An Evaluation of Six Alternative Compounded Diets for Juvenile European Lobsters (Homarus gammarus L.)

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ABSTRACT

Good results have been obtained from feeding hatchery produced lobster juveniles on natural diets but preparation and husbandry is labour intensive. This trial evaluated alternative diets which were commercially available or manufactured at Ardtoe. The best such diet in terms of stock growth and survival and suitability for automatic dispensing was a specially formulated crab-based pellet. This has now been adopted for the mass rearing of juveniles in the hatchery.

1. INTRODUCTION

In 1983 a lobster hatchery was established at Ardtoe to provide up to 10,000 four month old juveniles per year for stock enhancement trials in Scottish waters. The feeding of these animals has generally been based on their likely diet in the wild and natural diets such as mussel (Mytilus edulis), mysid shrimps (Order Mysidacae) and common shrimp (Crangon vulgaris) have given good results in terms of growth and survival of the stock. Unfortunately the preparation and feeding of such diets is very labour intensive and the husbandry associated with the initial batch of 2,300 individually held juveniles proved to be virtually a full time occupation for one person. This highlighted the requirement for an alternative, pre-prepared diet which could be dispensed by automatic feeder to reduce husbandry requirements to a minimum. During the winter of 1983/84, a number of proprietary diets intended for other species, but thought to be suitable for lobsters, were tested along with three pelleted diets specially manufactured at Ardtoe. The trial stock comprised 610 animals from the July 1983 hatch.

2. MATERIALS AND METHODS

2.1. Lobster Holding System

In order to avoid aggression and cannibalism in the stock, the lobsters were held in individual containers from post-larval stage IV onwards. These "cells" were formed from mesh bottom plastic trays subdivided into 80 compartments each 5cm x 5cm in area and 8cm deep. The trays were placed in shallow tanks supplied with 6 l/min. heated seawater (90% recirculation) at

15(±2)°C and supported 2cm above the tank floor allowing uneaten food, faeces and detritus to drop through the 2mm sq. mesh. An automatic tidal flushing mechanism on the tank outlet provided a positive water exchange through the mesh floor by varying the water level in the containers between 3 and 6cms above the mesh every 15 minutes or so. The trays were removed once a week for the tanks to be drained, cleaned and refilled.

2.2. Diet Preparation

As no pelleted food has been commercially formulated for lobsters it was decided to compare those commercial dry diets thought to be suitable with three alternative diets manufactured at Ardtoe. The commercial diets selected were an eel crumb made by British Petroleum and a salmon crumb and experimental prawn diet both made by Unilever. The "home made" diets were based on fresh fish, crabs and mussel flesh and were formulated as follows:

1. Fish based

   54.5% minced herring

   34.7% herring meal

   8.4% wheatmeal

   2.4% alginate

2. Crab based

   48.2% minced crab: *Cancer*, *Carcinus* and *Leiocarcinus*

   40.6% herring meal

   8.6% wheatmeal

   2.6% alginate

3. Mussel based

41.6% chopped mussel flesh

47.6% herring meal

8.3% wheatmeal

2.5% alginate

The raw fresh ingredient was minced and mixed with herring meal, which gave the fresh ingredient a drier consistency, together with wheatmeal and gluten as binders. The mixture was then extruded through a 2mm die and broken into pellets 3-4mm long. The pellets were frozen in semi-moist form and thawed before feeding.

The ingredients of the commercial diets were not disclosed. The eel and salmon crumbs were size 03 and had an average diameter of 2mm. The experimental prawn diet was in pellets 2mm diameter x 5mm long. To widen the scope of the trial these diets were also administered with a fresh food supplement of mussel flesh and mysid shrimps. This fresh feed was used as the control diet for the trial, the mysid shrimps having been collected locally and stored frozen.

2.3 Feeding and husbandry

The lobsters for the trial had been reared on fresh food for two months at the Ardtoe hatchery before being stocked in 10 different trays, one for each diet treatment.

The 10 different treatments were as follows:

Tray No.	Diet
1	Fish-based pellet
2	Crab-based pellet
3	Mussel-based pellet

4	BP Eel crumb
5	Unilever prawn pellets
6	Unilever salmon crumb
7	BP Eel crumb & fresh supplement
8	Unilever prawn pellets & fresh supplement
9	Unilever salmon crumb & fresh supplement
10	Fresh food only (control)

