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Effect of Multiple Plane Turning of Eggs During Incubation on Hatchability

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Effect of Multiple Plane Turning of Eggs During Incubation on Hatchability

E. M. Funk and Jas. F. Forward

The turning of eggs during incubation is necessary for normal embryonic development and successful hatching. In natural incubation the hen turns the eggs she is incubating by lateral movements of her body and by moving the eggs with her beak. The modern incubator turns the eggs with an electric motor that tilts the trays within the incubator and thereby tilts the eggs, which are trayed small end down, about their short axis, leaving them in two different positions while incubating.

Turning prevents the developing embryo from sticking to the shell membranes, reduces embryonic mortality throughout the incubation period and minimizes embryonic malpositions.

The operators of the early Egyptian and Chinese incubators turned, by hand, the eggs being incubated. Pliny, writing in the first century A.D. said, "It has been discovered that eggs placed on straw in moderate heat and turned day and night by an attendant would be hatched within the regular incubation period."

REVIEW OF LITERATURE

Reaumur (1749) advised turning twice daily, eggs being incubated artificially. Dareste (1885) reported that where eggs were not turned, the allantois frequently adheres to the yolk preventing the proper absorption of the yolk, or causing its rupture during the second or third week of incubation.

Eycleshymer (1907) found that where eggs were unmoved during the incubation period, only 15 per cent of the fertile eggs hatched. Eggs from the same hens that were turned at 6:00 a.m. and 6:00 p.m. daily, give a hatch of 58 per cent of fertile eggs. Banner (1920) reported that, with no turning, an 18 per cent hatch was secured; with one daily turning, 65 per cent; and with two daily turnings 77.9 per cent.

In each of ten trials involving a total of over 7,000 eggs, Lamson and Kirkpatrick (1918) obtained a better hatch from eggs turned five times daily than those turned twice daily.

Payne (1921) found that eggs turned four to six times daily during March and April hatched 4 to 22 per cent better than eggs turned twice daily with an average of about 10 per cent. Eggs handled in the same manner in May showed no advantage in the extra turnings. He also found that the percentage of deformed chicks was reduced during March and April by the extra turnings, but not in May. He stated that more results were needed to be conclusive.

Chattock (1925) found that eggs turned four to five times daily hatched from 6-10 per cent better than those turned only twice.

Bittenbender (1931) got an increase of 5.6 per cent hatch in four over two turnings daily.

Hannas (1919-1920) was doubtful whether turning more than four or five times daily resulted in further increase of hatchability, although Kotliarov (1936) believed turning eight times to be optimal.

Isnko and Martin (1932) using 8,000 eggs in both sectional type and force draft incubators, secured increased percentages of hatching with increased turning up to eight times daily.

Insko and Martin (1933) reported that the increase in hatchability of chicken eggs with more frequent turnings was due to a decrease in early embryonic mortality and in the incidence of certain malpositions.

Turning seems to be most necessary during the first week of incubation (Card, 1925).

Clark (1933) found that increasing the number of times the eggs are turned increased the growth of the chicken embryos. He found, however, that this effect was lost after the tenth day of incubation.

Olsen and Byerly (1936) compared the results of turning eggs three times daily in a hit or miss fashion with those obtained by moving the eggs up and down about their short axis 30° and their long axis 180° ninety-six times a day, and found an improvement of hatchability by 6.8 per cent and 7.0 per cent in two trials. These increases can more likely be attributed to more frequent turning (96 as compared to 3) than to position. They found that frequent turning in one direction resulted in high embryo mortality.

Byerly and Olsen (1931) found that eggs that had been incubated with the small end up gave low hatchability, because a large number of the eggs had embryos with the head in the small end of the egg. In this position, away from the air cell, it is very difficult for the chick to hatch.

Byerly and Olsen (1933) showed that chick embryos in the normal position have more than twice the chance of hatching than those with the head in the small end of the egg. In addition to low hatchability, eggs incubated with the small end up had a high percentage of embryonic mortality during the first 2 weeks of incubation. Byerly and Olsen later found (1936) that when the small ends of the eggs were held down during incubation, there was a noticeable decrease in the incidence of two malpositions: that of head in the small end of the egg (Malposition II) and that of head away from the air cell (Malposition IV).

