spermatophore within the path is then located chemotactically.

When a receptive female (a young one or one that has recently bred) finds such a path she searches for the spermatophore by moving her palpal hands in front of her and finally, on extended legs, steps over the spermatophore (Fig. 2, a and b). The fluid inside her genital opening, on contact with the spermatophore, initiates the swelling mechanism, which forces the sperm out of the sperm package and into the receptaculum seminis. The female then rubs her ventral side against the ground and walks away, leaving the spermatophore with the emptied sperm package on the ground (Fig. 2c).

When a male finds a spermatophore, he destroys it by pushing it down with his chelicerae (Fig. 4), and he carefully tears down most of the threads. This behavior is independent of the age of the spermatophore; he destroys even those that have been deposited a minute before. When a female is present he then deposits a new spermatophore in the same place and marks a new path. Nonreceptive females either do not pay attention to the spermatophores, pass them and try not to touch them, or destroy them in the same way as the male does.

The formation of threads in connection with sperm transfer is quite unusual in pseudoscorpions and is better known in several centipedes, one millipede, and some primitive insects which also construct spermatophore webs or paths leading to the spermatophore (*4*). The possession of an opisthosomal silk gland is even more unusual in pseudoscorpions. Histological sections show that the silk material is produced in part of the intestine. The last part of the midgut in pseudoscorpions, generally, and in the female of *Serianus* is differentiated into a rectal pocket, a large sac that serves as a storage space for excretory material [in pseudoscorpions the gut is the most important excretory organ (*5*)] which, from time to time, is emptied in defecation. This sac is surrounded by flattened epithelial cells. This part of the alimentary canal has quite a different histology in the male *Serianus*; its epithelium consists of tall, very closely packed cells, the tips of which extend far into the lumen of the pocket (Figs. 6*b* and 7B) and produces a secretion, which is stored in the lumen. This large silk gland, like the rectal pocket of other species, opens through the anus. In the small anal segment a little spinneret is developed with which the silk secretion can be attached to the substratum.

Excretory material is stored more anteriorly in the midgut of the male *Serianus*. A part of the midgut, which in other species and in the female *Serianus* is a narrow tube surrounded by cuboidal cells, is widened in the male *Serianus*, and its epithelial cells are flattened (Figs. 6*c* and 7*c*). In histological sections this segment appears to contain excretory material. It is not known, however, how the animal controls defecation and prevents the accumulation of excretory material in the silk gland.

The rectal pocket is derived from the endoderm (*6*), and the silk gland must, therefore, also be derived from the endoderm. Silk glands are common in arachnids and may occur in the prosoma (for example, pseudoscorpions and some mites) or in the opisthosoma (spiders). However, no arachnid has been reported to have a silk gland derived from the endoderm. In most other cases the silk glands are not connected to the alimentary canal, except in some mites (*7*) in which silk glands open into the stomodaeum, but these are considered to be homologous to salivary glands and not derived from the endoderm. That part of the midgut of the male *Serianus* is differentiated into a gland for silk production seems, therefore, to be quite unique. This silk is used only in connection with sperm transfer. The male *Serianus* also has the usual silk glands in the prosoma, which open through the chelicerae, but they are less well-developed than those in the female. The silk produced by this gland is probably used for the formation of winter nests.

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Addition Radicals Formed by Hydroxyl Radical Bombardment of Uracil

Abstract. *Direct addition of O—H radicals at room temperature to the carbon No. 5 of the uracil ring has been proved by measurement of the proton hyperfine structure in the electron spin resonance of the resulting uracil + O—H radicals. Upon addition of the OH, the H originally bound to carbon No. 5 shifts to No. 6, thus forming a methylene group at carbon No. 6, with the two protons having equivalent coupling of 28 gauss. The spin density on carbon No. 5 is 0.64. The radicals were produced when powdered samples of uracil were subjected to a low-velocity beam of O—H radicals coming from either hydrogen peroxide or water vapor under reduced pressure and subjected to an electric discharge.*

As judged by electron-spin resonance (ESR) patterns of resulting free radicals, hydrogen atoms from an atomic spray add directly at room temperature to carbon atoms of the ringed groups of uracil, thymine, adenine, and guanine in the solid state (*1*). We have now performed similar experiments that show that hydroxyl radicals likewise add directly at room temperature to the uracil ring. So far, we have been unable to

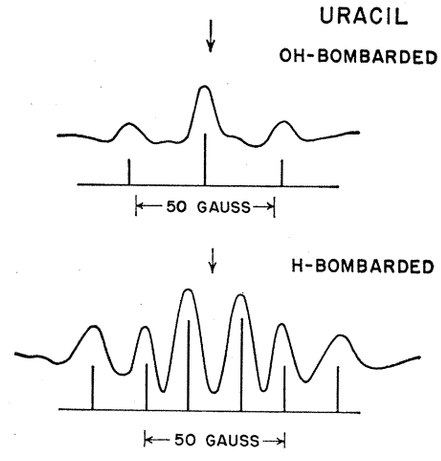
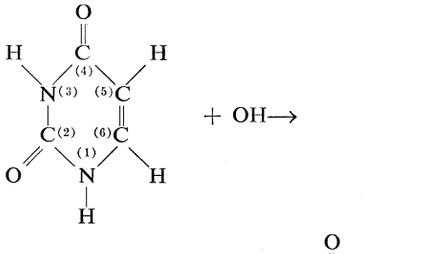
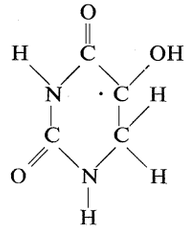


Fig. 1. Observed ESR patterns (second derivative curves) for uracil bombarded with O—H radicals (upper curve) and with H-atoms (lower curve). The bars under the upper curve represent the theoretical pattern expected for OH-addition radical (I) described in the text; those under the lower curve, for the H-addition radical (II). The observations were made at room temperature and at a frequency of 9000 Mc/sec. The lower curve is repeated from (*1*).

produce similarly detectable signals from O—H addition radicals for thymine, cytosine, adenine, and guanine.

