (including the so-called ‘naked names’), and can be made available later for the same or different concept. If these conditions are met, the available names enter the zoological literature. Once part of the literature, the names ‘compete’ for validity, which mainly refers to the so-called ‘Principle of Priority’. Simply put, the oldest available name applied to a taxon is the valid name for this taxon (Art. 23.1, ICZN). The other names are invalid names, including synonyms, homonyms, and dubious names. Of course, in real life things are not so simple, as there are several exemptions from these rules and a multitude of complicated cases; the Code contains numerous articles and examples that try to account for all these situations.

Obviously, the purpose of this article is to propose a set of names for the animals of the World of Ice and Fire, but a curious reader might ask: do those names also become part of the ‘real life’ zoological nomenclature? The answer is no, these names will not form part of the zoological nomenclature for the main following reasons:

1. As the *Journal of Geek Studies* is an electronic publication, any name (or nomenclatural act) published in it should conform to the rules of Art. 8.5 (ICZN) for works published/distributed electronically. But it fails to conform to the provisions of the sub-article 8.5.3, which mandates the registration of the work and the names on the *Official Register of Zoological Nomenclature* (a.k.a. *ZooBank*).

2. Even though several of the animals of the World of Ice and Fire are referred to the Common Tongue with similar names and concepts of wild and domesticated animals that exist or existed in our world (*e.g.*, a dog, a horse, a mammoth), those animals are actually purely hypothetical concepts (*sensu* Art. 1.3.1, ICZN) that exist in the fantasy

World of Ice and Fire and the mind of G.R.R. Martin. Thus, they are excluded from the zoological nomenclature.

3. The names, as published herein, are not formed properly according to the Code. Both words are capitalized, not italicized, with diacritic signs, and are connected by a dash.

Therefore, all the names herein are unavailable names for our ‘real life’ zoological nomenclature. I suppose that a similar need of a system of nomenclature would be eventually necessary in the World of Ice and Fire as well, most probably among its scholars—the Maesters. The study of the natural world has largely been neglected by the great Maesters of the Citadel, in Oldtown. Maester Yandel in his work (Martin et al., 2014) provides some basic information on various animals — in many cases by citing other authors — but without any specific focus on nature. However, one cannot understand and explain the mysteries of the world, unless they are able to explain and describe the life on it. Therefore, and to avoid misunderstandings among Maesters across the continent, this new system of nomenclature

would greatly assist in the communication among scholars in the World of Ice and Fire.

I strongly insist that the Maesters of the Citadel should try to promote the study of the natural mysteries of the world. I further propose that the Maester who will complete the study of a significant portion of the natural world should be awarded a wooden link to add to his chain. This link should be made by a weirwood tree and would symbolize that all life on the World is related, and originated from a common root, just like the branches and leaves of a weirwood tree.

METHODOLOGY

In order to differ from the common, vernacular, names of the animals in the Common Tongue of the World of Ice and Fire, their scientific names will be created in the High Valyrian.

The Valyrian languages are a group of languages that were spoken in the past, with High Valyrian being spoken in Valyria and its descendants languages (Astapori and Meereenese Valyrian) spoken in Astapor and Meereen respectively, as well as a variety of dialects and corruptions of the pure High Valyrian spoken in the Free Cities (Martin et al., 2014). Although several words in High Valyrian were already present in the books of the series *The Song of Ice and Fire* written by G.R.R. Martin, the language was created by D.J. Peterson for the TV series (Peterson, 2013).

For the purpose of establishing the 'Zoological Nomenclature of Ice and Fire', the names will be written in High Valyrian, with the use of the letters of the Latin alphabet (High Valyrian was certainly written in its own

alphabet). The source of linguistic information is the Dothraki Wiki (2018; information stored therein is copyrighted by the Language Creation Society, HBO, and G.R.R. Martin).

The main objective of this work is to name the main species of animals (*e.g.*, the species of humans) and also provide some names for large groups (*e.g.*, a name for 'mammals'). The basic information comes from the bestiary of A Wiki of Ice and Fire (2018, and references therein). Parts of this work have been preliminary published in the subreddit *r/asoiaf* (<https://www.reddit.com/r/asoiaf/>) by the author, under the alias *E_v_a_n* (2017, and references therein). Very few names have been proposed by some other redditors and they are not included herein. The terms 'species', 'subspecies', and 'genus' are used in a similar sense as in modern taxonomy and nomenclature for simplicity.

The various names were created based on the following basic rules and recommendations, which are illustrated by examples where necessary. The formation of the majority these rules is based largely on valuable comments of David J. Peterson, whom I deeply thank.

Rule 1. Names for large groups consist of a single word, whereas names for 'species' consist of two words. **Example:** **VALAR** for humans, **Sylvie-Valar** for the wise humans, which is included in **VALAR**.

Rule 2. The two words comprising the 'species' names are hyphenated and each start with a capital letter. We do not know if such kind of punctuation was present in High Valyrian. The purpose of adding the hyphen

here is mainly to distinguish these names from original binomina in nomenclature.

Rule 3. Group names are written in small capitals. This rule is only for stylistic purposes.

Rule 4. All original diacritics of High Valyrian must be kept. Besides its stylistic purpose, the application of this rule further distinguishes the names herein from original names in nomenclature.

Rule 5. Formation of group names is done either with nouns in the collective or adjectives with the addition of the derivational affix *-enka* (meaning 'like').
Example A: To form the name of the group of humans ('equivalent' to a genus name) we could use the word 'vala' (1lun; man) in the collective, as **VALAR**.
Example B: To form the name of the group of reptile-like animals we could use the word 'rīza' (1lun; reptile, lizard) with the addition of the derivational affix *-enka* (adj. I), as **RIZENKA**. Note that in this case we need to use only the root of the word 'rīza' (rīz-).

Rule 6. Formation of a species name is done with the combination of an adjective and a noun in the collective. Note that adjectives must agree in gender (*i.e.*, lunar, solar, terrestrial, aquatic), case, and number, with the noun they modify; however, as the noun is in the collective, the adjective should be in the singular. Also, the adjective goes before the noun it modifies. **Example A:** To create the name for the wise humans we

could use the combination of the noun 'Valar' (1lun; 'all the men', in the collective) with the adjective 'Sylvie' (adj. III). The singular of this adjective would be 'Sylvie' for lunar/solar and 'Sylvior' for terrestrial/aquatic (in the singular; see Rule 5 above). As the word 'Valar' is of lunar gender, it should be combined with the adjective in the lunar gender as well, as **Sylvie-Valar**.
Example B: To create an adjective from a noun one should use one of the derivational affixes like *-enka* (adj. I) (see Rule 5). Again, there must be agreement in gender.

Rule 7. To create a name that consists of three components ('equivalent' to a subspecies or for other purposes), insert the third component in its proper place according to the desired meaning, again in agreement to Rule 6. **Example:** For the name of the white walkers, supposedly a further subdivision of the wise humans, we could use the name **Sylvie-Valar**, inserting in between the adjective 'Timpa' (adj. I) in the lunar gender and in singular, as **Sylvie-Timpa-Valar**. In this arrangement it reads: 'all the wise white men'. Contrary to our own nomenclature, the position of the components may vary depending on the desired meaning. For example, 'all the white wise men' would read as **Timpa-Sylvie-Valar**. Both versions are equivalent for nomenclatural purposes herein.

Rule 8. To form a name from a toponym, one should add the derivational suffix *-sīha*, or *-īha* (depending if the root ends in

consonant or vowel), to form an adjective of Class I. It then follows in agreement to Rule 6. Alternatively — and this could be done with other names as well, not only with toponyms — one could use the derivational suffix *-ōñe* (which means ‘from the’) to form a Class II adjective. **Example A:** To name the species of humans from Ibben, we could add the suffix *-īha*, as **Ibbenīha-Valar**. In this form it reads: ‘all the Ibbenian humans’. **Example B: Ibbenōñe-Valar**. In this form, it reads: ‘all the humans from Ibben’. This is a quite useful suffix to form many other names as well (see below).

All original information below comes from *The Song of Ice and Fire* books (Martin, 1996, 2000, 2005, 2011) and *The World of Ice and Fire* (Martin et al., 2014). For simplicity, I will not add these citations below.

The relationships among the main ‘species’ named herein are depicted across the branches of a weirwood tree (Fig. 1).

The maps presented herein (Figs. 2 and 4) are based on the original map available in Wikimedia Commons (CC-BY-SA 4.0), which was subsequently edited in Adobe Photoshop (removing words) and Adobe Illustrator (tracing) to create the final ‘clean’ version for this article. Silhouettes of animals are re-drawn manually from pictures available online with permission to be modified.

Abbreviations: Nouns: numbers denote the declension, followed by the abbreviated gender (**aq**, aquatic; **lun**, lunar; **sol**, solar; **ter**, terrestrial). **Adjectives** (adj.): Roman numerals indicate the class.

NOMENCLATURE

BRŌZIR

(all the names; from the noun ‘brōzi’, 5lun, meaning ‘name’)

DŸÑENKA, animals.

Etymology. **DŸñenka**, from the word ‘dŸñes’ (4sol; animal) and the suffix *-enka* (adj. I), which means ‘like’; altogether the name means ‘animal-like’.

Remarks. The distribution of the animals of the World of Ice and Fire is shown in Figure 2. Those with a roughly cosmopolitan distribution (e.g., horses) were excluded for simplicity.

JŪLRENKA, mammal-like animals.

Etymology. **Jūlrenka**, from the word ‘jūlor’ (3aq; milk) and the suffix *-enka* (adj. I).

Uēpys-Nusper, all the ancient cows or aurochs.

Etymology. **Uēpys** from the adjective ‘uēpa’ (adj. I; old); **Nusper** from the nominative collective of the noun ‘nuspes’ (4sol; cow).

Remarks. This is the ancestor of the modern-day cows, and was larger, with longer and more robust horns. Although not present in most of Westeros as a result of domestication, their presence is reported beyond the Wall, and are served in feasts in some of the Great Houses of the North.

Lantarōvatsienkys-Ñomber, all the elephants with two big teeth.

Etymology. **Lantarōvatsienkys**, from the combination of the words ‘lanta’ (adj. I; two), ‘rova’ (adj. I; big), ‘atsio’ (3lun; tooth), and the suffix *-enkys*, referring to the animals’ large

tusks; **Ñomber** from the noun ‘ñombes’ (4sol; elephant).

Remarks. Native to Essos, quite common in Astapor.

Krubenkys-Ñombītsor, all the dwarf elephants.

Etymology. **Krubenkys**, from of the word ‘krubo’ (3lun; dwarf) and the suffix –enkys; **Ñombītsor** from the noun ‘ñombes’ (4sol; elephant) and the diminutive suffix –ītsos (2sol), in the collective.

Remarks. Related to elephants, but never reaching a large size; used as transportation in Volantis.

Timpa-Kēlior, all the white lions or hrakkars.

Etymology. **Timpa** from the adjective ‘timpa’ (adj. l; white); **Kēlior**, from the collective of the noun ‘kēlio’ (3lun; lion).

Remarks. A rare species of white lion, native to the Dothraki Sea.



Figure 1. The taxonomy of the animals of the World of Ice and Fire, depicted on the branches of a weirwood tree.



Figure 2. The distribution of known animal species in the World of Ice and Fire, excluding those with cosmopolitan distribution.

Dothrakōñe-Anner, all the horses of the Dothraki.

Etymology. **Dothrakōñe**, from the Dothraki, the horselords, and the suffix *-ōñe* (adj. II); **Anner**, from the nominative collective of the word ‘anne’ (4lun; horse).

Remarks. Widespread on the entire world, medium of transportation, and used in combat as well. They are especially important for the Dothraki horselords.

Rizmenkys-Annītsor, all the dwarf horses of the sand or sand steeds.

Etymology. **Rizmenkys** the word ‘rizmon’ (3ter; sand) and the suffix *-enkys* (adj. I); **Annītsor** from the word ‘anne’ (4lun; horse) and the diminutive suffix *-ītsos* (2sol) in the collective.

Remarks. Long neck, narrow head, slim and swift, with red, golden, black or pale fur. Bred in Dorne.



Figure 3. The first known occurrences of **Starkenka-Zoklar** south of the Wall, seen here as two pups of a female direwolf. A typical example of **Sylvie-Ēlie-Valar** (Jon Snow) for scale. Screen capture from Episode #1 ('Winter is Coming'), Season #1, of *Game of Thrones* (HBO, 2011–present).

Starkenka-Zoklar, all the wolves of the Starks or direwolves.

Etymology. **Starkenka**, from the name of House Stark, whose sigil is the direwolf, and the suffix *-enka* (adj. I); **Zoklar** from the nominative collective of the word 'zokla' (1lun; wolf).

Remarks. An ancient relative of the common wolf, but much more robust and strong. Absent south of the Wall. However, a dead female direwolf was found south of the Wall; Ned Stark's children and Jon Snow were allowed to keep and raise the pups (Fig. 3).

Qohorōñe-Valyrītsor, all the Little Valyrians from Qohor.

Etymology. **Qohorōñe** from Qohor and the suffix *-ōñe* (adj. II); **Valyrītsor** from the word Valyria and the diminutive suffix *-ītsos* (2sol) in the collective.

Remarks. Lemur-like primates with silver-white fur and purple eyes, living in the forest of Qohor.

Lannenka-Kēlior, all the lions of the Lannisters.

Etymology. **Lannenka** from Lann the Clever, founder of House Lannister whose sigil has a golden lion, and the suffix *-enka* (adj. I); **Kēlior**, from the collective of the word 'kēlio' (3lun; lion).

Ōgharenkys-Ñomber, all the great woolly elephants or mammoths.

Etymology. **Ōgharenkys**, from the word 'ōghar' (1aq; hair) and the suffix *-enkys* (adj. I); **Ñomber**, see above.

Remarks. Related to elephants, but more robust, with thick fur and curved tusks, from beyond the Wall. Giants usually ride them.

Sōnōñe-Gryver, all the snow bears.

Etymology. **Sōnōñe**, from the word 'sōna' (1lun; snow) and the suffix *-ōñe*; **Gryver** from the collective of the word 'gryves' (4sol; bear).

Remarks. Related to the brown bears, but adapted to survive in the cold environments beyond the Wall.

Mēremolrenkys-Epser, all the goats with a single horn or unicorns.

Etymology. **Mēremolrenkys** from the combination of the words 'mēre' (one) and 'molry' (2lun; horn) and the suffix *-enkys* (adj. I); **Epser**, from the nominative collective of the word 'epses' (4sol; goat).

Remarks. Goat-like animals with a single horn, believed to survive in Skagos and on the tall mountains of Ib. This disjointed distribution could be explained by two hypotheses: either they are native to one island and their presence on the other is explained by human interference; or this animal used to be widely

distributed in the past (perhaps in times when the sea-level was lower and the two islands were connected to each other or to the mainland), and the present distributions are remnants.

Zōbritimpa-Anner, all the black-and-white horses or zorses.

Etymology. **Zōbritimpa** from the combination of the words ‘zōbrie’ (adj. III; black), ‘timpa’ (adj. I; white); **Anner**, from the nominative collective of the word ‘anne’ (4lun; horse).

Remarks. Related to horses, but with black and white stripes; they live in eastern Essos.

VALENKA, the group of humans and human-like creatures.

Etymology. From the word ‘vala’ (1lun; man) and the suffix –enka (adj. I), meaning all-together ‘like humans’.

Remarks. This is the group that contains all human-like sentient species. Besides the group of humans, **VALAR** (see below), there are several other species, mythical or not, that are most probably more closely related to the **VALAR** than anything else. Although some of the species mentioned below could be myths and the product of fantasies and stories, I still prefer to properly name them. The distribution of **VALENKA** is shown in Figure 4.

Guēsōñe-Riñar, all the children from the forest.

Etymology. **Guēsōñe** from the word ‘guēsín’ (4lun; forest) and the suffix –ōñe; **Riñar** from the nominative collective of ‘riña’ (1lun; child).

Remarks. Dark and beautiful, less barbarous than the giants; renowned for working with

obsidian and beautiful songs. Currently live beyond the Wall.

Rōvalar-Rōvalar, all the giants.

Etymology. **Rōvalar** (all the giants) from the nominative collective of ‘rōvala’ (1lun; giant). Both components of the name are identical for emphasis.

Remarks. Giants once had a broader distribution in the World of Ice and Fire, but currently are restricted to the lands north of the Wall.

Hagedornōñe-Annevalar, all the horsemen of Hagedorn, also known as the Centaurs.

Etymology. **Hagedornōñe**, in honor of the great Archmaester Hagedorn, who wrote that centaurs never existed and were simply mounted warriors; **Annevalar**, from the combination of the words ‘vala’ (1lun; man) and ‘anne’ (4 lun; horse), meaning horsemen in the nominative collective.

Remarks. Most probably, the specimens examined in the Citadel are artifacts of mixtures of skeletons of humans and horses, probably confused with the Dothraki. Even so, it is still possible, especially in a world of magic like the World of Ice and Fire, that they once existed. Supposed distribution in the eastern grasslands of Essos during the Dawn Age.

Theronōñe-Valĩtsor, all the little humans of Theron, also known as the Deep Ones.