Hutt and Pilkey (1934) studied the incidence of malpositions in eggs incubated: (1) in tilted trays with the large end of the egg at an angle of 45° above the horizontal and (2) in similar trays kept horizontal. The tilted eggs were turned in the usual way by rotating the tray through an angle of 90°. The others were turned by hand. Both groups were turned 2 or 3 times daily. It was found that the frequency of Malposition I (head between thighs) was twice as great in tilted as in horizontal eggs and that Malposition VI

(beak over wing) was 25 per cent higher. On the other hand, Malposition II (head in small end) was more than twice as frequent, and Malposition IV (rotated from air cell) more than 3 times as frequent in horizontal as in tilted eggs.

The cause of the beneficial effects of turning is not known, but the reasoning behind the research reported here is that frequent turning by bringing the embryo in contact with fresh egg material provides more suitable nutrition for the embryo and more favorable orientation of the embryo and thereby promotes more normal development. If this is true, turning in more than one plane (multiple-plane turning) or incubating the eggs in several positions should provide more suitable environmental and nutritional conditions for the developing embryo than by turning eggs through one plane only and incubating in two positions.

EXPERIMENTAL

To test the above theory, eggs were obtained from a commercial hatchery as well as from the University of Missouri Poultry Farm. These eggs were paired as they were placed in the trays for incubation. The same conditions prevailed throughout the remainder of the experiment except that the controls were turned a total of 60° in the conventional manner (through a single plane) to positions 1 and 2 - (See Figures 1 and 2) while the experimental lots were turned in two or three planes (60° in one plane and 80° in the other planes). The eggs were turned every hour or every two hours and those turned in two planes were turned to positions 3, 4, 5 or 6 (Figures 3, 4, 5 and 6) and those turned in three planes were turned six times daily (8:00 a.m., 10:00 a.m., 12:00 noon, 1:30 p.m., 3:30 p.m., and 5:00 p.m.) so that they incubated in positions 1, 2, 3, 4, 5 and 6 (Figures 1, 2, 3, 4, 5 and 6). All eggs were turned until the 18th day when the eggs were transferred to the same separate hatcher. From these positions the eggs were tilted every hour as in the single plane turning. The hatching results obtained are presented in Tables 1, 2 and 3.

It will be observed that in each experiment there was an increase in hatch of all eggs and of fertile eggs when the eggs were incubated in more than the conventional two positions now used in modern incubators.

Table 1 shows the results when the eggs were placed in different positions during incubation by tilting the trays lengthwise as well as by tilting the trays sidewise with the conventional mechanisms used for turning eggs during incubation. There was an increase in hatch from such turning.

Table 2 presents the results secured when eggs were incubated in two, four and six positions, the eggs being turned by tilting within the tray and the tray being turned sidewise only and not lengthwise. Better results were obtained when this method of turning the eggs was used than when the eggs were turned by tilting the trays both sidewise and lengthwise (Table 1). This difference may be due to the fact that with the incubator used, such changing of the arrangement of the trays affected the movement of air through the eggs and thus failed to provide an optimum environment for the full response of these eggs to multiplane turning during incubation.

Tables 1, 2, and 3 show highly beneficial effects from multiplane turning or multipositioning of eggs during incubation.

In each experiment there was an increase (1.0 per cent to 8.1 per cent) in the percentage hatch of all eggs set. These differences are statistically significant. They show decided improvement in hatching by turning in two planes or incubating in four positions and still better results by turning in three planes, and thereby incubating in six positions when 2, 4 and 6 positions were compared (Table 2). It will also be observed that eggs of low (59.8 per cent), medium (69.8 per cent) and high (80.5 per cent) hatchability were all benefited by this new method of turning (see Figure 7).

The quality of the chicks at the end of 21 days of incubation was definitely better when eggs were incubated in multipositions. They hatched several hours earlier and were "fluffed out" before the chicks incubated in the conventional manner. However, 24 hours after the chicks were in boxes these noticeable differences had disappeared.

