EDITORIAL

One Longs For A Weed

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Abstract

Let us have no doubt - the adverse effects of weeds have been so significant in agriculture that they led to a whole field of science - *Weed Science* - our discipline. Founded in the 1950s, it has since become a formidable discipline that makes an enormous contribution to agriculture, land management, and the conservation of the Planet's land and water resources. Yet, many weed scientists and agriculturists still have a relatively poor grasp of this special group of plants.

Suffice it to say, *Not All Weeds Are Bad All the Time*. *If weeds could speak, they would explain this better to humans*. *Weedy species are universally nothing but colonising taxa*. A weed also does not know that it is a 'weed'. The term is a human epithet, a human construct. The 'weed', on the other hand, is simply a highly successful living organism possessing attributes that we also possess and value.

Humans present the greatest threat to biodiversity, of which people and weedy species are constituent parts. However unpalatable this message might be to some farmers, conservationists and others, it needs to be given much more publicity to achieve a better balance between human greed, the development aspirations of nations, and global biological diversity. A change in attitude and a shift in focus are required to address the issue.

Weedy taxa have long been used as a scapegoat to hide human follies (related to disturbances caused by land-clearing, deforestation, inappropriate forms of agriculture, and excessive population growth). Our discipline, which is now more than 80 years old, recognises that '*consensus helps but is not always necessary for cooperation in successfully conducting investigative research*,' which sheds more light on colonising taxa. Divergent views on weeds appear to be influenced by the experiences of individuals and groups (i.e. negative perceptions about weeds in monoculture agriculture).

In science or any other field of human endeavour, for that matter, repetition is not a crime. It is a fundamental principle in scientific inquiry. It helps to verify hypotheses, ensure consistent results, and build a strong foundation of knowledge. Therefore, I plead again that weed science should broaden the mandate it has and stop ignoring the virtuous side of weedy species. Not to do so would be a human folly and would add to the mistakes that we have made in the last century or so, which have placed the Planet on the brink of collapse.

Keywords: War With Weeds, Colonising species, utilization of weeds, Weed Science, weed research

If A weed Could Speak

"…One longs for a weed, here and there, for variety; though a weed is no more than a flower in disguise, which is seen through at once if love gives a man eyes..." Lowell (1876)

"…It is time for us to eliminate weeds from our cultivated lands. But we should also understand why we do it and what we're doing. Nature has a reason for allowing weeds to grow where we do not want them.

If this reason becomes clear to us, we will have learned from Nature how to deprive weeds of their 'weedy' character; that is, how to eradicate them…, or rather, how to improve our methods of cultivation so that weeds are no longer a problem…" Pfeiffer (ca. 1950)

The first quote, from James Russel Lowell - a famous American poet, pleads people to open their eyes and appreciate *Nature*, of which weeds are an essential part. The poetic freedom of expression allowed Lowell to promote a sympathetic view of weeds rather than viewing them negatively.

The second quote, from Dr. Ehrenfried Pfeiffer, a soil scientist, states that weeds become a nuisance when they interfere with crops or human activities. Pfierffer, the pioneer of *Biodynamic Farming*, suggested that problematic 'weeds' need to be eliminated from arable lands, but people should do so only with a good understanding of why they are there in the first place. Both viewpoints are essential in broadening our thinking about weeds.

Let us have no doubt - the negative impacts of weeds have been so significant in agriculture that they led to a whole field of science - *Weed Science* - our discipline. Founded in the 1950s, weed science has since become a formidable discipline. Over the past seven decades, the discipline, despite its primary focus on herbicides, has significantly enhanced the methods and tools available for effective weed control in farming.

Nevertheless, in tracing the history of *Weed Science* in the USA, Timmons (1970), Holm (1971) and Appleby (2005) concluded that few agriculturists considered weeds a problem before 1500 AD and that weed control was *incidental* to land preparation for growing crops.

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Where *Weed Science* fits within the space of biological sciences, ecology, agriculture, or environmental sciences does not really matter, as weeds affect many areas of human interest. Away from agriculture, the discipline has expanded rapidly in the last few decades to address the problems that native vegetation and landscapes can pose to colonising taxa. *Weed Science* now encompasses studies on the ecological restoration of damaged environments, utilising weedy species to remediate land and water resources or using such species to generate biofuel energy through biomass.

Our founders, many of whom were leading ecologists of the 1950s and 1960s, stated that understanding why weeds are present in the first place is crucial before attempting to control them (Baker, 1965, 1974; Bunting, 1960; Harper, 1960, 1967, 1977). If we also do not forget why weeds are so successful, perhaps we can learn how to mitigate their negative impacts more effectively and *save ourselves some effort and money along the way, too*.

Some people hate weeds without much reason. Others do so because weeds can be a back-breaking nuisance. Weeds despoil their tidy and homely worlds, bothering them in various situations. Even some environmentalists loathe weeds due to their concern that some aggressive taxa will colonise forests, native bushlands, and grasslands, displacing native species. Many people dislike aquatic weeds because their excessive growth makes water bodies unusable for various purposes. Large stands of aquatic weeds can choke rivers, interfering with livelihoods, water supplies, recreational uses, navigation and drainage.

Ecologists and Agriculturists know that weedy species are notorious for occupying places we do not want them to be. They are also sturdy, recalcitrant to control and persistent. They will also cost you time, effort, and money. Weed control labour and herbicides are not cheap. However, the dislike of weeds among people is not universal. I know many people who wonder whether weeds have any redeeming value (Chandrasena, 2023).

Are humans making another mistake by the relentless search-and-destroy missions against weeds, backed by the excessive use of chemical weapons? The devastating damage caused to plants and humans by the US Military spraying the notorious herbicide *Agent Orange* over Vietnam cannot be forgotten. It resulted in the destruction of vast acreages of vegetation and dire health consequences for thousands of Vietnamese, as well as American soldiers, livestock and wildlife (Martini, 2012). Dioxins, byproducts of large-scale chemical manufacturing, were the main culprit.