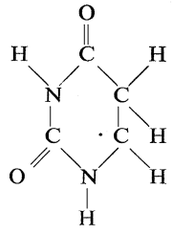
The upper curve of Fig. 1 represents the observed ESR of uracil in powdered form at 300°K, previously evacuated and subjected to gaseous O—H radicals produced by dissociation of H_2O_2 in an electric discharge. Production of O—H radicals from H_2O vapor gave similar results, but with some evidence for H-addition radicals also. The bars of the upper diagram of Fig. 1 represent the theoretical pattern expected for radical (I) below, which would be formed by OH addition to C(5) (the numbers in parentheses indicate the ring position in the diagram below) with a subsequent transfer of the H from C(5) to C(6).





(I)

The corresponding radical formed by H bombardment of uracil is structure (II):



(II)

It gives rise to the lower pattern of Fig. 1 which was obtained earlier (1) and is repeated here for comparison what that of radical (I). That the primary addition occurs on C(5) rather than C(6) is in agreement with the theory of Pullman and Mantione (*2*).

At room temperature the couplings on the CH_2 hydrogens are equivalent for both (I) and (II). This indicates that the two C—H bonds have symmetrical orientation relative to the molecular plane. For symmetrical orientation, the dihedral angle θ between the plane determined by C(5) — C(6) — H and the plane of the π-orbital lobes between C(5) and C(6) must be 30°. From the relation (*3*)

$$A_\beta = \rho_\alpha Q \cos^2 \theta$$

with θ equal to 30° and Q equal to 58 gauss (*4*), and with the observed coupling A_β equal to 28 gauss for radical (I), the spin density on C(5) is estimated to be 0.64. A similar calculation with $A_\beta = 33$ gauss yields $\rho_\alpha = 0.76$ for radical (II). From the α H coupling, a value of $\rho_\alpha = 0.71$ is obtained for radical (II). Although there is no α H for calculation of ρ_α for radical (I), this comparison indicates that it may be slightly lower than the 0.64 estimated from the β H's, possibly 0.60 (Table 1).

Table 1. Coupling constants and spin densities.

Radical species	Proton coupling (gauss)		π Spin density on C_α
	$C_\alpha H$	$C\beta H$	ρ_α
Uracil + OH		28	0.64
Uracil + H	18.5	33	.71

Unless special care is taken, a sharp singlet is produced in the center of the pattern for samples bombarded with H, D, or OH. In all instances the singlet increases in strength with the increase in energy delivered to the sample per unit time. Elimination of these singlets is more difficult in D or OH bombardment than in H bombardment. The singlet occurs for other nucleic acid bases as well as for uracil and for the nucleosides and nucleotides. This nonspecific signal results from a localized degradation or a surface charring of the sample by the bombardment.

We have bombarded the other nucleic acid bases with OH, but so far have been unable to produce detectable signals from OH addition radicals. These failures may be due to an inability of the OH radicals to penetrate these solid samples rather than their inability to add to the carbons of these rings. By other methods Ekert (*5*) has shown that the stable molecular compounds thymine glycol and dihydrothymine are formed in γ-irradiated solutions of thymine in de-aerated water.

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Urea Synthesis in the Lungfish: Relative Importance of Purine and Ornithine Cycle Pathways

Abstract. *The relative importance of the purine pathway (uricolysis) and the ornithine cycle as routes for urea synthesis was assessed in isolated liver preparations from the African lungfish* Protopterus dolloi. *Incorporation of C^{14}-labeled precursors into urea was used for comparison. Both pathways are present in the lungfish, but the ornithine cycle is quantitatively more important.*

During its aquatic phase, the African lungfish obtains about 50 percent of its total metabolic energy from protein, and, as in some aquatic amphibians, the nitrogenous endproducts are excreted mainly as ammonia and urea (*1, 2*). During aestivation the fish is entirely enveloped by a leathery cocoon, urine formation is completely suspended, and the metabolic rate markedly decreases; the animal may survive for several years entirely without food and water. Endogenous protein provides most of the fish's metabolic energy during this period; ammonia does not accumulate, and the nitrogen from catabolized protein is almost entirely quantitatively incorporated into urea, which accumulates in the animal's body fluids and comes to constitute 0.5 to 1 percent of its total weight within a year (*1, 3*).

The need to detoxify ammonia during aestivation is evident, but the mechanism whereby the accumulation of ammonia is suppressed in favor of ureogenesis is not known. Brown (*4*) and Janssens and Cohen (*5*) have provided evidence for the presence of all of the enzymes of the ornithine cycle in the liver of the lungfish. These studies indicate that in the lungfish urea may be synthesized via the classical ornithine