TPO 5 – 1 Minerals and Plants
矿物质和植物

Research has shown that certain minerals are required by plants for normal growth and development. The soil is the source of these minerals, which are absorbed by the plant with the water from the soil. Even nitrogen, which is a gas in its elemental state, is normally absorbed from the soil as nitrate ions. Some soils are notoriously deficient in micro nutrients and are therefore unable to support most plant life. So-called serpentine soils, for example, are deficient in calcium, and only plants able to tolerate low levels of this mineral can survive. In modern agriculture, mineral depletion of soils is a major concern, since harvesting crops interrupts the recycling of nutrients back to the soil.

研究表明，某些矿物质是植物正常生长发育所必需的。土壤是这些矿物质的来源，它们通过水分被植物从土壤中吸收。即使是元素状态为气体的氮，也通常作为硝酸根离子从土壤中被吸收。众所周知，一些土壤缺乏微量营养素，因此大多数植物不能生长。例如所谓的蛇纹岩土壤，由于缺乏钙，只有那些能忍受如此低含量的钙的植物才能够存活。在现代农业，土壤矿物质枯竭是一个大问题，因为收割庄稼切断了养分返回土壤的循环。

Mineral deficiencies can often be detected by specific symptoms such as chlorosis (loss of chlorophyll resulting in yellow or white leaf tissue), necrosis (isolated dead patches), anthocyanin formation (development of deep red pigmentation of leaves or stem), stunted growth, and development of woody tissue in an herbaceous plant. Soils are most commonly deficient in nitrogen and phosphorus. Nitrogen-deficient plants exhibit many of the symptoms just described. Leaves develop chlorosis; stems are short and slender, and anthocyanin discoloration occurs on stems, petioles, and lower leaf surfaces. Phosphorus-deficient plants are often stunted, with leaves turning a characteristic dark green, often with the accumulation of anthocyanin. Typically, older leaves are affected first as the phosphorus is mobilized to young growing tissue. Iron deficiency is characterized by chlorosis between veins in young leaves.

矿物质缺乏通常可由特定的症状检测出来，如褪绿（叶绿素损失导致黄叶或白叶的现象）、坏疽（孤立的坏死斑）、花青素的形成（形成深红色叶片和茎色素沉积）、发育不良以及草本植物长木质组织。土壤最常缺乏的是氮和磷。氮缺乏植物表现出了刚才描述的许多症状：叶片黄化、茎短而细以及发生在茎、叶柄以及下叶表面的花青素变色。磷缺乏的植物往往发育不良，叶片变成特殊的深绿色，经常伴随着花青素的积累。由于磷流向新生的组织，通常较老的叶片首先受到影响。铁缺乏症的特点是嫩叶的叶脉之间萎黄。

Much of the research on nutrient deficiencies is based on growing plants hydroponically, that is, in soilless liquid nutrient solutions. This technique allows researchers to create solutions that selectively omit certain nutrients and then observe the resulting effects on the plants. Hydroponics has applications beyond basic research, since it facilitates the growing of greenhouse vegetables during winter. Aeroponics, a technique in which plants are suspended

and the roots misted with a nutrient solution, is another method for growing plants without soil.

大多数关于营养素缺乏症的研究都基于水培法，即在无土营养液中培养。这项技术允许研究人员创造缺乏某种营养素的溶液，然后观察对植物生长造成的影响。水培法的应用已经超越了基础研究，因为它促进了温室蔬菜在冬季的生长。空气培养法，一种把植物悬挂起来，将其根部喷上营养液的技术，是另外一种无土栽培的方法。

While mineral deficiencies can limit the growth of plants, an overabundance of certain minerals can be toxic and can also limit growth. Saline soils, which have high concentrations of sodium chloride and other salts, limit plant growth, and research continues to focus on developing salt-tolerant varieties of agricultural crops. Research has focused on the toxic effects of heavy metals such as lead, cadmium, mercury, and aluminum; however, even copper and zinc, which are essential elements, can become toxic in high concentrations. Although most plants cannot survive in these soils, certain plants have the ability to tolerate high levels of these minerals.