The military use of herbicides, a rare event, cannot be equated with the everyday use of herbicides to manage weeds. However, poorly executed herbicide-based weed control practices can cause unintended consequences. Similarly, grubbing and other forms of mechanical weed control using heavy machinery cause unnecessary soil disturbances while also reducing the cover of existing vegetation. Intact forests and grasslands are often affected by such interventions. Additionally, depending on the scale, disproportionate weed control can exacerbate soil erosion and disrupt habitats. It also creates conditions under which other colonizers arrive and displace indigenous plants.

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The standard but subjective definition, '*a weed is a plant growing where it is not wanted,*' runs the risk of branding some of the most valuable plants in the world as undesirable. Giving too much credit to human judgments is fraught! This definition is still cited in a large number of *Weed Science* articles without qualification. My suggestion is that it should be urgently replaced with a meaningful (ecological) one. I prefer the one: '*A weed is a pioneering or colonising species, which grows abundantly in a disturbed habitat, often associated with human-caused disturbances*'.

We have known for over 60 years that specific plant taxa possess unique biological attributes that enable them to colonise previously vacant habitats (Bunting, 1960; Baker, 1965; Chandrasena, 2023). Such plants display attributes that collectively appear as a '*weediness syndrome*'. Confusingly, this term also describes the '*weedy condition*' of a cropping field or flower bed. In the latter case, '*weediness*' refers to the abundance of weeds at a given site rather than to the collective traits of the biological entity itself.

Evolutionary evidence suggests that colonising taxa occupied the Earth long before humans. Some taxa evolved with traits and attributes that allowed them to quickly inhabit vacant spaces created by various disturbances. The colonization of the Planet's surface by pioneering plants occurred during the Pleistocene Epoch (approximately 2.6 million to about 11,000 years ago) of the Quaternary Era (2.6 million years ago to the present).

The *Quaternary Era* is called the *'Age of Humans'* because our species (genus *Homo*) evolved in its latter part. However, colonising taxa, most of which are flowering plants (Angiosperms), evolved approximately 140 million years ago, well before our ancestors. Our primate ancestors separated from other mammals around 35-55 million years ago (*Eocene Epoch*). Our closest kin, the great apes (*Hominidae*), evolved less than 20 million years ago. The evolution of humans can be traced back to a few million years (the last 2-4 million years) only [1].

We now live in a period that has been termed the *Anthropocene*. It refers to the geologic epoch dating from the start of a significant human impact on the Planet's ecosystems, including the present era, where humans have expedited climate change (Nature, 2024). As the era of human-induced change, the term will remain an invaluable descriptor in human-environment interactions, of which the relations with weeds are also significant.

Various start dates for the *Anthropocene* have been proposed. These range from the beginning of the *Neolithic Agricultural Revolution* (approximately 12,000 years ago) to the advent of extensive settled Agriculture (approximately 5,000 years ago), the Industrial Revolution (dated to the 18th century), and as recently as the 1960s.

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The concept of 'weediness' is a valuable tool to better understand weeds. It describes the possession of a set of heritable traits, as well as life-cycle strategies, in members belonging to a group of plants. More than 60 years ago, one of our founders - Herbert George Baker - explained this:

> *"A plant is a weed if, in any specified…area, its populations grow entirely or predominantly in situations disturbed by man (without, of course, being a deliberately cultivated plant). Thus, weeds include plants that are called agrestals (they enter agricultural land) and ruderals (which occur in waste places and along roadsides). In many cases, the same species occupy both kinds of habitat."*
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> *"Ruderals and agrestals face many similar ecological factors…Such disturbed habitat is mostly, but not exclusively, associated with man's activities and is at least partially created by man".* Baker (1965)

Plants of all kinds dominate our world. Although fungi, bacteria, and animals are vital for sustaining natural processes, plants, including both more primitive and evolutionarily advanced plants, are the most abundant life forms on Earth. Importantly, plants not only harness the sun's energy into sugars (which serve as food for animals), but they also oxygenate the air. These effects, directly and indirectly, sustain all life on Earth. In the plant kingdom, *where there are no weeds*, the fast-growing weedy taxa play a crucial role in provisioning these services.

As Baker explained, a weed is a *colonising species*, a *pioneer* taxon, whose populations [2] grow

[1] *Hominid* refers to the 'great apes', including Asian great apes (orangutans), African great apes (chimpanzees, bonobos, and gorillas) and humans.

[2] A *population* comprises individuals of the <u>*same*</u> species. A *community*, on the other hand, is an

mainly in situations disturbed by man. Some of the world's major crops are closely related to weedy pioneering taxa. As Jack Harlan (1965) explained, they share a large proportion of their genes with '*wild*' relatives, which is one reason why we can grow crop plants well and produce food for everyone.

Many fast-growing trees, such as willows (*Salix* L. spp.) and poplars (*Populus* L. spp.), and woody shrubs, such as wattles (*Acacia* Mill. spp.), mesquite (*Prosopsis* L. spp.) and lantana (*Lantana camara* L.), are extraordinary colonizers. Ecologically speaking, these species are *pioneers of secondary succession*. Many soft herbs that grow abundantly around our homes also belong to this category. These taxa rapidly colonise and thrive in human-disturbed environments. They have adaptations to succeed not just in human-modified habitats but also in other situations disturbed by natural forces, such as floods, cyclones, landslides, and bushfires.

In agriculture, where the colonising taxa earned their dubious reputation, their interactions with crops are complex and multifaceted. *Not all weeds compete with crops equally or even efficiently*. But those that do can cause significant yield losses (Zimdahl, 1980). Crops also differ significantly in their sensitivity to the abundance of weeds and the duration of weed competition.