Etymology. **Theronōñe**, in honor to Maester Theron who first wrote about these creatures; **Valĩtsor** from the word ‘vala’ (1lun; man) and the diminutive suffix –ĩtsos (2sol) in the nominative collective.

Remarks. Supposedly misshapen creatures that fathered the merlings (see below). Their exact distribution is not known, but reports mention the destruction of the Lorathi mazemakers by sea creatures and the sacrifice of sailors on the Thousand Islands to fish-headed gods, likely connected to the Deep Ones. As such, we can speculate that the Deep Ones had a Shivering Sea distribution.

Klihenka-Valar, all the fish-men, also known as merlings.

Etymology. **Klihenka**, from ‘klios’ (3sol; fish) and the suffix –enka (adj. l); for **Valar**, see below.

Remarks. Aquatic human/fish hybrids, with a cosmopolitan distribution. House Manderly has a merling at its sigil.

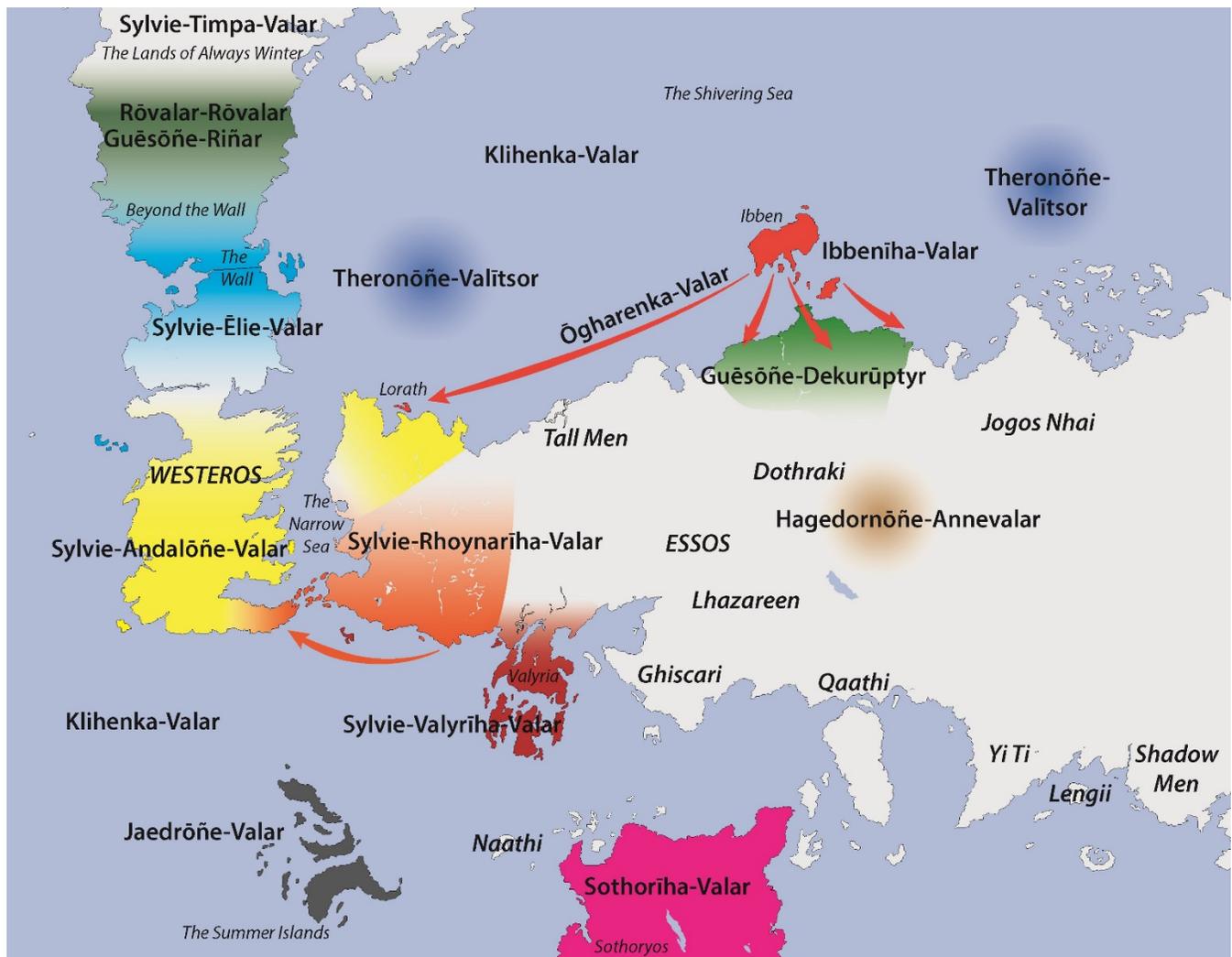


Figure 4. The distribution of known species of **VALENKA** and **VALAR**, the human-like species in the World of Ice and Fire.

Guēsōñe-Dekurūptyr, all the walkers of the forest, also known as the Ifeqevron.

Etymology. **Guēsōñe** (of the forest) from the word ‘guēsīn’ (4lun; forest); **Dekurūptyr** comes from the word ‘dekurūbagon’ (to walk) and the suffix –tys (2sol) to form the word ‘walker’ in the nominative collective.

Remarks. Ifeqevron means, in the Dothraki language, ‘those who walk in the woods’, which served as the inspiration behind the name in High Valyrian. They inhabit the great forest of the Kingdom of Ifeqevron in northern Essos, between Vaes Dothrak and the Ibben Islands.

VALAR, the group containing all humans.

Etymology. From the nominative collective of the noun ‘vala’ (1lun; man), meaning ‘all the humans’.

Remarks. Besides the major ethnic groups of **VALAR** described below (the First Men, the Andals, and the Rhoynars), there are other ‘species’ of **VALAR** that deserve their own name, some of them clearly distinct (e.g., the Ibbenese and the Hairy Men) and others probably distinct from **Sylvie-Valar**, like the Valyrians. In other cases, we do not have enough information to discern if some ethnic groups are truly distinct from those mentioned above. The horselords Dothraki are, of course, the most important example, including the tribes around them (e.g., the Lhazareen, Jogos Nhai, Qathii). As the First Men originate from the grasslands of Essos, and the Andals were also a nomadic group that stretched eastward in Essos, it is likely that the origin of these groups could be found in them. In the absence of convincing evidence, I prefer not to name all these **Sylvie-Valar** groups for the moment.

Ibbenīha-Valar, all the Ibbenians.

Etymology. **Valar**, see above; **Ibbenīha** comes from the combination of the word Ibben, their island of origin, and the suffix –īha (adj. I), which would mean in the Common Tongue ‘Ibbenian’.

Remarks. They are included in their own species of **VALAR**, as they are apparently unable to produce viable offspring with other species of humans.

Ōgharenka-Valar, all the Hairy Men.

Etymology. **Valar**, see above; **Ōgharenka**, from the word ‘ōghar’ (1aq; hair) and the suffix –enka (adj. I).

Remarks. As the Hairy Men are supposed to be closely related to the Ibbenians, I assume that they represent a distinct species of **VALAR**. Some say that they originated in Ibben and then spread out to Essos, settling in places like Lorath.

Sothorīha-Valar, all the Sothorysians.

Etymology. **Valar**, see above; **Sothorīha** comes from the combination of the word Sothoryos, their island of origin, and the suffix –īha (adj. I), which would mean in the Common Tongue ‘Sothorysian’.

Remarks. As the humans from Sothoryos, or Brindled Men, were unable to produce viable offspring with other species of humans, I suppose that they represent a distinct species of **VALAR**.

Jaedrōñe-Valar, all the humans from the Summer Islands.

Etymology. **Jaedrōñe** comes from the word ‘jaedria’ (Summer Islands; 1aq.), and the suffix

–ōñe, in allusion to the Summer Islands, their place of origin; **Valar**, see above.

Remarks. They are included in their own species of **VALAR**, as they, throughout their history, apparently lived isolated from the rest.

Sylvie-Valar, all the wise humans.

Etymology. **Sylvie**, from the nominative singular of the adjective ‘sylvie’ (adj. III; wise); **Valar** see above.

Remarks. The First Men, the Andals and Rhoynars represent the three major ethnic groups in the World of Ice and Fire and we have evidence of their interbreeding producing viable offspring. As such, I include them in the same ‘species’, with different ‘subspecies’.

Sylvie-Ēlie-Valar, all the wise First Men.

Etymology. **Ēlie** comes from the adjective ‘ēlie’ (adj. III; first, primary).

Sylvie-Andalōñe-Valar, all the wise Andals.

Etymology. **Andalōñe** comes from the word for the Andals and the suffix –ōñe (adj. II).

Sylvie-Rhoynarīha-Valar, all the wise Rhoynarians.

Etymology. **Rhoynarīha** comes from Rhoynar and the suffix –īha (adj. I), denoting their place of origin.

Sylvie-Valyrīha-Valar, all the wise Valyrians.

Etymology. **Valyrīha** comes from Valyria and the suffix –īha (adj. I), denoting their place of origin.



Figure 5. A typical specimen of **Sylvie-Timpa-Valar**, a white walker from beyond the Wall, from the Lands of Always Winter. Screen capture from Episode #8 (‘Hardhome’), Season #5, of *Game of Thrones* (HBO, 2011–present).

Sylvie-Timpa-Valar, all the wise white humans.

Etymology. **Timpa** comes from the adjective ‘timpa’ (adj. I; white).

Remarks. Although their origin remains unclear, they probably represent a variation of the First Men. As such, they are tentatively included in the same ‘species’, but in a different ‘subspecies’ (Fig. 5).

HONTENKA, the group that contains all the birds.

Etymology. Comes from the stem of the nominative collective of the word ‘hontes’ (4sol; bird) and the suffix –enka (adj. I).

Remarks. This group contains all birds. Note that birds are not defined by their flight ability, which was developed independently in other groups, such as dragons and insects.

Bantenka-Lārar, all the crows of the night.

Etymology. **Bantenka**, from the word bantis (5sol; night) in honor of the Night’s Watch, whose members are called ‘crows’, and the suffix –enka; **Lārar**, from the collective of ‘lāra’ (1lun; crow).

Remarks. Iconic birds, mainly because of their association with the Night's Watch.

Hontenkys-Dāryr, all the birds of the king, also known as the Eagle.

Etymology. **Hontenkys**, from the word 'hontes' (4sol; bird) and the suffix –enkys (adj. I); **Dāryr**, from the collective of the word dārys (2sol; king).

Udrenkys-Vōljer, all the ravens.

Etymology. **Udrenkys**, from the word 'udir' (5aq; word, news) and the suffix –enkys (adj. I); **Vōljer**, from the collective of the word 'vōljes' (4sol; raven).

Remarks. One of the animals with special importance to humans, as they are used in long-distance communication between settlements. They are usually under the care of the Maester of each castle.

Sōnenkys-Vōljer, all the ravens of the winter, also known as the White Ravens.

Etymology. **Sōnenkys** from the word 'sōnar' (1lun; winter) and the suffix –enkys (adj. I), in allusion to their use by the Maesters of the Citadel to announce the change of seasons; **Vōljer**, from the collective of the word vōljes (4sol; raven).

Remarks. A different species of raven, kept and raised in the Citadel. They are used to announce the changing of seasons in Westeros.

Sōnenkor-Vāedar, the song of the snow, also known as the Snow Shrike.

Etymology. **Sōnenkor**, from the word 'sōna' (1lun; snow) with the suffix –enkor (adj. I);

Vāedar, from the nominative of the word 'vāedar' (1aq; song).

Remarks. Found mainly in the North, but go as south as the Riverlands.

TĪKUNĪSENKA, the small winged animals.

Etymology. From 'tĭkun' (3sol; wing) and the suffixes –ĭtsos (2 sol; diminutive) and –enka (adj. I).

Ānogro-Bĭbire-Zōbros, the purple, blood-sucking animal, or bloodfly.

Etymology. **Ānogro**, from the word 'ānogar' (1aq; blood) in the genitive; **Bĭbire**, from the verb 'bĭbagon' (to suck); **Zōbros**, from the substantive of the word 'zōbrie' (adj. III; purple). The name means the "bloodsucking purple one".

Remarks. Bloodsucking, purple insect, living in marshes and ponds in Essos.

Kastys-Raeder, all the green scorpions, or manticores.

Etymology. **Kastys**, from the adjective 'kasta' (adj. I; blue, green), in allusion to the Jade Sea where this creature lives; **Raeder**, from the nominative collective of the noun 'raedes' (4sol; scorpion).

Remarks. They have a black carapace, a barbed tail, and a human-like face. Its sting is poisonous and causes heart attack in humans. They live in the islands of the Jade Sea.

RĪZENKA, the group of reptile-like animals.

Etymology. From the word 'rīza' (1lun; reptile, lizard) and the suffix –enka.

Basiliskīha-Rīzar, all the Basiliskian reptiles.

Etymology. **Basiliskīha**, from Basilisk and the suffix –īha (adj. I), meaning “Basiliskian”; **Rīzar** from the collective of the noun ‘rīza’ (1lun; reptile, lizard).

Remarks. The basilisk is a venomous, large, reptile from the Basilisk Isles.

Drakarenkys-Zaldrīzer, all the fire dragons.

Etymology. **Drakarenkys**, from the word ‘drakarys’ (2sol; dragon-fire) and the suffix –enkys (adj. I); **Zaldrīzer**, from the nominative collective of the word ‘zaldrīzes’ (4sol; dragon).

Remarks. These magical creatures once lived in the entire World of Ice and Fire, with four limbs, two wings, strong jaws, sharp teeth and claws, horns, and a long pointed tail (Fig. 6); they breathe fire. Once the source of power for the Valyrian dragonlords and the Targaryens, they were considered extinct since the last dragon died in the 153 AC (After Conquest) following the events of the Dance of the Dragons. However, Daenerys Targaryen was recently able to hatch three dragon eggs.



Figure 6. Drogon, named after Khal Drogo, one of the two surviving **Drakarenkys-Zaldrīzer**, seen in the dragon pit of King’s Landing. Screen capture from Episode #7 (‘The Dragon and the Wolf’), Season #7, of *Game of Thrones* (HBO, 2011–present).

Suvenkys-Zaldrīzer, all the ice dragons.

Etymology. **Suvenkys**, from word ‘suvion’ (3ter; ice) and the suffix –enkys (adj. I); **Zaldrīzer**, see above.

Remarks. A mythical species of dragon that was larger than the fire dragons and breathed ice (Fig. 7). Rumor has it that the Night King was able to create a **Suvenkys-Zaldrīzer** beyond the Wall.



Figure 7. Viserion, named after Viserys Targaryen (brother of Daenerys Targaryen), the only known specimen of **Suvenkys-Zaldrīzer** in the World of Ice and Fire. Although seemingly identical to a **Drakarenkys-Zaldrīzer**, there is clear evidence that this species does not breathe fire. Scholars disagree if a **Suvenkys-Zaldrīzer** breaths ice or some kind of ‘icy fire’. Screen capture from Episode #7 (‘The Dragon and the Wolf’), Season #7, of *Game of Thrones* (HBO, 2011–present).

Tikunoqittys-Zaldrīzer, all the dragons without wings, or firewyrms.

Etymology. **Tikunoqittys**, from the nominative plural of the word ‘tīkun’ (3sol; wing) with the suffix –oqittys (adj. I; –less); **Zaldrīzer**, see above.

Remarks. Wingless fire dragons from the Valyrian peninsula. Extinct.

Drakaroqittys-Zaldrīzer, all the fireless dragons, or wyverns.

Etymology. **Drakaroqittys**, from the word *drakarys* (2sol; dragon-fire) and the suffix –*oqittys* (adj. I; less); **Zaldrīzer**, see above.

Remarks. Related to dragons but fireless, surviving in Sothyryos.

Rīdōñe-Rīskelior, all the lizard-lions of the Reeds.

Etymology. **Rīdōñe**, meaning ‘of the Reed’, in honor to House Reed, whose sigil has a black lizard-lion, and the suffix –*ōñe* (adj. II); **Rīskelior**, from the word ‘*rīza*’ (1lun; reptile, lizard) and the word ‘*kēlio*’ (3lun; lion) in the collective.

Remarks. Crocodile-like lizards with large teeth that live in the streams and swamps of the Neck.

Qarthōñor-Qintrir, all the turtles of Qarth, or phantom tortoises.

Etymology. **Qarthōñor**, from the city of Qarth and the suffix –*ōñe* (adj. II); **Qintrir**, from the nominative col of the noun ‘*qintir*’ (5aq; turtle).

Tegōñior-Qintrir, all the terrestrial turtles.

Embōñior-Qintrir, all the marine turtles.

Qelbōñior-Qintrir, all the aquatic turtles.

Etymology. The first components are formed from the adjectives ‘*tegōñe*’ (adj. II; terrestrial), ‘*embōñe*’ (adj. II; marine), and ‘*qelbōñe*’ (adj. II; aquatic, from the river); **Qintrir**, see above.

Remarks. Reptile-like animals, whose body is enclosed within a bony shell; they can reach large sizes and have a cosmopolitan

distribution. Although probably there are dozens of different species of turtles in the World of Ice and Fire, they are grouped here under three species only, based on their preferred habitat. Further work should focus on describing the various species of turtles included in each of these above-named groups.