虽然缺乏矿物质会抑制植物生长，但某些矿物质过量可能会有毒，同样也会抑制植物生长。含有高浓度的氯化钠和其他盐类的盐碱土壤抑制植物生长，于是研究继续集中开发耐盐农作物品种。着重研究重金属的毒性作用，如铅、镉、汞、铝；然而即使是铜和锌这样的必需元素，如果浓度过高也会产生毒性。虽然大多数植物无法在这种土壤生存，某些植物却能够忍耐如此高含量的矿物质。

Scientists have known for some time that certain plants, called hyperaccumulators, can concentrate minerals at levels a hundredfold or greater than normal. A survey of known hyperaccumulators identified that 75 percent of them amassed nickel; cobalt, copper, zinc, manganese, lead, and cadmium are other minerals of choice. Hyperaccumulators run the entire range of the plant world. They may be herbs, shrubs, or trees. Many members of the mustard family, spurge family, legume family, and grass family are top hyperaccumulators. Many are found in tropical and subtropical areas of the world, where accumulation of high concentrations of metals may afford some protection against plant-eating insects and microbial pathogens.

科学家早前就了解到，某些所谓的富集植物能够比普通植物多集中 100 倍甚至更多的矿物质。一项对已知富集植物的调查表明，它们中 75%积聚了镍，而钴、铜、锌、锰、铅和镉则是其他选择性聚集的矿物质。富集植物存在于整个世界范围，它们可能是草本植物、灌木或树。芥属、大戟属、豆科和禾本科植物中的许多成员都是靠前的富集植物。许多富集植物被发现于热带和亚热带，金属可以为植物提供保护，对抗植食昆虫和细菌病原体。

Only recently have investigators considered using these plants to clean up soil and waste sites that have been contaminated by toxic levels of heavy metals–an environmentally friendly approach known as phytoremediation. This scenario begins with the planting of

hyperaccumulating species in the target area, such as an abandoned mine or an irrigation pond contaminated by runoff. Toxic minerals would first be absorbed by roots but later relocated to the stem and leaves. A harvest of the shoots would remove the toxic compounds off site to be burned or composted to recover the metal for industrial uses. After several years of cultivation and harvest, the site would be restored at a cost much lower than the price of excavation and reburial, the standard practice for remediation of contaminated soils. For examples, in field trials, the plant alpine pennycress removed zinc and cadmium from soils near a zinc smelter, and Indian mustard, native to Pakistan and India, has been effective in reducing levels of selenium salts by 50 percent in contaminated soils.

直到最近研究者才考虑用这些植物来清理已经被有毒重金属污染的土壤和废弃物处理点——一种被称为植物修复法的修复方法。这套方案首先从在目标区域种植超积累物种开始，如在废弃矿井和被径流污染的灌溉池塘。有毒矿物质首先被根吸收，随后被运送至茎和叶。收割下来的枝叶将被焚烧以移除有毒化合物或被制成混合肥料回收金属用于工业。经过几年的种植和收割，该污染点将被修复，而其造价远比修复污染土壤的标准做法——挖掘和填埋来得低。举例来说，在实地试验中，高山葶苈从靠近一个锌冶炼厂的土壤中去除了锌和镉，原产自巴基斯坦和印度的印度芥菜可以将染土壤中硒的水平有效地降低了 50%。

TPO 5 – 2 The Origin of the Pacific Island People
太平洋群岛居民的起源

The greater Pacific region, traditionally called Oceania, consists of three cultural areas: Melanesia, Micronesia, and Polynesia. Melanesia, in the southwest Pacific, contains the large islands of New Guinea, the Solomons, Vanuatu, and New Caledonia. Micronesia, the area north of Melanesia, consists primarily of small scattered islands. Polynesia is the central Pacific area in the great triangle defined by Hawaii, Easter Island, and New Zealand. Before the arrival of Europeans, the islands in the two largest cultural areas, Polynesia and Micronesia, together contained a population estimated at 700,000.

广义的太平洋地区，传统上被称作大洋洲，由三块文化区域组成：美拉尼西亚，密克罗尼西亚和波利尼西亚。美拉尼西亚在西南太平洋，包含了新几内亚岛、所罗门、瓦努阿图和新喀里多尼亚的广大岛屿。密克罗尼西亚在美拉尼西亚的北边，主要由一些分散的岛屿组成。波利尼西亚是太平洋中心地区，位于由夏威夷、复活节群岛和新西兰的三大岛屿组成的三角区域中。在欧洲人到来之前，最大的波利尼西亚和密克罗尼西亚岛屿群一共有差不多 70 万人口。