The contest in the agricultural field between weeds and crops for resources is most intense at the early stages of a crop's life. This period is called the "*critical period of crop-weed competition*" or the "*critical weed-free period*". It refers to the maximum period that weeds can be tolerated without affecting final crop yields or the point at which weed growth no longer affects the yield. Generally, weeds that emerge earlier, typically during the first third of the crop's life cycle, are more damaging to yields than those that appear much later (Zimdahl, 1980).

Most weed scientists are well aware that a guiding principle of '*weed management*', compared with herbicide-based '*weed control*', is to delay weed emergence relative to the crop. The critical '*weed-free*' period for any crop varies considerably among sites and years due to climate and soil conditions. These conditions influence the emergence of both crops and weeds, as well as their growth rates, weed species composition, and abundance (i.e., densities) (see Zimdahl, 2024).

Man is the 'Weediest' Species

Jack Harlan (University of Illinois), whose primary expertise was in crop evolution, was an early advocate for a better understanding of weeds [3]. To achieve this, he drew analogies with other successful organisms that also thrived under human influence, such as the fruit fly, field mouse, pigeons, and the English sparrow. He also called humans the *weediest* of all species on Earth:

> *"The word 'weed' means a species or a race adapted to conditions of human disturbance. By this definition, weeds are not confined to plants. Animals, such as the English sparrow, the starling, the pigeon, the house mouse, Drosophila melanogaster, and others, are specially fitted to environments created by human disturbances".*
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> *"Indeed, perhaps no species thrives under human disturbance more than Homo sapiens himself. In an ecological sense, man is primarily a weed".*
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> *"Weeds have been constant and intimate companions of man throughout his history and could tell us a lot more about man, where he has been and what he has done if only we knew more about them".*
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> *"Weeds are adapted to habitats disturbed by man. They may be useful in some respects and harmful to others. They may be useful to some people and despised by others,"* Harlan (1965).

Harlan receives no mention in *Weed Science* textbooks written over the past 70 years. This is most likely because the discipline's early focus was on the practices and tools of weed control, especially herbicides. But he was the first to argue that humans are not just the *weediest* of all species but also the *first weed*.

> *"There can be no doubt that the more humans disturb their environment, the more they thrive on those disturbed landscapes". If 'weeds' are species adapted to human disturbances, man*

assemblage of different species populations sharing the same habitat.

[3] For an appreciation of Jack Harlan's enormous contribution to understanding crops and weeds, see Qualset (1998) and Hymowitz (2003). Harlan's book - *The Living Fields: Our Agricultural Heritage* (1968) also provides deep insights into how agriculture and human influence shaped crops and weedy species.

is the first and ‘primary weed’ under whose influence all other weeds evolved” (Harlan,1965)

Most early *Weed Science* textbooks failed to emphasise such viewpoints and the role of humans as culpable in spreading weeds or causing perturbations that allow weeds to thrive. In that setting, Harlan and De Wet (1965) and De Wet and Harlan (1975) provided a robust contextual background for our discipline. In 1975, they wrote:

“Weeds evolve and are still evolving, within the man-made habitat in three principal ways:

(1) from wild colonizers through selection towards adaptation to continuous habitat disturbances; (2) as derivatives of hybridization between wild and cultivated races of domestic species; and (3) from abandoned domesticates through selection towards a less intimate association with man.

“Domesticates [wheat and maize] differ from weeds primarily in the degree of dependency on man for survival. They evolved from wild food plants, which were brought into cultivation. The process of domestication was initiated when man started to propagate plants by means of seed or vegetative propagules”.

“Artificial selection by man during the domestication process is primarily responsible for subspecific variation in domestic species”. (Harlan and De Wet, 1975)

Weeds Are Pioneers of Ecological Succession

The vast repository of *Weed Science* and related ecological literature also reveals that the ‘*period of ecological enlightenment*’ was between 1955 and 1975, during which some defining ideas evolved. These include Baker’s views on the ‘*Ideal Weed*’ (Baker, 1965). Contributions of several other ecologists, such as Charles Elton (1958), Herbert Baker (1965; 1974), Ledyard Stebbins (Anderson and Stebbins, 1954), Baker and Stebbins, 1965), Richard Lewontin (1965), Hugh Bunting (1965), Ernst Mayr (1965) and John Harper (1958; 1960; 1977), illuminated this period.

The contributions from plant ecology and population biology have shaped and informed the study of weeds and their management (Sagar and Harper, 1961; Harper, 1967, 1983). These ecological insights essentially drove forward the early development of Weed Science into the formidable scientific discipline it has become today. We should thank our founding ecologists for illuminating the pathway forward.

Summarising the famous 1964 symposium on ‘*Genetics of Colonizing Species*’ (Baker and Stebbins, 1965), Ernst Mayr, the renowned vertebrate zoologist from Harvard, said:

“Except for a few endemics, every species is a colonizer because it would not have the range it has if it had not spread, thereby range expansion, or ‘colonization’, from its place of origin”.

Based on ecological knowledge, we now recognise that colonising taxa thrive in habitats disturbed by human activities (such as cropping fields) or natural phenomena. In any habitat, they can be *pioneers* where there is no organic soil to begin with. They can establish themselves on barren land and rocky areas devoid of soil where other species will struggle. After establishment, they guide the changes that follow, including building substrates for others to live on. This is called *primary succession*.

The *pioneers* then take charge and drive changes in plant communities where well-developed soil exists and has been disturbed in some way. Such vegetation changes are referred to as *secondary succession*. Weedy taxa are, therefore, best described as *pioneers of secondary succession*.

Terms such as pioneers, disturbances, succession, and colonization are indeed the ecological keys to understanding why, when, and how weeds emerge and grow. Weedy plants are the first to grow in areas disturbed by humans or other animals (such as grazing livestock) or in areas affected by natural forces, including floods, bushfires, hurricanes, or similar events.