Martino-Qintrir, the turtle of Martin, also known as the Old Man of the River.

Etymology. **Martino**, genitive of Martin, in honor of G.R.R. Martin, the author of the *Song of Ice and Fire* series; **Qintrir**, see above.

Remarks. The Old Man of the River is a sacred giant turtle that lived in the river Rhoyme, and is worshiped by the Rhoynars. G.R.R. Martin has publicly expressed his love of turtles and the role that they played in the development of the World of Ice and Fire², so this species is named after him.

EMBENKA, all the sea-dwelling animals.

Etymology. From the noun ‘*embar*’ (1aq; sea) and the suffix –*enka* (adj. I).

Grējojōñor-Uēhor, all the great squids of the Greyjoys, or krakens.

Etymology. **Grējojōñor**, in allusion to House Greyjoy, whose sigil bears a golden kraken, with the suffix –*ōñe* (adj. II); **Uēhor**, from the word ‘*uēs*’ (3sol; squid) in the nominative collective.

Remarks. A kind of giant squid, supposedly living in the sea south of Dorne.

² From <http://www.simplethingcalledlife.com/interesting/game-of-thrones-turtles/>

Embrōñe-Jēnqañōgher, all the sea creatures with eight arms, also known as octopods.

Etymology. **Embrōñe**, from the genitive collective of the word ‘embar’ (1aq; sea) with the suffix –ōñe (adj. II); **Jēnqañōgher**, from the combination of the words ‘jēnqa’ (eight) and ‘ñōghe’ (4lun; arm) in the collective.

Qaedrāzmar-Qaedrāzmar, all the great whales, or leviathans.

Etymology. **Qaedrāzmar**, from the word ‘qaedar’ (1aq; whale) and the augmentative suffix –āzma (1lun) in the collective.

Remarks. An enormous grey whale, among the most ancient creatures of the World of Ice and Fire. Found in the Shivering Sea.

Naggōñe-Embrōñe-Zaldrīzer, all the sea dragons of Nagga.

Etymology. **Naggōñe**, of Nagga, the mythical sea dragon, with the suffix –ōñe (adj. II); **Embrōñe**, from the word ‘embar’ (1aq; sea) and the suffix –ōñe (adj. II); **Zaldrīzer**, see above.

Remarks. A sea dragon, feeding on krakens and leviathans. Supposedly extinct since the Age of Heroes, although some believe it still survives in the Sunset Sea.

FUTURE WORK

This is only the first account on the names of some of the most important animals of the World of Ice and Fire. Many more kinds of beings remain lacking formal names, including most domesticated animals and plants. Future work should focus on refining this system of taxonomy and describing the remarkable living and extinct diversity of Westeros and Essos.

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ACKNOWLEDGEMENTS

I would like to thank the Dothraki Wiki community for making available the rules, grammar and dictionary of High Valyrian. I thank the Reddit communities of the Song of Ice and Fire and Game of Thrones for inspiration and comments. Special thanks to the redditors u/hm0119 and u/jackm0ve for their interest to jump in and name some species of their own; these names have not been included herein. I would like to deeply thank the editor of the JGS, Rodrigo B. Salvador, and the rest of the editorial board for useful comments that greatly improved this manuscript. I would like to express my gratitude to David J. Peterson, the creator of the Valyrian and Dothraki languages, who reviewed an earlier version of the manuscript; he managed not only to point out the numerous mistakes I made in the formation of the words in my early version but also to provide valuable lessons through his critical

review. His comments and suggestions also made the entire system much more consistent and uniform. Of course, I am solely responsible for any mistakes in the formation of the High Valyrian names. This project has been developed in my free time, but was inspired by the importance of zoological nomenclature and the art of coining species names. I would like to thank my family for their understanding and support when I spend time with projects like this.

ABOUT THE AUTHOR

Evangelos Vlachos is a big fan of the World of Ice and Fire and, just like G.R.R. Martin, a huge fan of turtles and tortoises. He is currently a CONICET researcher in the *Museo Paleontológico Egidio Feruglio*, in Trelew, Chubut, Argentina, working on fossil turtles and tortoises.



What is the answer to Life, the Universe and Everything?

Deep Thought

Pan-Dimension.

Forty-two.

FUTURE WORK

This is quite definitely the answer to the ultimate question. The problem, though, is that no one ever actually knew what the ultimate question was. As such, the next step for this research is to design an even more powerful computer, which can calculate the question to the ultimate answer.

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ACKNOWLEDGEMENTS

This is a little homage from the editors of the *Journal of Geek Studies* to Douglas Adams, one of the most influential authors in geekdom. This is the forty-second article in the history of the Journal, so this seemed rather appropriate. Don't panic, and always know where your towel is.

ABOUT THE AUTHOR

Deep Thought is the second greatest computer in the Universe of Time and Space. After calculating the answer to the ultimate question for seven and a half million years, and designing the computer to find the ultimate question, it now spends its time watching television.



The entomological diversity of Pokémon

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Pocket Monsters or as they are better known, Pokémon, are playable monsters which first appeared in the 1990's as a video game in Japan, but soon expanded worldwide. They are still very successful with numerous games, a TV series, comic books, movies, toys and collectibles, additionally to the trading card game and video games. Most recently the release of Pokémon GO, an augmented reality game for smartphones, meant that Pokémon became as popular as never before. The game launched in 2016 and almost 21 million users downloaded it in the very first week in the United States alone (Dorwald et al., 2017).

The games and TV series take place in regions inhabited by humans and Pokémon. Each Pokémon lives in a specific environment (forests, caves, deserts, mountains, fields, seas, beaches, mangroves, rivers, and marshes). The humans try to catch Pokémon with Pokéballs, a device that fits even the largest Pokémon but that is still small enough to be placed into a pocket, hence the name Pocket Monster (Whitehill et al., 2016). After Pokémon have been caught, they are put to fight against each other, just like in the real world, in which humans (unfortunately) let cockerels, crickets, or dogs fight (Marrow, 1995; Jacobs, 2011;

Gibson, 2005). The origin of Pokémon goes back to the role-playing game created by Satoshi Tajiri and released by Nintendo for the Game Boy (Kent, 2001). Tajiri was not only a game developer, but like many Japanese adults, grew up catching insects as a child. He wanted to design a game so that every child in Japan could play and let their critters fight, even if they lived in areas which are too densely populated to find insects in the wild. This resulted in the 151 Pokémon in the first versions of the game ("first generation"), with each version adding more Pokémon.

Today, there are 807 Pokémon (seventh generation). Almost all are based on real organisms (mostly animals, but many plants as well), while some depict mythological creatures or objects (e.g., stones, keys). Each Pokémon belongs to one or two of the following 18 types: Normal, Fire, Fighting, Water, Flying, Grass, Poison, Electric, Ground, Psychic, Rock, Ice, Bug, Dragon, Ghost, Dark, Steel, and Fairy (Bulbapedia, 2018). All Pokémon in the game are oviparous, which means they all lay eggs; probably because the creator was fond of insects or just for practical reasons.

Certain Pokémon also evolve; however, this kind of evolution is not the same as the

biological concept of evolution. In Pokémon evolution is largely synonymous to metamorphosis, such as when a caterpillar turns into a butterfly. As this is the core concept of the game, almost all Pokémon evolve, not only the insects, but also mammals, rocks, and mythological creatures. Usually, they evolve with a complete or incomplete metamorphosis: either they just grow larger, or their look differs significantly between the adult and the young stages.

Insects are the largest group of organisms on earth (Zhang, 2011). There are more than one million described species of insects, of a total of 1.8 million known organisms (Zhang, 2011). They occupy all terrestrial environments (forests, fields, under the soil surface, and in the air) and freshwater; some are even found in the ocean. Additionally, they show a wide range of morphological and behavioral adaptations. This biodiversity is not reflected in the Pokémon world. In the present Generation VII, only 77 of the 807 Pokémon are “Bug type”: about 9.5% of all Pokémon. The aim of this work is to describe the entomological diversity of Pokémon based on taxonomic criteria of the classification of real insects.

METHODOLOGY

The Pokédex was the source of primary information on Pokémon (Pokémon Website, 2018). The criteria to identify insects are either based on the type (Bug type) or morphology (resembles a real insect). Afterwards, the insect Pokémon were classified to the lowest possible taxonomic level (family, genus, or species) according to their real world counterparts. This classification of the Pokémon allowed the

comparison of their biological data (such as ecological or morphological traits; Bulbapedia, 2018) with the current knowledge of real insects. The information of the biology of real insects is largely based on Borror et al. (1981).

RESULTS

Not all Bug types are insects; many of them represent other arthropods, like spiders, while some are from other invertebrate groups (Table 1). Also, five insect Pokémon do not belong to the Bug type (*e.g.*, Trapinch (#328) is a Ground type; Table 2). In total, insects represent only 62 of the 807 Pokémon. In comparison, the vertebrate groups are overly well-represented by birds (61), mammals (232), reptiles (57), amphibians (23), and fishes (39) (Table 3).

Eleven insect orders are represented in the Pokémon world, namely Blattodea (with 1 Pokémon), Coleoptera (11), Diptera (3), Hemiptera (7), Hymenoptera (6), Lepidoptera (22), Mantodea (4), Neuroptera (3), Odonata (2), Orthoptera (2), Phasmatodea (1). They are listed below in systematic order.

Order: Odonata

Families: Libellulidae and Aeshnidae

Genera: *Erythrodiplax* and *Anax*

Yanma (#193) evolves to *Yanmega* (#469).

Yanma is a large, red dragonfly Pokémon. Like all dragonflies and damselflies, it lives near the water and hunts other insects for food. *Yanma* is territorial and prefers wooded and swampy areas. Based on its appearance, it belongs to the dragonfly family Libellulidae, and further to the genus *Erythrodiplax* Brauer, 1868.

Table 1. List of the 20 Pokémon that are Bug type, but are not insects. Mostly, they belong to other groups within the phylum Arthropoda.

Pokédex #	Name	Type	Subphylum	Class	Order	Family, Genus, Species
167	Spinarak	Bug / Poison	Chelicerata	Arachnida	Aranae	Theridiidae, <i>Theridion grallator</i> (happy-face spider)
168	Ariados	Bug / Poison	Chelicerata	Arachnida	Aranae	Salticidae, jumping spider
213	Shuckle	Bug / Rock	n/a	n/a	n/a	possibly an endolithic fungi
347	Anorith	Rock / Bug	n/a	Dinocaridida	Radiodonta	<i>Anomalocaris</i>
348	Armaldo	Rock / Bug	n/a	Dinocaridida	Radiodonta	<i>Anomalocaris</i>
451	Skorupi	Poison / Bug	Chelicerata	Arachnida	Scorpiones	generalized scorpion
543	Venipede	Bug / Poison	Crustacea	Malacostraca	Isopoda	woodlouse
544	Whirlipede	Bug / Poison	Crustacea	Malacostraca	Isopoda	woodlouse
545	Scolipede	Bug / Poison	Myriapoda	Chilopoda	n/a	centipede
557	Dwebble	Bug / Rock	Crustacea	Malacostraca	Decapoda	hermit crab
558	Crustle	Bug / Rock	Crustacea	Malacostraca	Decapoda	hermit crab
595	Joltik	Bug / Electric	Chelicerata	Arachnida	Ixodida	tick
596	Galvantula	Bug / Electric	Chelicerata	Arachnida	Aranae	Theraphosidae, tarantula
616	Shelmet	Bug	Conchifera	Cephalopoda	Nautilida	nautilus
617	Accelgor	Bug	Conchifera	Cephalopoda	Nautilida	nautilus
649	Genesect	Bug / Steel	n/a	n/a	n/a	man-made insectoid creature
751	Dewpider	Water / Bug	Chelicerata	Arachnida	Aranae	Dictynidae, <i>Argyroneta aquatica</i> (diving bell spider)
752	Araquanid	Water / Bug	Chelicerata	Arachnida	Aranae	Dictynidae, <i>Argyroneta aquatica</i> (diving bell spider)
767	Wimpod	Bug / Water	Crustacea	Malacostraca	Isopoda	isopod
768	Golisopod	Bug / Water	Crustacea	Malacostraca	Isopoda	isopod

Yanmega on the other hand is a large, dark green Pokémon. It is actually a different real-world species. Not only the colors are different, but also the morphology, like the appendages on the tip of the tail. Based on this, it belongs to the dragonfly family Aeshnidae, and to the genus *Anax* Leach, 1815. One could argue that it is based on *Meganeura* Martynov, 1932, a very large (wingspan up to 70 cm) but extinct dragonfly genus from the Carboniferous Period. However, the size alone should not be the indicator to classify the species, as many insectoid species are larger in the Pokémon world compared to the real world.

Order: Mantodea

Family: Mantidae

Scyther (#123) evolves to *Scizor* (#212, incl. *Mega-Scizor*).

Scyther is a bipedal, insectoid Pokémon. It is green with cream joints between its three body segments, one pair of wings and two large, white scythes as forearms. Scyther camouflages itself by its green color. Based on its appearance, it is classified as a praying mantis (or possibly a mantidfly).

Scizor is also a bipedal, insectoid Pokémon. It is primarily red with grey, retractable forewings. Scizor's arms end in large, round pincers. It appears to be based on a praying mantis, maybe with some references to flying red ants and wasp-mimicking mantidflies.

Although Scizor evolves from Scyther, they are very different and would actually be two different real-world species. Not only are the colors different, but also the morphology: the arms end in either scythes or pincers; Scyther has one pair of wings, Scizor has two.

Table 2. Taxonomic classification of the insect Pokémon (Arthropoda: Hexapoda: Insecta). All images are official artwork from *Pokémon* games (obtained from Bulbapedia, 2018). An asterisk (*) denotes Pokémon that are not Bug type.

Pokédex #	Name	Figure	Type	Order	Family
10	Caterpie		Bug	Lepidoptera	Papilionidae
11	Metapod		Bug	Lepidoptera	Papilionidae
12	Butterfree		Bug / Flying	Lepidoptera	Papilionidae
13	Weedle		Bug / Poison	Hymenoptera	Tenthredinidae
14	Kakuna		Bug / Poison	Hymenoptera	Tenthredinidae
15	Beedrill		Bug / Poison	Hymenoptera	Tenthredinidae
46	Paras		Bug / Grass	Hemiptera	Cicadidae
47	Parasect		Bug / Grass	Hemiptera	Cicadidae
48	Venonat		Bug / Poison	Lepidoptera	Geometridae

Table 2. (cont.)

Pokédex #	Name	Figure	Type	Order	Family
49	Venomoth		Bug / Poison	Lepidoptera	Arctiidae
123	Scyther		Bug / Flying	Mantodea	Mantidae
127	Pinsir		Bug / Flying	Coleoptera	Lucanidae
165	Ledyba		Bug / Flying	Coleoptera	Coccinellidae
166	Ledian		Bug / Flying	Coleoptera	Coccinellidae
193	Yanma		Bug / Flying	Odonata	Libellulidae
204	Pinenco		Bug	Lepidoptera	Psychidae
205	Forretress		Bug / Steel	Lepidoptera	Psychidae
212	Scizor		Bug / Steel	Mantodea	Mantidae
214	Heracross		Bug / Fighting	Coleoptera	Scarabaeidae

Table 2. (cont.)

Pokédex #	Name	Figure	Type	Order	Family
265	Wurmple		Bug	Lepidoptera	Nymphalidae, Saturniidae
266	Silcoon		Bug	Lepidoptera	Nymphalidae
267	Beautifly		Bug / Flying	Lepidoptera	Nymphalidae
268	Cascoon		Bug	Lepidoptera	Saturniidae
269	Dustox		Bug / Poison	Lepidoptera	Saturniidae
283	Surskit		Bug / Poison	Hemiptera	Gerridae
284	Masquerain		Bug / Flying	Hemiptera	Fulgoridae
290	Nincada		Bug / Ground	Hemiptera	Cicadidae
291	Ninjask		Bug / Flying	Hemiptera	Cicadidae
292	Shedinja		Bug / Ghost	Hemiptera	Cicadidae

Table 2. (cont.)

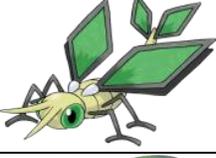
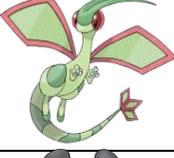
Pokédex #	Name	Figure	Type	Order	Family
313	Volbeat		Bug	Coleoptera	Lampyridae
314	Illumise		Bug	Coleoptera	Lampyridae
328	Trapinch *		Ground	Neuroptera	Myrmeleontida e
329	Vibrava *		Ground / Dragon	Neuroptera	Myrmeleontida e
330	Flygon *		Ground / Dragon	Neuroptera	Myrmeleontida e
401	Kricketot		Bug	Orthoptera	Gryllidae
402	Kricketune		Bug	Orthoptera	Gryllidae
412	Burmy		Bug	Lepidoptera	Psychidae
413	Wormadam		Bug / Grass / Ground / Steel	Lepidoptera	Psychidae
414	Mothim		Bug / Flying	Lepidoptera	Psychidae

Table 2. (cont.)