The animals were fed the dry diets every week day, with treatments 7, 8 and 9 receiving a bi-weekly supplement of fresh food, which was alternately chopped mussel and frozen mysid. The control (Treatment 10) was fed for four weekdays on frozen mysids and for one weekday on chopped fresh mussel. Feeding took place after a daily inspection and removal of waste food and mortalities. This was continued for 138 days for treatments 1, 3, 4, 5, 7 and 9 and up to 170 days for treatments 2, 6, 8 and 10. Each treatment started with 60 animals, except tray 10 (control) which had 70. After 18 days an accidental overflow in the tank holding trays 1-5 caused a few mortalities due to fighting where animals had moved from one container to another. For the purpose of the trial these animals together with individuals suspected to be in the wrong container were removed and discarded from any of the calculations. At the start of the trial the lobsters were weighed individually (to $\pm$0.01g) after drying on paper towelling. They were weighed again after approximately 50 days, and finally after 135-140 days (except

treatment 2 where the final weighing was after 95 days). It was not possible to weigh all the lobsters in the trial on the same day and so the start of the trial and subsequent weighings were staggered over a number of days. Conditions in the recirculation system were sufficiently constant to allow the assumption that this staggering had no effect. Feeding of diets 1, 3, 4 and 5 was terminated after the final weighing at approximately 138 days as survival was poor, (see Fig.1) but the remaining treatments were continued for 170 days to further monitor survival.

3. RESULTS

Mortalities among the experimental lobsters were noted daily and the monthly totals are plotted in Fig.1 as a percentage of the initial numbers. This shows the survival as being high for the first two months (all treatments over 95%). After this time survival subsequently dropped by varying degrees. The animals fed only dry pellets generally showed poorer survival than those supplemented with fresh food. Only 17 out of an initial 58 animals on the fish based pellet (29%) were alive after 139 days. Those fed prawn pellets, eel crumb and mussel based pellets performed only moderately, survival being between 58% and 75% after the same period. Two dry diets did return good survival however, salmon crumb and crab-based pellets giving 90% and 94% respectively after 170 days. The lobsters fed dry pellets supplemented twice weekly with fresh food all survived throughout, while in the fresh fed control 95% survived.

To compare growth rates among all the experimental stock regardless of weight, specific growth rates were calculated for the intervals between weighings. The specific growth rate is an

expression of percentage increase in body weight on a daily basis, according to the formula:

$$S.G. = \frac{(Ln\ Wt - Ln\ Wo)}{t} \times 100\%$$

where S.G. = specific growth

Wt = weight at time t

Wo = Initial weight

t = time interval in days

Specific growth was calculated from the mean weight of the survivors in each treatment for two intervals as shown in Table 1 The results are at the mid point of their respective intervals in Fig.2. All the growth rates in the second interval are slower than in the first, the relative decrease varying considerably.

The prawn diet gave high initial growth rates with and without supplement, but the drop off was quite rapid. Several of the dry diets exceeded the growth rate returned from the fresh control in the first interval. However the control animals were the fastest growing during the second interval.

Fig.3 shows a combination of growth rate and survival in the total biomass change within each treatment. Where growth rate and latterly survival were poor the total weight of the stock actually decreased in treatments 1 and 5. The high survival and consistent reasonable growth puts the fresh fed or fresh supplemented animals (treatments 7-10) clearly above the dry fed

treatments. However if the curve for treatment 2 (crab pellet) was extrapolated it would fall not far below that for the animals which received fresh food. Although salmon crumb (treatment 6) returned good survival the growth rates were poor and so the total weight increase was low.

4. DISCUSSION

The range of diets used gave considerable variation in performance, some exceeding the fresh fed control which was expected to return the best growth and survival. It seems likely that the good performance of treatments 7, 8, and 9 which were supplemented with fresh food was mainly due to the supplement. In terms of growth and survival they approximated the fresh fed control whereas they could have been expected to fall somewhere between the control and their unsupplemented counterparts. Differences between these supplemented diets are therefore probably not very meaningful.

The high survival amongst all the stock for the first 60 or so days may well be because they had been grown from post-larvae (weight Ca.0.04g) up to juveniles of around 0.55g on fresh food for 2-3 months before the start of the trial. They probably had considerable nutritional reserves so that deficiencies took a long time to appear in the form of poor growth and survival. Two rather strange patterns are that growth was vigorous in the prawn diet treatment for the first interval and rapidly dropped in the second. The survival did drop at the same time however. The other inexplicable result is that although survival was good in the salmon crumb treatment, growth was poor, which was consistent with the supplemented salmon crumb having the slowest overall

biomass increase of all the treatments receiving fresh food (see Fig.3). The crab-based pellet returned a good combination of growth and survival and exceeded all the dry diets in overall biomass increase. The growth rate of the mussel pellet fed survivors did in fact exceed that of the crab pellet animals in the second interval, although their survival was poor.

All the growth rates in the second interval were slower than in the first. The size of the container is recognized as being a possible restriction on growth rates and this may have started to have an influence in the second interval. However the fresh fed control animal's growth rate dropped only slightly (0.96%/day to 0.85%/day), and so it is likely that the differences in growth shown in the trial are indeed attributable to the differences in nutritional value of the food.