Weeds colonise and grow exceptionally well in garden beds, crop fields, cemeteries, golf courses, urban bushlands, and other areas that are continually modified by humans. As Alfred Crosby (1986) explained, weedy species are a kind of ‘*Ecological Red Cross’*: they are the first to rush into disturbed places, occupy those places, and initiate the transformative ecological processes, such as nutrient cycling and soil microbial interactions.

Taken individually by species or genera, weeds are top-notch survivors. They can thrive in harsh conditions that would be detrimental to other plants,

especially the slow-growing but long-lived perennials. Weeds are often present in the earliest stages of ecological succession. For example, in abandoned croplands, they grow in abundance because there is usually a large weed seed bank in the soil that is still rich in nutrients. In pristine forests also, if natural forces cause a perturbation that opens up an area, it would be the fast-growing 'weedy' taxa that would first occupy the forest floor before giving way to their co-existing colleagues.

All pioneering plants are, however, not 'weedy'. Consider the various liverworts (Bryophytes) and mosses (Pteridophytes) that inhabit damp places, forming mats on moist surfaces, such as on bricks or the gaps between backyard pavers. All liverworts, such as *Marchantia* L. species, and mosses, such as *Pogonatum* P. Beauv. Species, are typically innocuous, pioneering plants. Such *pioneers of primary succession* can also occasionally expand to nuisance levels that bother humans.

Weeds Are Good Teachers

It can be said that all species and the entire group we call 'weeds' are exclusively colonising pioneers, which can move into vacant and disturbed spaces unoccupied by others (in both space and time). From an ecological viewpoint, it would be correct to say they move into '*ecological niches*' (see below) unoccupied by other species at a particular time and space in a disturbed environment. *Weeds can certainly teach us how to be frugal, use available resources more effectively and adapt to survive*.

One must wonder why some people are so hard-wired to malign other successful organisms. *Is this an innate jealousy against others who are equally or more successfu*l? As humans face significant uncertainty in an unstable future climate, the survival strategies of weeds teach us great lessons. *Weeds live frugally*; they do not ask for much, which is a lesson in itself. Yes, they may take some of the Earth's resources for their growth; they may also make humans toil a bit, but they give back a lot more than we realise.

In a fast-changing world with limited resources and a rapidly growing human population, weeds teach us how to share resources effectively. This survival and behavioural attribute of weeds, and indeed, of many other highly successful organisms, is the opposite of the indulgent way most humans live, relentlessly pursuing material wealth and, in so doing, damaging our environment.

Populations of different weeds are also adept at differentiating the *ecological niche* available to them (Hutchinson, 1957). Conceptualised initially by George Hutchinson, the "*Hutchinsonian Niche*" is a "*n-dimensional hypervolume*". The dimensions are environmental conditions that define the requirements of an individual or a species to practice "*its way of life*" and for its population to persist. Such 'requirements' include sunlight, water, nutrients, space to live and trophic interactions.

In Nature, the different species occupying a shared space assume various but overlapping functional ecological roles. Each species plays its part without necessarily being hierarchical. By so doing, they reduce conflicts with their neighbours. '*Co-existing*' with neighbouring plants is a crucial lifestyle strategy for colonising taxa, especially in the early stages of colonization (Harper, 1977).

In the natural world, no one is in charge or has a singular power to dominate, least of all humans. Ecology has taught us that the balance and stability of Nature depend on inter-relationships and biological interactions between species as well as their physical (abiotic) environment. Often, humans forget these crucial facts of life on Earth.

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The effects that colonising taxa have on their neighbours are usually subtle rather than violent conflicts and total displacement (Harper, 1958; 1967; Sagar and Harper, 1961). Over time, they will dominate the vegetation community due to the faster growth of individuals and more significant biomass production, or, simply, sheer abundance in numbers.

As John Harper explained (1965), in plant populations, the capacity to germinate quickly and establish a seedling population rapidly were among the most critical factors in the Darwinian sense of 'survival of the fittest'. These characteristics allowed the successful spread of species and their resistance to native flora (Harper, 1967, 1983). As George Baker identified, the same traits are among the dominant attributes of the more 'weedier' species (Baker, 1965 – '*The Ideal Weed*'). In my view, all the learning that is to be had in Nature can be found in the plant world.

Nevertheless, there may be short periods of precarious existence for weedy individuals, as in any plant population. However, once initially established, the grip of habitat capture by colonising taxa in any environment will tighten as they become firmly

rooted. Once entrenched, they are almost impossible to remove entirely.

A '*co-existence'* strategy will also reveal that humans often fall short. Sharing resources for the common good or living within one's means are other aspects in which humans fail miserably. My view is that if we learn a few key lessons from colonising taxa, we can then apply those learnings to all other living beings. We may also achieve some peace with Nature rather than bludgeoning our natural ecosystems to the point of collapse.

Prejudice against Other Successful Species

Paradoxically, weeds present a dilemma for most people. As weeds invade our *'humanised spaces'*, the whole group is vilified as *evil* plants! Negative attitudes towards weeds are hard-wired in many European-born Australians. These feelings evolved in Britain and Europe during the 17th and 18th Centuries as part of agricultural enterprises.

The broad generalisations about the harmful effects of weeds and constant disparagement of particular species are unfair. Persistent negative messages about weeds are prevalent in the media, particularly in developed countries. Regrettably, judging by those discourses, it appears that most people do not care much about human history, geography, and other cultures. As a result, weeds cop a terrible name.

Living in Australia, one is constantly exposed to shallow discourses that vilify weedy species. In my view, the narrative of ostracising weeds has gone on for too long. It is misleading, as it hides the role humans play in creating the conditions that cause the spread of weeds and then perpetuating those perturbations and disturbances. The subtext of this story suits those who want to blame everything else but themselves.