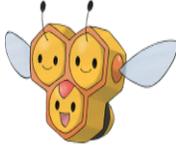
Pokédex #	Name	Figure	Type	Order	Family
415	Combee		Bug / Flying	Hymenoptera	Apidae
416	Vespiqueen		Bug / Flying	Hymenoptera	Apidae
469	Yanmega		Bug / Flying	Odonata	Aeshnidae
540	Sewaddle		Bug / Grass	Lepidoptera	Tortricidae
541	Swadloon		Bug / Grass	Lepidoptera	Hesperiidae
542	Leavanny		Bug / Grass	Phasmatodea	Phylliidae
588	Karrablast		Bug	Coleoptera	Elateridae
589	Escavalier		Bug / Steel	Coleoptera	Elateridae
632	Durant		Bug / Steel	Hymenoptera	Formicidae
636	Larvesta		Bug / Fire	Lepidoptera	Saturniidae

Table 2. (cont.)

Pokédex #	Name	Figure	Type	Order	Family
637	Volcarona		Bug / Fire	Lepidoptera	Saturniidae
664	Scatterbug		Bug	Lepidoptera	Riodinidae
665	Spewpa		Bug	Lepidoptera	Riodinidae
666	Vivillon		Bug / Flying	Lepidoptera	Riodinidae
736	Grubbin		Bug	Coleoptera	Lucanidae
737	Charjabug		Bug / Electric	Coleoptera	Lucanidae
738	Vikavolt		Bug / Electric	Coleoptera	Lucanidae
742	Cutiefly		Bug / Fairy	Diptera	Bombyliidae
743	Ribombee		Bug / Fairy	Diptera	Bombyliidae
753	Fomantis *		Grass	Mantodea	Mantidae

Table 2. (cont.)

Pokédex #	Name	Figure	Type	Order	Family
754	Lurantis *		Grass	Mantodea	Mantidae
794	Buzzwole		Bug / Fighting	Diptera	Culicidae
795	Pheromosa		Bug / Fighting	Blattodea	n/a

Table 3. Comparison between the diversity of Pokémon “species” and their respective representatives in the natural world (Zhang, 2011).

Pokémon		Nature	
Group	# of “species”	Group	# of species
Insects	62 (13.1%)	Insects	1,020,007 (66.0%)
Birds	61 (12.9%)	Birds	9,990 (0.9%)
Mammals	232 (48.9%)	Mammals	5,750 (0.5%)
Reptiles	57 (12.0%)	Reptiles	9,413 (0.9%)
Amphibians	23 (4.9%)	Amphibians	7,694 (0.7%)
Fishes	39 (8.2%)	Fishes	31,958 (2.9%)

foes (and prey). It also disguises itself as a Bug Pokémon for self-defense. Lurantis is likely based on the orchid mantis as well as the orchid flower itself, as it is impossible to say where the flower ends and the insect starts. Orchid mantises mimic parts of a flower, by making their legs look like flower petals. Well camouflaged, they can wait for their prey, which will visit the flower for nectar.

Fomantis (#753) evolves to Lurantis (#754).

Fomantis is a plant-like and, at the same time, an insect-like Pokémon. Its main body is pink, with green hair, green tufts on the head, and green leaves as a collar. Fomantis is somewhat bipedal and is likely based on the orchid mantis *Hymenopus coronatus* Olivier, 1792 (Fig. 1), which is known for being able to mimic the orchid flower, along with the orchid itself.

Lurantis is also plant- and insect-like. It is pink, white, and green. Lurantis looks and smells like a flower, to attract and then attack

Order: Blattodea

Pheromosa (#795).

Pheromosa is a bipedal anthropomorphic Pokémon. It has a rather slender build and is mostly white. Pheromosa originates from the Ultra Desert dimension in Ultra Space. Pheromosa is based on generic cockroaches just after they have molted (Fig. 2); during this stage, the animals are pale and vulnerable until their exoskeleton hardens and darkens.



Figure 1. Adult male of *Hymenopus coronatus*. Credit: Sander van der Wel (2010), Wikimedia Commons.

Order: Orthoptera
Family: Gryllidae

Kricketot (#401) evolves to Kricketune (#402).

Kricketot is a bipedal, bug-like Pokémon. It has a red body with some black and white markings. By shaking its head and rubbing its antennae together, it can create a sound that it uses to communicate. Based on its appearance, it is a cricket.

Kricketune is also a bipedal Pokémon with an insectoid appearance, also primarily red with some black and tan colored markings. It can produce sound by rubbing its arms on the abdomen. Kricketune appears to be based on crickets due to their sound-producing ability, but it somewhat resembles a violin beetle.

Both Kricketot and Kricketune are depicted with only 4 limbs, whereas insects are largely defined by having exactly six legs.



Figure 2. A freshly-molted cockroach (family Blattidae), leaving its exuvia behind. Credit: Donald Hobern (2010), Wikimedia Commons.

Order: Hemiptera
Families: Gerridae and Fulgoridae

Surskit (#283) evolves to Masquerain (#284).

Surskit is a blue insectoid Pokémon with some pink markings. It produces some sort of syrup, which is exuded as a defense mechanism or to attract prey. This Pokémon can also secrete oil from the tips of its feet, which enables it to walk on water as though skating. Surskit usually inhabits ponds, rivers, and similar wetlands, where it feeds on microscopic, aquatic organisms. This Pokémon is based on water striders. However, a water strider does not ooze syrup and neither does it need oil to walk on water; it can walk on water due to the natural surface tension.

Masquerain is a light blue Pokémon with two pairs of wings. On either side of its head is a large antenna that resembles an angry eye. These eyespots are used by many real-life moths and lantern-flies to confuse and

intimidate would-be predators. Masquerain is in fact based on a lantern-fly.

Both “species”, water striders and lantern-flies, are only distantly related, belonging to two different families within the “true bugs” (Hemiptera).

Family: Cicadidae

Nincada (#290) evolves to *Ninjask* (#291) and then to *Shedinja* (#292).

Nincada is a small, whitish, insectoid Pokémon. The claws are used to carve the roots of tree and absorb water and nutrients. Nincada builds underground nests by the roots of trees. It is based on a cicada nymph, which lives underneath the soil surface. However, a cicada nymph usually does not have fully developed wings. Instead, they have short wing stubs which eventually will become fully functional wings – as usual amongst hemimetabolous insects.

Ninjask is a small, cicada-like Pokémon with two pairs of wings. Its body is mostly black with some yellow and grey markings. Ninjask is a very fast Pokémon and it can seem invisible due to its high speed. It is based on an adult cicada, with the colors somewhat resembling *Neotibicen dorsatus* (Say, 1825) (Fig. 3).

Shedinja is a brown and grey insectoid Pokémon. A hole between its wings reveals that its body is completely hollow and dark, as it possesses no internal organs. It is based on the shed husk (exuvia) that cicadas and other hemimetabolous insects leave behind when they molt.



Figure 3. Adult female of *Neotibicen dorsatus*, the bush cicada. Credit: Yakkam255 (2015), Wikimedia Commons.

Paras (#046) evolves to *Parasect* (#047).

Paras is an orange insectoid Pokémon with an ovoid body. On the top it has two little red and yellow mushrooms known as *tōchūkasō*. The mushrooms can be removed at any time, and grow from spores that are doused on this Pokémon’s back at its birth by the mushroom on its mother's back. *Tōchūkasō* is an endoparasitoid that replaces the host tissue and can affect the behavior of its insect host. The base insect is based on a cicada nymph. The real-world *tōchūkasō* live on hepialid caterpillars in Tibet. However, there are many

more species of entomopathogenic fungi in the world, most notable the genus *Cordyceps* (L.) Fr. (1818).

Parasect is an orange, insectoid Pokémon that has been completely overtaken by the tōchūkasō mushroom. The adult insect has been drained of nutrients and is now under the control of the fully-grown tōchūkasō. Parasect can thrive in dank forests with a suitable amount of humidity for growing fungi. The base insect is a deformed version of what is probably a cicada nymph, the parasitic mushroom having caused a form of neoteny, when the adults look like a juvenile form.

Order: Neuroptera
Family: Myrmeleontidae

Trapinch (#328) evolves to Vibrava (#329) and then to Flygon (#330).

Trapinch is an orange, insectoid Pokémon. This Pokémon lives in arid deserts, where it builds its nest in a bowl-shaped pit dug in sand. It sits in its nest and waits for prey to stumble inside. Once inside, the prey cannot climb back out. It is based on the larval stage of the antlion, which lives in conical sandy pits before maturing into winged adults.

Vibrava is a dragonfly-like Pokémon. Vibrava's wings are not fully developed, so it is unable to fly very far. However, it is able to create vibrations and ultrasonic waves with its wings, causing its prey to faint. Vibrava is a saprotroph – it spits stomach acid to melt its prey before consumption. Vibrava is based on the adult stage of an antlion. Adult antlions and dragonflies look from a distance quite similar

and are therefore often mistaken for each other.

Flygon is a desert-dwelling insectoid dragon with a green body and one pair of wings. Its wings make a “singing” sound when they are flapped. It uses this unique ability to attract prey, stranding them before it attacks. It is based on the winged, adult stage of the antlion.

Order: Coleoptera
Family: Lucanidae

Pinsir (#127, incl. Mega-Pinsir).

Pinsir is a bipedal beetle-like Pokémon with a brown body and a large pair of grey, spiky pincers on top of its head. Pinsir is based on a stag beetle.

Grubbin (#736) evolves to Charjabug (#737) and then to Vikavolt (#738).

Grubbin is a small insectoid Pokémon. It has a white body with three nubs on either side resembling simple legs. Grubbin typically lives underground. It uses its jaw as a weapon, a tool for burrowing, and for extracting sap from trees. Grubbin appears to be based on a larval beetle, also known as “grubs”.

Charjabug is a small cubic Pokémon resembling an insect-like battery. Its body consists of three square segments with two brown stubs on each side. It generates and stores electricity in its body by digesting food. This energy is stored in an electric sac. Charjabug appears to be based on a cocooned bug and a battery. It may also be based on the denkimushi (*Monema flavescens* Walker, 1855), a caterpillar in Japan that, when touched, can

give a sting that is said to feel like an electric shock (Fig. 4).

Vikavolt is a beetle-like Pokémon with a large pair of mandibles. It produces electricity with an organ in its abdomen, and fires powerful electric beams from its huge jaws. Vikavolt appears to be based on a stag beetle. Its straight, scissor-like mandibles resemble those of *Lucanus hayashii* Nagai, 2000.



Figure 4. Larva of *Monema flavescens*. Credit: Pan et al. (2013), Wikimedia Commons.

Family: Coccinellidae

Ledyba (#165) evolves to *Ledian* (#166).

Ledyba is a red ladybird-like Pokémon with five black spots on its back. Female Ledyba have shorter antennae than male Ledyba. Ledyba is a very social Pokémon, e.g. in the winter they gather together to keep each other warm. Ledyba is probably based on the five-point ladybird *Coccinella quinquepunctata* Linnaeus, 1758 due to its color and/or on the harlequin ladybird *Harmonia axyridis* (Pallas, 1773), which clusters together in the winter.

Ledian is a large red bipedal ladybird-like Pokémon. Female Ledian's antennae are

shorter than the males'. Ledian sleeps in forests during daytime inside a big leaf.

Family: Scarabaeidae

Heracross (#214, incl. *Mega-Heracross*).

Heracross is a bipedal beetle-like Pokémon with a blue exoskeleton. The prolonged horn on its forehead ends in a cross-shaped (males) or heart-shape (females) structure. Heracross is most likely based on the Japanese rhinoceros beetle *Allomyrina dichotoma* Linnaeus, 1771 (Fig. 5).



Figure 5. Adult male of *Allomyrina dichotoma*. Credit: Lsadonkey (2016), Wikimedia Commons.

Family: Lampyridae

Volbeat (#313) and *Illumise* (#314).

Volbeat is a bipedal firefly-like Pokémon. Its body is black with some blue, yellow, and red portions. It has a spherical yellow tail, which glows to communicate and draws geometric patterns in the sky while in a swarm. This is a male only Pokémon "species"; Illumise is its female counterpart. Volbeat lives in forests near clean ponds and is attracted by the sweet aroma given off by Illumise. It is based on a firefly like its counterpart Illumise. Its

appearance may be based on a greaser, a subculture from the 1950's.

Illumise is a bipedal firefly-like Pokémon. It is black and blue with some yellow markings. This is a female only Pokémon "species"; Volbeat is its male counterpart. It is a nocturnal Pokémon that lives in forests. Illumise does not seem to share its coloring with any particular species. Illumise may be based on flappers, a 1920's women's style. Its mating behavior only slightly resembles the behavior of real-world fireflies, in which females use light signals to attract mates.

Family: Elateridae

Karrablast (#588) evolves to Escavalier (#589).

Karrablast is a round bipedal Pokémon with a yellow and blue body. When it senses danger, it spews an acidic liquid from its mouth. It targets another Pokémon, Shelmet, so it can evolve. It resides in forests and fields, and it often hides in trees or grass if threatened. Karrablast may be based on a Japanese snail-eating beetle due to its preference for attacking Shelmet, a snail-like Pokémon.

Escavalier is an insectoid Pokémon wearing a knight's helmet. Its tough armor protects its entire body. It flies around at high speed, jabbing foes with its lances. Escavalier is probably based on the *Drilus* Olivier, 1790 genus, with references to a jousting knight. *Drilus* larvae are known for eating snails and stealing their shells, explaining why it attacks Shelmet and takes its shell to evolve into Karrablast.

Order: Hymenoptera
Family: Tenthredinidae

Weedle (#013) evolves to Kakuna (#014) and then to Beedrill (#015, incl. Mega-Beedrill).

Weedle is a small larval Pokémon with a body ranging in color from yellow to reddish-brown. It has a conical venomous stinger on its head and a barbed one on its tail to fend off enemies. Weedle can be found in forests and usually hides in grass, bushes, and under the leaves it eats. Weedle appears to be based on the larva of a wasp or hornet, although these real-world larvae usually don't have defense strategies. The only larvae which feed directly off leaves are those of sawflies.

Kakuna is a yellow cocoon-like Pokémon. Kakuna remains virtually immobile and waits for its "evolution" to happen, often hanging from tree branches by long strands of silk. Although Kakuna is the pupa stage of a Hymenoptera, it showcases a silky cocoon, a feature usually found in Lepidoptera and only some Hymenoptera, like sawflies.

Beedrill is a bipedal, wasp-like Pokémon. Its forelegs are tipped with long, conical stingers. It stands on its other two legs, which are long, segmented, and insectoid in shape. Beedrill has two pairs of rounded, veined wings, and another stinger on its yellow-and-black striped abdomen. By its color pattern, Beedrill looks like a vespid wasp, but due to the previous stages of this Pokémon species, it must be based on *Tenthredo scrophulariae* Linnaeus, 1758, the figwort sawfly.

Family: Apidae

Combee (#415) evolves to Vespiquen (#416, female).

Combee is a small insectoid Pokémon that resembles three social bees inside three hexagonal pieces of honeycomb stuck together; the top two have wings. Female Combee have a red spot on the forehead. Male Combee are not known to evolve into or from any other Pokémon. The sex ratio of Combee is 87.5% male and 12.5% female. Combee can fly with its two wings as long as the top two bees coordinate their flapping. They gather honey, sleep, or protect the queen. Combee is based on a mix of bees and their larvae living in honeycombs. (Bees arrange their honeycombs in a vertical manner, whereas wasps arrange them horizontally.)

In the hive of the real-world honey bee (*Apis mellifera* Linnaeus, 1758), there is usually one queen bee and up to 40,000 female workers. So, the sex ratio of Combee does not reflect the ratio of female (workers) and male (drones) honey bees, but of the reproductive bees, the drones and the fertile queens. The larger number of drones is needed, since each queen will often mate with 10–15 males before she starts a new hive. Usually, drones can make up to 5% of the bees in a hive.

Vespiquen is a bipedal bee-like Pokémon with a yellow and black striped abdomen resembling an elegant ballroom gown. Underneath the expansive abdomen are honeycomb-like cells that serve as a nest for baby Combee. Vespiquen is a female-only Pokémon “species”. Vespiquen is the queen of a Combee hive, controlling it and protecting it,

as well as giving birth to young Combee. The horizontal honeycombs hints that this “species” is a wasp rather than a bee.

Family: Formicidae

Durant (#632).

Durant is an ant-like Pokémon with a grey body and six black legs. It is territorial, lives in colonies and digs underground mazes. Durant grows steel armor to protect itself from predators. Durant is based on an ant, possibly the Argentine ant (*Linepithema humile* Mayr, 1868), due to the jaw and their invasive behavior.

Order: Lepidoptera

Family: Papilionidae

Caterpie (#010) evolves to Metapod (#011) and then to Butterfree (#012).

Caterpie is a green caterpillar-like Pokémon. It has yellow ring-shaped markings down the sides of its body and bright red “antenna” (osmeterium) on its head, which releases a foul odor to repel predators. The appearance of Caterpie helps to startle predators; Caterpie is probably based on *Papilio xuthus* Linnaeus, 1767, the Asian swallowtail (Fig. 6). The osmeterium is a unique feature of swallowtails. Caterpie will shed its skin many times before finally cocooning itself in thick silk. Its primary diet are plants.

