per cent. were in either position II, III or IV. A X^2 test for significance shows that the difference in the results, including all positions between the nineteenth and the twentieth day of incubation, is highly significant. It is evident that there is a decided shifting of embryonic position after the nineteenth day of incubation.

An examination of all embryos dying after the eighteenth day of incubation and examined on the twenty-second day of incubation shows that most of the so-called embryonic malpositions occur from the eighteenth to the twentieth day of incubation, with the exception of position VII. None of the dead embryos in this group were in the normal hatching position until the twentieth day of incubation. Also few of the embryos were in malpositions on the twenty-first day of incubation.

The data of the second phase of this study substantiate the examinations made in the first phase. There is a very decided change in embryonic position from the eighteenth to the twentieth day of incubation. An examination of 117 live embryos on the eighteenth day of incubation failed to show any individuals which could be classified in the normal hatching position. An examination of 100 live embryos on the nineteenth day showed 25 embryos in the normal hatching position. Thus there is a very decided increase of embryos found in the normal hatching position on the nineteenth day of incubation and a corresponding decrease in the number of embryos found in the so-called malpositions. On the twentieth day there is a marked change in embryonic position from that found on the eighteenth and nineteenth days, for 76 live embryos out of 103 examined were in the normal hatching position.

The results obtained from these embryonic examinations present a new problem on the concept of embryonic malpositions. Previous available evidence would indicate that embryonic malpositions are the immediate cause of death of the embryo, particularly after the eighteenth day of incubation. It is a well-known fact that embryonic mortality is generally the highest during the eighteenth and nineteenth day of incubation. Seemingly, then, malpositions might be one of the reasons for this high eighteenth and nineteenth day embryonic mortality. If, however, malpositions cause the death of the embryo very few of the eggs used in this study would have hatched. The position most prevalent on the eighteenth and nineteenth day of incubation is that of the head between the thighs, which has been designated as position II in this study. It is obvious that if the embryo persists in this position up to the twenty-first day the egg can not hatch.

The evidence presented is conclusive that embryonic changes take place within the egg after the eighteenth day of incubation and that certain of the so-called malpositions are but a natural occurrence in the normal development of the chick embryo. If embryonic death occurs during the approximate eighteenth day period the embryo will probably not be in the normal hatching position. It is very probable that certain of the previously designated embryonic malpositions are not necessarily lethal, but that death is caused by some other agency and the embryo is in its normal position for its particular stage of development.

NELSON F. WATERS
IOWA AGRICULTURAL EXPERIMENT STATION

MATERNAL BEHAVIOR IN MALE RATS[1]

MATERNAL behavior has recently been described[2] in *virgin* rats and attributed to the lactogenic hormone of the anterior pituitary. This paper proposes to show that maternal behavior can be induced experimentally in *male* rats and that this can occur in the absence of mammary development.

Chronic administration of bovine anterior pituitary implants (Table I), or complete thyroidectomy without treatment (Table II), induced adult male rats to

TABLE I

EFFECT OF CHRONIC ADMINISTRATION (60 DAYS) OF BOVINE ANTERIOR PITUITARY IMPLANTS ON ADULT MALE RATS (5 MOS. OLD)

No. rats	No. implants	Total mg tissue implanted	Weight in mg				Maternal behavior
			Hyp.	2 Adr.	2 Thyr.	2 Testes	
10	14	7,100	14	103	36	2,825	Yes
10*	.....	.....	9	36	43	3,171	No

* Controls.

behave differently from their normal brothers and virgin sisters, as evidenced by the following actions: (1) making a nest for young rats put in their cages, and lying over them for hours[3]; (2) nest-building and nesting even in absence of young; (3) settling down

[1] From a dissertation submitted in partial fulfilment for the degree of doctor of philosophy in anatomy, University of California.

[2] B. P. Wiesner and N. M. Sheard, "Maternal Behaviour in the Rat," London, 1933. O. Riddle, E. L. Lahr and R. W. Bates, *Proc. Soc. Exp. Biol. Med.*, 32: 730, 1935.

[3] The young suck the skin and hairs of the abdomen, and are permitted to hang on the hairs when the foster parent arises.