It helps to conceal the human folly of destroying Australia's environment through the overexploitation of the continent's natural resources, large-scale deforestation and land clearing, unsustainable farming practices, excessive livestock farming, and relentless urban expansion. The lack of balanced attention given to weeds as potentially valuable resources is a blight on human intelligence.

Ironically, parts of Australian society also have a xenophobic attitude towards new immigrants. They seem to forget that most of them were also unwittingly 'colonizers' themselves. The new colonists then killed or displaced the Indigenous population [4] from much of the areas on the continent.

In Australia, an *inconvenient truth* is that the early Australian settlers were convicts who were, at one time, unwillingly transported to a distant continent and then forced to take possession of someone else's land. This was done under the pretence that no one lived on the continent ('*terra nullius'*) [5]. In 1788, London wanted the convicts to move '*as far away as possible*' from Britain.

Colonization in Australia led to land grabs, mass killing and the destruction of Indigenous people and their culture. Aboriginal Australians immediately lost their right to self-determination (the right to determine their social, cultural, and economic development) (Horton, 2000).

As a relic of colonialism, Australia's mistaken notion is that Indigenous Australians are static, lethargic, unchanging cultural, political, and spiritual people, less civilised than Europeans. Such an attitude, palpably prevalent even today, has done enormous damage to Australia's image as a nation.

When dealing with plants, the same feelings of dislike are readily extended towards weeds, which are denigrated as unwelcome intruders. *Why this nastiness*? Perhaps it is the hard-wired fear that *new immigrants, weeds, or newly arriving people might take up the available and limited resources, which the established colonists may lose*. Arguably, modern-day asylum-seekers fall into this category.

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The inability of most Anglo-European Australians to recognise *virtues in weeds* is partly due to deeply entrenched prejudices of a pioneering society. No doubt, in the late 18th century, from 1788

[4] The term 'indigenous' arose in the 17th Century from the Latin word: '*indigena*', meaning "*sprung from the land; native*" or '*existing naturally in a region or country'*. The United Nations took into account the modern European colonist era (15th to 20th Century), which displaced native people from their traditional lands and defined '*Indigenous*' as: "*peoples of long settlement and connection to specific lands, adversely affected by colonization and incursions by industrial economies, displacement and settlement of their traditional territories by others*".

[5] *Terra nullius*, in Latin, meaning "nobody's land", is a principle used in to justify claims that territory may be acquired by a state's occupation of it.

onwards to be precise, the new colonists had a pretty hard time as they battled to colonise the harsh Australian landscapes. In so doing, they also overran the original inhabitants of the continent who had prevailed on those unforgiving lands for more than 70,000 years (Horton, 2000).

The conquest of Australia is similar to those of other continents invaded by Europeans. Colonization is characterized by violence - war, death, murder, rape, and similar atrocities. As Donald Horne (1964) said, *'Colonization of continents never occurred through amicable settlements, although this truth is usually well hidden in official government narratives'*.

In Australia, the denial of the past atrocities was then combined with other distasteful policies to create the *Commonwealth of Australia* in 1901. It included preferential immigration for white people - the '*White Australia Policy*', or the *Immigration Restriction Act* (1901), which created a racially-insulated society in Australia.

The Act remained in effect until superseded by the *Racial Discrimination A*ct of 1975 (Horne, 1964). These are possibly why many Australians subconsciously dislike anything 'non-white', deemed 'foreign'. It is then extended to weeds and other highly successful organisms. Resentment towards newcomers is a prevalent negative attitude in Australia and most other wealthy countries.

The common factor is that these societies are still clinging to *Eurocentric values*. It is, therefore, not surprising to find intolerant and nasty attitudes in societies built around the forced colonization of already inhabited continents. The constant maligning of weeds reflects this intolerance.

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Most Australians also forget that many of the continent's problematic weeds were introduced by the colonists after 1788 during the colonization process [6]. Weeds are harshly blamed for despoiling everything, from home gardens to urban parks and bushlands. It is a flawed and mistaken attitude built on the mythology that humans can and do dominate every other species on Earth.

The same negative attitudes are extended to other introduced but highly successful organisms. Species, such as camels (*Camelus* L. spp.), cane toads (*Rhinella marina* L.), European rabbits (*Oryctolagus cuniculus* Lilljeborg), European foxes (*Vulpus vulpes* L.) and Indian mynah (*Acridotheres tristis* L.) did not come to Australia on their own. All of these highly successful animal species were accidentally introduced or deliberately imported for perceived benefits during the past 240 years of the continent's colonial history.

Such species are among the best survivors under highly adverse conditions, as encountered in Australia's harsh outback. Their adverse effects on ecosystems are often overstated. A good example is the aforementioned Indian myna. It is disliked for displacing Australian native birds, including the Indigenous 'noisy miner' (*Manoria melanocephala* Latham), from tree hollows. Research, however, has shown that the overall impact of the noisy indigenous miner on natural ecosystems is far more profound than that of the Indian myna [7].

However, such stories are not sensational enough to receive publicity in an era of intense intolerance compounded by a 24-hour news cycle. While the Indian mynah can be an irritating and noisy inhabitant, it is not as problematic as it is made out to be. The species thrives on scavenging food in our backyards, shopping complexes and other humanised spaces. It is hardly found elsewhere.

The noisy miner, on the other hand, is regarded as a dangerous pest in public spaces due to its aggressive behaviour, especially during the breeding season. This species is also an urban dweller, occupying a range of habitats that extend out towards the per-urban fringes of cities and townships. In my view, there is room in the natural world for both species to play their roles and co-exist successfully. *Neither is any more villainous than we humans are*.

The media thrives on sensationalising issues to attract audiences. However, the media alone cannot be blamed because they reflect our society. Driving a balanced discourse on contentious matters of

[6] The manifest of Captain Arthur Phillips' First Fleet (1788) shows that plants and seeds of cocoa, cotton, coffee, guava, oranges, and tamarind were brought, along with prickly pear (*Opuntia* spp.) (**http://home.vicnet.net.au/~firstff/story.htm**).