Metapod is a green chrysalis Pokémon. Its crescent shape is based upon a Swallowtail chrysalis with a large nose-like protrusion and side protrusions resembling a Polydamas

Swallowtail or Pipevine Swallowtail chrysalis (genus *Battus* Scopoli, 1777).

Butterfree is a butterfly Pokémon with a purple body and large, white wings, somewhat resembling a black-veined white *Aporia crataegi* (Linnaeus, 1758). Although it is supposed to be a butterfly, it lacks the proboscis, which is typical of Lepidoptera, and presents teeth instead. Additionally, the body does not consist of the typical three segments of insects. Therefore, each stage seems to be based on a different species.



Figure 6. Larva of *Papilio xuthus*, with everted orange osmeterium. Credit: Alpsdake (2011), Wikimedia Commons.

Families: Geometridae and Arctiidae

Venonat (#048) evolves to *Venomoth* (#049).

Venonat has a round body covered in purple fur, which can release poison. It feeds on small insects, the only Lepidoptera caterpillar which is known to feed on prey instead of leaves belong the genus *Eupethecia* Grote, 1882 (Geometridae). However, Venonat does not resemble a caterpillar in general body shape or numbers of legs.

Venomoth is a moth-like Pokémon with a light purple body and interestingly two small

mandibles. It has two pairs of wings, which are covered in dust-like, purple scales, although the color varies depending on their toxic capability. Dark scales are poisonous, while lighter scales can cause paralysis. These scales are released when Venomoth flutters its wings. The general appearance resembles species belonging to the Actiidae.

There is no cocoon stage for this species it is doubtful whether both stages were based on the same real-life species.

Family: Riordinidae

Scatterbug (#664) evolves to *Spewpa* (#665) and then to *Vivillon* (#666).

Scatterbug is a small caterpillar Pokémon with a grey body. If threatened by a bird Pokémon, it can spew a powder that paralyzes on contact. Similarly, the large white butterfly *Pieris brassicae* (Linnaeus, 1758) is known to throw up a fluid of semi-digested cabbage, which contains compounds that smell and taste unpleasant to predators, such as birds.

Spewpa is a small insectoid Pokémon with a grey body covered by white furry material. In order to defend itself, Spewpa will bristle its “fur” to threaten predators or spray powder at them. Spewpa is based on a generic pupa of a moth or butterfly, probably a silkworm cocoon.

Vivillon is a butterfly-like Pokémon with wings that come in a large variety of patterns, depending in which climate it lives or rather, in which real-world region the player is. There is a total of 20 patterns known. It would be interesting to know whether they evolved due to allopatric speciation or if it is a case of mimicry.

Family: Psychidae

Pineco (#204) evolves to Forretress (#205).

Pineco is a pine cone-like Pokémon without visible limbs. It is based on a bagworm, the caterpillar stage of psychid Lepidoptera. Bagworms cover themselves with a case (the bag) made of surrounding material. This Pokémon uses tree bark and thus resembles a pine cone.

Forretress is a large spherical Pokémon, also without any visible limbs. It lives in forests, attaching itself immovably to tree trunks. Forretress is also based on a bagworm.

Different bagworm species are adapted to their environment, to the plants they eat, and to the materials available for producing their case. Therefore, Pineco and Forretress are actually based on two different species, as they both are caterpillars. There is no adult stage for this Pokémon.

Burmy (#412) evolves to Wormadam (#413, female) or Mothim (#414, male).

Burmy is a small pupa-shaped Pokémon with a black body and six stubby legs. It is based on a bagworm pupa, which will metamorphose into a winged moth if male, or wingless moth if female. Burmy can change its “cloak” (case) depending on the environment it last battled.

Wormadam is a black bagworm-like Pokémon with a cloak of leaves, sand, or building insulation. Its cloak depends on Burmy’s cloak when it evolved, and so does its type (Grass, Ground or Steel). It is a female-only “species”, with Mothim as its male counterpart. Female psychid moth either don’t have wings at

all or have only small wing stubs that don’t develop fully.

Mothim is a moth-like Pokémon with two pairs of legs and two pairs of wings, one larger than the other. Mothim is a nomadic nocturnal Pokémon, searching for honey and nectar. Instead of gathering honey on its own, it raids the hives of Combee. It is a male-only “species”, with Wormadam as its female counterpart.

Family: Nymphalidae

Wurmple (#265) evolves to Silcoon (#266) and then to Beautifly (#267).

Wurmple is a small caterpillar-like Pokémon with a mostly red body and many spikes on the top of its body. It can spit a white silk that turns gooey when exposed to air. Spikes or hairy appendages are common amongst nymphalid caterpillars. Also, it has five pairs of legs, whereas insects are known to have only three pairs of legs. However, many lepidopteran caterpillars have additionally “prolegs” (small fleshy stub-like structures) to help them move.

Silcoon is a cocoon-like Pokémon which is completely covered by white silk. Silcoon also uses the silk to attach itself to tree branches. Nymphalid cocoons are usually not woolly or hairy, but smooth.

Beautifly is a butterfly-like Pokémon with two pairs of wings. Beautifly has a long and curled black proboscis that it uses to drain body fluids from its prey. In the real world, Lepidoptera usually drink the nectar of flowers. One of the few exceptions are the species of the genus *Calyptra* Ochseneimer, 1816, which pierce skin of animals and drink blood.

Family: Saturniidae

Wurmple (#265) evolves to Cascoon (#268) and then to Dustox (#269).

The caterpillar stage of this species is morphologically identical to the caterpillar stage of the “species” above: Wurmple. It appears that Wurmple can evolve in two forms: due to mimicry, sympatric speciation or are there morphological or biological characters, which have not been notices yet?

Cascoon is a round cocoon-like Pokémon covered in purple silk. Saturniid cocoons are usually covered in silk.

Dustox is a moth-like Pokémon. It has a purple body, two pairs of tattered green wings, and – just like Beautifly – two pairs of legs. Dustox is nocturnal and is instinctively drawn to light. Clearly, this is a moth. Some of the markings on its wings resemble typical markings of noctuid moths, but the big “fake eye” is typical of saturniids.

Larvesta (#636) evolves to Volcarona (#367).

Larvesta is a fuzzy caterpillar-like Pokémon. It has five red horns on the sides of its head, which it can use to spit fire as a defensive tactic to deter predators. Larvesta is based on a saturniid caterpillar.

Volcarona is a large moth-like Pokémon with four small feet and three pairs of wings. It releases fiery scales from its wings. Just like Larvesta, Volcarona is based on a saturniid moth, likely the Atlas moth *Attacus atlas* (Linnaeus, 1758).

Order: Diptera**Family: Bombyliidae**

Cutiefly (#742) evolves to Ribombee (#743).

Cutiefly is a tiny Pokémon with large wings. Cutiefly appears to be based on the bee fly, specifically the species *Anastoechus nitidulus* (Fabricius, 1794) (Fig. 7).

Ribombee is a tiny insectoid Pokémon with a large head, slightly smaller body, and thin arms and legs. It is covered in fluffy yellow hair. Two wings nearly as large as its body sprout from its back. The wings are clear with three brown loop designs near the base. Its four thin limbs have bulbous hands or feet. Ribombee uses its fluffy hair to hold the pollen it collects from flowers. It is based on a bee fly.



Figure 7. Adult of *Anastoechus nitidulus*. Credit: karakotokako (2007), image retrieved from <https://karakoto.exblog.jp/>.

Family: Culicidae

Buzzwole (#794).

Buzzwole is a bipedal anthropomorphic Pokémon. It has four legs and two pairs of orange translucent wings. It uses its proboscis

to stab and then drink “energy” off its enemies/prey. Buzzwole originates from the Ultra Desert dimension in Ultra Space. It is based on a mosquito and may specifically derive inspiration from *Aedes albopictus* (Skuse, 1894), which is an invasive species worldwide.

Mixed Orders: Lepidoptera and Phasmatodea

Families: Tortricidae, Hesperiiidae, and Phylliidae

Sewaddle (#540) evolves to *Swadloon* (#541) and then to *Leavanny* (#542).

Sewaddle is a caterpillar-like Pokémon with a green body with three pairs of legs. It makes leafy “clothes” using chewed-up leaves and a thread-like substance it produces from its mouth. The leafy hood helps Sewaddle to hide from enemies. Sewaddle appears to be based on the caterpillar of the silver-spotted skipper *Epargyreus clarus* (Cramer, 1775), which produce silk and fold leaves over themselves for shelter (Fig. 8).

Swadloon is a round yellow Pokémon inside of a cloak of leaves. It lives on the forest ground and feeds on fallen leaves. Swadloon appears to be based on the chrysalis of *Epargyreus clarus*. *Epargyreus clarus* fold leaves over themselves for shelter as they age and, when cocooning, eventually use silk to stick the leaves together and form its chrysalis.

Leavanny is a bipedal, insectoid Pokémon with a yellow and green body with leaf-like limbs. It lives in forests and uses its cutters and sticky silk it produces to create leafy “clothing”. It also warms its eggs with fermenting fallen leaves. Leavanny has the features of several insects. Primarily it appears to be a bipedal leaf-

insect (Phylliidae). Its general body structure is also similar to that of *Choeradodis* Serville, 1831 mantises, which also have laterally expanded thoraxes and abdomens.



Figure 8. Larva of *Epargyreus clarus*. Credit: Seth Ausubel (2013), image retrieved from <https://bugguide.net/>.

DISCUSSION

Only 11 insect orders (out of 30) are represented in the Pokémon world. Possible more, as differentiation of insect Pokémon and non-insect Pokémon are sometimes difficult. The main reason is, that many insect Pokémon are not depicted as a typical insect with its segmented body, the six legs, and two pairs of wings¹. Many are depicted as bipedal (e.g., #401 Krickctot) or even in an anthropomorphic way (e.g., #795 Pheromosa). Also, insectoid Pokémon typically have only four limbs (instead of six). Many insectoid Pokémon also have fewer wings than insects (except for #637 Volcarona, which has more). Therefore, the definition of what is an insect Pokémon is debatable.

¹ Not all insects have two pairs of wings, though. For instance, the Diptera (flies) have only one, while the Siphonaptera (fleas) have none.

One clue is to look at the types each Pokémon belongs to. However, from the circa 80 Bug-type Pokémon, only about 60 are insects. The others belong to other arthropods groups, like Chelicerata, Crustacea, and Myriapoda. This is not surprising, as often creepy crawlies (basically everything that is small with legs) are all addressed as “bugs”. In fact, only member of the insect order Hemiptera are called “true bugs”.

Interestingly, Prado & Almeida (2017) have included Pokémon on their insect list, which are doubtful: #251 Celebi, #247 Pupitar, and #206 Dunsparce. None of them are considered insects here. Celebi may resemble a bipedal somewhat anthropomorphic insectoid, but nothing of the lifestyle or beyond the vague appearance gives a clue to an insect. Similarly, #247 Pupitar, might look like a pupa of an insect. However, both its “larval” stage (#256 Larvitar) and its final stage (#248 Tyranitar) resemble a dinosaur or some sort of dragon. Only the hint of “pupa” in its name, links Pupitar to an insect. Lastly, #206 Dunsparce was classified as a Hymenoptera by Prado & Almeida (2017). It may look somewhat like an insect, even showing two pairs of wings (and no legs at all). Dunsparce, however, is based on a mythical “snake-like animal” called Tsuchinoko, also known as “bachi hebi” (or “bee snake”). Finally, Prado & Almeida (2017) have classified #212 Scizor as “unknown”, but here it is treated as a praying mantis (Mantodea). Similarly, those authors have classified #284 Masquerain as a Lepidoptera, but here we treat it as a true bug (Hemiptera).

Lastly, #649 Genesect resembles somewhat an ant covered by steel. However, according to

the Pokédex (Pokémon Website, 2018), it is a man-made machine.

Compared to the vertebrates (birds, mammals, reptiles, amphibians, and fishes), many more insects live on earth (66,000 described species to about 1 million, respectively; Zhang, 2011). This ratio is, however, not represented in the Pokémon world (Table 3), most likely due to the fact that the majority of people prefer (cute and cuddly) furry animals over creepy insects, even though butterflies and dragonflies are regarded as beautiful.

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ACKNOWLEDGEMENTS

I am grateful to Seth Ausubel (<https://www.flickr.com/photos/96697202@N07/collections>) for kindly granting permission to use his photograph of *Epargyreus clarus* on this article. I would also like to thank Miles Zhang for valuable comments on an earlier version of the manuscript.

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Douglas Adams and the world's largest, fattest and least-able-to-fly parrot

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"The system of life on this planet is so astoundingly complex that it was a long time before man even realized that it was a system at all and that it wasn't something that was just there." —Douglas Adams, 1990

Douglas Noel Adams was born on 11 March 1952 in Cambridge, UK, and grew up to become one of geekdom's most revered icons. Adams is the author of... Well, that is pretty obvious and I should not have to write this down, but I will nonetheless, just because I won't be able to sleep well otherwise. So bear with me for a moment – here goes: Adams is the author of the trilogy *The Hitchhiker's Guide to the Galaxy*, the self-proclaimed world's largest trilogy, with five books in total¹.

However, unbeknownst to many of his fans, Adams was also an environmental activist. He spearheaded or participated in several conservation initiatives, such as *Save the Rhino International*. His history with conservation started in 1985, when the *World Wide Fund for Nature* (better known as WWF) and British newspaper *The Observer* partnered up, sending

¹ Or six, if you count *And Another Thing...* by Eoin Colfer (2009).

writers to visit endangered species to raise public awareness (BBC, 2014). Adams travelled to Madagascar in search of a lemur species, the aye-aye (*Daubentonia madagascariensis*). As he put it, "My role, and one for which I was entirely qualified, was to be an extremely ignorant non-zoologist to whom everything that happened would come as a complete surprise" (LCtS: p. 1).

In Madagascar Adams met not only weird lemurs, but also British zoologist Mark Carwardine. They enjoyed the experience and decided to travel the world to see other endangered animals. I mean, Adams and Carwardine travelled the world, not the lemurs; the lemurs stayed in Madagascar as far as anyone can tell. According to Carwardine, "We put a big map of the world on a wall, Douglas stuck a pin in everywhere he fancied going, I stuck a pin in where all the endangered animals were, and we made a journey out of every place that had two pins" (BBC, 2014).

Their travels resulted in *Last Chance to See*, a BBC radio documentary series that aired in the end of 1989. The companion book (by Adams & Carwardine, 1990, henceforth

abbreviated as “LCtS”) was published in the following year² (Fig. 1). As a matter of fact, Adams considered this book as his favorite work (Adams, 2005).

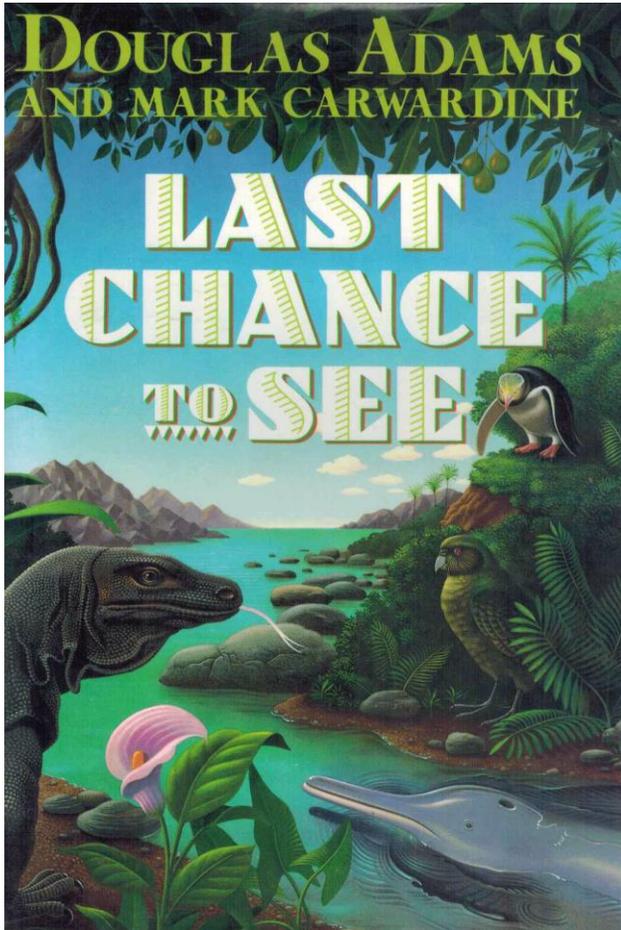


Figure 1. Cover art of the American edition of *Last Chance to See* (Harmony Books, New York, 1991).

Despite Adams’s calling himself an “ignorant non-zoologist”, world-renowned evolutionary biologist Richard Dawkins politely disagreed, writing: “Douglas was not just

² Later, in 1992, a CD-ROM set was published, with photos and audio of Douglas Adams reading the book. In 2009, BBC released a TV series of *Last Chance to See*, in which British comedian Stephen Fry took the place of the late Adams.

knowledgeable about science. He didn’t just make jokes about science. He had the mind of a scientist, he mined science deeply and brought to the surface... humour, and a style of wit that was simultaneously literary and scientific, and uniquely his own” (Dawkins, 2009: p. xiii).

