news and views

Gametes of malaria parasites

from F. E. G. Cox

IT has always been one of the major aims of parasitology to maintain parasites in culture and to minimise as far as possible the use of human subjects or laboratory animals. A year ago, the possibility of growing all stages of the human malaria parasite, *Plasmodium falciparum*, in culture was brought a step nearer when Trager and Jensen (*Science* **193**, 673; 1976) described the continuous cultivation of the blood-inhabiting asexual stages of this parasite in a simple medium. The next stage in the malaria life cycle is the development of gametocytes (the stages that infect mosquitoes) from the asexual stages in the blood and in this issue of *Nature* (page 240) Carter and Beach describe how this can be achieved *in vitro*. The early stages of *P. falciparum* that invade red cells can develop into either asexual stages, a process which takes about 18–24 h, or into gametocytes which takes about 10 days (Smalley *Nature* **264**, 271; 1976). It was the development of the asexual stages that Trager and Jensen achieved. Carter and Beach observed that in cultures of *P. falciparum* maintained in Trager's medium, without the dilution that is usually carried out, obvious immature gametocytes were present after the expected 10 days. The problem was how to bring these stages to maturity. This was achieved by adding 50% human serum instead of the usual 10% to the cultures and after 8 days morphologically mature gametocytes were present. The next step was to confirm that these gametocytes were functionally mature by transforming them into gametes and this was done by suspending the gametocytes in foetal calf serum at *p*H 8.0 or human serum at *p*H 8.2. Trager's culture medium requires a *p*H of 7.3–7.4 for the growth of asexual stages so it is essential to change the *p*H in order to bring about these transformations.

The gametocytes and gametes produced by Carter and Beach look normal in every way and occur in similar proportions of male to female (1 : 3.5 compared with 1 : 4) to those in humans. There is no reason to doubt that they should be able to infect mosquitoes. This means that it should now be possible to complete the asexual and sexual cycles of *P. falciparum* without the need for a mammalian host. It will next be necessary to grow the liver stages of the parasite *in vitro* but this should not present any insuperable difficulties. In the meantime, numerous experiments on the infectivity of *P. falciparum* to mosquitoes have become possible.

The question as to how long the gametocytes of *P. falciparum* are infective to mosquitos is an interesting one. Hawking, Wilson and Gammage (*Trans. R. Soc. trop. Med. Hyg.* **65**, 549; 1971) calculated that gametocytes were produced in a circadian pattern and that they would be infective for only a short period. Bray, McCrae and Smalley (*Int. J. Parasit.* **6**, 399; 1976) on the other hand, found no evidence for a circadian rhythm and Smalley and Sinden (*Parasitology* **74**, 1; 1977) showed that, in humans, gametocytes are infective for 2 weeks or more. The observations of Carter and Beach suggest that gametocytes can mature to gametes for several days at least and this supports the observations of Smalley and Sinden. The technique itself will be useful in resolving problems of this kind in future. It should also be possible to test the effects of drugs on gametocytes—a hitherto relatively unexplored field. □

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Coevolution of *Calvaria* and the dodo

from Robert M. May

MUTUALISTIC associations, in which two species interact in such a way that each benefits from the presence of the other, are fascinating for several reasons. For the theoretician, they are increasingly shedding light on the interplay between the long sweep of evolution and the immediate dynamical effects of population interactions (for example, King, Gallaher & Levin *J. theor. Biol.* **53**, 263; 1975). For the naturalist, and even for the pure aesthete, they provide some of nature's richest wonders: the homes and food that many tropical acacias supply for their protective ants; the nectar supplied by flowering plants as the price for pollination; the almost erotic coupling between many tropical orchids and their obligate bee pollinators.

One class of mutualistic interactions we should all be grateful for is that between fruit-producing plants and the animals that disperse their seeds. The fleshy part of the fruit is the cost the plant pays to induce animals (typically birds) to eat the fruit; the associated benefit is that the seeds, having taken some time to pass through the animals, are spread widely. The fruits we eat are the direct or horticulturally-improved outcome of such coevolutionary cost–benefit calculations.

In systems of this kind, a major design problem is producing a seed that can survive the passage through the digestive tract of the fruit-eating animal. A partial answer is to speed the passage of the seed; hence the mildly laxative effect of many fruits (notably prunes).

All this brings us, rather surprisingly, to the dodo. This large, flightless bird was endemic to the 700-square-mile island of Mauritius. Its disappearance by 1681 is probably the most familiar

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