Taiwan's gift to the world

Jared M. Diamond

Study of the giant Austronesian language family tells us a great deal about the history of Pacific peoples and boatbuilding, as well as about Aboriginal Australia.

We humans are defined and fascinated by our languages. Especially intriguing are the 1,200 or so languages of the Austronesian language family, possibly the largest family among the 6,000 languages of the modern world[1]. Until the European colonial expansion spread Indo-European languages far and wide after AD 1492, Austronesian was the most widely distributed family, spoken across a realm spanning 26,000 km from Madagascar in the west to Easter Island in the east (Fig. 1).

Austronesian history has been difficult to reconstruct, however, because there are no preserved samples of writing in any Austronesian language until about AD 670, by which time the family's expansion was nearly complete. A reanalysis of Austronesian languages by Robert Blust[2] strengthens the identification of the first Austronesian way-station, illuminates archaeological findings and the history of boatbuilding, and may help reinterpret the histories of other language families.

Blust's analysis yields an astonishing pattern. Those 1,200 Austronesian languages fall into ten subgroups, of which nine (containing only 26 languages) are spoken only by the non-Chinese aborigines of the island of Taiwan. The tenth subgroup encompasses all Austronesian languages outside Taiwan, from Madagascar to east Polynesia — all 1,174 of them. It is as if the Indo-European language family consisted of 1,174 closely related Slavic languages, spoken from Britain to Sri Lanka, with all nine other Indo-European language groups — Germanic, Celtic, Hittite, Italic and the rest of them — being confined to Ireland. Previous studies had recognized several distinctive Austronesian language groups on Taiwan, but it had not been appreciated that the number was so high.

How do language families differentiate? With time, languages change, and dialects that at first are mutually intelligible gradually become more and more distinct. So it seems that the early diversification of existing Austronesian languages must have taken place long ago, on Taiwan. Eventually, just one group of Taiwanese emigrated to other islands, and their descendants in turn emigrated to still other islands, to become ancestral to all living Austronesian peoples outside Taiwan.

Figure 1 **The geographical span of Austronesian languages. This language family encompasses all languages spoken on all Pacific islands from Sumatra in the west to Easter Island in the east, except for the Papuan languages of New Guinea and a few adjacent islands. They are also spoken in Madagascar and in mainland Malaysia. From the work[2] discussed here, it turns out that of the ten subgroups of Austronesian languages, nine are confined to Taiwan (red circle), and that all Austronesian languages outside Taiwan belong to the tenth subgroup (green), which includes Polynesian languages (dark green; only a few of the hundreds of Polynesian islands are shown here). (Redrawn from ref. 1.)**

This linguistic evidence for the Austronesian expansion correlates well with archaeological evidence. Studies of pots, tools and bones have shown that all farming in the Pacific outside New Guinea stems from the colonization of Taiwan by south Chinese farmers by around 4300 BC, followed by their expansion through the Philippines and Indonesia to Polynesia, the Malay peninsula and Madagascar[1,3]. Of course, pots do not talk, and it can be impossible to guess the languages spoken by the pot-makers. But in the Pacific, identifying the potmakers is easy, because all Polynesian islands were uninhabited until the arrival of people making so-called Lapita pots began at around 1200 BC, and there is no archaeological evidence for arrivals of other peoples after them[4]. Because all traditional languages throughout Polynesia are Austronesian, those first potters must have spoken Austronesian languages.

Especially for those of us interested in boats, the details of Austronesian languages prove as instructive as this main pattern. The contrast between big differences among Taiwanese languages and much more modest differences among extra-Taiwanese languages suggests that there was a 'long pause' between the Austronesian colonization of Taiwan and the Austronesian expansion out of Taiwan. But there is also another contrast, within those extra-Taiwanese languages themselves, between non-Polynesian languages and a discrete sub-subgroup consisting of the closely related Polynesian languages. This suggests that there was a further long pause, between the first colonization of a bridgehead in Polynesia and the subsequent expansion throughout Polynesia.

Both of these linguistically deduced long pauses are confirmed by archaeological evidence. From this it seems that there was a 1,000-year gap (from about 4300 to 3300 BC) between farmers' colonization of Taiwan and their subsequent colonization of the Philippines, and a further 1,000-year gap (from about 1200 to 200 BC) between the Lapita colonization of west Polynesia and the colonization of east Polynesia[1–4].

Blust suggests that these two long pauses were due to the time required to develop two leaps in boat technology. Crossing the 375-km seas separating Taiwan from the Philippines would have required much better boats than crossing the mere 140-km strait between mainland China and Taiwan. The ship-building revolution that brought the Philippines and Indonesia within reach may have involved the invention of outrigger canoes. Blust identifies many words in extra-Taiwanese Austronesian languages, but none in the Taiwanese languages, for the component parts of these canoes — which, in historical times, were widespread among Austronesian peoples except for the Taiwanese, who only had bamboo sailing rafts. Similarly, the second ship-building revolution essential to mastery of the open oceans separating the islands of east Polynesia may have been the invention of the Polynesian double-hulled platform sailing canoe, rated by eighteenth-century European seafarers as superior to contemporary European ocean-going ships.

Blust's study may help us to understand another issue in historical linguistics. The 260 or so Aboriginal Australian languages are usually considered to belong to a single language family[5]. That is surprising, for two reasons. First, people have been living in Australia for at least 50,000 years, ample time for repeated differentiation of language families; and Aboriginal Australian history has been without the homogenizing population movements analogous to the spread of Chinese farmers, whereby one language family could replace all others. Second, Australian languages are similar in their sounds but diverse in their vocabularies, leading linguists to consider them related but to try to explain away their divergent vocabularies.