Last Chance to See describes Adam’s and Carwardine’s travels around the globe to see nearly-extinct species, such as the Amazonian manatee (*Trichechus inunguis*) and the northern white rhinoceros (*Ceratotherium simum cottoni*). As one could expect, nearly all the species are mammals, since most of the public are primarily concerned with cuddly and relatable species. I, however, will focus here on the only bird on their list that got an entire chapter for itself. And I’ll do that for various reasons: (1) I am not very normal, so I am not that fond of smelly mammals; (2) it is a success story and people like success stories; and (3) this is a very funny-looking bird, I promise you.

This bird is called kakapo.

THE KAKAPO

Mark Carwardine first described the kakapo to Douglas Adams as “the world’s largest, fattest and least-able-to-fly parrot” (LCtS: p. 7). His description might seem a little disparaging at first, but it was meant in an affectionate way – you cannot help but smile when you see a kakapo. Besides, Carwardine’s description is actually spot-on (Fig. 2).

According to Adams, “[the] kakapo is a bird out of time. If you look one in its large, round, greeny-brown face, it has a look of serenely innocent incomprehension that makes you want to hug it and tell it that everything will be all right” (LCtS: p. 108).



Figure 2. Sirocco, a male kakapo, looking funny as kakapos usually do. Image extracted from New Zealand Birds Online (<http://nzbirdsonline.org.nz/>); credit: Dylan van Winkel.

The kakapo (or kākāpō, in Māori or Te Reo spelling) is a nocturnal flightless bird and its face resemble that of an owl, with the eyes positioned more to the front. For this reason, it is also known as owl-parrot or night parrot. Kakapos have green feathers, speckled with black and yellow (Fig. 3).



Figure 3. A kakapo looking unusually serious. Image extracted from New Zealand Birds Online (<http://nzbirdsonline.org.nz/>); credit: Colin Miskelly (2011).

Furthermore, kakapos are solitary birds, have a polygynous lek mating system (don't panic, I'll explain that later), lack male parental care, and breed in irregular intervals (with gaps of 2 to 7 years; Powlesland et al., 2006). Kakapos are so unique that ornithologists classified the species in its own family: Strigopidae. They are the very first lineage to have branched out of the parrot group (the Order Psittaciformes). Even their closest "relatives", the kaka and the kea (also from New Zealand), are already considered to be very distinct from kakapos.

Being such an ancient lineage of parrots, researchers consider that it could have split off the rest of the parrot groups when New Zealand got separated from the what is now Australia and Antarctica around 80 million years ago (Gibbs, 2016). All the southern landmasses had been previously joined in the supercontinent Gondwana, which was made up of South America, Africa, India, Antarctica, Australia and Zealandia (Fig. 4) and was by that time finishing its separation.

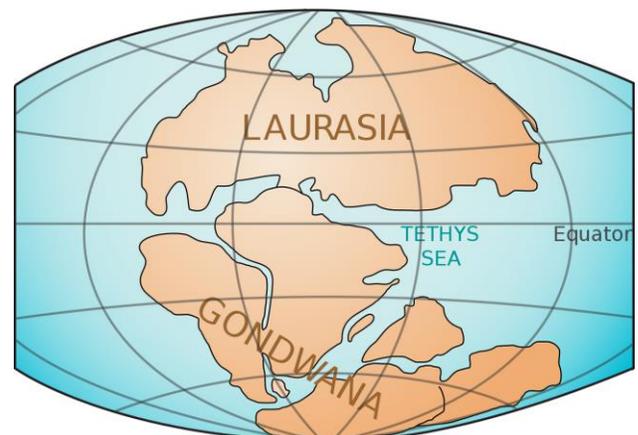


Figure 4. The supercontinent Gondwana during the Triassic (circa 200 million years ago). Image modified from Wikimedia Commons; credit: LennyWikidata (2008).

This break up left Zealandia with no mammals and a bird “paradise” island started to take shape. It is considered that the kakapo followed the trend of oceanic island bird lineages (where nasty mammals are not present) to evolve larger and flightless forms (Powlesland et al., 2006). For instance, that happened with the lineages of the dodo, moa, and elephant bird.

BIOLOGY

I cannot overstate how weird kakapos are for a parrot – or for a bird, actually. Adams considered the kakapo the strangest and most intriguing of all the creatures he saw during his travels with Carwardine (LCtS: p. 105). So I’ll illustrate that by highlighting some aspects of its biology that are of broader interest or peculiar weirdness. If you, however, are looking for a complete guide to the species’ biology, do take a look at the work of Powlesland et al. (2006).

We already covered that kakapos are nocturnal and flightless, and thus have good hearing and sense of smell, alongside massive legs and feet to walk around and climb trees. Yes, they do not fly, but do climb trees to feed. Evolution works in mysterious ways, it seems. Elliot (2017) wrote: *“They often leap from trees and flap their wings, but at best manage a controlled plummet.”* I prefer, however, the way Douglas Adams put it: *“it seems that not only has the kakapo forgotten how to fly, but it has forgotten that it has forgotten how to fly. Apparently a seriously worried kakapo will sometimes run up a tree and jump out of it,*

whereupon it flies like a brick and lands in a graceless heap on the ground” (LCtS: p. 109)³.

It seems kakapos are not able to follow the suggestion of the Hitchhiker’s Guide: *“There is an art, it says, or rather, a knack to flying. The knack lies in learning how to throw yourself at the ground and miss. (...) Clearly, it is this second part, the missing, which presents the difficulties”* (Adams, 1982). Kakapos just constantly fail to miss the ground.

Overall, kakapos are quite large birds, weighing around 2 kg, but males may weigh up to 4 kg and be 40% larger than females (Eason et al., 2006; Elliot, 2017). Their life span is unknown, but is estimated at 60 to 90 years (Department of Conservation, 2018a, 2018b).

Kakapos are vegetarian and eat almost every possible parts of plants. In fact, they only breed in years with a good abundance of fruit (Cockrem, 2006; Elliot, 2017). In their current habitat, kakapo reproduction is tied with that of the rimu (*Dacrydium cupressinum*), an evergreen coniferous tree of the podocarp family (Fig. 5). These plants bloom together every 2 to 4 years (sometimes it takes more); the kakapos must wait for the rimu because they depend on its “fruits” (Fig. 6) to feed the chicks (Cockrem, 2006; Ballance, 2010).

Unlike any other parrot, kakapos are lek breeders. This behavior is common for other groups of birds and even other animals, though. It consists in males gathering relatively

³ However, he soon changed the tone to blame flying birds instead: *“There is something gripping about the idea that this creature has actually given up doing something that virtually every human being has yearned to do since the very first of us looked upwards. I think I find other birds rather irritating for the cocky ease with which they flit through the air as if it was nothing”* (LCtS: p. 120).



Figure 5. A rimu tree is really tall for a flightless bird to climb. Image retrieved from Wikimedia Commons; credit: Kahuroa (2008).



Figure 6. A ripe rimu “fruit”, or better put, a seed sitting on a fleshy cup. Image retrieved from Wikimedia Commons; credit: Department of Conservation (2002).

close to each other and starting a competition to show off to females. Birds can do this mainly by song or dance (or both), but might also include somersaults and flying maneuvers. Each female will choose the best performer (in their opinion at least) and successful males typically mate with more than one female during a single season.

Male kakapos sing to attract females. Or rather, they do something akin to “Pink Floyd studio out-takes” (LCtS: p. 111). The most common type of call produced by kakapos is called booming. This is a low-frequency (<100 Hz) resonant call, which can be heard up to 5 km away (Merton et al., 1984; Higgins, 1999). To produce this sound, male kakapos fill up internal air sacs; they can inflate until they look like a fluffy watermelon (Figs. 7, 8). Adams described the sound as a heartbeat, a powerful throb you felt before actually hearing it; and this gave the title to the kakapo’s own chapter in LCtS: “Heartbeats in the Night”.



Figure 7. A male kakapo booming – and looking like a watermelon. Image extracted from New Zealand Birds Online (<http://nzbirdsonline.org.nz/>); credit: Department of Conservation (image ref 10027966, photo by Ralph Powlesland).

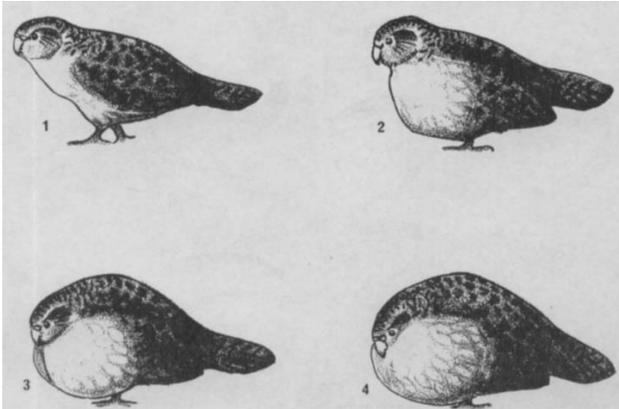


Figure 8. How to camouflage as a watermelon in four easy steps. OK, now serious caption: postures of a male kakapo booming. Figure reproduced from Merton et al. (1984: fig. 4). The original caption reads: “(1) Normal stance; (2) Alert static pose between booming sequences; (3) Commencement of booming: inflation of thorax while giving preliminary ‘grunts’; (4) Maximum thoracic inflation during loud booming.”

Booming also serves to indicate the male’s overall location to the female. Once they are close by, males can produce a sharp metallic “ching” call to enable females to pinpoint their exact location (Powlesland et al., 2006). A good place to hear kakapo booming and chinging is New Zealand Birds Online (<http://nzbirdsonline.org.nz/>).

The female nests on the ground, either on a spot covered by dense vegetation or in natural cavities (Elliot, 2017). Kakapos usually lay 2 to 4 eggs and the female raise the chicks alone (Fig. 9; Cockrem, 2006; Powlesland et al., 2006). Young birds leave the nest within 2 to 3 months, but remain close to their mother’s home range until they are 6.5 to 8.5 months old (Farrimond et al, 2006; Powlesland et al., 2006).

So how do we summarize kakapos? Adams gives us a nice idea: “*The kakapo (...) pursues its own eccentricities rather industriously and*

modestly. If you ask anybody who has worked with kakapos to describe them, they tend to use words like ‘innocent’ and ‘solemn’, even when it’s leaping helplessly out of a tree. This I find immensely appealing” (LCtS: p. 121).



Figure 9. Alice, a female kakapo, on her nest with her two chicks (circa 45 days old). Image extracted from New Zealand Birds Online (<http://nzbirdsonline.org.nz/>); credit: Department of Conservation (image ref 10048384, photo by Don Merton, 2002).

Box 1. Kakapo names

Since there are so few kakapo left and the whole population is managed, each bird has its own name. When Adams and Carwardine visited Codfish Island, they met a kakapo named Ralph. Later on, Adams himself got to name a kakapo Jane, after his then-girlfriend (Balance, 2010). You can check this amazing infographic (by DeMartini et al.) with all the names and family trees of known kakapos: https://public.tableau.com/views/TheKakapo/Dashboard1?:embed=y&:display_count=yes&:tooltips=no&:showVizHome=no.

Presently, the most famous kakapo is Sirocco, who became a YouTube star after he tried to mate with Carwardine’s head during the filming of the *Last Chance to See* TV series (Carwardine, 2010). Today, Sirocco is 21 years old and is the official “spokesbird” for conservation in New Zealand (Department of Conservation, 2018b), a title given to him by then Prime Minister John Key.

HISTORY

Kakapos were present in New Zealand long before humans arrived there: some subfossil bones have been dated from 2500 years ago (Wood, 2006). They were very common and lived throughout both the North and South Islands (Tipa, 2006), with few natural enemies. They were successful in their pre-human environment, but that was soon to change.

Polynesian settlers arrived in Aotearoa⁴ between 1200 and 1300 CE (Wilmshurst et al., 2010) and became known as the Māori. As typical of all humans, they brought domestic/pest species with them: dogs and rats.

As many island species, kakapos were only concerned with their known immediate predators; these mostly harmless birds were thus unprepared for a wave of invaders. Kakapos have the strategy of staying perfectly still when facing danger, which works fine against predators that rely on sight. However, this had little effect against dogs, which hunt by scent. The parrots were hunted for food and ornamentation (for instance, the Māori used the feathers in cloaks; Tipa, 2006) and the population declined. Polynesian rats also played a major role, preying upon defenseless kakapo eggs and chicks.

European settlers arrived on the 19th century and, as one might expect, colonization (and new mammalian predators, such as cats and mustelids) accelerated the species' decline. The Europeans also brought naturalists, who collected specimens for study at museums (Fig. 10). British zoologist George Robert Gray officially named the kakapo *Strigops*

*habroptilus*⁵ in 1845. Later naturalists (some already born in New Zealand) went further, observing live parrots in the wild and studying their natural history.



Figure 10. Museum drawer full of preserved kakapo specimens, from the collection of the Museum of New Zealand Te Papa Tongarewa. Photo by the author (©Te Papa, all rights reserved).

Already in the 1890's, naturalists became aware that the species was heading towards extinction, so the first efforts in conservation (transferring animals to islands in Fiordland; Fig. 11) were undertaken (Hill & Hill, 1987). They failed and eventually the species fade out from the thoughts of New Zealanders, being considered extinct or nearly so (Ballance, 2010).

BUT DON'T PANIC

That lasted until the work of Williams (1956), which summarized all knowledge about the kakapo and brought it back to the spotlight. With this renewed interest, expeditions were

⁴ The Māori name for New Zealand.

⁵ *Strigops* means "owl-faced", while *habroptilus* means "soft feather".

formed to find the species in the southernmost reaches of New Zealand.

A serious take on conservation efforts started again in the 1970's, when a population of around 200 kakapos was found on Stewart Island (Fig. 11; Powlesland et al., 2006). A new process of translocation and monitoring then began. During the 1980s and 1990s, the animals were all moved to predator-free islands: Codfish, Maud and Little Barrier (Fig. 11; Elliot, 2017). When Adams and Carwardine visited Codfish Island in 1992, there were only around 40 kakapos left (Ballance, 2010; Carwardine, 2010).

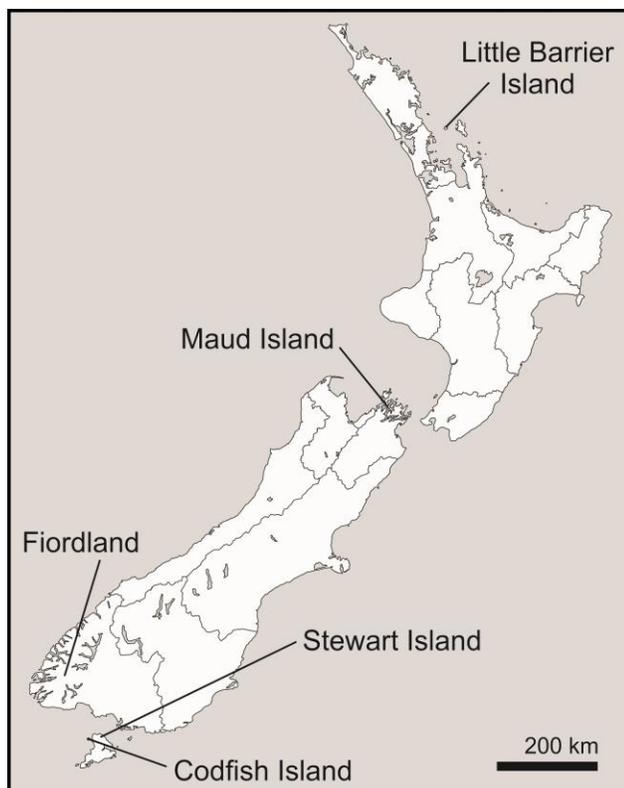


Figure 11. Map of New Zealand showing the locations mentioned on the text. Image modified from Wikimedia Commons; credit: NordNordWest (2009).

However, things started to look brighter after a review in the management of the species (Elliot et al., 2001). A strong and focused policy and full support of the government were essential during the decades since (Jansen, 2006). The kakapo population started to recover and can now be considered one of the greatest successes among global conservation programs – and a good example of how our species can, in fact, clean up after its own mess.

The last report, from June 2017, counted a total of 154 birds (Elliot, 2017), a number exceeding previous population simulations (Elliot, 2005). Recovering the kakapo from the brink of extinction was a feat, but more challenges remain. Presently, the species is considered as “critically endangered” according to the IUCN’s Red List (BirdLife International, 2016). Although this seems better, it is good to remember that this is just one step away from the “extinct in the wild” status in this classification scheme (which the kakapo held during two issues of the Red List in the mid-1990s). Presently, kakapos only survives on offshore islands and there is still lot of work to be done until we have a viable, and self-sustaining population that does not need human management.

Maybe just panic a little bit...

The kakapo is not the only endangered species in the New Zealand – everyone has heard about kiwis, at least. So what about all the other threatened species, birds and otherwise, in the country? Jansen (2006: 190) ominously wrote: “*While extinction of kakapo is now less likely than 10 years ago, the future of*

the 600+ New Zealand species listed as acutely and chronically threatened (...) and that presently do not receive any management is by no means secure." So yes, there is still a lot of work to be done.

