aspects. Overall health was reduced by both the introduction of agriculture and the arrival of the Europeans.

Larsen is on shakier ground when he suggests that these phenotypic changes resulting from changes in lifestyle have been an important part of the evolution of our species. Skeletons can alter dramatically from one generation to the next depending on use and disuse, but these changes can be purely phenotypic, with no effect on the genes of their owners. Did the gene pools of the native Americans change during this period? And were any changes the result of selection for survival under new circumstances, or simply the result of tribal migrations? Mitochondrial DNA analysis shows that the Stillwater people were a mixture of different tribal groups, and a change in that mix could have taken place over time even in the absence of natural selection.

The skeletons are silent on the subject of true evolutionary change, but DNA from them may provide us with some answers in the near future. We will have a far better chance of detecting any genetic changes that resulted from the North American agricultural revolution and the arrival of Europeans than from similar but earlier traumatic events in Europe, Asia and Mesoamerica, because they are far closer to us in time. There seems no doubt that, as our expertise grows, the study of native American skeletons that Larsen has pioneered so effectively will tell us even more about our evolutionary history. This is because it seems unlikely that such huge events as the agricultural revolution and invasion by alien cultures have been squeezed into such a short span of time at any other point in our five-million-year history. Even the replacement of Neanderthals by the Cro-Magnons and other modern Europeans took at least 10,000 years. My guess is that we will find that true evolutionary changes took place as a result of these traumas, and that the changes were pronounced. ■

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Dancing in the blue

***Dolphins* (National Geographic, $35, £20) by Tim Cahill follows the lives and careers of three scientists involved in dolphin research. Underwater photographs, such as the one above showing a group of spotted dolphins, sit beside pictures of the scientists at work, and play, on land. The book documents their motivation, and their achievements.**

From donkeys and cows to whales

Marine Mammals: Evolutionary Biology
by Annalisa Berta & James L. Sumich
Academic/Harcourt: 1999. 494 pp. $59.95/£39.95

Axel Meyer

The study of marine mammals is a highly fragmented and multidisciplinary endeavour, often conducted in an intensive, but seldom eclectic, manner. The discipline is united solely by its objects of study, the 100 or so species of mammal that are considered to belong to the marine mammal club. Species from three mammalian orders make up the list: those from the Carnivora include the pinnipeds (seals, sea lions and walruses), sea otters and polar bears; those from the Cetacea include whales, dolphins and porpoises; and those from the Sirenia the dugongs and manatees.

These mammals spend most, if not all, of their lives in the sea. Interestingly, during evolution, the marine ancestors of dolphins in South America, India and China repeatedly and independently recolonized freshwater habitats. Sadly, and ironically, the study of cetaceans began in earnest only in the first part of last century, just as it was beginning to be recognized that they were vanishing from our oceans and sustainable catch quotas had to be established.

Various marine adaptations permitted warm-blooded, air-breathing mammals to leave the safe confines of land and return to the watery habitats of their distant ancestors. These include insulation (blubber) and circulatory adaptations such as countercurrent heat-exchange systems to deal with the extra heat loss in cold water. The animals' eyes, nose, ears and limbs also became highly modified, sporting sensory adaptations and key evolutionary innovations such as echolocation, baleen to allow filter-feeding, collapsible lungs that allow deep and prolonged diving, a tail and flippers. In the cetacean lineage, the evolution of many of these adaptations for marine life was apparently extremely rapid — much faster than in the closely related artiodactyls (which include cows, pigs and giraffes) and perissodactyls (donkeys, rhinos and horses).

The study of marine mammals, and particularly that of dolphins and whales, shares with primatology the cachet (or stigma, depending on your point of view) of intense public interest. Romantic notions of 'talking with dolphins', saving whales and emulating the French oceanographer Jacques Cousteau have eager students flocking to this field. But reliable data collection and controlled experiments on marine mammals can be extremely difficult, if not impossible. The great rarity of some species, frequently as a result of whaling, and the animals' often enormous body size prevent many experimental approaches. As a result, a lot of problems, particularly in behavioural ecology, are still unanswered. This remains the case in spite of advances in microelectronics such as satellite telemetry, and molecular approaches using the polymerase chain reaction and DNA fingerprinting, which have revealed many new and often unexpected insights into areas such as social systems and migration.

Comprehensive texts on marine mammal biology are few and far between. This is particularly true of books that use a comparative phylogenetic approach, which is based on studying the evolutionary relationships among species and interprets data within an explicitly evolutionary framework. For example, based on the knowledge of phylogenetic relationships among cetaceans and their extinct closest land-bound relatives — the four-legged artiodactyl group, the mesonychids — it is clear that whale locomotion evolved through various stages. In now extinct forms, locomotion advanced from being quadrupedal, to pelvic paddling, and through caudal undulation of feet and tail to the modern condition of vertical movements of the tail only, with the concomitant loss of the hind limbs.

