the island of Shapinsay (3,000 acres). *Laminaria saccharina* is dominant in both areas.

Unlike the formula above, it is found that the square root of the mean density of total sampling operations divided by the percentage cover is approximately a constant:

$$\frac{\sqrt{d_t}}{C} = k,$$

where d_t is mean density of total sampling operations, and C is cover (number of samples with weed expressed as a percentage of total number of sampling operations).

For Bay of Firth

$$\frac{\sqrt{d_t}}{C} = 3{\cdot}04 + 0{\cdot}10f\ (\pm 4\%)\ 1\text{–}6 \text{ fathoms L.W.}$$

For Shapinsay

$$\frac{\sqrt{d_t}}{C} = 4{\cdot}06 - 0{\cdot}07f\ (\pm 4\%)\ 1\text{–}7 \text{ fathoms L.W.}$$

Very strong tidal streams are associated with Wide Firth.

A recently completed survey of Sanday Sound (8,300 acres), involving more than 2,500 sampling operations, showed a similar formula to that found for Bay of Firth and Shapinsay. *Laminaria saccharina* is the dominant species in these two areas, whereas *Laminaria Cloustoni* is dominant in Sanday Sound as in Scapa Flow.

The value for Sanday Sound is

$$\frac{\sqrt{d_t}}{C} = 3{\cdot}05 - 0{\cdot}02f\ (\pm 5\%)\ 1\text{–}10 \text{ fathoms L.W.}$$

$$\text{Now } d_t = d_w C.$$

$$\therefore \frac{\sqrt{d_t}}{C} = \sqrt{\frac{d_w}{C}},$$

$$\text{so that } d_w \propto C,$$

where d_t is mean density of total sampling operations, d_w is mean density of sampling operations which brought up weed, and C is cover expressed as percentage.

It follows, therefore, for Bay of Firth, Shapinsay coast and Sanday Sound, where very strong tides occur, that seaweed density (d_w) is directly proportional to the cover of the whole area, and in Scapa Flow and around the Argyllshire coast, where strong tidal streams do not occur, the mean density (d_t) of the whole area is inversely proportional to depth.

In the former cases $d_t \propto C^2$ and in the latter case $d_t \propto 1/f$.

Variations from the constant, $\frac{\sqrt{d_t}}{C}$, are due to small differences in the weights of individual plants.

Sampling has shown that at 4 and 5 fathoms in the Bay of Firth and Shapinsay, the *number* of plants and not their individual weights is chiefly responsible for great differences in mean density. The number of plants is found to be exactly proportional to the cover of the whole of the survey areas:

	% Cover at 4 and 5 fathoms	No. of plants/unit area
Bay of Firth	41	2·5
Shapinsay	77	4·7

The most interesting points brought out in these surveys of the sublittoral zone is that seaweed density of the larger brown algæ and the depth at which they grow conform to two simple mathematical laws: (1) that where strong tidal forces occur, the density of algæ is proportional to the weed coverage of the *whole* area. This can be accounted for by reproduction and spore dispersal; (2) that where strong tidal forces do not occur, the density is inversely proportional to the depth at which the algæ grow.

Full details will be published later.

The above surveys are part of the programme of research of the Scottish Seaweed Research Association.

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Transplantation of Fertilized Rabbit Ova: the Effect on Viability of Age, *in vitro* Storage Period, and Storage Temperature

In 1890 and 1897, Heape[1] demonstrated the unimportance of somatic tissue to the germ cells by his successful transplantation of rabbit ova to a uterine foster mother. In 1934, Pincus and Enzmann[2] obtained normal young by transplanting rabbit ova fertilized or cultured *in vitro*. Recently[3], I reported normal development of ova stored at low temperature, and an optimal temperature for storage. I now have data on the probability of normal development after various treatments.

Ova were obtained from superovulated rabbits[4], and kept in undiluted rabbit serum. 25 hours after insemination they were recovered from the oviducts, and were mostly in the two-cell stage. If recovered after 72 hours they were mostly morulæ, some in the oviducts and some in the uterus. At 96 hours they were nearly all in the uterus, some being at the blastocyst stage. The ova were either transplanted fresh, or stored at 0° C. (slow cooling over a five-hour period) or at 10° C., or cultured at 38° C. (subcultured daily), before transplantation.

Recipient does were caused to ovulate by gonadotrophin injection. In one series of experiments, fresh 25-hour ova were transplanted to the uterus. In all the other experiments (most of which are summarized in the table), irrespective of the period of culture or storage, ova one day old at recovery were transplanted to the oviducts of does injected one day before the operation, while ova three and four days old were put into the uteri of does injected three and four days previously. Ova were placed in the oviducts through the fimbria, and into the uterus by puncturing its wall with a pipette containing the ova. Each host doe received five to twenty ova, the average number being increased with the length of time the ova were kept *in vitro*.