But why should we care if some species go extinct? Why should we strive so much to save them? Carwardine (LCtS: p. 205) gave what Dawkins (2009) considered to be the typical explanations for business-minded humans: (1) we mess with the environment, everything goes haywire, and that ultimately affects our survival, and (2) living beings have their uses as food, drugs, etc. However, Carwardine then presented his preferred explanation, one more typical of scientists and that we say to each other over coffee: we try to save them because they are cool. Or, as Carwardine put it: "*There is one last reason for caring, and I believe no other is necessary. It is certainly the reason why so many people have devoted their lives to protecting the likes of rhinos, parakeets, kakapos and dolphins. And it is simply this: the world would be a poorer, darker, lonelier place without them*" (LCtS: p. 206).

"Up until that point it hadn't really clicked with man that an animal could just cease to exist. It was as if we hadn't realised that if we kill something, it simply won't be there anymore. Ever. As a result of the extinction of the dodo we are sadder and wiser."

—Douglas Adams, 1990

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ACKNOWLEDGEMENTS

I am very grateful to Colin Miskelly, Dylan van Winkel, the Department of Conservation, and the Museum of New Zealand Te Papa Tongarewa for allowing the usage of their photographs herein.

ABOUT THE AUTHOR

Dr. **Rodrigo Salvador** is a biologist specializing in the classification and evolution of land snails. Yes, you might say, that has nothing to do with kakapos. But it so happens that the universe conspires to keep him entangled with bird work. As a scientist, he learned with Douglas Adams that knowing the right question is sometimes more important than knowing the answer.



Moa v Superman

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During his heroic career Superman fought several foes. Some of these stories are truly memorable, like *The Death of Superman* (1992–1993), when he faced Doomsday. But many stories just ended up completely forgotten. Granted, there are some stories that most fans prefer to forget, like the film *Batman v Superman: Dawn of Justice* (2016), but some are curious or weird enough to eventually deserve a fresh look. The story I'm about to tell you is one of the latter kind.

This one happened during the first years of the so-called Bronze Age of Comics (1970–1985). Comic books from the Bronze Age retained lots of elements and conventions from the preceding Silver Age, but started to introduce stories more in tune with social issues, like racism and drugs. Likewise, comics also began including environmental issues and this is the topic I will focus on here. More specifically, on extinction.

THE LAST MOA ON EARTH

It is the first story on *Action Comics* no. 425 (July 1973), written by Cary Bates, illustrated by Curt Swan and Frank Giacoia. It is called “The Last Moa on Earth!” and by the title alone, you can see it is about a giant extinct bird.



It's a Bird... It's a Plane... It's Super— no, wait, it is actually a bird this time!

My goal here is to guide you through the story and offer some Biology inputs every now and then, explaining some things and “correcting” the bits the comics got wrong. I do

know that writers should be free to invent and I wholeheartedly agree with that – it is science fiction after all! However, there are some sciency bits and pieces that are so simple to get right that there can be no excuse for giving the public wrong information.

The story starts off with hunter Jon Halaway in a New Zealand forest, being attacked by a giant flightless bird. He shoots and kills it, and decides to visit a local scientist (in Hawera, a town on the west coast of the North Island) to confirm his suspicions of the bird's identity.



Elementary, my dear Halaway.

The scientist tells Halaway that he shot a bird thought to be extinct for 500 years and that there were once thousands of these animals in New Zealand. Both pieces of information are correct. Scientists estimated that there were circa 160,000 moa in New Zealand when Polynesian settlers arrived between 1,200 and 1,300 CE (Holdaway & Jacomb, 2000; Wilmshurst et al., 2010). There were nine species of moa in total and the Polynesians (who later became known as the Māori) had already extinguished them all by the

early 1,400's CE (Tennyson & Martinson, 2007; Perry et al., 2014).

The scientist then says that the bird was the largest of the moa species, *Dinornis*¹ *maximus*. While indeed this species was likely the largest², it inhabited only the South Island of New Zealand. The species from the North Island, where Halaway was hunting, is called

¹ *Dinornis* means "terrible bird", just like dinosaur means "terrible lizard".

² The largest tibia (a leg bone) ever found belongs to this species, being 1 m long (Tennyson & Martinson, 2007).

Dinornis novaezealandiae. So the writer got the species wrong, but we cannot truly blame him: tens of moa “species” were described throughout the years, mostly because of the huge difference in size between the sexes of some species confused early researchers. Thus, the classification of moa species was really messed up until genetic studies started to be conducted from the late 1990’s onwards.



The skull of a North Island giant moa, *Dinornis novaezealandiae*. Source: Museum of New Zealand Te Papa Tongarewa (specimen MNZ S.242); ©Te Papa, all rights reserved.

On a similar note, *D. maximus* is actually an invalid name; the valid name for the South Island giant moa is *D. robustus* (Gill et al., 2010). That is because “*D. maximus*” was a second name given to describe the same species; to avoid confusion, only the first name ever used (*D. robustus*) is valid in these cases.

Halaway estimated the size of the slain moa at 12 feet (approximately 3.6 m), which is quite reasonable. The largest known specimens would have been 2 meters high at their backs or 3 meters high with their necks held straight up (something that they did not do; Tennyson & Martinson, 2007). Moreover, Halaway’s dead

bird was a female, which are typically much larger than males in the two *Dinornis* species (Bunce et al., 2003; Tennyson & Martinson, 2007).

Box 1. What’s a moa anyway?

The moa belong to a group of birds called “ratites”, which also includes ostriches, emus, cassowaries, kiwi, rheas, and the extinct elephant birds. Recent research has shown that moa are not closely related to the other notable New Zealand ratites, the kiwi. Rather, they are closer to the charismatic South America tinamous³ (Mitchell et al., 2014; Yonezawa et al., 2017). Since tinamous still retain some ability to fly, the moa’s ancestor was actually a flying bird (Gibbs, 2016).



The elegant crested tinamou, *Eudromia elegans*. Source: Wikimedia Commons (Evanphoto, 2009).

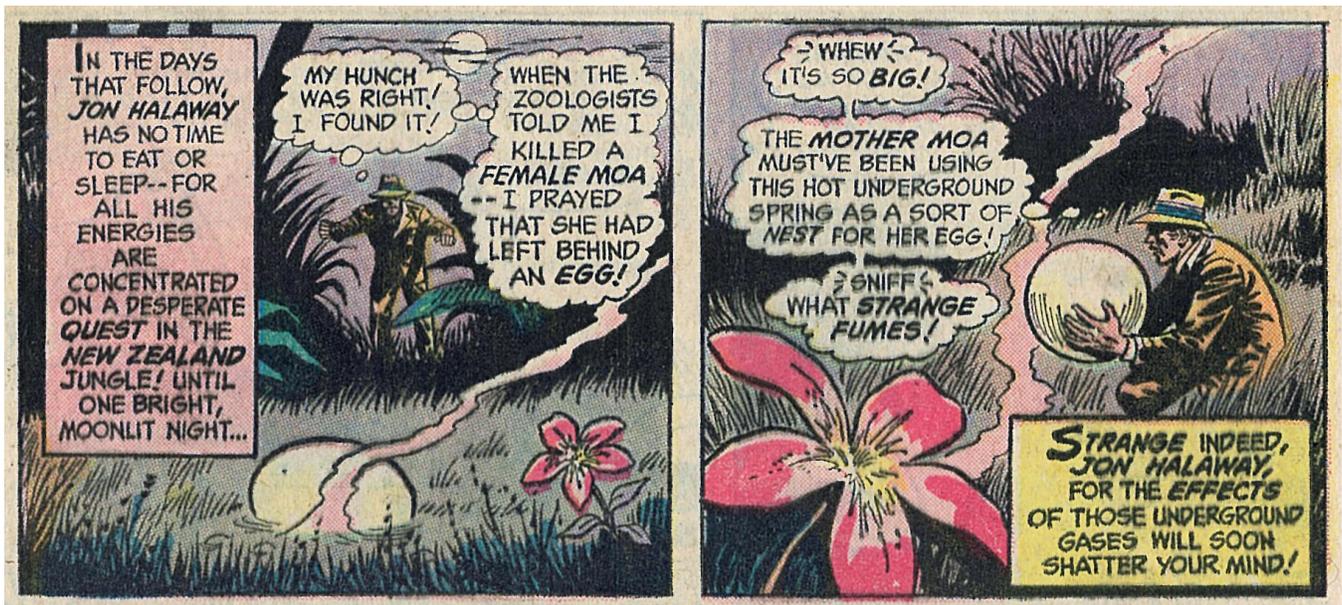
The loss of flight (alongside attaining a large body size) is a common occurrence on island environments where no mammalian predator is present. Other New Zealand species have also lost this ability; besides the kiwi (the typical example of a flightless bird), there are parrots (kakapo), rails (takahē) and wrens.

³ Tinamous are not typically included in the ratites group, rather being historically considered a separate (basal) lineage and grouped together with ratites in the more inclusive “palaeognaths” group. However, the work of Mitchell and collaborators (2014) have placed the tinamous well inside the ratites.

SECOND-LAST, ACTUALLY

Halaway realizes that what he did was plain wrong. As mentioned above, during the Bronze Age comics became conscious of social and environmental problems – and extinction is a major problem, since it is usually our fault. This is important because, even though more than 350 years have elapsed after the last dodo was killed, most people still do not really grasp the idea that a species can disappear forever (Adams & Carwardine, 1900).

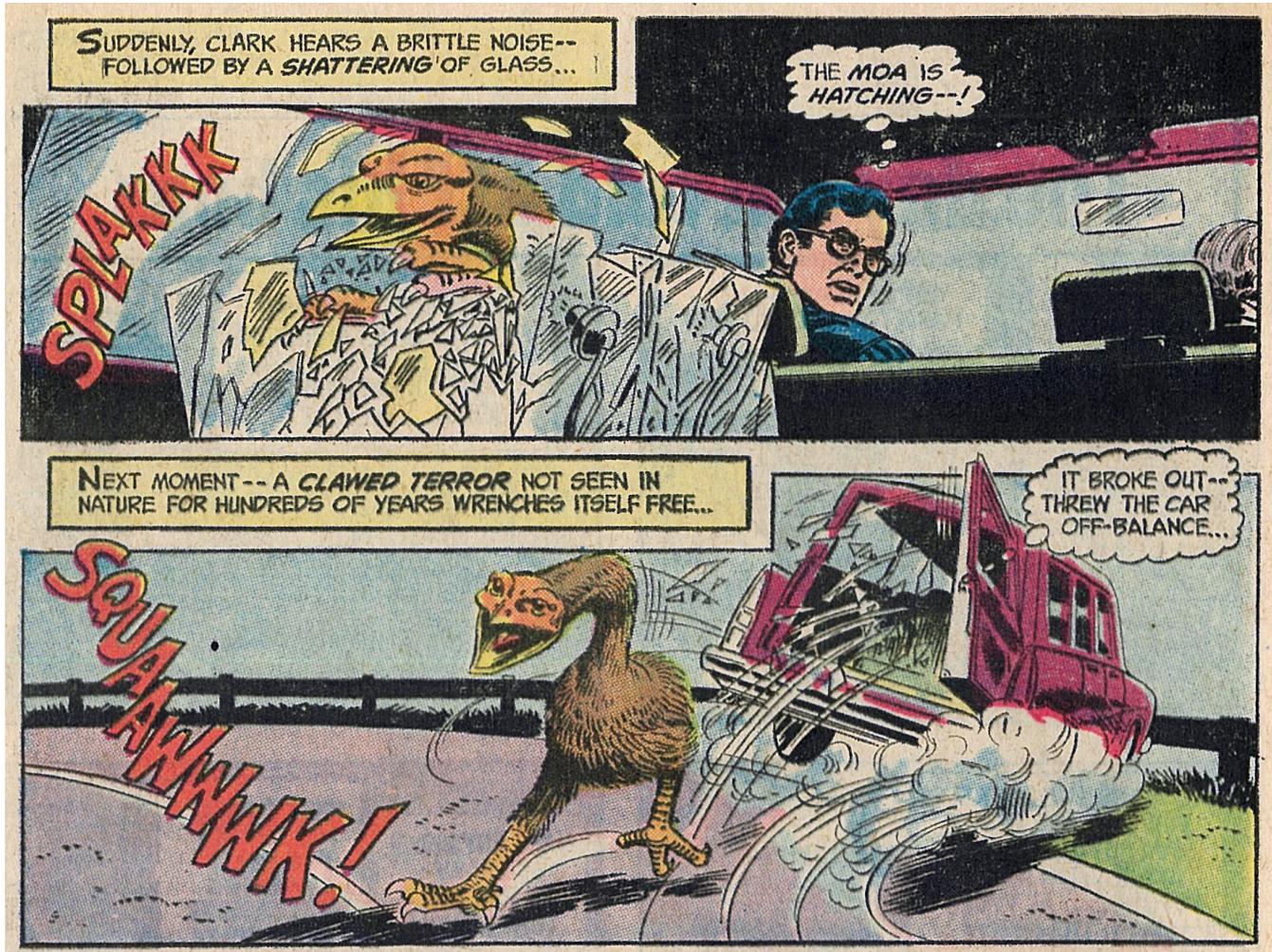
The “good” Mr. Halaway than devoted all his energy and resources into finding the slain moa’s egg. He succeeds and notes that the egg was being incubated in a hot spring with “strange fumes”. The egg was really big and appear egg-shaped in one panel and spherical in the other. Moa’s eggs were not spherical and not that large. Nevertheless, they were quite big and the largest known intact eggs are 20 and 25 cm tall (respectively, for the North Island and South Island *Dinornis*).



Of course the strange chemicals will grant the baby moa superpowers; otherwise this wouldn't be a comic book.

Halaway finally arrives in Metropolis, where he is interviewed by none other than Clark Kent. On the highway, Halaway tells Clark that he wants to redeem himself of his “unforgivable deed” and hope that scientists will figure a way to use the egg to produce more moa. The repented hunter then faints, just as the baby moa hatches and escapes, throwing the car off-balance and into a river.

Clark takes off his suit and glasses and, after he's more comfortable in his supersuit, saves Halaway and takes him to a hospital. Now I will cut the whole weird plot short and just say that the moa created an “organic link” (whatever that is) with Halaway via a microorganism, and was draining his energy. Typical crazy comic book stuff, but that's not the point here. So let's get back to the baby moa.



These “clawed terrors” were actually fluffy herbivores.

SUPERMOA

Superman starts searching Metropolis for the runaway moa and eventually finds it flying. Yes, flying – without wings, the comic-book moa flies by “thrashing its feet at super-speed”. In fact, Superman notices that the moa can fly faster than a super-sonic jet.

Also, even though just a few hours had passed since the moa escaped, when Superman found it, the bird had already doubled in size. And these were not the only superpowers granted to the moa by the mysterious fumes.



Yep, you read it right – that moa is flying with its feet.

Box 2. The moa's archnemesis

The moa were herbivores, browsing on several types of leafy herbs, shrubs and trees (Wood et al., 2008). They were so abundant that it is thought their presence in New Zealand resulted in the evolution of a set of counter-measures in some plant lineages, which have small and hardened leaves, and sometimes also spines (Greenwood & Atkinson, 1977; Cooper et al., 1993; Worthy & Holdaway, 2002). But who ate the moa? Well, they were so large that one would think they had no natural predators before the hungry Polynesians arrived. But that would be wrong – moa were hunted by giant eagles.



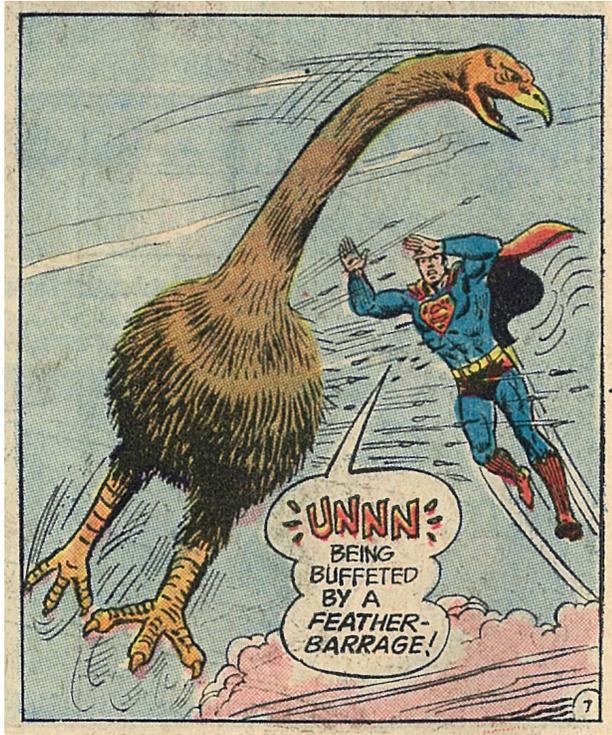
Naturally one would think of this – it is New Zealand after all! Source: *The Hobbit: An Unexpected Journey* (Warner Bros. Pictures, 2012), screen capture.