Speculation on the origin of these Pacific islanders began as soon as outsiders encountered them, in the absence of solid linguistic, archaeological, and biological data, many fanciful and mutually exclusive theories were devised. Pacific islanders are variously thought to have come from North America, South America, Egypt, Israel, and India, as well as Southeast Asia. Many older theories implicitly deprecated the navigational abilities and overall cultural creativity of the Pacific islanders. For example, British anthropologists G.Elliot Smith and W.J.Perry assumed that only Egyptians would have been skilled enough to navigate and colonize the Pacific. They inferred that the Egyptians even crossed the Pacific to found the great civilizations of the New World (North and South America). In 1947 Norwegian adventurer Thor Heyerdahl drifted on a balsa-log raft westward with the winds and currents across the Pacific from South America to prove his theory that Pacific islanders were Native Americans (also called American Indians). Later Heyerdahl suggested that the Pacific was peopled by three migrations: by Native Americans from the Pacific Northwest of North America drifting to Hawaii, by Peruvians drifting to Easter Island, and by Melanesians. In 1969 he crossed the Atlantic in an Egyptian-style reed boat to prove Egyptian influences in the Americas. Contrary to these theorists, the overwhelming evidence of physical anthropology, linguistics, and archaeology shows that the Pacific islanders came from Southeast Asia and were skilled enough as navigators to sail against the prevailing winds and currents.

对于太平洋群岛居民起源的思索开始于外来者和岛民们接触的最初，由于缺乏可靠的语言学、考古学和生物学资料，出现了很多奇异并且互斥的理论。之前太平洋岛民曾被认为来自北美洲、南美洲、埃及、以色列、印度以及东南亚。许多古老的理论含蓄地贬低了太平洋群岛居民的航海能力和综合文化创造力。比如说，英国人类学家 G. Elliot Smith 和 W. J. Perry 认为只有埃及人才能熟练地航海和统治太平洋。他们推断埃及人甚至曾经穿越过太平洋去寻找新世界的文

明（北美洲和南美洲）。1947 年，挪威探险家 Thor Heyerdahl 为了证明他的太平洋群岛居民是美国本土居民（也被称作美国印第安人）的理论，用一只带有标志的轻质木筏，借助风力和水流从南美洲漂流过了太平洋。后来 Heyerdahl 表明太平洋人来自三个移民群体：从北美洲西北部太平洋地区漂流到夏威夷的美国本土居民，从秘鲁去往复活节岛的漂流者，还有美拉尼西亚人。1969 年，他驾驶一条埃及样式的芦苇船穿过大西洋，证明埃及人在美洲的影响。与这些理论相矛盾的是，有关物理人类学、语言学和考古学的权威证据表明，太平洋岛居民来自东南亚，并且他们有足够的能力来逆着风和洋流航行。

The basic cultural requirements for the successful colonization of the Pacific islands include the appropriate boat-building, sailing, and navigation skills to get to the islands in the first place, domesticated plants and gardening skills suited to often marginal conditions, and a varied inventory of fishing implements and techniques. It is now generally believed that these prerequisites originated with peoples speaking Austronesian languages (a group of several hundred related languages) and began to emerge in Southeast Asia by about 5000 B.C.E. The culture of that time, based on archaeology and linguistic reconstruction, is assumed to have had a broad inventory of cultivated plants including taro, yarns, banana, sugarcane, breadfruit, coconut, sago, and rice. Just as important, the culture also possessed the basic foundation for an effective maritime adaptation, including outrigger canoes and a variety of fishing techniques that could be effective for overseas voyaging.

成功地将太平洋群岛殖民地化需要的基础文化条件包括：适当的造船、航行和航海技术以首先到达岛屿；适应贫瘠条件的驯化植物和园艺技术；各种各样的捕鱼器具和技术。现在普遍认为这些先决条件是那些说南岛语（一个有几百种亲属语种的语系）的人所带来的，他们公元前 5000 年前就出现在东南亚。通过考古学和语言学的重建发现，那个时候的文明拥有广泛的植物储存，包括芋头、纱、香蕉、甘蔗、面包果、椰子、西米和稻米。同样重要的是，当时的社会也具备适应海洋的基础，包括桅杆船和各种各样有利于越洋航行的捕鱼技术。

Contrary to the arguments of some that much of the pacific was settled by Polynesians accidentally marooned after being lost and adrift, it seems reasonable that this feat was accomplished by deliberate colonization expeditions that set out fully stocked with food and domesticated plants and animals. Detailed studies of the winds and currents using computer simulations suggest that drifting canoes would have been a most unlikely means of colonizing the Pacific. These expeditions were likely driven by population growth and political dynamics on the home islands, as well as the challenge and excitement of exploring unknown waters.

