(Expt. II). Atheromatosis was 3 times as extensive in the birds of Group 5 as in those of Group 2.

The dramatic action of iron feeding in the prevention of the rise in plasma cholesterol is clearly shown in Fig. 2. The feeding of iron even in the presence of bile (Group 6) held plaque formation to a degree approximately 1/5 that observed in birds of Group 5. No toxic manifestations (cataracts or weight loss) were noted in the birds fed the ferric chloride-containing diet.

Experiment III. Two groups of birds (4/group) were studied in this experiment (Table 1). Group 7 was fed Diet E. Group 8 was fed Diet F.

The birds were 5 months old at the start of the feeding, and the experimental period was shortened to 4 months. During this period no untoward manifestations were noted in the birds fed the iron-bile-cholesterol diet.

The results of the experiment, shown in Fig. 3 and Table 3, are essentially the same as those of the second experiment. The degree of atheromatosis in the birds fed bile and cholesterol was approximately 4 times as great as that observed in the birds fed bile, cholesterol, and iron.

The interesting finding is that the feeding of ox bile along with cholesterol results in a greater degree of atherosclerosis, as well as a higher cholesterolemia, than does the feeding of cholesterol alone. The hypercholesterolemic effect of bile, which has been noted previously (*3, 4*), is probably the result of augmented cholesterol absorption. This view is supported by the observation that birds fed Purina chow supplemented with Wesson oil and bile but no cholesterol showed no greater cholesterolemia nor atheromatosis than control birds fed the Purina chow plus Wesson oil.

The enteral administration of ferric chloride reduced the extent of the rise of plasma cholesterol not only in birds fed cholesterol but also in those fed cholesterol plus bile. It is likely, although not yet proved, that the iron acted by precipitating bile salts in the intestinal tract.

The action of bile in facilitating the appearance of atheromata in the cholesterol-fed bird, as well as an earlier finding that bile controls the rate of cholesterol absorption by the intestine in the rat (*1*), raises an interesting point—namely, the part played by intestinal bile in the development of arteriosclerosis in man. Our findings suggest that the binding of bile salts in the intestinal tract, thereby suppressing cholesterol absorption, may offer a means of controlling the development of arteriosclerosis.

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Comments and Communications

Photoperiodicity in Animals: The Role of Darkness

Recent results with quail (*1*) have been claimed as apparently "the first clarification of the importance of the dark period in the photoperiodic responses of any higher animal" (as opposed to results with plants, aphids, and snails). In a neat experiment, 5 groups of birds were exposed to artificial lighting daily: either as 17 hr (followed by 7 hr darkness) or as 9 hr plus 1 hr (the two periods separated by a 0-, 1½-, 3½-, or 7-hr dark period, and followed by another dark period to complete the 24-hr cycle).

The results are summarized by pointing out that stimulation (gonad and oviduct size) is roughly "inversely proportional to the length of the longest dark interval. . . . It is evident that the dark period is an inhibitory factor." The growth effects obtained with 17 hr light (and one 7-hr dark period) seem to have been about the same as with 10 hr total light (with two 7-hr dark periods daily).

These results might have been expressed in another way—that stimulation was roughly proportional to the length of day (above a threshold level); and that the "day" did not have to be continuous but could be broken by a dark interval. It is perhaps a mistake to think of darkness—which is merely the absence of light—as playing an active role.

Hart's demonstration (*2*) that ferrets would become oestrous if the dark period was broken was open to criticism (*1*). But experiments (*3*) at the Worcester Foundation, based on Hart's results, showed that only 7 hr illumination daily, if divided over a 12-hr period, will stimulate: so indeed (*4*) will 4 hr divided over 14 hr.

There seem to be differences between photoperiodic mechanisms of birds and mammals; but in both there is evidence that the length of the dark period affects the response to light, and not in an inhibitory fashion. In the weaverbird (*5*) an optimum length of day (and hence of night) has been postulated. In the ferret interpretation of experiments is complicated by what has been termed an "inherent rhythm" (*6*).

This rhythm may be due, or partly due, to the dissipation in darkness of inhibitory aftereffects of long days. Analogy with results on mink (*3, 7*) suggests this: stimulatory effects of light can be stored for long periods (*4*).

Hart (*2*) found a more rapid response to 16 hr than to 24 hr of light daily; unfortunately, his lighting intensity fluctuated. However, with constant intensity (*4*) response was more rapid with 14 hr than 24 hr of illumination. Indeed, in the latter experiment the delay in response with 24 hr of light was such that onset of oestrus might be attributed to an "inherent rhythm" (supposing it "independent of light"), rather than to the long day length.

Part of another experiment (*8*) also demonstrates that darkness enhances the response to light. Nine ferrets (after a year on rather complex, controlled, artificial light schedules) were on Aug. 18 put in 3 groups—on 15 hr light, on 18 hr light, and on 6 hr divided light (4 hr + 2 hr) spread over 15 hr, each day. (They were kept thus for a year; but oestrus developed much sooner than that.) One in each group was in fact oestrous when the phase which is reported here started; dates when the others became oestrous are shown in Table 1. On previous phases of the experiment there was little individual variation.

TABLE 1

Animal	15 hr	18 hr	Broken 15 hr
(i)	Oct. 13 (after 8 weeks)	Dec. 8 (16 weeks)	Nov. 10 (12 weeks)
(ii)	Oct. 20 (9 weeks)	Dec. 29 (19 weeks)	Died (Sept.)

It will be noted that response was much slower on 18 hr of light daily than on 15 hr. Thus the extra 3 hr of light may be said to have had an inhibitory effect (alternatively, 3 hr of darkness stimulated!). "Stimulating effects of darkness" in "long-day" animals need not seem very strange; they have been postulated in "short-day" animals (*9*), and the fundamental mechanism is likely to be the same in each. In plants (*10*) quite closely related species may belong on either side of the "long-day"/"short-day" fence.

