(after berry shatter), Thompson Seedless vines, four per treatment, were sprayed with gibberellin at 0, 5, 20, or 50 p.p.m. The same vines were similarly sprayed in 1958 and 1959 at the same physiological stage of development. Table 2 shows the harvest results for 1957 and 1959. Gibberellin at 20 and 50 p.p.m. produced greatly enlarged berries in 1958 but had much less effect in 1959, probably because the crop was unusually heavy. The percentage of total soluble solids (degrees Balling) in 1959 was typical of other years. This experiment shows that gibberellin is non-toxic to Thompson Seedless grapes.

Table 2. RESPONSE OF THOMPSON SEEDLESS GRAPES TO VARIOUS CONCENTRATIONS OF GIBBERELLIN SPRAYS APPLIED IN JUNE 1957

Concentration of gibberellin (p.p.m.)	Average weight fruit per vine (lb.) 1959	Average weight per berry (gm.) 1957	1959	Degrees Balling 1957	1959
0	19·5	1·59	2·30	22·4	22·2
5	32·1	1·91	2·62	23·2	22·6
20	37·1	2·71	2·89	18·9	21·4
50	44·3	3·15	2·59	17·6	17·3
d 0·05		0·13		0·7	

One Thompson Seedless and one Black Corinth vine, sprayed after flowering in two consecutive years, showed no visible injury from 1,000 p.p.m. and 100 p.p.m., respectively. Thus, high concentrations are non-toxic to the seedless varieties although far lower concentrations are highly toxic to the seeded varieties studied. A generalization must await tests with more varieties.

The difference between seeded and seedless grapes in sensitivity to gibberellin probably relates to differences previously noted[3,4]. Girdling shortly after flowering greatly enlarges seedless grapes but has little effect on seeded varieties[3]. Thinning, in contrast, ordinarily increases berry size in seeded grapes but not much in seedless grapes[4]. Gibberellin increases size of seedless fruit, but has little or no effect on seeded grapes. It is interesting, therefore, that natural gibberellins have been found in seedless, but not in seeded, varieties[5].

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[1] Weaver, R. J., *The Blue Anchor*, **34**, 10 (1957).
[2] Weaver R. J., and McCune, S. B., *Hilgardia*, **28**, 297 (1959).
[3] Jacob, H. E., Univ. Calif. Agric. Ext. Serv. Circ. **56** (1931).
[4] Winkler, A. J., Univ. Calif. Agric. Exp. Sta. Bull. 519 (1931).
[5] Coombe, B. G., Ph.D. thesis, University of California (Davis) (1959)

ENTOMOLOGY

Breeding of the Rabbit Flea, *Spilopsyllus cuniculi* (Dale): Requirement of a 'Factor' from a Pregnant Rabbit for Ovarian Maturation

A STUDY of the biology of the European rabbit-flea (*Spilopsyllus cuniculi*) was commenced by this department when it became apparent that it was an important vector of myxomatosis in Great Britain. A technique for the laboratory culture of the flea was required, but was not rapidly forthcoming. It was repeatedly found that fleas released on domestic or wild rabbits kept in various types of hutches failed to produce eggs. However, Miriam Rothschild[1] reported that the flea bred when rabbits were kept under semi-natural conditions in an outdoor enclosure, and with her encouragement a study was made of ovarian development in the flea (Mead-Briggs, A. R., unpublished work).

Recently we found that if the fleas were placed on pregnant does the ovaries of the fleas matured and eggs were laid in the nest shortly after the young were born, whereas the ovaries of fleas kept on non-pregnant rabbits did not develop. In one experiment to follow the maturation of the ovaries up to ovulation, thirty-five female and twenty-five male virgin fleas were released on each of four rabbits housed in similar two-compartment hutches, one compartment being dark for nesting. The rabbits were: (1) a non-pregnant adult doe; (2) a doe pregnant 1–2 days; (3) a doe pregnant 11 days; (4) a doe pregnant 20 days. Samples of three female fleas were removed periodically (after a minimum of 10 days on the rabbits), and the reproductive systems dissected out. The degree of development of the ovaries was assessed by measurement of the length of the proximal oocyte follicle in one of the ovarioles. (In one individual there is little variation in this dimension between the several ovarioles until shortly before ovulation; then the final stage of egg maturation and subsequent ovulation occurs in only half the ovarioles at a time (Mead-Briggs, A. R., unpublished work).)