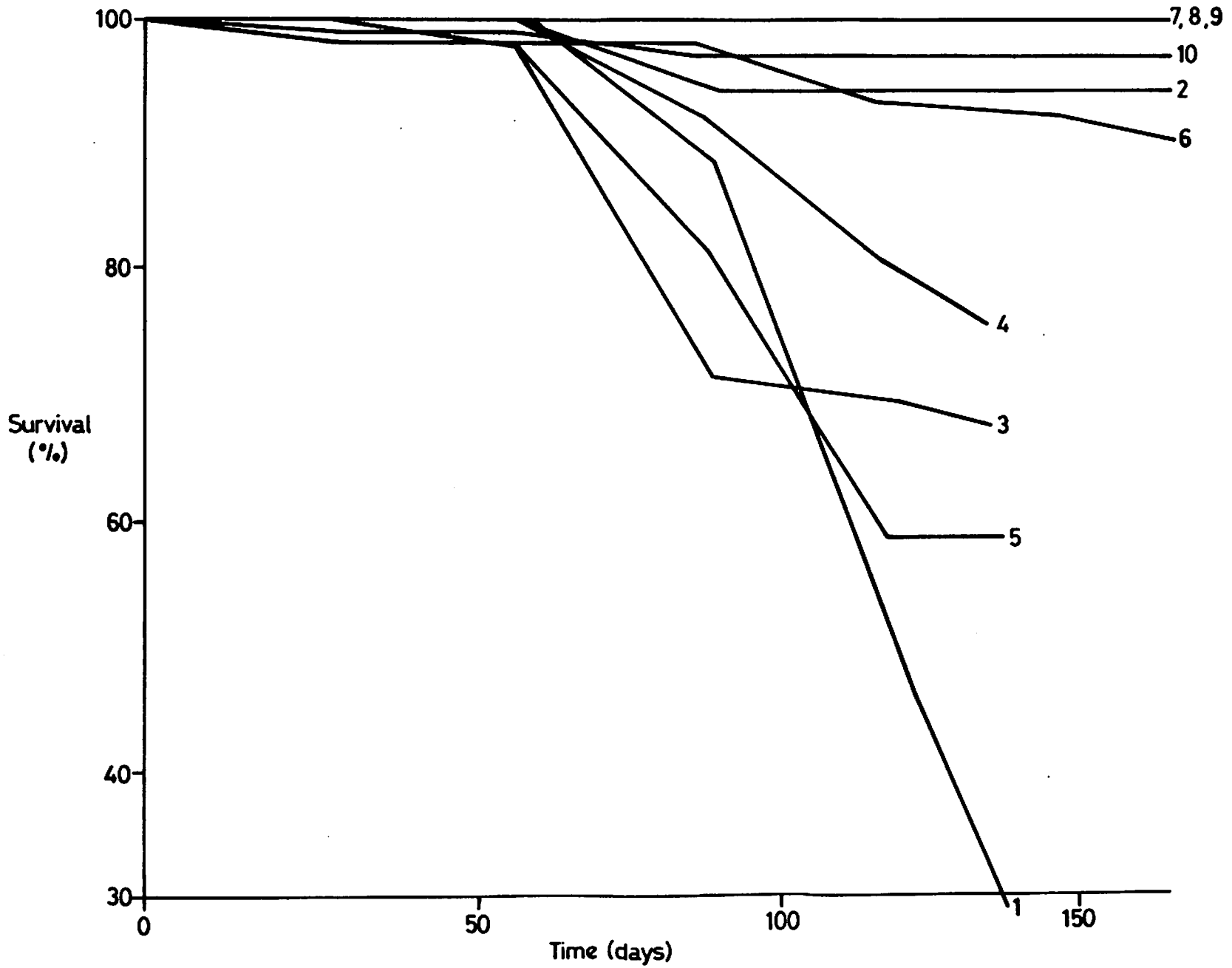
As the crab-based pellets returned the best overall performance without supplement this diet has been adopted for the mass rearing of juveniles at Ardtoe in 1984. Subsequent trials have shown that when dried at 30^{o}C for 24 hours the pellet maintains good performance and can be dispensed using an automatic feeder. To ensure that the main production batches achieve the best possible growth and survival, the crab pellet is used with a fresh food supplement, which rank it equal to or above the other supplemented diets used in this trial.