[7] Under Section 183 of Australia's *Environment Protection & Biodiversity Conservation Act* (EPBC Act), 'Aggressive exclusion of birds from potential woodland and forest habitat by over-abundant noisy miners (*Manoria melanocephala*)' is a *Key Threatening Process*.

social and scientific interest (such as climate change) is a collective responsibility of all of us.

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In sharp contrast to Australia, plant resources are highly revered in many parts of the world. Many species are deemed sacred and revered. In Southeast Asian countries like Japan, South Korea, and China, there is a respectful attitude towards all plants in general, with some mild intolerance of weeds. A pragmatic view is prevalent in Africa, as well as in most parts of Central and South America and the Mediterranean region, recognising that even weeds have utility values (mainly in the form of medicines and food), serving the needs of societies (Chandrasena and Rao, 2017).

A respectful attitude towards plants is prevalent in the Indian subcontinent (comprising India, Nepal, Bhutan, Tibet, Pakistan, Bangladesh, and Sri Lanka), rooted in religious beliefs that have evolved over millennia. Hinduism, Buddhism, and Islam, in that order, influenced the sub-continent. Through Buddhism, reverence for all plants exists in Thailand, Myanmar, Vietnam, Laos, and Cambodia.

People of ancient cultures, including those in China, Korea, and Japan, instinctively knew that all plants are critical elements in Nature. Other, more trade-based cultures in the Asian-Pacific region (Thailand, Malaysia, Indonesia and the Philippines) also value plant resources as they are consumptive and tradeable. The ancient indigenous societies (Papua New Guinea) and the Pacific Islands also value all plants primarily because of their practical and marketable values.

Not denigrating any plant is a cultural attitude and has nothing to do with the wealth of individual farmers or landowners. Pre-industrial societies certainly valued plants and animals for practical purposes. Such attitudes are prevalent across all societies and cultures on every continent (Chandrasena and Rao, 2017).

In my view, one must consider different cultures to gain a thorough understanding of human ecology, human history, and how people interact with weeds. Over many decades, as a weed scientist, ecologist and an educator, I have observed that many weed researchers lack a solid foundation in botany, plant physiology, ecology, evolution, and plant taxonomy. Such subjects are never taught adequately in the agricultural degrees of most countries. I would also add biogeography and human history to this list.

There is far too much emphasis in agriculture degrees on the ‘*agri-cultural’* aspects of cropping, i.e., agronomy, soil, pests and diseases, etc. Many agriculture colleagues lament not being exposed to more profound learnings of botany and ecology.

As a result, most *Weed Science* courses in agricultural faculties fail to provide the foundational ecological basis for understanding weeds, their strengths and weaknesses, as well as their beneficial and utilitarian values and roles in Nature. To reiterate, although humans accuse weeds of being evil vagabonds, in Nature, there are no weeds.

Virtuous Weeds

As the title of this article says, *I long for a weed* because of the multifaceted beneficial roles these colonising species play in Nature. In doing so, they offer a vast array of benefits to society (see Chandrasena, 2023, 2024).

I am not alone in promoting such views, which date back to the latter half of the 19th century. For example, Ralph Waldo Emerson, one of the most prominent orators of that period, had an enlightened view of weeds. His words, spoken in a famous speech, ‘*Fortune of the Republic*’, in December 1863, were: “*What is a weed? A weed is a plant whose virtues have not yet been discovered*. These words are often quoted in *Weed Science* books.

As a humanist, Emerson was keen to highlight to his audience and followers that *Weeds have admirable virtues, and one would see them if one looked hard*. Undoubtedly, his comments would have raised the eyebrows of the more agriculture-focused farmers. Yet, naturalists and conservationists across the Americas would have welcomed Emerson’s rational views.

However, one also needs both *humility* and a positive attitude to recognise virtues in others. These are qualities that Emerson had in abundance. For a long time, such thoughts have inspired me to look at weeds *with new eyes*. However, I fully understand that *through the eyes of long-suffering farmers, weeds may appear as nothing but trouble!*

Humans and weeds are highly successful exploiters of opportunities, using different tactics to colonise habitats and spread across the globe. Both humans and weeds can thrive in association with disturbances to natural habitats. More often than not, humans cause those large-scale disturbances to which weeds respond. They trek the world with men.

Weeds are, therefore, '*shadows of men'*, just like flies, mice, mosquitoes and cockroaches. Weeds, as well as some of these pest species, follow in the footsteps of humans, leaving behind an imprint. *The history of weeds, spanning past millennia, is an integral part of human history.* Weeds certainly spotlight man's relentless, adverse impacts on Nature. Not only did they 'evolve' with man, but by stealing resources, they earned our wrath.

Many people malign weeds, but this dislike is not universal. Ancient cultures universally accepted weeds as part of Nature and valued them for the benefits they provided (Chandrasena, 2023; Chandrasena and Rao, 2017). These sharply divergent attitudes towards weeds are part of the paradox we have. Conceived in arrogance, some people believe that humans are 'masters of the universe' when, in fact, we are not. *People need to understand that Nature does not exist for the convenience of man*.

Apart from Lowell and Pfieffer's appreciation of weeds, others have shared a similar sentiment. A memoir written in 1950 by Joseph Cocannouer is laudable. Introducing Cocannouer's book - *Weeds – Guardians of the Soil*, the publisher said:

> *"This is perhaps the first book to be written in praise of weeds. While Professor Cocannouer does not believe that weeds should be allowed to go rampant and take over our farms and gardens, the book demonstrates how the controlled use of weeds can be sound ecology, good conservation and a boon to farmers".*

According to Cocannouer (1950), weeds perform valuable services: (1) When used in crop rotation, they produce roots to feed deeply; (2) They fertilize and improve the condition of soil, making soil productive; (3) They are also indicators of soil condition; (4) Weeds are deep divers and feeders; they enable crops to withstand drought better; (5) As companion crops, they enable crops to get unavailable food; (6) Weeds store up minerals and nutrients and keep them readily available; and (7) Weeds also make good eating. Indeed, they do.