The principal effect of multiplane turning was in the reduction of dead embryos during the later stages of incubation. Table 4 shows the different malpositions observed when the unhatched eggs were opened. Multiplane turning reduced the percentage of embryos developing with head-between-thighs, feet-over-head and beak away from air cell. Multiplane turning increased the incidence of embryos with head in the small end of egg. The incidence of head-between-thighs was reduced from 2.33 per cent to 0.66 and 0.60 per cent respectively. This is a relative decrease of 72 per cent and 74 per cent in the incidence of embryos with head-between-thighs.

Many additional experiments will be needed to clarify and answer the many problems suggested by the results reported here.

CONCLUSIONS

Hatchability of eggs was significantly increased by multiplane turning and thereby incubating in several (4 to 6) positions as compared to incubating eggs in two positions (conventional turning).

Eggs of low, medium, and high hatchability were all benefitted by incubating in more than two positions.

The principal result of multiplane turning was in the reduction of embryonic malpositions during the later stages of incubation, notably head-between-thighs, feet-over-head and beak turned away from air cell.

There was a noticeable difference in the quality of the chicks at the end of 21 days in incubation. Those incubated in four and six positions hatched several hours earlier than those incubated in two positions.

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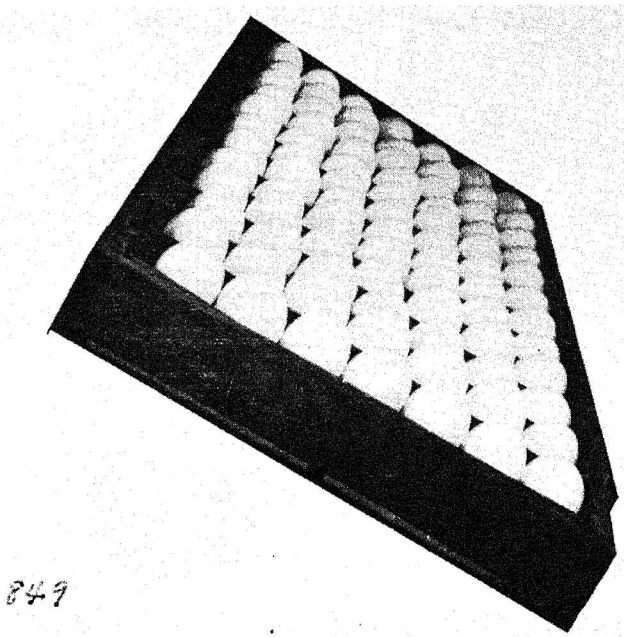

Figure 1. Eggs standing on small end in upright position, tray tilted to turn eggs to position 1 (conventional turning).

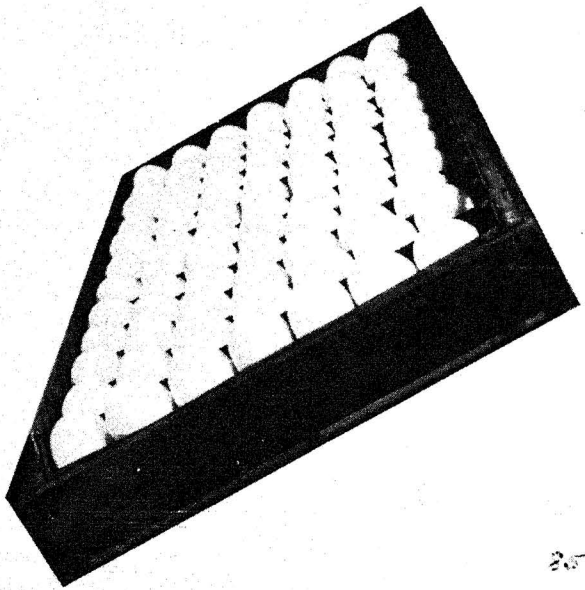

Figure 2. Eggs standing on end in upright position, tray tilted to turn eggs to positions 2 (conventional turning).