TABLE II

EFFECT OF THYROIDECTOMY ON MALE RATS (3½ MOS. OLD) OPERATED ON AT THE AGE OF 1 MONTH

No. rats	Body wt. (gm)	Weight in mg				Maternal behavior
		Ant. Hyp.	2 Adr.	2 Thyr.	2 Testes	
20	215	13	36	.....	2,965	Yes
20*	290	6	37	41	2,989	No

* Controls.

for long periods on a pile of newborn rats in a can placed on a table; (4) picking up the newborn rats and licking them in a maternal way; (5) desire to doze and snuggle in corners or up against objects, if given the freedom of a large shelf in the laboratory; (6) tendency to huddle in small groups, at intervals licking each other affectionately, when allowed to roam at will on the floor.

In both groups, the pituitaries were considerably enlarged, compared with those of the male controls. No mammary development was observed in the thyroidectomized males.

MORVYTH MCQUEEN-WILLIAMS
UNIVERSITY OF CALIFORNIA
BERKELEY

EGG QUANTITY AND THE RESPIRATORY RATES OF SEVERAL MARINE EGGS

IN previous publications[1] the rates of oxygen consumption by the eggs of *Fucus, Cumingia, Nereis, Chaetopterus* and *Arbacia* were expressed in mm^3O_2 per hour per 10 mm^3 eggs. The quantity of eggs was determined in volume units by centrifuging to approximate equilibrium packing of the eggs in calibrated vaccine tubes having diameters of the order of 2 mm. As the eggs distort to pack tightly under strong centrifugal force, the measured volumes were regarded as only slightly too great, due to interstitial space among the eggs. The centrifugal force used was not reported.

More recently, in the case of *Arbacia,* Gerard and Rubinstein[2] have compared volume determination by centrifuging, and by haemocytometer counts and dilution counts with measurements of egg size. They have found centrifuge determinations to average 80 per cent. or more too great. This was with relatively low centrifugal force, 400–750 × gravity. Shapiro[3] has compared the equilibrium centrifuge volume of *Arbacia* eggs at various centrifugal forces with the volume determined by haemocytometer and dilution counts. He finds that at 2700 × g centrifuge volumes agree with determinations by haemocytometer counts to within an average of approximately ± 10 per cent. Fifteen determinations showed an average greater volume by centrifuging of 12 per cent., while fourteen showed an average lesser volume of 7.7 per cent.

Since the magnitude of the error of volume determination by centrifuging depends on the centrifugal force (being greater at low force), the particular centrifugal forces used in deriving the respiratory rates referred to above should be reported. When conversion factors have been established for the several eggs the rates may then be converted to absolute volume units. Late in the summer of 1934, with the kind assistance of Dr. Samuel Pond, the same (unaltered) centrifuge previously used at the Marine Biological Laboratory for the eggs referred to (except *Fucus*) was accurately calibrated under conditions previously used. The centrifugal force was 2850 × g, or if an allowance of 10 per cent. speed retardation during calibration is made, it may have been as high as 3400 × g. The duration of the original centrifuging in the cases of *Cumingia, Nereis* and *Chaetopterus* was 15 minutes. *Arbacia* eggs were centrifuged in some cases 15, in some 10 and in some 18 minutes. *Fucus* eggs were centrifuged 15 minutes or longer at lower centrifugal force, probably of the order of 1500 × g.

This does not affect relative rates previously given for the same eggs measured before and after fertilization. Comparisons[4] of absolute rates of different species of eggs (or of the same species when volumes are measured by different methods) are untenable,[2] except upon the assumption that the errors of volume determination are small (or are similar[5]).

D. M. WHITAKER
STANFORD UNIVERSITY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

STROBOSCOPIC OBSERVATION OF CILIARY MOVEMENT IN THE PROTOZOA

STROBOSCOPIC observation is carried out by means of light interrupted into consecutive flashes of known frequency and duration. In the study of normally beating cilia under a microscope supplied with stroboscopic light it is possible by varying the flash frequency to obtain the effect of slowing the cilia to any

1 *Jour. Gen. Physiol.,* 15: 167–200, 1931; and 16: 475, 1933.
2 *Ibid.,* 17: 375, 1934.
3 *Biol. Bull.,* in press.
4 *Jour. Gen. Physiol.,* 16: 497, 1933.
5 J. Runnström, *Protoplasma,* 20: 1, 1933.