Just like me, Cocannouer (1950) resented deriding weeds as homeless '*vagabonds*'. In fact, quite the opposite is true. At a time when agriculture in the USA was in trouble due to soil degradation, overuse of pesticides, groundwater contamination, pollution and other unsustainable, ecological perturbations, he saw the positive roles weeds play in such battered landscapes.

For him, weeds were simple but often functional, practical and friendly immigrants to areas where space and opportunities existed for occupation. These were significant ideas at a time (1950s) when ecological and biological studies on weeds were beginning to take place in Britain and the USA (see Harper, 1967; Baker and Stebbins, 1965).

* * *

Two notable quotes that I have come across, both from Britain, suggest that, for some people, weeds are virtuous. Audrey Wynne Hatfield's (1969) and Joy Griffith-Jones's (1978) views on the virtues of weeds resonate with me:

> *"We have corrupted the word 'weeds' and its meaning; it was wèods, the Anglo-Saxon name for all herbs or small plants; some they call wyrt, our wort. To past generations of men, all plants were regarded with respect, some with affection, and some feared. Many of them were either food or medicine, or they possessed religious or magical influences".*
>
> *"Plants we scorn today as weeds were ready with their health-giving qualities to serve man and beast long before grasses had fat ears, root crops had thick tubers or fruit trees produced large and juicy fruits…We should never belittle the constant value of such herbs".* (Hatfield, 1969).
>
> *"Generations of tidy gardeners have conditioned us to tear them up, banish them forever from our clean gardens. But these humble citizens of the soil have many virtues. In the garden, they can signal a need and then deal with it".*
>
> *"Daisies…not only indicate a lack of lime but, through death and decay, provide the remedy. Wild garlic drives moles from the ground. Lady's Smock attracts the Orange Tip butterfly. In the kitchen, nettles can be cooked like spinach, while coltsfoot brews a good wine. Chicory, chickweed, and red clover can also be used to grace a salad. In the sickroom, cleavers can treat skin cancer, cinquefoil makes an efficacious gargle, and a decoction of lesser celandine does wonders with piles".*
>
> *"Henbane is a must for witches, whom red clover will detect and cinquefoil keep at bay, while buttercup chains were used to garland the cows and bless the milk; virgins used powder from this plant for bridal beds…"* (Griffith-Jones, 1978).

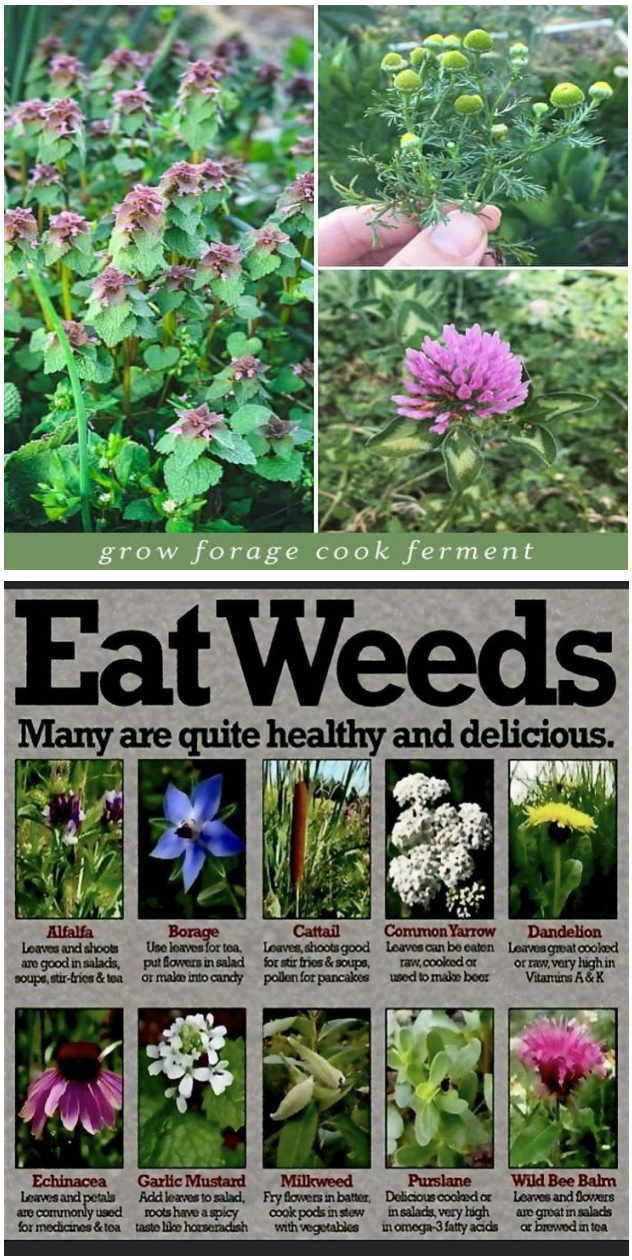

Figure 1. As Joy Griffith-Williams and Audrey Wynn Hatfield suggested, many weeds in our backyards are now promoted for use as edible weeds or medicinal weeds (Chandrasena, 2024)

Another popular American website promoting edible weeds is *Mother Earth Living*, which highlights the palatability of many weeds, including dandelion, nettle, purslane, and chickweed, among others, with advice on preparing these species as food.

Much like the Permaculture Movement, *Mother Earth Living* promotes the principles of sustainable living, in resonance with Nature, fostering an attitude of tolerating and utilizing edible and medicinal weeds where possible [8].