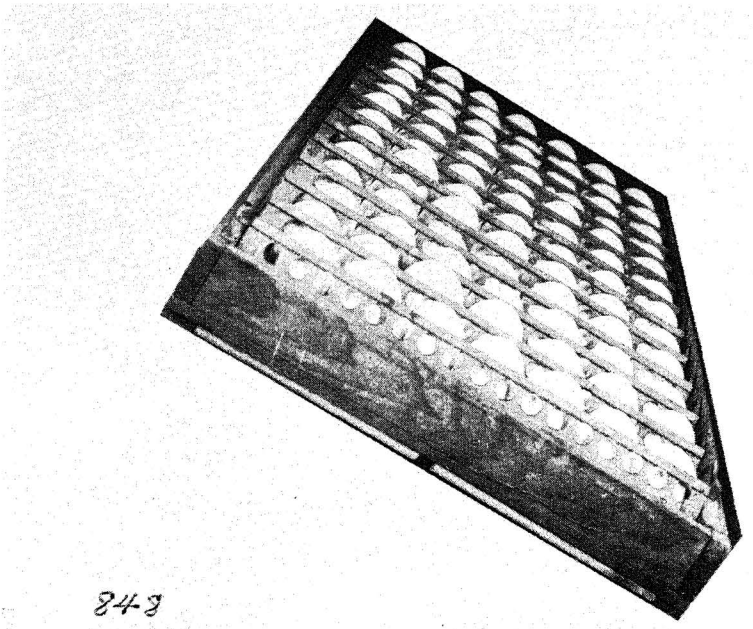

Figure 3. Eggs tilted in tray away from observer and tray tilted to place eggs in position 3.

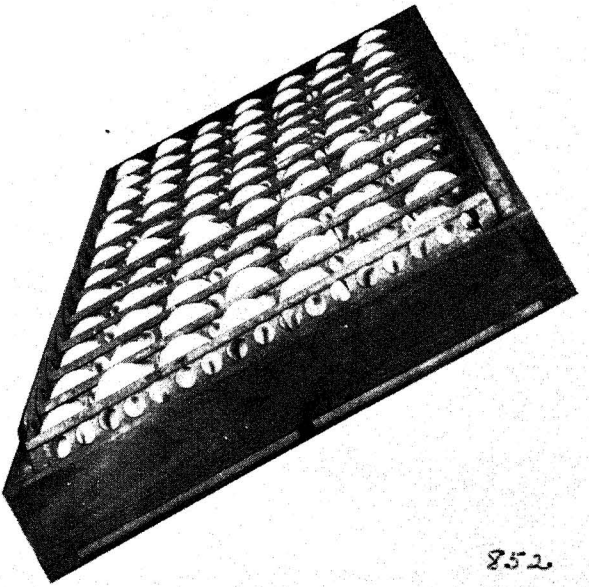

Figure 4. Eggs tilted in tray away from observer and tray tilted to place eggs in position 4.

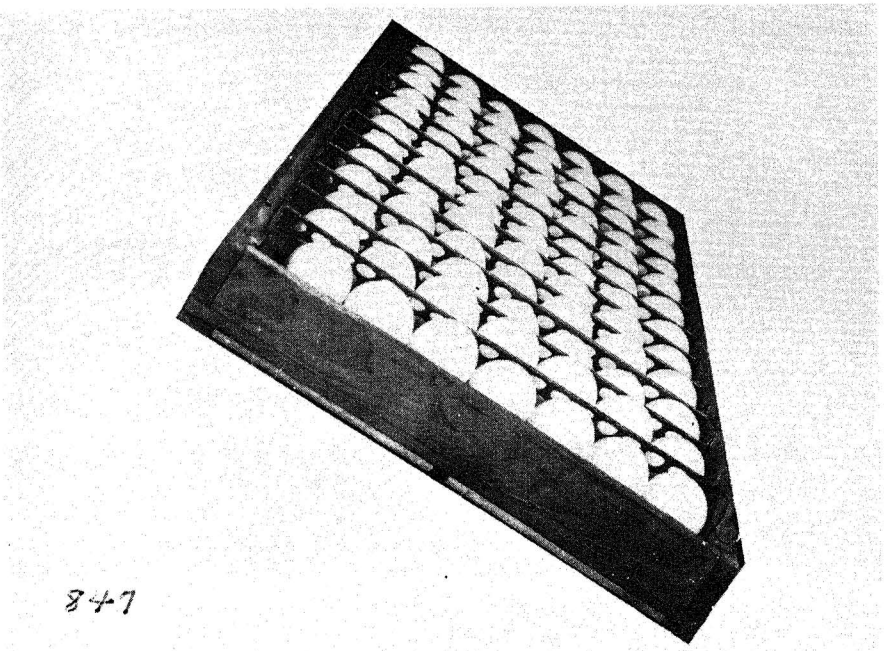

Figure 5. Eggs tilted in tray toward observer and tray tilted to place eggs in position 5.