与那个太平洋人很多都是波利尼西亚人偶然迷失并漂流而定居下来的说法相反的是，这些功绩是通过有意的殖民远征来实现的，他们那些准备周详，出发时满载食物、已培育好的植物和以驯化的动物。通过电脑模拟对风向和洋流进行的详细研究表明，船只漂流是最不可能的殖民太平洋的途径。远征可能是由本土的人口增长、政治动荡以及探索未知水域的挑战和兴奋所驱动的。

Because all Polynesians, Micronesians, and many Melanesians speak Austronesian

languages and grow crops derived from Southeast Asia, all these peoples most certainly derived from that region and not the New World or elsewhere. The undisputed pre-Columbian presence in Oceania of the sweet potato, which is a New World domesticate, has sometimes been used to support Heyerdahl's "American Indians in the Pacific" theories. However, this is one plant out of a long list of Southeast Asian domesticates. As Patrick Kirch, an American anthropologist, points out, rather than being brought by rafting South Americans, sweet potatoes might just have easily been brought back by returning Polynesian navigators who could have reached the west coast of South America.

因为所有的波利尼西亚人、密克罗尼西亚人和很多美拉尼西亚人说南岛语，种植的庄稼起源于东南亚，所以所有的这些人最有可能来自那个地方，而不是新世界或者其他地方。甘薯，一种新世界的品种，在哥伦比亚发现美洲大陆前它就在大洋洲的出现，这是无可置疑的，这有时候被用来证明 Heyerdahl 的太平洋岛民是美国印第安人的理论。然而，这是一种在东南亚培育的植物的长名单之外的植物。正如美国人类学家 Patrick Kirch 所指出的，比起从南美漂流过来，甘薯更容易被那些到过南美的玻利尼西亚返航者携带来。

TPO 5 – 3 The Cambrian Explosion
寒武纪大爆发

The geologic timescale is marked by significant geologic and biological events, including the origin of Earth about 4.6 billion years ago, the origin of life about 3.5billion years ago, the origin of eukaryotic life-forms (living things that have cells with true nuclei) about 1.5billion years ago, and the origin of animals about 0.6 billion years ago. The last event marks the beginning of the Cambrian period. Animals originated relatively late in the history of Earth-in only the last 10 percent of Earth's history. During a geologically brief 100-million-year period, all modern animal groups (along with other animals that are now extinct) evolved. This rapid origin and diversification of animals is often referred to as "the Cambrian explosion."

地质年代是由重大地质事件和生物事件标记的，包括 46 亿年前地球的形成、35 亿年前生命的起源、15 亿年前真核生物（细胞中有真核的生命体）的起源以及 6 亿年前动物的起源；最近的一个事件标志着寒武纪的开始。动物的起源相对处于地球历史的晚期——仅存在于地球历史时间的 1／10。在短暂的 1 亿年地质学周期中，所有现代动物群（包括现在已经灭绝的生物）进化了。这次快速的动物起源和分化常常被称为“寒武纪大爆发”。

Scientists have asked important questions about this explosion for more than a century. Why did it occur so late in the history of Earth? The origin of multicellular forms of life seems a relatively simple step compared to the origin of life itself. Why does the fossil record not document the series of evolutionary changes during the evolution of animals? Why did animal life evolve so quickly? Paleontologists continue to search the fossil record for answers to these questions.

一个多世纪以来，科学家们对这次大爆发一直有疑惑。为什么它发生的得这么晚？多细胞生物的出现相对于生命的出现而言则是一次相对简单的进化。为什么化石没有记录下动物演化的一系列变化呢？为什么动物生命进化得如此迅速呢？古生物学家们仍旧在研究化石记录以期回答这些问题。

One interpretation regarding the absence of fossils during this important 100-million-year period is that early animals were soft bodied and simply did not fossilize. Fossilization of soft-bodied animals is less likely than fossilization of hard-bodied animals, but it does occur. Conditions that promote fossilization of soft-bodied animals include very rapid covering by sediments that create an environment that discourages decomposition. In fact, fossil beds containing soft-bodied animals have been known for many years.

关于这重要的 1 亿年内化石的缺失，有一种解释是早期的动物都是软体动物，它们很难形成化石。软体动物的化石比硬体动物化石少见得多，但是也是存在的。促使软体动物成为化石的条件是沉积物的迅速覆盖以形成一个抑制分解的环境。事实上，含有软体动物的化石层在很多年以前就已经为人们所知了。

The Ediacara fossil formation, which contains the oldest known animal fossils, consists exclusively of soft-bodied forms. Although named after a site in Australia, the Ediacara formation is worldwide in distribution and dates to Precambrian times. This 700-million-year-old formation gives few clues to the origins of modern animals, however, because paleontologists believe it represents an evolutionary experiment that failed. It contains no ancestors of modern animal groups.