The results for fleas from rabbits 1 and 2 are shown in Fig. 1, each point being a mean obtained from the measurement of three dissected specimens. The absence of change in size (from that of immaturity) of the first oocyte follicle of the fleas kept for up to 28 days on the non-pregnant rabbit is contrasted with the increase occurring among fleas fed on the pregnant rabbit.

The rate and period of growth of the ovaries of the fleas fed on the three pregnant rabbits is indicated in Fig. 2. Maximum development is reached at the time of parturition when the fleas immediately leave the adult and are to be found only in the nest or on the nestlings. Development of the ovaries appears to commence about 10 days prior to parturition although the size of the eggs produced may be influenced by

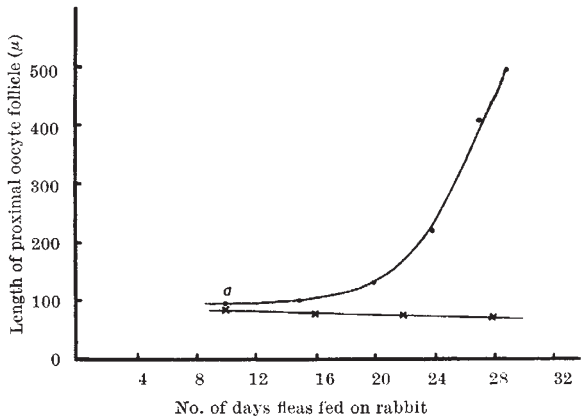

Fig. 1. Development of proximal oocyte follicle of fleas fed on pregnant and non-pregnant rabbits. Point *a* corresponds to the eleventh day of pregnancy. ●, Fleas from rabbit 2; ×, fleas from rabbit 1

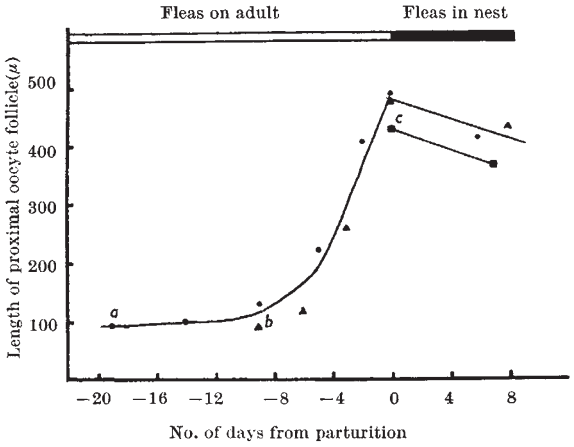

Fig. 2. Development of proximal oocyte follicle of flea related to time of parturition by host. Points *a*, *b* and *c* correspond to stage of development after 10 days feeding on respective rabbit. ●, Fleas from rabbit 2; ▲, fleas from rabbit 3; ■, fleas from rabbit 4

the feeding life of the flea. Thus fleas from rabbit 4 which could only feed for 10 days before commencing egg laying had relatively small eggs (although they were fully fertile) compared with fleas that fed for 19 and 29 days (rabbits 3 and 2 respectively).

At present the nature of the factor initiating ovarian development of the fleas fed on pregnant does is uncertain. Various controls have precluded it being related to nest-building habits by the pregnant rabbits. A likely hypothesis is that it is a factor, perhaps nutritional, present only in the blood of a pregnant rabbit and perhaps only at the required level during the later stages of pregnancy. Buxton[2] compared the production of eggs by *Xenopsylla cheopis* when fed on baby and adult mice and found that with the baby mice eggs were produced in smaller numbers and only after an unusual delay. He suggested this might result from the lack of mammalian sex hormones normally obtained in the blood of adult mice.