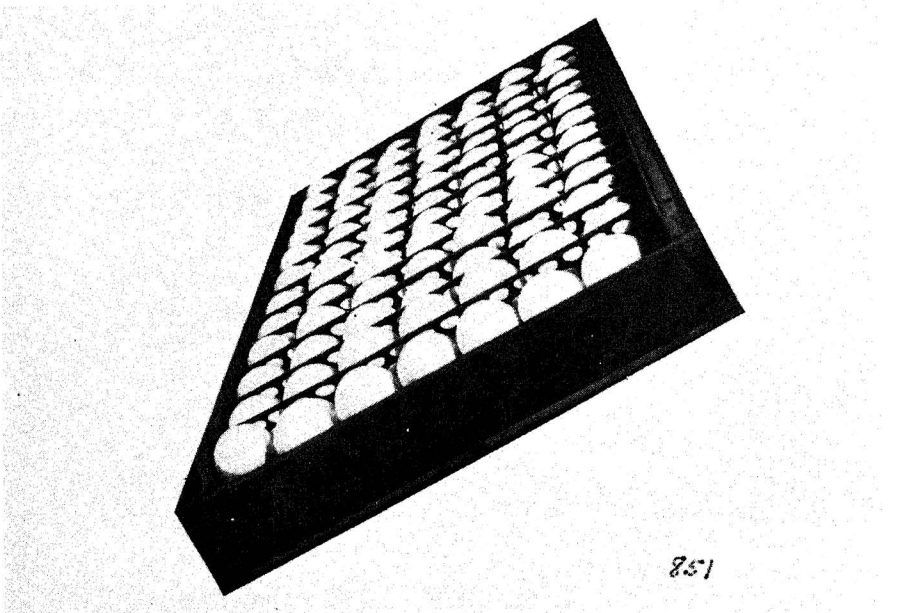

Figure 6. Eggs tilted in tray toward observer and tray tilted to place eggs in position 6.

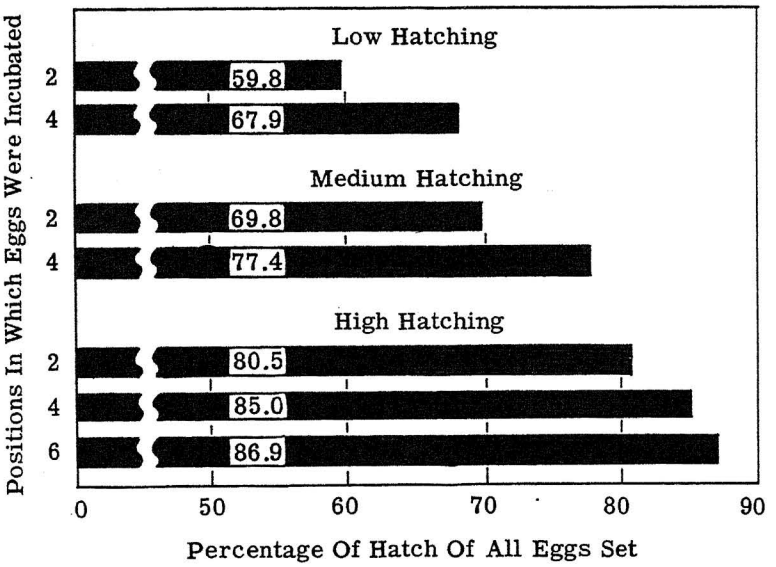

Figure 7. The beneficial effect of multiposition incubation of eggs of low, medium and high hatchability.