It is also important to remember that the ready availability of weeds as nutritious food makes them ‘*the ultimate convenience food*’. As Grub and Raser-Rowland (2012) noted, *gathering requires only a walk in the park before dinner*. Their popular Australian book highlights the virtues of weeds as both food and medicine: “*Weeds ask of you no money, no search for a parking space at the supermarket, no planting, no watering or any other maintenance whatsoever*”. Can anyone argue against these enlightened comments?

* * *

Introducing Griffith-Jones’ book (1978), Ernst Schumacher (1911-1977), the economist famous for “*Small Is Beautiful*” (1975), emphasised that *the more we learn about Nature, the more we must doubt our theories* [9]. Schumacher said,

> *“While evolution by natural selection allows the fittest to survive, it obscures the marvels of Nature, which is an artistic wonder, infinitely playful, subtle and inventive, whose wisdom we should be humbly eager to understand”.*

Praising weeds, Schumacher wrote:

> *“Is there no virtue in weeds? Are they really unmanageable? Thoughtful, gentle, loving management instead of ‘killing the enemy’ (weeds), and study, as our ancestors have done, with science and sensitivity, and learning from Nature…We can start where we may expect the least, but can find enough for a lifetime, in our own backyard, with The Virtuous Weed”* (Griffith-Jones, 1978).

The Virtuous Weed is powerful terminology in conveying the message I want to give. *Weeds are indeed virtuous*. Revisiting the topic allows me to

[8] *Mother Earth Living* (https://www.motherearthnews.com/natural-health/herbal-remedies-zmaz10onzraw/).

[9] Wes Jackson (1981), delivering the *Schumacher Memorial Lecture* said: “It is significant that Schumacher, economist that he was, was very much interested in ecology. He was president of the Soil Society of England. He was a strong advocate of planting and caring for trees, which he saw as more than bearers of fruit, for he thought of them as symbols of what he called “permanence,” for him a synonym for sustainability. He was a man who grew a garden, which by definition consists of patches. A man whose primary message was *transcendence* of the economic world saw perennial trees as *redeemers* of the landscape”.

share my own experiences with weeds and make an effort to reevaluate their place in our lives.

My plea is also for weed scientists, agriculturists and conservationists not to despise the humble weed. '*Living with weeds'* fits the narrative of '*living in harmony with Nature*'. The Earth does not belong to us; we belong to the Earth, sharing the Planet's environment with trillions of other organisms.

In rethinking this conundrum of how to deal with weeds, we should not deny that some of these taxa are recalcitrant to control efforts, will fight back and pose challenges to human endeavours, including how to produce enough food. Nevertheless, the prevailing narrative of blaming weeds for our inability to improve agricultural production or better manage our environment is essentially flawed.

A vast repository of knowledge about the harmful effects of weeds and how to manage them exists within the field of *Weed Scienc*e. Those tools must be deployed intelligently in situations where and when the colonising taxa have to be appropriately managed. Nevertheless, the much-neglected dimension in weed discourses is the virtuous side of weeds, although the topic has not been entirely forgotten.

In the new millennium, as the discipline looked to the future, the Weed Science Society of America (WSSA) agreed that weeds can be used beneficially. The review cautiously highlighted two areas – that weedy taxa are likely to be future sources of pharmaceuticals and that there are possibilities of using some species for phyto-remediation of degraded landscapes (Hall et al., 2000).

Interestingly, and quite regrettably, the WSSA review was hesitant to venture into other, more contentious areas, such as the promising biofuel options provided by many colonising taxa. Also noteworthy was the lack of promotion of edible weeds and their wild relatives, which, in my view, are crucial for meeting the nutritional needs of societies and cultures worldwide. Already in the USA, a wealth of information is available on edible weeds (Duke, 1992), and these ideas have been well promoted among suburban populations (see XXXX).

As the review was USA-focused, it paid no attention to recognising that weedy taxa provide critical raw materials for the broadest spectrum of rural employment in many developing countries.

More than two decades after the WSSA review, the reluctance to bring the beneficial uses and potential utilisation of colonising taxa to a more central position has continued. This is because, from the outset, the discipline's anchoring pillars have been the development and dissemination of knowledge on how to manage weeds. The viewpoint that *weeds perform an ecologically beneficial role or have multiple uses for society* runs counter to this.

There is palpable resistance to change. However, this trend is not limited to developed countries; it also continues in India, Malaysia, Sri Lanka, Pakistan, and other similar countries.

As Zimdahl (2012) has often expressed,

> *"Ecological considerations have never been a central theme within Weed Science, dominated by research and solutions based on herbicides".*
>
> *"Weed scientists are also not historians, nor are most scientists". However, "it will be helpful if we study our history, not assume it, and evaluate it as a guide to the future".*

This *Weeds* Journal, from its inception in 2019, has endeavoured to highlight the virtues of these constant companions of ours. On a personal level, I urge people to consider that the next time you dig weeds out of your lawn or garden beds, it may be a needless action. Unless you are careful, that disturbance will attract more weeds. As I have argued (Chandrasena, 2023), one will also need to consider ways to suppress those weeds in the long term, utilising the many well-developed tools and techniques available.

I urge weed researchers to appreciate that the conflicts weedy species have with humans begin when the taxa start *behaving as they should*. The conflict escalates when their verdant growth interferes with the economic, social, and environmental interests of humans (in that order). Paradoxically, as explored in this book, the same impressive attributes also make these taxa invaluable as bio-resources.

My final words in this plea resonate with those of the Nature-lover, as Joy Griffith-Jones: "*Useful, practical, full of goodness- do not despise the humble weed*". However, to recognise virtues in others, such as weedy taxa, I am well aware that one needs both *humility* and a *positive attitude*.

As Emerson expounded, *Weeds have admirable virtues, and one would see them if one looked hard*. Therefore, I make no excuses for *Longing for A Weed*, especially to see weeds in our

human-impacted environments with a burgeoning and hungry population, crying out to save the Planet.

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