They are known as Haast's eagles, after the naturalist who first described them, Sir Johann von Haast. They are the largest known true raptors, in both size and weight. They could reach a 2.6 m wingspan (somewhat smallish for their bulk) and 16 kg in weight, with females being larger (Brathwaite, 1992; Tennyson & Martinson, 2007). To hunt and eat their massive prey, Haast's eagles had strong legs and feet, with huge claws. Unfortunately, these amazing birds could not survive after the moa became extinct and likely did not last much longer than 1,400 CE (Tennyson & Martinson, 2007).

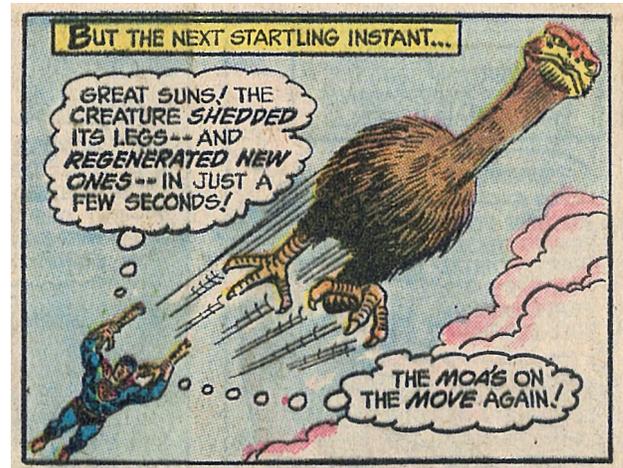


The skull of a Haast's eagle, *Aquila moorei*. Source: Museum of New Zealand Te Papa Tongarewa (specimen MNZ S. 22473); ©Te Papa, all rights reserved.

The moa also gained the ability to use its feathers as projectiles that could even pierce an elephant's hide (according to Superman). Needless to say, birds cannot do that unless they are also Pokémon. Finally, the moa could instantly regrow lost limbs, a feat that few heroes (and absolutely no birds) can achieve.



Giant Moa uses *Feather Barrage*. It's not very effective...



Holy regeneration, Batman!

After some more fighting, Superman understands that the bird just wants to go back home – to that place with the fumes and the lonely pink flower. Superman realizes that the flower is a “Quixa blossom”, as he calls it, and says it is a rare plant found only in northwest New Zealand.

Since my knowledge of plants is fairly limited, I asked a New Zealand botanist for help with this one. I was told that there is no flower with that name in the country and actually nothing that even remotely looks like it.



The “Quixa blossom” is actually the least believable thing in this whole story.

In any event, Superman finds the moa's home and takes it back there, thus stopping the energy draining effect and saving Halaway. Superman then proclaims the area a "moa preserve" and sets up a fence around it. A thoughtful move, but one that completely overlooks the fact that the supermoa could fly.

THE END

The story ends with Halaway saying that "the world owns the moa another chance for survival". Unfortunately, reality is not so kind: our species has wiped the moa off the face of the Earth and there is no second chance.

Overall, if you ignore the superpowers and the "organic link" stuff, this Superman story is actually a nice portrayal of an extinct species and its tragic fate on the hands of humankind. If nothing else, I hope it has inspired a reader somewhere to become a scientist or to fight to preserve other endangered animals.

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ACKNOWLEDGEMENTS

I am very grateful to Dr. Carlos Lehnebach for the help with flower, to Alan Tennyson for helping me to correct some mistakes on moa/eagle biology, and to Museum of New Zealand Te Papa Tongarewa for allowing the usage of the photographs herein.

ABOUT THE AUTHOR

Dr. **Rodrigo Salvador** is a paleontologist/zoologist who studies mollusks, but just happens to have a soft spot for giant flightless birds. He is a diehard DC Comics fan, but to be honest, he never really liked Superman. Instead, he prefers to read the stories of the caped crusader and his extensive Gotham “family”.



Cephalopods of the Multiverse

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Magic the Gathering (MTG) is a popular trading and collectible card game, first published by Wizards of the Coast in 1993. Although the game now spans many formats and game types, the core concept pits two players “Planeswalkers” against each other, drawing power (mana) from plains, swamps, mountains, forests and islands to summon creatures and cast spells to battle and defeat opponents. The game has a complex and ever evolving set of rules. Wizards of the Coast regularly release new sets and blocks introducing new cards, mechanics and lore to the rich Multiverse, the planes of existence that Planeswalkers can travel between, that makes the games setting.

One aspect of the game which arguably underpins the continued success of MTG is the vibrancy and colour which gives flavour to the complex ruleset of the game. Storylines featuring several recurring characters, normally Planeswalkers, are told across novelisations, through flavour text and the beautiful artwork of the cards. The designers and artists liberally take inspiration for the denizens of the Multiverse from wider science-fiction, fantasy and of course the natural world.

Although your average game of MTG may feature battles between Inexorable Blobs,

hammer wielding cat wizards and goblin bombers, more zoologically minded Planeswalkers may summon an Allosaurus, Hammerhead Shark or a Grizzly Bear or two to the fray. Of course, as numerous *Journal of Geek Studies* papers have highlighted (Salvador, 2014, 2018; Cavallari, 2015; Salvador & Cunha, 2016), cephalopod molluscs have also inspired the designers of MTG and this paper will look at known cephalopods from the Multiverse with some comments on differences between their biology and the cephalopods we’re more familiar with on our humble plane.

HERE WON’T BE KRAKENS

‘Squid’, octopuses and nautilus have all featured in MTG so far on creature, other spell and even Planeswalkers cards. Krakens are also a creature type within the Multiverse but differ from the Kraken of historical and contemporary mythology, normally associated with giant squid or squid-like creatures. In MTG krakens are giant, island destroying, beasts which show a diversity of cetacean, arthropod and molluscan features amongst others. For this reason, krakens get an honourable mention here but won’t be examined as the mutating magical

powers of the deep sea defy current systematic reasoning.

Mirroring trends in scientific research and literature on cephalopods, although they are culturally important organisms they make up a small niche of known creatures in the Multiverse. Unlike other creature types which have been a mainstay in MTG sets, cephalopod cards are comparatively rare. Cephalopod-themed cards were published as early as 1997 but it's only comparatively recently that enough cards have been produced to attempt an all-cephalopod themed standard 60-card deck.

The different cards will be examined in a hybrid taxonomic and card type order starting with creature cards then moving onto enchantments, Planeswalkers and sorcery types. In total, excluding reprinted cards and art variants, there are 21 cephalopod-themed cards currently published for MTG: 14 creatures, 2 sorceries, 2 enchantments, 2 tokens and 1 Planeswalker.

A NOTE ON POWER LEVELS

In MTG the comparative power, strength and endurance of different creatures is expressed as a number on the bottom right hand of creature cards. The numerator represents the power of a creature (the amount of damage it can do by punching, slicing, psychically tormenting or oozing on a defending creature) and the denominator represents toughness (the amount of punching etc. it can take).

The power levels of various creatures of the Multiverse is the subject of much debate and mirth amongst players but for this paper the Grizzly Bear with the power/toughness 2/2 will be used as a baseline to make inferences about

analogies between cephalopods from other planes and our own.

CREATURES: NAUTILOIDEA

Perhaps unfairly maligned as hangers-on or 'living fossils' on our plane, today's diversity of living species of nautiluses, the only externally shelled cephalopods, have inspired philosophers, artisans and scientists for centuries. The exact species diversity and relationships between them is still in flux, compounded by the difficulty in accessing and studying these organisms.

There are just two nautiluses in MTG, the **Chambered Nautilus**, which shares its name with a generic name used to refer to the whole living group, or sometimes, specifically *Nautilus pompilius*, and the **Crystalline Nautilus** (Fig. 1). Much like living nautiluses, which are nationally and internationally protected by law, the flavour text for chambered nautilus suggests that their shells are also exploited by jewellers on some planes at least:

"What's merely a home for the nautilus can become exquisite jewelry in the hands of Saprazan artisans."

— Flavour text from Chambered Nautilus card.

Chambered nautiluses are 2/2 creatures in MTG and the card art shows one giving a merfolk an unwanted cuddle. The art and power level suggests that Magic's nautiluses are significantly larger than living ones. Interestingly, they share a fleshy hood, numerous tentacles and a lenseless eye complete with iris groove for channelling mucus (Muntz, 1987).



Figure 1. The nautiluses. Source: Gatherer.

By contrast the crystalline nautilus, masterfully depicted by artist Brad Rigney, suggests extreme adaptation unlike that of known nautiloid species. In the first instance, the crystalline nautilus is both a creature and enchantment and is shown with a vivid pearlescent shell similar to polished shells of nautiluses. The soft tissue anatomy is consistent with known species of *Nautilus* and *Allonautilus*; however, the crystalline nautilus is shown moving at speed over the surface of the water. This has never been documented in known species and furthermore, from the depiction, the hyponome plays no part in this high speed aquaplaning mode of locomotion. A power and toughness of 4/4 suggests that crystalline

nautilus is significantly more durable and powerful than *Magic's* chambered nautilus too.

CREATURES: 'SQUID'

As a general term, squid is often used for decapodiform cephalopods excluding cuttlefish which is not a natural grouping of these soft-bodied cephalopods. There are three squid creatures in MTG and two squid producing creatures. With the exception of Gulf Squid, the squid appear to have corneal membranes and are classified, albeit tentatively, here as myopsid squid.

The three squid creatures in MTG are the **Fylamarid**, **Sand Squid** and the intriguing **Gulf Squid** (Fig. 2). Sand Squid appear the most similar to known myopsid species albeit

significantly larger than any known decapodiform cephalopod, depicted embracing a human-sized creature with thick, flat arms. Fylamarids are flying squid which appear to have evolved true sustained flight beyond the shorter bursts of flight in species of flying squid

(Muramatsu et al., 2013) with adaptations of large wing like projections underneath the siphon region, huge lateral fins and vampire squid-like filament arms alongside usual arm array. The tentacles appear to have been lost, but they can squirt ink.



Figure 2. MTG's 'squid' cards including the presumably misclassified ~~Omastar~~ Gulf Squid. Source: Gatherer.

Although the Gulf Squid has been categorised as a squid by MTG (presumably informed by scholars from across the Multiverse), the gulf squid possesses a large ornamented spiral shell suggesting an ammonoid affinity or convergence. The direction of shell coiling with relation to the position of the aperture as well as the skin colour, suggests a close resemblance to another well-known fictitious cephalopod (Salvador, 2014). Further study of this group is required to confirm relationship with other known cephalopods from the Multiverse.

Likewise, **Chasm Skulkers**, categorised by MTG as a 'squid horror' also defies known relationships within Cephalopoda. Upon the death of a Chasm Skulker, a number of 1/1 squid creatures are created. It is unknown if these are symbiotic or parasitic cephalopods, who attack on the death of their 'host', or spontaneously created with magical forces. The last 'squid' card gives some insight into ecology in the oceans of different planes, summoning a **Coral Barrier** also brings with it a 1/1 squid creature consistent with reef species in our plane.



Figure 3. The octopuses, with fourth wall breaking Jules Verne quote on this printing of the card. Source: Gatherer.

CREATURES: OCTOPODA

In terms of types of octopuses in MTG, which in some cases seems to be analogous to species, octopuses are the most speciose of known cephalopods from the Multiverse. There are six octopus creatures. Like cephalopods in our plane, the Multiverse also seems to be plagued with problematic naming conventions when it comes to octopus types.

In order of power, **Crafty Octopus** (Fig. 3) is the weakest octopus card, but like living species, makes up for it in terms of brain power. In addition to showing an advanced range of tool use, Crafty Octopus is also wearing glasses, steadfast evidence of intelligence in ethological studies.

The next octopus in terms of power is the **Giant Octopus** (Fig. 3), depicted at a size larger

than buildings and capable of destroying ships with their arms. Although certainly giant by comparison to the largest known species of octopuses in our plane, the name may be a misnomer as they are the second smallest type of octopus in MTG, and therefore not biologically giant as defined by Klug et al. (2015). The flavour text for the various reprints of this card tell us many things. Firstly, that calamari is appreciated across the Multiverses and secondly with a quote from Jules Verne's *Twenty Thousand Leagues under the Sea*, that this influential volume has somehow also made its way across the Multiverse (or perhaps Verne walked the planes?).

Tied at 5/5 power and toughness are the ship-crushing **Sealock Monster** and multi-mouthed **Godhunter Octopus** (Fig. 4). Studying

specimens of this size would have huge implications for understanding the evolution of colossal size in coleoid cephalopods. From a restricted glimpse of Godhunter octopuses, it

appears they possess numerous toothed mouth-like openings, superficially similar to toothed sucker rings.



Figure 4. The octopod monsters, depicted destroying people, boats and mountains? Source: Gatherer.

Moving up the power scale, the **Elder Deep-Fiend** (Fig. 4) is next, literally bursting from inside another creature which is handy in a pinch. The Elder Deep-Fiend shows some interesting anatomy similar to Godhunter Octopus with a toothed maw on the surface of the mantle rather than in the centre of arms. However, it's important to note that this octopus is a physical manifestation formed from the ceaseless hunger of titans from the Blind Eternities so adherence to biological principles is not necessarily a given.

The last of the octopus creatures is **Lorthos, the Tidemaker** (Fig. 5) a whopping and cephalopod-theme pleasing 8/8 legendary creature. Unfortunately, last seen being

dismembered by an Eldrazi titan, this unique specimen is presumed lost to science (Digges, 2015).

SORCERIES, ENCHANTMENTS & PLANESWALKER KIORA

In addition to summoning creatures to go head to head with each other in magical conflicts, Planeswalkers can also use a variety of spells to tip the table in their favour and control the field of play. They can also summon other Planeswalkers to assist in battles. There are a number of cephalopod spells in MTG but unfortunately, their magical and ethereal nature defies existing classification systems and biological concepts.



Figure 5. Lorthos. Source: Gatherer.

Crush of Tentacles (Fig. 6; although crush of cephalopod arms appears to be more accurate) is a powerful sorcery spell that makes all other creatures disappear and, if you've got the mana to spare, summons an 8/8 octopus to boot. **Octopus Umbra** (Fig. 6) is an enchantment aura that can be used to give other creatures 'the

power of Octopus' boosting them to 8/8 power and toughness with the ability to shut down creatures with a power less than 8 (see what they did there?).

Then there are two spells and one creature which cause pause for thought on cephalopod taxonomy. **Quest for Ula's Temple** (Fig. 6), **Whelming Wave** and summoning **Slinn Voda** all affect creature types. Quest for Ula's Temple becomes a tidal wave of creatures and the other two remove certain creatures from play. Interestingly, octopuses are the only cephalopods affected by these alongside aforementioned Krakens, Leviathans and Serpents. Quite why it's only octopuses and not all cephalopods which are affected is currently unknown. Interestingly, Whelming Wave summons a... err... whelming wave, but octopuses are spared from its destructive power. This then allows them to take over the land presumably as happened recently in Wales (Ward, 2017).



Figure 6. Cephalopod flavoured spells: Quest for Ula's Temple, Octopus Umbra, Crush of Tentacles [sic]. Source: Gatherer.



Figure 7. Both depictions of Planeswalker Kiora A.K.A. 'The one with all the fan art'. Source: Gatherer.

The last cephalopod-themed card worth mentioning is Planeswalker Kiora. A merfolk Planeswalker, she has the power to summon 8/8 octopuses into battle and is depicted in both her Master of the Depths and Crashing Wave (Fig. 7) as keeping a suckered beast or two on hand at all times. A must-have ally for those wanting to literally bring more arms to the fight.

SO LONG SUCKERS

As of the time of writing, these are all the known cephalopod and cephalopod-related creatures, spells and Planeswalkers from the MTG Multiverse. In this examination there is some biological conservatism across planes of existence when it comes to cephalopod biology, anatomy and ecology. There are also some

marked differences, which although may be biologically questionable, implausible or indeed impossible, they make for a fun game. There are still plenty of cephalopods yet to draw inspiration from including early fossil forms, cuttlefish, ram's horn squid and bobtail squid. Here's hoping that many more cephalopods will be making their way to a card table soon.

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ACKNOWLEDGEMENTS

I'd like to thank 'Worm Tongue' Murphy, 'Tap to Block' Nick, 'Read the Cards' Andy and 'Bobby' Big Balls for hours of field testing these ideas and concepts. Special thanks go to the staff of Dark Sphere London for their patience in cephalopod card hunting.

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Mark Carnall is a natural history curator specialising in all living things across time which isn't really a specialism. As a museum curator he knows better than most that there is no prying apart popular culture and science as they both feed on and into each other. All animals are the best but cephalopods are more best.

- **Vlachos, E.** – Zoological Nomenclature of Ice and Fire _____ Pp. 01–17.
- **Thought, D.** – What is the answer to Life, the Universe and Everything? _____ P. 18.
- **Kittel, R.N.** – The entomological diversity of Pokémon _____ Pp. 19–40.
- **Salvador, R.B.** – Douglas Adams and the world’s largest, fattest and least-able-to-fly parrot _____ Pp. 41–50.
- **Salvador, R.B.** – Moa v Superman _____ Pp. 51–59.
- **Carnall, M.A.** – Cephalopods of the Multiverse _____ Pp. 60–68.