tance, not merely for the vegetable world but also for the higher animals. Furthermore, the fact that sunlight is efficacious in the rickets of both human beings and rats, serves to show the similarity of this disorder in these two species. These results indicate that in the prevention and causation of rickets at least one hygienic factor plays an important rôle which will have to be carefully considered in future studies of this disorder.

6 (1753)

Identical twins in pigeons arise from ova of markedly aberrant size.

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During 10 years data have been accumulated for yolk size and total egg size in 15,000 to 18,000 eggs of doves and pigeons. Such measurements of these two associated structures permit us, within certain limits, to know some definite things concerning the size of either structure if the weight of the other is known. Another group of 15,000 to 20,000 eggs have been weighed, incubated, and later observations made upon the embryos and young. Incidental to these latter observations 7 instances of identical twins have been found. Such twins other than the seven listed here have almost certainly not appeared; or, if present, they attained a stage of less than 2-day embryos.

The figures of Table I make it clear that at least most of the particular eggs which gave rise to twins were of markedly different size from all other eggs then being produced. This is particularly well shown in the first four instances—given in the upper eight rows of figures—since the twin-bearing egg was in these four cases by far the *largest* egg produced by its parent during one entire year,—and so much larger as to indicate, in all probability, that it contained the largest ovum produced during the year. The seventh case was likewise of aberrant size—being the *smallest* of a group of undersized eggs. However, the weights of all eggs obtained in connection with this seventh case, as also with cases 5

and 6, are known to be rather unreliable indices of the weights of the enclosed yolks because the parent birds (K469, P843) suffered from special reproductive disorders which involved the production of irregular and inadequate quantities of shell and albumen, unpaired eggs and embryos often incapable of hatching. The early death of these three pairs of twins is probably to be associated with this circumstance. The significance of the egg weights of the four cases listed at the top of the table is wholly clear since differences of 15 per cent. in egg size (between the two eggs of a clutch) have been found in normal birds to reliably indicate that differences of yolk size lie in the same direction. The two cases listed at the top of the table have been earlier fully described[1] and the data given there will likewise demonstrate the abnormally large yolk size which must have been present in cases 3 and 4 of the present tabulation.

Apparently the known facts concerning these cases of twins do not well accord with a strict application of Stockard's[2] conclusions as to the cause of twinning and "double monsters," particularly as he has described it in relation to birds, since in the present cases we learn that the twin-producing ovum of the pigeon is "marked" for twinning even before it leaves the ovary. However, it seems possible that even these instances may fall within the range of his general explanation. We have learned that extraordinary yolk-size means a low oxidizing level of the ovum. Since this level is lowest in the largest ovum of the given bird this exceptionally low level may account for the first 4 cases of the list. In the last three cases the size of the contained ova is questionable but in these cases a disorder of the reproductive organs—already known to involve the abnormal functioning of some of the endocrine glands—may conceivably effect a retardation of development previous to gastrulation as Stockard's theory demands. The early death of many of these particular embryos, as well as an apparent excess of twins derived from the meager amount of this material, may afford evidence for such retardation. It should also be stated that in case 3 the embryo was subjected to ice-box temperatures (13°–16° C.) during the first 23 hours after laying; and that the parent in case 4 was a generic hybrid.

[1] Riddle, O., *Jour. Exp. Zoöl.*, 1918, xxvi, 227.

[2] Stockard, C. R., *Amer. Jour. Anat.*, 1921, xxviii, 115.

The sex of the twins from the large twin-yielding ova (sex known for first 3 cases only) is of real importance; for, much earlier work by the author has shown that in pigeons the females arise from larger ova and males from smaller ova. Each of the three present cases supplies a rigorous test of the validity of that conclusion,—and each affords a confirmation. If either of these extraordinarily large ova had produced *male* twins, it would have directly contradicted the conclusions drawn from related lines of study conducted over a period of several years. If prospectively male twins were present in this series they were necessarily confined to origins from yolks of relatively small size.

TABLE I.

SIZE OF EGGS YIELDING TWINS COMPARED WITH OTHER EGGS FROM SAME BIRD.

No. of Female Parent.	Clutch.	Data on Eggs of Twin-bearing Clutch.				Average Weight of 5 Eggs Laid by Same Female Immediately:		Maximum and Minimum Weights for Other Than Twin-bearing Eggs (Same Year).		
		Date.	W't.	Per Cent. of Diff.	Sex (or Stage).	Before.[1]	After.[1]	Maximum.	Minimum.	Total
A248...	K1	4/7	7.43		♂	7.62	8.11	8.22	7.10	23
	K2	4/9	*10.63*	+43.1	♀ ♀	8.75	8.92	9.17	8.46	22
60...	F1	3/5	8.07		♂	8.21	7.58	8.68	6.72	22
	F2	3/7	*10.08*	+24.9	♀ ♀	8.13	7.84	8.65	6.15	21
V49[2]..	D1	10/16	15.77[2]		♂	14.80	17.05	17.40	14.80	8
	D2	10/18	*20.60*	+30.6	♀ ♀	15.33	18.06	18.23	15.33	7
P450...	D1	5/30	8.92		♂	8.76	9.02	9.21	7.82	17
	D2	6/1	*10.39*	+16.5	(4-5d.)	8.90	9.17	9.75	8.12	14
K465...	E1	3/4	8.00		(1.0d.)	7.59	7.95	8.87	6.87	17
	E2	3/6	*8.05*	+ 0.6	(2.5d.)	8.24	8.50	9.29	7.82	13
K465...	K	5/14	*8.47*	——	(4.5d.)	7.95	8.18	8.87	6.87	17
						8.50	8.64	9.29	7.82	13
P843...	C1	3/15	*6.40*	− 3.7	(3.0d.)	7.51	7.04	(?)	(?)	2
	C2	3/17	6.64		(2.0d.)	7.10	6.90	(?)	(?)	3

[1] In some instances the twin-bearing clutch was preceded or followed by fewer than 5 eggs (see second and last columns).

[2] Common pigeon; all other groups are ring-doves.

Note.—The weights of twin-bearing eggs are set in italic type. First and second eggs of the clutch are kept separate throughout the table.