aquatic immature stage, and in the absence of water, they cannot breed. During the long dry season of the African savannas and the Sahel region, the rains cease for months, surface water evaporates, humidity plummets and temperatures soar. As long as there is no permanent surface water from reservoirs or rivers nearby, malaria transmission becomes undetectable and the local vector mosquitoes also disappear, only to return again with the rains.

Understanding malaria-vector ecology during the dry season, when populations have reached their lowest point, has great strategic significance because deploying mosquito control specifically at those times and places can have the greatest impact. There are two main possibilities for what happens to the mosquitoes during the dry season: long-distance migration to and from refugia where water persists; or stasis, in which the vectors enter a state of dormancy (referred to as aestivation or summer diapause[4]) that allows them to safely ride out the dry season *in situ*, hidden deep inside (unknown) shelters. Yet finding the disappeared mosquitoes is even harder than it sounds.

In fact, Dao *et al.* did not solve the mystery directly, by physically locating mosquitoes in hiding places or capturing them in the act of long-distance migration, although such efforts are under way[5]. Instead, their detective work was indirect, using detailed analyses of mosquito population dynamics over time. Although researchers have adopted conceptually similar approaches in the past, the insights that emerge from Dao and colleagues' data were made possible by a sampling effort that is unprecedented both in its detail, allowing the detection of short-lived phenomena, and in its duration, allowing true seasonal patterns to be distinguished from one-off events.

Based in the Sahelian village of Thierola in Mali, the researchers collected mosquitoes from around 120 houses for 2 weeks of every month for 5 years, yielding about 40,000 *A. gambiae s.l.* samples. From time-series analysis of the combined data from all three species, the authors inferred a statistically significant repeating seasonal pattern that was unexpectedly complex. They observed the predicted wet-season peak and mid-dry-season trough in vector density, but this was followed by a surprising rise in density in the late dry season, before another low as the dry season ended.

To make biological sense of these data, Dao *et al.* recognized the importance of splitting *A. gambiae s.l.* into the three genetically defined units found simultaneously in Thierola: *A. gambiae sensu stricto* (*s.s.*), *Anopheles coluzzii* and *Anopheles arabiensis*. Mosquitoes from the three groups are very closely related and cannot be physically distinguished at any stage in their development. All three hybridize occasionally in nature, but the first two — only recently named as species[6] and not universally recognized as such — diverged evolutionarily much more recently than other species in the complex.

Despite the relative youth and morphological homogeneity of this species complex, the fact that the species radiations were accompanied by, if not promoted by, differential adaptations to environmental heterogeneities[7] makes it unlikely that its members would respond uniformly to a common physiological stress. Notwithstanding this expectation, it is striking that, when Dao and colleagues partitioned the data by species, the two closest relatives (*A. coluzzii* and *A. gambiae s.s.*) showed the most distinct population dynamics (Fig. 1). The authors also found that the population density of *A. gambiae s.s.* follows a relatively simple pattern of peak abundance in the wet season and a trough throughout the dry season. By contrast, although the density of *A. coluzzii* also peaks in the wet season, the onset of population growth precedes that of *A. gambiae s.s.* by two months and, far from disappearing in the dry season, two peaks in population density are consistently observed, despite the absence of rain.

Dao *et al.* make the case that these data best fit a model in which *A. coluzzii* persists locally in a form of diapause and emerges from hiding for two short periods. The cues that provoke this emergence are unknown, but could include abiotic factors, such as increases in humidity or temperature, and biotic factors, such as the need to replenish nutritional reserves — for example, by blood feeding without egg maturation, known as gonotrophic dissociation[4]. By contrast, it seems that *A. gambiae s.s.* disappears and, when the rains resume, more slowly recolonizes the area from refugia hundreds of kilometres distant.

Although the population dynamics of *A. arabiensis* were not statistically different from those of *A. gambiae s.s.*, small numbers of *A. arabiensis* were collected each dry season, suggesting that at least a fraction of the population remains in place. Whether this implies that the species uses a mixed strategy of diapause and long-distance migration, as the authors propose, or whether there is some other explanation (such as a different type or greater depth of diapause) will require further investigation.

Final proof for these hypotheses will have to come from catching the mosquitoes in the act. Nevertheless, there is now strong evidence that *A. coluzzii* overcomes the stress of the dry season through local diapause, a strategy that ensures its rapid population expansion at the earliest stages of the rainy season and thereby amplifies disease transmission. The long-distance migration proposed for *A. gambiae s.s.* will also influence the dynamics of disease transmission and vector control, because both processes determine the ability of vector populations to expand their range and invade distant regions. Unfortunately, we know

NATURE

50 Years Ago

Dr. H. J. Kingsley and Dr. J. E. A. David of Bulawayo have described … the case of a girl aged 22 months … She appeared to be completely insensitive to pain … She was admitted to hospital for investigation and was noticed to have periods of blankness which were thought to be some type of petit mal. Many investigations were made and all results were normal. While she was in hospital her sensitivity to pain was tested and it was found that the child was insensitive to pain almost all over the trunk, limbs and face, and a sterile hypodermic needle could be stuck through the skin to the subcutaneous tissues without any flinching … Confusion exists in the literature about congenital absence of pain … Dr. Walter B. Shelley of Philadelphia thinks that these cases are not as rare as is supposed and that there are people who experience coronary thrombosis or a perforating appendicitis, or have babies, without pain. Apparently, where pain is absent, itching is also absent.

From *Nature* 19 December 1964

100 Years Ago

Physics of the Household. By Prof. C. J. Lynde — The author of this book is professor of physics in the Macdonald College, an affiliated college of the McGill University, Montreal, where a school of household science is one of the branches of the institution, and it is for students of household science that the book is written. It presents the subject of physics in close relation to its domestic applications, and abounds in illustrations and examples of household appliances and processes. It should be of great use to science teachers, especially those who have to teach girls.

From *Nature* 17 December 1914