Most of the pregnant recipient does were killed 25–28 days after the operation. Some fœtal degeneration is normal in the rabbit[5], and young dead *in utero* (about 6 per cent of all young) were taken to represent normal development. The sex of live young, the number of maternal placentæ (ova implanted but failing to develop) and number of fœtal placentæ (resorption of embryo or fœtus) were recorded.

TRANSPLANTATION OF FERTILIZED RABBIT OVA: THE EFFECT ON VIABILITY OF AGE, *in vitro* STORAGE PERIOD, AND STORAGE TEMPERATURE

Storage temperature (°C)	Storage time (hr.)	Age of ova before storage (days)	Number of				Young as percentage of ova transplanted
			Ova transplanted	Recipient does	Does pregnant	Normal young	
30	1–2	1	239	24	21	130	54
		3	132	11	5	41	31
		4	89	9	5	21	24
10	24	1	94	7	4	35	37
		3	103	7	6	38	37
		4	138	8	7	26	19
	96	1	182	14	9	28	15
		3	46	4	3	21	46
0	24	1	91	7	3	10	11
	96	1	146	9	4	9	6
38	24	1	137	13	8	28	20
	48	1	153	9	6	41	27

The results (see table) show: (1) that the younger the ova transplanted, the better is their chance of normal development. This is seen clearly in the case of ova freshly transplanted (1–2 hours storage time) and is also shown with ova stored 24 hours at 10° C. In the latter series the percentages of ova developing normally in the does actually pregnant were respectively 70, 44 and 22 with ova recovered at one, three and four days. The figures for ova kept 96 hours at 10° C. are not in agreement with this result; but the 46 per cent survival of the three-day ova is exceptionally high—perhaps because of the small number of cases.

(2) With storage at 0° C., normal development of one-day ova was very low after only 24 hours; but some young (6 per cent) were obtained after 96 hours storage. None of 59 three-day ova stored for 96 hours at 0° C., and transplanted among four does, developed into normal young. These results confirm that 10° C. is the optimal temperature for storage—as previously found[3] in a study on cleavage *in vitro*.

(3) When ova recovered at one day were cultured at 38° C. and then transplanted to the oviducts of does injected one day before operation, 20 per cent of those cultured 24 hours developed normally, and 27 per cent of those cultured 48 hours; but none of 109 ova cultured for 72 hours (six does) yielded normal young.

(4) The sex ratio of the young was not altered after storage *in vitro*; there is, therefore, no obvious differential mortality of the sexes at different storage temperatures. Of 429 young, only one, dead *in utero*, was abnormal, having a hernia and deformation of the fore limbs. It is probable that defective ova or embryos degenerated early. Because all non-pregnant animals were not sacrificed for examination, the recorded degeneration may be lower than its actual occurrence; several does were diagnosed as pregnant at two weeks but found to be not pregnant later, presumably owing to early degeneration of embryos.

Most of the ova that did not develop normally left no trace of having become implanted. Degeneration after implantation was more common with cultured or stored ova than after fresh transplantation. For does pregnant from freshly transplanted ova the mean litter size was 6·2, plus 0·58 degenerate. The corresponding figures for ova stored at 10° C. were 5·1 and 1·55, and for cultured ova 4·9 and 1·93.

(5) In the experiments previously mentioned, two-cell ova were transplanted to the oviduct; in other experiments (not shown in the table) they were freshly transplanted to the uterus. 92 one-day ova were divided among six does injected 72 hours before operation; none developed normally. 109 one-day ova were placed in the uteri of does 24 hours after injection; of the eight recipients one only became pregnant, the thirteen transplanted ova in this animal being represented at killing by a single normal fœtus, with no trace of other implantations. It seems that two-cell ova can survive *in vitro* at 0° C., 10° C. or 38° C., but fail to do so *in utero*.

(6) The following cases demonstrate the normal potentiality for development of large numbers of ova obtained by gonadotrophin injection; 53 two-cell ova from one doe, transplanted to four others, yielded 46 normal young. In another instance, 26 young were obtained from 35 two-cell ova divided among three recipients.

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Hearing in Cetacea

DR. FRASER's remarks in *Nature* of November 29, 1947, p. 759, on sounds emitted by dolphins reached me by sea transport shortly after I had made the following observations which appear pertinent to his subject.

While examining male adults of the sperm whale (*Physeter catodon*) on board this factory, I have established that the external auditory meatus is a short blind sac which penetrates from the auditory aperture a distance no deeper than the blubber thickness, and which has altogether lost organic connexion with the middle ear. The sac has somewhat thickened unpigmented walls wherein muscular tissue may be developed: internally, these walls are thrown into transverse folds. On the other hand, the blue whale and the fin (*Balœnoptera musculus* and *B. physalus*) retain the normal mammalian pattern, and in these whales one can trace, from external aperture to tympano – petrosal bone, a continuous meatus the thin smooth epidermal lining of which is pigmented