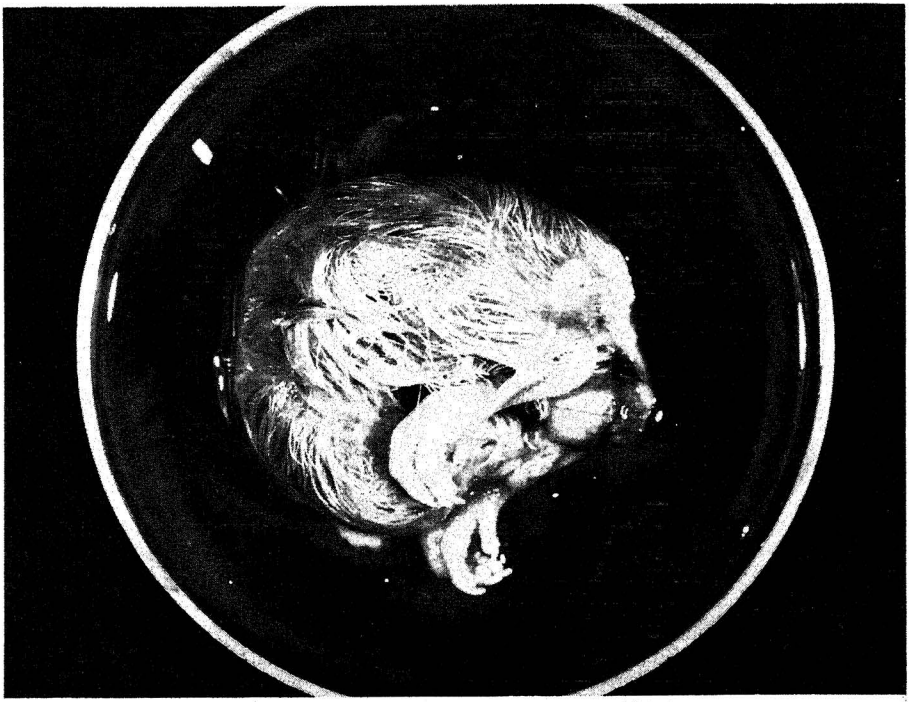

Figure 8. The embryonic malposition (head between thighs) which was minimized by incubating eggs in more than two positions.

Table 1--Effect on Hatchability of Incubating Eggs in Six Positions as Compared to Two Positions; the Eggs Being Turned by Tilting the Trays Both Sidewise (every 2 hours) and Lengthwise Three Times Daily (8:00 A.M., 12:00 noon, 5:00 P.M.) From Heavy Breeds; Mainly Delaware x New Hampshire.

Date Set	No. positions during incubation	Eggs set	Percentage Hatch of All Eggs	Difference	Percentage Hatch of Fertile Eggs	Difference
4-18-51	2	385	63.6		75.4	
	6	385	67.3	+3.7	82.5	+7.1
6-14-51	2	1419	63.7		74.8	
	6	1419	66.5	+2.8	76.8	+2.0
9-5-51	2	1383	70.1		76.1	
	6	1354	71.1	+1.0	77.0	+0.9
9-26-51	2	1506	69.1		76.2	
	6	1487	73.4	+4.3	79.4	+3.2
10-17-51	2	1329	73.8		79.3	
	6	1321	75.3	+1.4	82.3	+3.0
Total	2	6022	68.7		76.5	
	6	5966	71.2	+2.5	79.1	+2.6

Table 2--The Effect on Hatchability of Incubating Eggs in Four and Six Positions as Compared to Two Positions; the Eggs Being Tilted Six Times Daily in the Trays and the Trays Tilted From Side to Side Every Hour. White Leghorn Eggs Produced on the University Poultry Farm.

Date Set	No. Positions	Eggs set	Percentage Hatch of All Eggs	Difference	Percentage Hatch of Fertile Eggs	Difference
3-9-52	2	420	80.5		81.5	
	4	420	85.0	+5.0	86.7	+5.2
	6	420	86.9	+6.9	87.3	+5.8
	2	414	73.0		79.3	
4-15-52	4	420	74.8	+1.8	85.1	+5.8
	6	420	77.4	+4.4	85.8	+6.5
	2	414	72.2		82.6	
5-7-52	4	336	78.3	+6.1	89.5	+6.9
	6	420	75.7	+3.5	87.6	+5.0
	2	409	68.9		82.5	
5-26-52	4	336	71.4	+2.5	86.3	+3.8
	6	420	74.3	+5.4	89.1	+6.6
	2	1657	73.7		81.4	
Total	4	1512	77.7	+4.0	86.8	+5.4
	6	1680	78.6	+4.9	87.4	+6.0