There is great need for a text that takes a strongly evolutionary approach to the study of marine mammals. This book fills that niche. It will be useful for both upper-level undergraduates and graduates and for researchers in marine mammal science. It is well researched, lucidly written and bang up-to-date. I was also impressed by the informed and balanced treatment of current debates, such as that on the phylogenetic relationships within and among cetaceans.

The systematics of marine mammals is relatively well known, largely through molecular phylogenetic investigations over the past ten years. However, questions such as the relationship of the walrus to the other two groups of pinnipeds, the seals and sea lions, or the position of beaked whales to other whales, remain unresolved. Another topic still being debated by molecular phylogeneticists is whether cetaceans should have their own order, or be nested within the artiodactyls, with hippos as their closest living relatives. What is well established is that whales are more closely related to cows and their relatives than they are to donkeys and horses and their perissodactyl relatives. Rates of morphological evolution have apparently been very fast in the whale lineage, rendering their appearance almost totally different from that of their artiodactyl relatives. Yet morphological traits and molecular evidence strongly indicate that donkeys don't belong with cows and whales. ■

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Science in culture

Debate, not didacticism

Shining some scientific light through the anger and the acne at Edinburgh

Sara Abdulla

Amid the angry comedy, fire-eating mime and acne-encrusted Molière of this year's Edinburgh Fringe Festival, there are three plays funded by the Wellcome Trust, "not to be didactic but to engender debate". Three good, thought-provoking, skilfully produced dramas that should send scientists and non-scientists into the night with some meaty ideas to chew on.

Most daring, most theatrical, most creative is Paul Jepson's *The Idiot*, which he and actor Claus Damgaard developed with the help of one of the trust's first Science on Stage and Screen awards in 1998 (worth £35,000 [US$53,000]). This one-man show is a visceral, troubling, touching exploration of epilepsy based on Dostoevsky's novel.

Impressively, while it stands as an original and exhilarating piece of physical theatre, *The Idiot* is also a theatre-in-education work. It will tour schools (more Wellcome money) augmented by information packs and workshops, helping children better understand, discuss and think about this still-stigmatized condition.

Less thrilling theatrically, but more interesting as science-meets-arts, are two 'straight' plays.

Safe Delivery, another Science on Stage and Screen recipient (to the tune of £36,000) is the likeable result of a collaboration between the venerable playwright Tom McGrath and his geneticist daughter Julie Webb, of the Institute of Child Health in London. Ostensibly about viral gene therapy, it is also about the people beneath the lab coats. "It has struck me as odd since the seventies," says McGrath, "that there are so many scientists in theatre audiences and yet they are never represented on stage."

He addresses that problem in many enjoyable ways. Set in a UK university genetics lab, *Safe Delivery* is a simple drama of human frailty, loss, vanity, ambition, disappointment and love. Some of the basic science is worryingly tabloid — gene therapy straight from test tube to human in three months without going via animals?

But the characters are otherwise spot on, delicious in their astute, bitchy, fleshy colour. The lecherous, camera-courting media-babe medic with his priorities all askew. The harried prof, so busy writing grants to make sure his empire doesn't lag behind his American collaborators that he doesn't know what's going on in his own cold-room. The eager postdoc, hoarding scant praise. The pretty young PhD student sharing a toast to Barbara McClintock with the embittered, scintillating lecturer she could one day become.

The third of the trio is this year's instalment from Y Touring, beneficiaries of a £300,000 'Creating Debate' grant from the trust for four plays over three years' worth of theatre-in-education touring. *Learning to Love the Grey* is their feisty, if slightly clunky, take on cloning and the conundrums of individual versus collective responsibility that it throws up.

In a contrived and parochial (but ultimately successful) device, writer Jonathan Hall gets in all the necessary information by making this a play about a London woman commissioned to write a play about cloning. One wonders how Y Touring's benefactors took to Hall's astute digs at the plush Public Understanding of Science outfit that his heroine is financially obliged to work with. But no one could disagree with her cry that giving ordinary people information using jargon and condescension is "as bad as not telling us at all".

Structure aside, Hall, who like McGrath has a gratifying flair for dialogue, neatly weaves the myriad issues raised by cloning and stem-cell research into an intelligent and thought-provoking piece. This play will probably have the shortest shelf-life of the three, but UK schoolchildren should benefit enormously from it.

The Trust says it is "very pleased" with these plays. And so it should be. ■

Sara Abdulla is the senior science writer on the Nature News Service.

***The Idiot* and *Learning to Love the Grey* are playing at the Pleasance in Edinburgh. *Safe Delivery* is running at Dynamic Earth. The festival ends on 28 August.**

TIM SMITH

Claus Damgaard in Paul Jepson's play *The Idiot*.