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After studying the comments of John Hammond, Jr., concerning our recent paper on the role of darkness in sexual activity of the quail (*1*), we conclude that he is making essentially two criticisms. First, in suggesting that darkness may not play an active role (inhibition, as we reported), he submits that our data could be alternatively interpreted as responses to day length, if one assumes that the day did not necessarily have to be continuous. Second, he suggests that darkness is not necessarily inhibitory, but in some cases may promote sexual activity in animals. We should like to comment on each of these points.

TABLE 1

Quantitative Response in Sexual Activity of Bob-white Quail to Duration of Interruption of Dark Period

Hours of light	Night interruption	No. of birds	Percentage in full sexual activity after 64 days
17 hr (7:00 A. M.–12:00 M.)	0	9	100
10 hr (7:00 A. M.–5:00 P. M.)	0	10	0
10 hr (7:00 A. M.–5:00 P. M.)	15 min (11:45 P. M.–12:00 M.)	9	33.3
10 hr (7:00 A. M.–5:00 P. M.)	30 min (11:45 P. M.–12:15 A. M.)	9	78
10 hr (7:00 A. M.–5:00 P. M.)	60 min (11:30 P. M.–12:30 A. M.)	10	100

The first criticism seems to us difficult to defend. If the results with quail were to be explained by assuming that the day did not have to be continuous, the additional assumption would have to be made that dark periods as long as 7 hr (the length of summer nights in England) interspersed in the "day" period would not alter the animals' response. We feel that the simpler point of view is the more tenable until the basis for such an additional assumption is established. As direct evidence against Mr. Hammond's suggestion, we have evidence that the response of the quail is quantitatively proportional to the duration of the night interruption, even though the time of night at which the interruption occurs is essentially the same. Results of a sample experiment are shown in Table 1. Such quantitative responses to the duration of the interruption would hardly be expected if the interruption were acting only to extend the day, for the space of time from the beginning of the photoperiod to the end of the night interruption was essentially the same for all groups.

With reference to the second suggestion, that darkness is not necessarily inhibitory in photoperiodic phenomena in animals in general, we hasten to agree. Shull (*2*) showed clearly that wing production in aphids required a period of darkness, the optimum period being 10–14 hr. In *Citellus* full spermatogenesis occurs naturally in the darkness of the hibernation burrow (*3*). Whether darkness is stimulating in this case may be debatable, but it can scarcely be inhibiting. In the case of plants it is well known that a long night either stimulates or inhibits reproduction when applied to short-day or long-day species, respectively (*4*).

The comments of Mr. Hammond are interesting and in our opinion serve to emphasize even further that the experiments in our report are the first to indicate *clearly* that the night or dark period exerts a discrete and specific influence in the photoperiodic responses of higher animals.

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The Languages of the Language of Science

THERE has been some discussion among mathematicians as to the Ph.D. requirements with respect to languages. One faction maintains that the rate of increase of papers published in the Russian language requires a revision of the usual French and German requirement to one that would admit Russian as an alternative at least. Some graduate schools have adopted this modification, and others are considering it. The other faction has said that, since there are still more papers published each year in each of the languages now required than are published in Russian, there is no point in making a change. Their other well-taken point is that in the past the Russian language did not come close to either French or German in quantity of publication. The literature of the past is, of course, of great importance.

We present herewith the results of a survey of mathematics papers, the abstracts of which appeared in *Mathematical Reviews*. Our data represent the classification by language of 34,733 papers. Of this number, 33,769 papers were written in one of seven languages. The other 964 papers were distributed among 23 languages as varied as Chinese, Esperanto, Serbian, and Gaelic.

TABLE 3

	USSR (1946–49)		Worldwide (1940–50)	
	No. of papers	Percentage of total	No. of papers	Percentage of total
Algebra	50	7.1	3,934	11.3
Analysis	425	60.9	14,251	41.1
Applied	51	7.3	9,208	26.5
Geometry	72	10.3	5,040	14.5
Group	54	7.7	1,039	3.0
Topology	47	6.7	1,261	3.6
Total	699	100.0	34,733	100.0

Table 1 is a summary of the languages in which these 34,733 papers were written. It is immediately apparent that English was used for almost half the papers, being over twice as prevalent as French, which ranks second. One reason for the extremely high position of English and the relatively high position of French is that prior to 1947 Russian scientists were given the choice of one language other than Russian into which their papers might be translated for publication. That choice usually went to French or English. It should be noted that, although Spanish and Dutch are included in the table, almost 95% of the papers were written in one of five languages.

Table 2 shows the number of papers written in the several languages in 1940 and in 1950. It also includes the ratio of increase from 1940 to 1950. The total number of papers written during the year has increased by a ratio of 2.38:1, but this does not necessarily mean that there has been that great an increase in papers in the field of mathematics. The number of journals abstracted by *Mathematical Reviews* has also increased since 1940. There is no easy way to determine the validity of Table 2 in view of this circumstance. It is interesting, nevertheless, to note that, with the exception of Dutch, in which the number of papers

TABLE 1

Language	English	German	French	Russian	Italian	Spanish	Dutch	Others	Total
No. of papers	15,789	4450	6722	3043	2652	859	254	964	34,733
Percentage of total	45.5	12.8	19.4	8.8	7.6	2.5	0 7	2.7	100 0

TABLE 2

	English	German	French	Russian	Italian	Spanish	Dutch	Total
1940	1052	365	349	92	145	33	9	2045
1950	2099	729	882	610	423	59	63	4865
Ratio $\frac{1950}{1940}$	1.99	2.00	2.51	6.63	2.92	1.79	7.00	2.38