含有最古老的动物化石的伊迪卡拉化石群就全部由软体动物化石组成。尽管伊迪卡拉是以澳大利亚的一处地名而命名，但是伊迪卡拉沉积层的分布却遍及世界各地，并且可以追溯到前寒武纪时期。这些 7 亿年前形成的地层为现代动物的起源提供了一些新的线索。因为古生物学家们认为它代表着一次失败的进化试验，其中并没有包含任何现代动物的祖先。

A slightly younger fossil formation containing animal remains is the Tommotian formation, named after a locale in Russia. It dates to the very early Cambrian period, and it also contains only soft-bodied forms. At one time, the animals present in these fossil beds were assigned to various modern animal groups, but most paleontologists now agree that all Tommotian fossils represent unique body forms that arose in the early Cambrian period and disappeared before the end of the period, leaving no descendants in modern animal groups.

以俄罗斯的一处地名而命名的 Tommotian 是一层包含动物残骸的较年轻的化石层。它形成于寒武纪的早期，并且同样只含有软体动物化石。在一段时间内，人们认为这些化石中的动物分化出了各种各样的现代动物。但是古生物学家们现在却认为，所有的 Tommotian 化石都仅代表在寒武纪初期出现但到寒武纪结束时就消失了的特别生物，所以它们没有在现在动物中留下后代。

A third fossil formation containing both soft-bodied and hard-bodied animals provides evidence of the result of the Cambrian explosion. This fossil formation, called the Burgess Shale, is in Yoho National Park in the Canadian Rocky Mountains of British Columbia. Shortly after the Cambrian explosion, mud slides rapidly buried thousands of marine animals under conditions that favored fossilization. These fossil beds provide evidence of about 32 modern animal groups, plus about 20 other animal body forms that are so different from any modern animals that they cannot be assigned to any one of the modern groups. These unassignable animals include a large swimming predator called Anomalocaris and a soft-bodied animal called Wiwaxia, which ate detritus or algae. The Burgess Shale formation also has fossils of many extinct representatives of modern animal groups. **For example, a well-known Burgess Shale animal called Sidneyia is a representative of a previously unknown group of arthropods (a category of animals that includes insects, spiders, mites, and crabs).**

第三种化石层既包含了软体动物也包含了硬体动物，它为寒武纪大爆发提供了证据。这种叫做伯吉斯页岩的化石群就在加拿大的大不列颠哥伦比亚石山上的约霍国家公园内。在寒武纪大爆发后不久，滑落的泥土迅速掩埋了成千上万的海洋动物，形成了极有利于化石形成的环境。这

些化石层含有大约 32 种现代动物，还有大约 20 种与现在动物截然不同以至于不可能分类为任何一种现代动物的其他动物体。这些无法划分的动物包含一种叫做奇虾的肉食动物和一种叫做威瓦亚虫的以岩屑和藻类为食的软体动物。伯吉斯页岩化石群也含有很多现在已经灭绝了的动物化石。**例如伯吉斯页岩化石群中的一种著名动物，Sidneyia，就是一种典型的以前还不为人知的节肢动物（一种动物分类，它包括昆虫、蜘蛛、螨虫和螃蟹）。**

Fossil formations like the Burgess Shale show that evolution cannot always be thought of as a slow progression. The Cambrian explosion involved rapid evolutionary diversification, followed by the extinction of many unique animals. Why was this evolution so rapid? No one really knows. Many zoologists believe that **it was because so many ecological niches were available with virtually no competition from existing species.** Will zoologists ever know the evolutionary sequences in the Cambrian explosion? Perhaps another ancient fossil bed of soft-bodied animals from 600-million-year-old seas is awaiting discovery.

像伯吉斯页岩化石群这样的化石层表明进化不能总是被认为是缓慢的过程。寒武纪大爆涉及到了快速的进化分化，接着就是很多独特动物的灭绝。为什么这种进化如此迅速呢？没有人真正的明白。很多动物学家认为**这是很多几乎没有任何竞争性物种的环境使然**。动物学家们是否知道寒武纪大爆发的动物的进化顺序呢？或许另一些含有来自于 6 亿年前的海洋动物的化石亟待发现。