Wigglesworth[3] has shown that in a number of blood-sucking arthropods a small amount of hæmoglobin is absorbed into the hæmolymph without digestion, and some of this hæmoglobin is transferred with little change to the yolk of the developing eggs. He concluded that some of the normal protein constituents of egg yolk may perhaps be formed elsewhere in the insect body and merely transmitted to the yolk via the follicle cells and not synthesized in them. This could be the case in fleas which have simple, panoistic ovarioles lacking any trophic tissue other than the follicle epithelium. While flea eggs do not contain any pigmented hæmoglobin derivatives, variation in the serum proteins of the host could be important. Hence, in the present case, it may be significant that Brambell *et al.*[4] found marked differences between the sera of non-pregnant, adult rabbits and rabbits 25 days pregnant, both in respect of the total protein concentration and in the proportions of the components.

So far as we are aware *Spilopsyllus cuniculi* is the only flea shown to require a pregnant host for egg maturation, but failures to breed a few species of flea in captivity may indicate others have similar requirements. The most important result of this mechanism which produces perfect synchronization between maturation of eggs by the flea parasite and parturition by the host is that the eggs are immediately ready to be laid in a microclimate ideal for further development provided by the rabbits' breeding nest.

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[1] Rothschild, M., *Entomologist*, **90**, 304 (1957).
[2] Buxton, P. A., *Parasitol.*, **39**, 119 (1948).
[3] Wigglesworth, V. B., *Proc. Roy. Soc.*, B, **131**, 313 (1943).
[4] Brambell, F. W. R., Hemmings, W. A., Henderson, M., and Kekwick, R. A., *Proc. Roy. Soc.*, B, **141**, 300 (1953).

Experimental Breeding of *Anopheles gambiae* Giles in Papyrus Swamps

In Uganda, *Anopheles gambiae* Giles does not breed in the interior of papyrus swamps, in their natural, undisturbed state. But a considerable amount of breeding may occur at the periphery, outside the papyrus zone, particularly in hoof-prints, cattle-drinking places, and open natural pools[1]. Also, where papyrus swamps have been drained and the land used for cultivating such crops as *Colocasia*, larvæ may be found in the shallow, sunlit pools between cultivation-mounds. On the whole, the swamps are not a potent source of malaria[2].

The composition and nature of the breeding water have a twofold influence on the mosquito, affecting not only the larvæ present in the water, but also the gravid adult female looking for a place to deposit its eggs[3]. However, although it seems quite clear that the ecological distribution of larvæ in Nature is largely a result of the different oviposition habits of the adult mosquito[4], it is also generally accepted that the absence of mosquito larvæ from a particular breeding place admits of two alternative interpretations: either (*a*) the females do not oviposit there at all; or (*b*) they do rather indiscriminately and that larvæ will develop in certain types of water and not in others. The preliminary observations reported in this communication were made to investigate alternative (*b*), that is, whether the absence of *A. gambiae* larvæ from the interior of papyrus swamps, in Uganda, is because they cannot develop in such habitats.

The observations were made in two papyrus swamps near Kampala. Cages made of nylon gauze or from iron drums were planted in the swamps. All predators were removed or prevented from entering the cages. This made the breeding conditions less natural; but it excludes the factor of predators from consideration of the results. Larvæ of *A. gambiae*, in various stages of development, were then placed in swamp water, in the cages, and all adults emerging afterwards were recorded and removed. The results of seven experiments are summarized in Table 1. Experiments 1 and 3 were made at the periphery of the swamp, just outside the papyrus zone; 5, just inside the papyrus zone; 4, 6 and 11, inside the swamp among tall papyrus and under considerable shade; and 10, inside the swamp, but in an exposed previously cut papyrus area.

Table 1 shows that 93·7 per cent of the 1,120 *A. gambiae* larvæ introduced into the papyrus swamps