Table 3--The Effect on Hatchability of Incubating Eggs in Four Positions as Compared to Two Positions; Eggs Set in January and February Were Turned by Tilting the Eggs in the Trays and by Tilting the Trays Sidewise, and the Eggs Set in March Were Turned by Tilting the Trays Both Sidewise and Lengthwise.

Date Set	Number of positions during incubation	Eggs set	Percentage hatch of			
			All Eggs	Difference	Fertile eggs	Difference
1-23-52	2	420	69.8		76.1	
	4	420	77.4	+7.6	83.3	+7.2
2-13-52	2	420	59.8		66.2	
	4	420	67.9	+8.1	74.4	+8.2
3-5-52	2	1401	65.7		69.9	
	4	1434	71.8	+6.1	78.0	+8.1

Table 4--Effect of Incubating Eggs in Two, Four, and Six Positions Upon the Development of Embryonic Malpositions as Observed by Opening Eggs That Failed to Hatch.

Number of Positions:		2		4		6	
Malpositions	Date Set	Dead in Shell	Per cent of Eggs Set	Dead in Shell	Per cent of Eggs Set	Dead in Shell	Per cent of Eggs Set
Head between thighs	3-9-52	13	3.10	4	0.95	4	0.95
	4-15-52	6	1.45	2	0.48	3	0.71
	5-7-52	10	1.93	0	0.00	1	0.24
	5-27-52	8	1.96	4	1.19	2	0.48
	Total	37	2.23	10	0.66	10	0.60
Head in small end	3-9-52	4	0.95	1	0.24	4	0.95
	4-15-52	0	0.00	3	0.71	8	1.90
	5-7-52	1	0.24	4	1.19	3	0.71
	5-27-52	2	0.49	3	0.89	3	0.71
	Total	7	0.42	11	0.72	18	1.07
Head left	3-9-52	2	0.48	0	0.00	3	0.71
	4-15-52	5	1.21	3	0.71	5	1.19
	5-7-52	1	0.24	2	0.60	3	0.71
	5-27-52	1	0.24	0	0.00	0	0.00
	Total	9	0.54	5	0.33	11	0.65
Beak away from air cell	3-9-52	11	2.62	8	1.90	8	1.90
	4-15-52	0	0.00	0	0.00	0	0.00
	5-7-52	4	0.97	2	0.60	3	0.71
	5-27-52	9	2.20	1	0.30	3	0.71
	Total	24	1.45	11	0.72	14	0.83
Feet over head	3-9-52	9	2.14	2	0.48	2	0.48
	4-15-52	5	1.21	8	1.90	4	0.95
	5-7-52	2	0.48	0	0.00	1	0.24
	5-27-52	7	1.71	2	0.60	2	0.48
	Total	23	1.39	12	0.79	9	0.54
Beak above right wing	3-9-52	7	1.67	10	2.38	8	1.90
	4-15-52	22	5.31	3	0.71	12	1.67
	5-7-52	5	1.21	1	0.30	1	0.24
	5-27-52	3	0.73	3	0.89	3	0.71
	Total	37	2.23	17	1.01	24	0.43
Sticky	3-9-52	4	1.19	2	0.48	1	0.24
	4-15-52	5	1.21	1	0.24	3	0.71
	5-7-52	1	0.24	0	0.00	0	0.00
	5-27-52	1	0.24	1	0.30	1	0.24
	Total	11	0.66	4	0.26	5	0.30
Normal	3-9-52	1	0.24	0	0.00	0	0.00
	4-15-52	14	3.14	8	1.90	7	1.67
	5-7-52	10	2.41	3	0.90	7	1.67
	5-27-52	6	1.47	2	0.60	5	1.19
	Total	31	1.87	13	0.86	19	1.13
Total No. Dead		179	10.80	83	5.49	110	6.55
Total Eggs Set		1657		1512		1680	