Madrid earthquakes, and they make sense in terms of the active faulting in the region.

One of the most interesting results is that motions in the surrounding region are low compared with motion in the seismic zone itself. This unusual behaviour differs from that at plate boundaries, raising questions about the driving forces and earthquake processes within plates. Post-seismic afterslip — a process by which fault displacements at depths of several kilometres are expressed at the surface for a period of time following an earthquake[10] — seems a reasonable explanation for the regional pattern of motions. However, there is currently insufficient information about the physical properties of the Earth in the New Madrid region to test this and competing models.

Smalley and colleagues' results are consistent with the findings of geological studies that the seismic zone produced earthquakes about every 500 years of magnitude 7.6 or greater. As such, they provide scientific justification for the adoption of stricter earthquake provisions in the building codes for Memphis and other cities in the central United States[4]. Looking ahead, installation of additional field stations close to known faults would help to define their extent and further quantify their strain rates. One of the most daunting challenges will be to develop and test models that can explain how such large and frequent earthquakes are produced in the New Madrid region, and to see if the models also apply to other intraplate regions. ■

Martitia P. Tuttle is at M. Tuttle & Associates, 128 Tibbetts Lane, Georgetown, Maine 04548, USA.
e-mail: mptuttle@earthlink.net

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EVOLUTIONARY BIOLOGY

Island of the clones

Thomas N. Sherratt and Christopher D. Beatty

The discovery of an all-female population of damselflies in the Azores archipelago provides a novelty for entomologists. It also highlights the unique selection pressures faced by species that colonize islands.

Tucked away in the journal *Odonatologica* comes a paper by Cordero Rivera and colleagues[1] that will surprise many entomologists, and will exercise biologists studying evolution on islands and the mechanisms of sex determination. Cordero Rivera *et al.* have discovered that a species of damselfly on the Azores reproduces parthenogenetically (Fig. 1). This form of reproduction, in which females produce eggs that develop without fertilization by males[2], has been recorded in almost all insect groups. But until now it was not known to occur in any natural populations of damselflies or dragonflies (the Odonata)[3].

The Azores archipelago lies 1,500 km from the coast of Europe. Inspired by a report[4] that only females of the damselfly *Ischnura hastata* had ever been found there, Cordero Rivera and his team visited 15 localities on six of the islands. Although more than 330 adult specimens of *I. hastata* were examined, none of them was male. To test whether the species was parthenogenetic, a sample of larvae was reared to adulthood in the laboratory — more than 1,900 females were produced over nine generations, but no males.

Ischnura hastata is common in North and South America, yet it occurs in these regions as a classically sexual species with both males and females. The concept of 'geographic parthenogenesis'[5] proposes that the parthenogenetic forms of a species are more likely to occur in certain areas — such as higher latitudes and altitudes, and on islands — because of the different selection pressures that organisms face under these conditions[6,7]. One possibility, therefore, is that certain damselfly species can include both sexual and parthenogenetic forms, and that on arriving on a remote island it is the parthenogenetic form that is favoured, at least initially, owing to the difficulty of finding mates.

One might wonder why standard sexual reproduction does not kick in once the population builds up in size, but perhaps local conditions continue to favour parthenogenesis. Indeed, *I. hastata* frequents temporary or recently established habitats[4], and Cordero Rivera *et al.* note that there is anecdotal evidence of local extinctions of pond populations. Furthermore, chance may play a role in the establishment and maintenance of parthenogenesis: *I. hastata* is also found on the Galapagos Islands, but the population contains both males and females[8].

In at least some odonates, there may be a degree of predisposition to parthenogenesis; for example, there is evidence that unfertilized eggs of the dragonfly *Stylurus oculatus* can be artificially induced to develop[9]. Moreover, certain parasites that are inherited only in the female line can manipulate their insect host into producing predominantly (or only) female offspring[10]. Cordero Rivera and colleagues are testing whether any microbial agents are responsible for driving the absence of males in *I. hastata*, but they have ruled out one potential bacterial parasite, *Wolbachia*, which infects a range of other insect groups[10]. If parthenogenesis in *I. hastata* is parasite mediated, then the microbial agent might have had a beneficial effect on its host in the initial phases of colonization, allowing individuals to reproduce without mates.

