heart. Since morphine did not alter cardiac catecholamine levels, it was not surprising to find that isolated cardiac preparations failed to show any consistently different responses to either epinephrine, isoproterenol or tyramine in the presence or absence of morphine. It is possible that the beneficial results attributed to morphine in certain clinical conditions (see Introduction), may be the result of its central nervous system activity whereby catecholamines are released and peripheral levels eventually reduced, or by mechanisms unrelated to catecholamines (Guntheroth *et al*(17)). A likely possibility may reside in the explanation provided by Vasko and co-workers(13), who demonstrated that morphine markedly diminishes total peripheral resistance resulting in increased peripheral vascular capacitance and an overall improvement in hemodynamics. Their findings of augmented ventricular performance with morphine in the intact animal are in obvious conflict with earlier speculation that morphine would reduce "spasm" of the right ventricular infundibulum(3,4,5).

Summary. The action of morphine upon isolated mammalian cardiac preparations was reevaluated in order to test the hypothesis that morphine has the ability to antagonize the action of catecholamines on the heart. Over a wide range of concentrations (0.3-100 μg/ml) morphine slightly depressed contractile force, heart rate and coronary flow. Following exposure of the whole isolated heart preparation to morphine (100 μg/ml) for one hour, ventricular catecholamine levels were similar to their untreated controls. Furthermore, no consistent alterations in physiological response to epinephrine, isoproterenol or tyramine could be correlated with the presence or absence of morphine regardless of its concentration in the perfusate. These data fail to confirm the suggestion that morphine acts as a sympatholytic on the heart.

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Received March 8, 1966. P.S.E.B.M., 1966, v122.

Effect of Dietary Iodine Upon Egg Production, Fertility and Hatchability.*† (31245)

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Two recent reports(1,2) have described the toxic effects of excess dietary iodine upon rats and rabbits. The primary effect, when fed to pregnant rats, was a failure of lactation and high mortality of the young. Dietary levels of iodine from 500 to 2500 ppm as KI caused

* Florida Agri. Exp. Stations, Journal Series No. 2382.
† This work was supported by Grant AM08760, Nat. Inst. of Health.

TABLE I. Production, Fertility and Hatchability of Eggs from Hens Fed Iodine (10 Hens per Treatment).

ppm iodine	No. eggs Weeks 1	2	3	4	Total eggs	% Fertile	% Embryonic deaths*	% Died in shell*	% Hatched*	Delayed incubation, No. 24-36	36+†
					Trial 1						
0	31	26	29	32	118	94	5	6	88	—	—
2500	31	4	4	3	42	81	38	6	56	7	3
5000	22	0	1	0	23	83	11	32	58	4	1
					Trial 2						
0	44	35	37	37	153	86	13	4	83	—	—
312	36	39	36	36	147	86	44	8	47	10	5
625	34	28	35	32	129	78	66	6	28	5	5
1250	37	32	27	28	124	77	62	7	31	4	6
2500	30	13	9	7	59	83	59	10	31	2	3

* Based on fertile eggs. † Hours beyond average for control.

increasing mortality of the newborn which approached 100% at the higher level. Ovulation, implantation, number of young born and birth weight of young were not affected. The same levels of iodine fed to pregnant rabbits caused equal or greater mortality of the young but some female rabbits lactated even though all young died. Gestation time of rats was not affected, but prolonged and incomplete parturition and lack of mothering instinct were observed. Hamsters and swine were not affected by the dietary levels of iodine which were toxic to rats and rabbits (2).

Earlier studies with poultry(3,4) indicated harmful effects of excess iodine, but details of the effects upon reproduction were not reported.

The present study was designed to determine production, fertility, embryonic mortality and hatchability of eggs when hens were fed various levels of dietary iodine.

Methods. Eighty mature White Leghorn hens were used in 2 trials. Procedures for both trials were similar except for time and levels of iodine fed. In the first trial, iodine as KI was added to a basal laying diet in amounts to provide 0, 2500, and 5000 ppm. Levels of 0, 312, 625, 1250, and 2500 ppm were used in the second trial. The basal diet was composed of natural ingredients and identical to one previously described(5) containing 17% protein and 0.4% iodized salt which contributed 0.3 ppm iodine to the diet. Control diets contained K_2CO_3 to provide potassium equal to that in the diet with 2500 ppm iodine. Experimental diets and tap water were fed for 28 days to groups of 10 hens per treatment. Hens were housed individually in wire laying cages. On the day prior to iodine feeding, and weekly thereafter, hens were artificially inseminated using pooled semen from normal males.

Eggs were collected daily, identified and incubated at periodic intervals. On the 2nd, 4th, 9th, and 14th days of incubation, eggs were candled for determination of fertility and embryonic death. Hatchability was calculated as a percent of fertile eggs.

Results and discussion. Data representing egg production, fertility, hatchability and increased incubation are recorded in Table I. Hens fed 5000 ppm iodine ceased production within one week after the initial iodine feeding. Egg production ceased in 90% of the hens fed 2500 ppm in the first trial and rate of production at the same iodine level in the second trial was 21% of the controls. Production was slightly reduced in the third and fourth weeks in hens fed 1250 ppm iodine but not affected at the lower levels. All hens resumed laying within 7 days after removal from the iodine treatment. Molting, which normally accompanies a cessation of egg production, did not occur in hens which were fed iodine and ceased production. Body weight and condition of the hens were not adversely affected by the iodine fed.

Fertility of the eggs produced during the period of iodine feeding was not affected.

During incubation, however, mortality of the embryos was greater in eggs from hens fed iodine. Percent hatchability, based upon number of fertile eggs, was reduced from 85% in controls to an average of 43 and 58% in those fed 2500 and 5000 ppm iodine, respectively. Length of incubation time was increased by 24 hours or more beyond the normal in approximately 20% of the eggs from hens fed the two higher levels of iodine. Delayed hatching was also observed at the lower levels of iodine. Some embryos survived the incubation period but chicks died in the shell, apparently too weak to break the shell.

The adverse effect of iodine upon egg production appears to be temporary since hens resumed production after removal of iodine, but subsequent hatchability has not been determined. Rats and rabbits have produced and nursed litters normally after removal of dietary iodine(2). The absence of any acute gross effects upon hens appears related to similar observations on non-pregnant, non-lactating rats and rabbits. The mode of action of the excess iodine in producing the effects observed is not known, but results suggest an interference with hormone production or function.

A recent study(6) has shown that iodine depressed growth and increased mortality of chicks fed a diet low in chloride and also depressed growth when adequate chloride was fed. Dietary chloride (2400 ppm) in the present study was considered adequate and since little evidence for an interaction between the two elements was observed in the former study(6), a deficiency of chloride was apparently not a factor in this study. Following the report of chloride deficiency in relation to iodine, an experiment was conducted with rats(7) in which 2 percent additional NaCl was added to diets with toxic levels of iodine. The additional NaCl did not prevent or reduce the harmful effects of iodine.

Summary. Laying hens were fed 312 to 5000 ppm iodine as KI in a practical laying diet and egg production and hatchability determined. Production ceased within the first week in hens fed the highest level and production was reduced at the lower levels. Fertility of the eggs produced was not affected but early embryonic death, reduced hatchability and delayed hatching resulted. Hens resumed egg production within seven days after removal from iodine feeding.

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Received March 10, 1966. P.S.E.B.M., 1966, v122.