Blust's work on Taiwanese Austronesian languages suggests that Aboriginal Australia's divergent vocabularies should be taken seriously and attempts made to explain away their convergence in sounds. The diversity in Taiwanese languages was formerly overlooked for several reasons, including their similar sound inventories, for instance the lack of so-called palatal consonants (such as 'z', 'j', 'ch' and 'sh' in English). But Blust points to other cases in which similar sound systems have spread over geographically adjacent language families whose distinctness on other grounds is beyond question. Examples are the sharing of click consonants by South Africa's Zulu and Khoisan languages; the sharing of retroflex consonants (pronounced with the tip of the tongue curled back) among the four otherwise very different language families of the Indian subcontinent; and the shared absence of nasal consonants in languages of North America's Pacific northwest.

This sharing of sounds is expected to develop in an area (such as Aboriginal Australia) where each language is confined to a small tribelet, and where all children grow up multilingual so they can understand and marry members of neighbouring tribelets[6]. For instance, a few months ago, while I was sitting around a campfire in New Guinea with a dozen New Guinea highlanders, each of us volunteered how many languages he spoke. It turned out that every one of the New Guineans spoke between five and ten. Today, I and most other native English-speakers who speak French mangle it with an atrocious accent, and the same is true of most native French-speakers attempting English.

Suppose, however, that an English tribelet and a French tribelet, thrown together with 258 others in an area the size of Australia, were forced to seek marriage partners in other tribelets, and were left in isolation for 50,000 years. At the end of that era, there might still be 260 languages with distinct vocabularies and grammars, but French and English might now be so similar in their sounds that my wife would no longer blush at my fractured French. The multilingualism of Aboriginal Taiwanese and Australians represented the norm for almost all of human history; we *Nature* readers who grow up in big monolingual nations are an aberration of modern times. ■

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Display technology

Sidestepping the selection rules

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Organic semiconductors that can emit light have developed rapidly over the past decade[1,2]. These materials offer the prospect of flat, and even flexible, displays that operate at low voltage and emit light, giving excellent contrast and viewing angle. The displays use light-emitting diodes (LEDs) made up of thin layers of organic materials sandwiched between suitable contacts (Fig. 1a). When a voltage is applied to the contacts, charges are injected into the device. Opposite charges can meet up and combine to form an excited state known as an exciton, of which usually only 25% can go on to emit a photon[3].

On page 750 of this issue, Baldo *et al.*[4] report an ingenious way of getting light emission from the other 75%, thereby potentially improving the efficiency of organic LEDs. This will greatly help to reduce power consumption (which is especially important for portable devices), increase operating lifetime, and increase light output.

Light emission in organic materials commonly occurs when the material absorbs energy and becomes excited, then rapidly

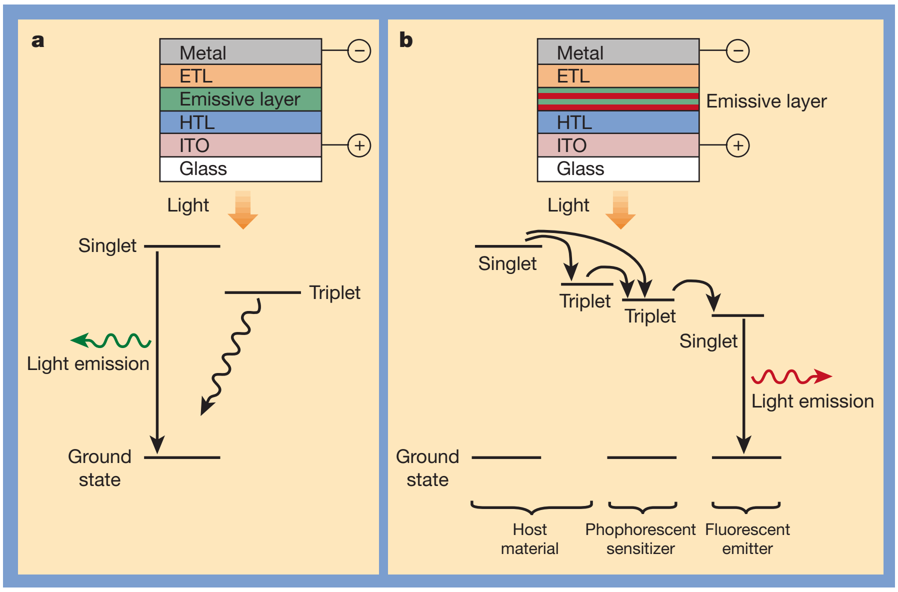

Figure 1 **A fourfold increase in the efficiency of an organic light-emitting device.** a, **A conventional organic light-emitting diode consists of a number of organic layers in between suitable contacts. Opposite charges are injected from each contact and pass through the organic layers and combine to form an exciton in either a 'singlet' or 'triplet' spin configuration. Only the singlet excitons emit light, with the triplets decaying to heat and being wasted. Positive charges move through the hole transport layer (HTL), and negative charges move through the electron transport layer (ETL) to reach the emissive layer where the excitons form.** b, **In Baldo and colleagues' device[4], the emissive layer consists of a set of alternating layers, which contain either a phosphorescent material or a fluorescent dye embedded in a host organic material. The result is that both singlet and triplet excitons are transferred from the host material to the phosphorescent sensitizer and on to the fluorescent dye, which then emits light. This avoids the triplet excitons being wasted, greatly increasing the efficiency of light emission. (ITO is a transparent contact, indium tin oxide.)**