There have also been intriguing accounts of other damselfly species on remote archipelagos. In particular, on the islands of Fiji, it seems that females of the damselfly *Nesobasis rufostigma* actively defend territories over aquatic habitats, whereas the males, which are infrequently encountered, reside some distance from the stream[11]. This phenomenon has been dubbed 'sex-role reversal'[11] and, if confirmed, would be the first example in an odonate. If males are in short supply, then this unusual mating system might be explained by female competition for access to males[12]. Furthermore, males of two rarer Fijian damselflies (*N. flavostigma* and *N. caerulescens*) have

Figure 1 | Reproduction without fertilization in a damselfly. A female *Ischnura hastata* lays eggs in a pond on the island of Pico, Azores. (Courtesy of A. Cordero Rivera, Univ. Vigo.)

never been found, raising the possibility that parthenogenesis occurs in these species.

Clearly, the evolutionary reasons why parthenogenesis is maintained in *I. hastata* remain largely unsolved. Entomologists, and those interested in island biology and parasite-mediated sex determination, have a new case for investigation. ■

Thomas N. Sherratt and Christopher D. Beatty are in the Department of Biology, Carleton University, 1125 Colonel By Drive, Ottawa, Ontario K1S 5B6, Canada.
e-mail: sherratt@ccs.carleton.ca

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CONSCIOUSNESS

Crick and the claustrum

Charles F. Stevens

Francis Crick believed that, in biology, structure is the natural path to understanding function. In his later career, he applied this dictum to the study of consciousness.

Pretty much everyone is interested in the big questions about the brain, and the biggest big question is: what is consciousness? Just as historically the vitalists could not imagine how life can be explained by just physics and chemistry — they believed that a non-physical 'life force' had to be involved — the dualists of today cannot believe our experience of the feeling of love or the redness of red could arise just through nerve impulses in a bunch of brain cells. Although everyone who enters the field of neuroscience starts with an interest in the big questions, we soon settle into much smaller questions that we can see how to answer with the tools of modern biology. Questions about consciousness were therefore mostly left to philosophers and kooks, and no respectable neuroscientist would even have considered working on such a problem — until Francis Crick, that is.

After he and James Watson solved one of biology's really big problems, the mechanism of inheritance, Crick moved to neuroscience and set himself the task of answering that field's biggest question. Working closely with Christof Koch, Crick made the study of consciousness respectable and, directly and indirectly, had a profound influence on all of neuroscience and on the types of questions that are considered acceptable to study. Crick's final paper, written with Koch, has just been published in *Philosophical Transactions of the Royal Society of London* (doi: 10.1098/rstb.2005.1661) and it proposes that an obscure part of the brain, the claustrum, may be involved in consciousness. Crick was working on this paper literally on his deathbed, and Koch has put the finishing touches on it for publication.

How can a scientist think about consciousness? Crick's approach had two parts. The first was to identify what properties of consciousness had to be explained, and the second was to find brain structures that might account for those properties. Crick and Koch note that a key feature of our conscious experiences is that all of the components are integrated into a unified whole: how a rose looks, smells and feels are bound together with our emotional experience of it. Because these different aspects of experience are related to neuronal

ANIMAL BEHAVIOUR

Congo's art

The decisive brush strokes are not the most notable feature of this painting, nor the powerful colour combinations. It is the artist and the artist's mentor — Congo the chimpanzee and Desmond Morris, respectively — that are the main points of interest. The painting, along with two others of Congo's, came up for auction at Bonhams, London, earlier this week.

Morris trained as an ethologist and has long been a painter himself. In the 1950s, he was the host of the television series *Zootime*, and it was here that Congo came to public attention. This picture was produced by the chimpanzee when he was three years old.

Congo was neither the first nor the last of ape artists, and his talent remains a question for experts in the disparate fields of art appreciation and animal behaviour. But his celebrity status has undoubtedly made his oeuvre more collectable. **Tim Lincoln**

BONHAMS