5. FURTHER WORK

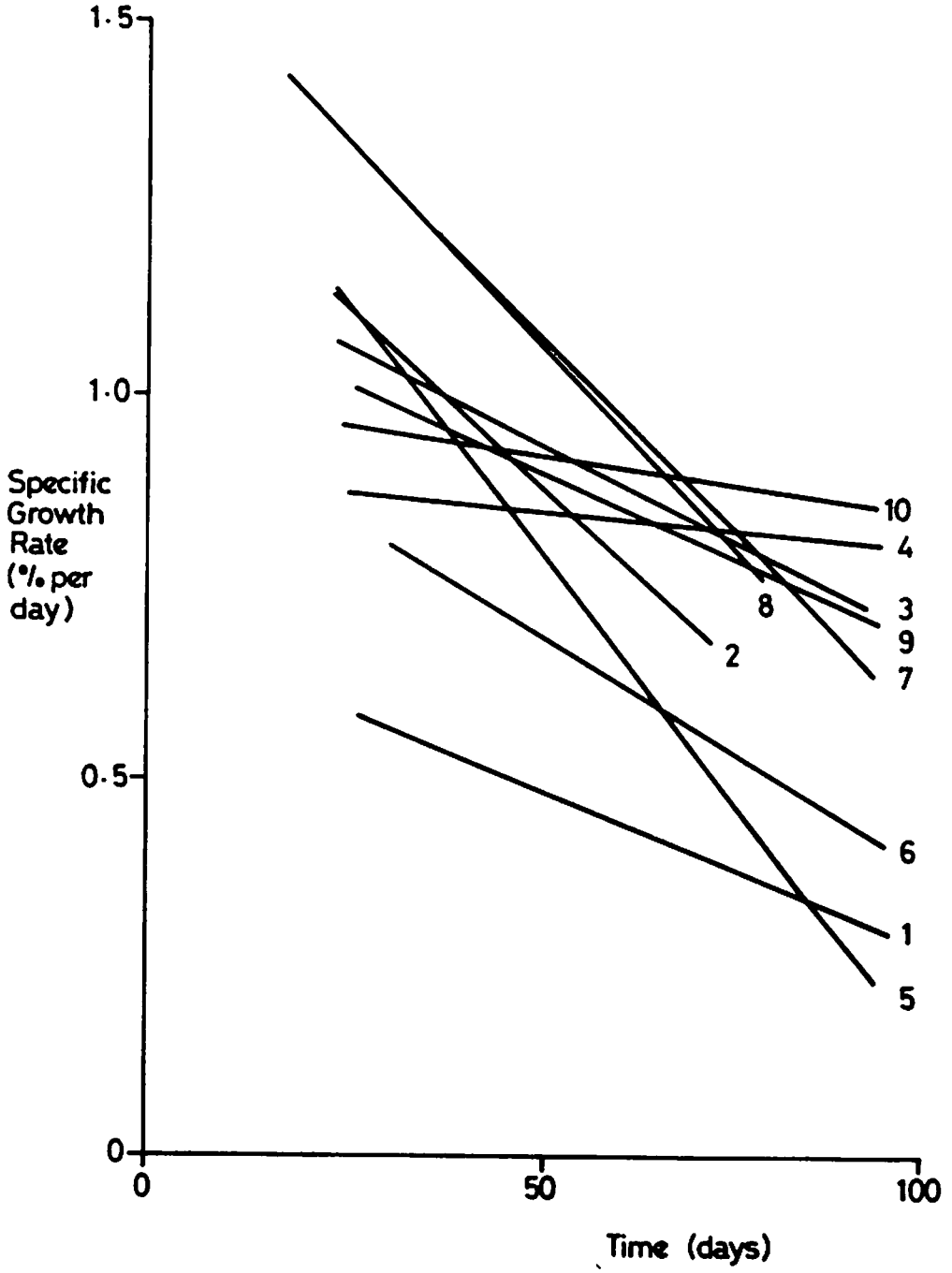
During the summer of 1985 it is proposed to examine more closely the comparative growth rates of juveniles fed on different combinations of the crab pellet and fresh supplements. The age of the stock will be similar to that normally held in the hatchery, more frequent sampling will be carried out and greater attention will be directed to the effects of moulting on growth.

TABLE 1 Specific growth rates in two intervals of juvenile *Homarus gammarus* fed various diets

Tray No.	Treatment	Interval 1	Specific Growth	Interval 2	Specific Growth
1	Fish based	d1 - d50	0.58	d51 - d139	0.29
2	Crab based	d1 - d49	1.13	d50 - d95	0.67
3	Mussel based	d1 - d49	1.07	d50 - d137	0.72
4	Eel crumb	d1 - d49	0.87	d50 - d137	0.82
5	Prawn pellet	d1 - d49	1.14	d50 - d136	0.23
6	Salmon crumb	d1 - d49	0.80	d50 - d139	0.41
7	Eel crumb + supp.	d1 - d49	1.35	d50 - d139	0.63
8	Prawn pellet + supp.	d1 - d36	1.43	d37 - d125	0.76
9	Salmon crumb + supp.	d1 - d49	1.01	d50 - d138	0.70
10	Fresh (control)	d1 - d49	0.96	d50 - d141	0.85

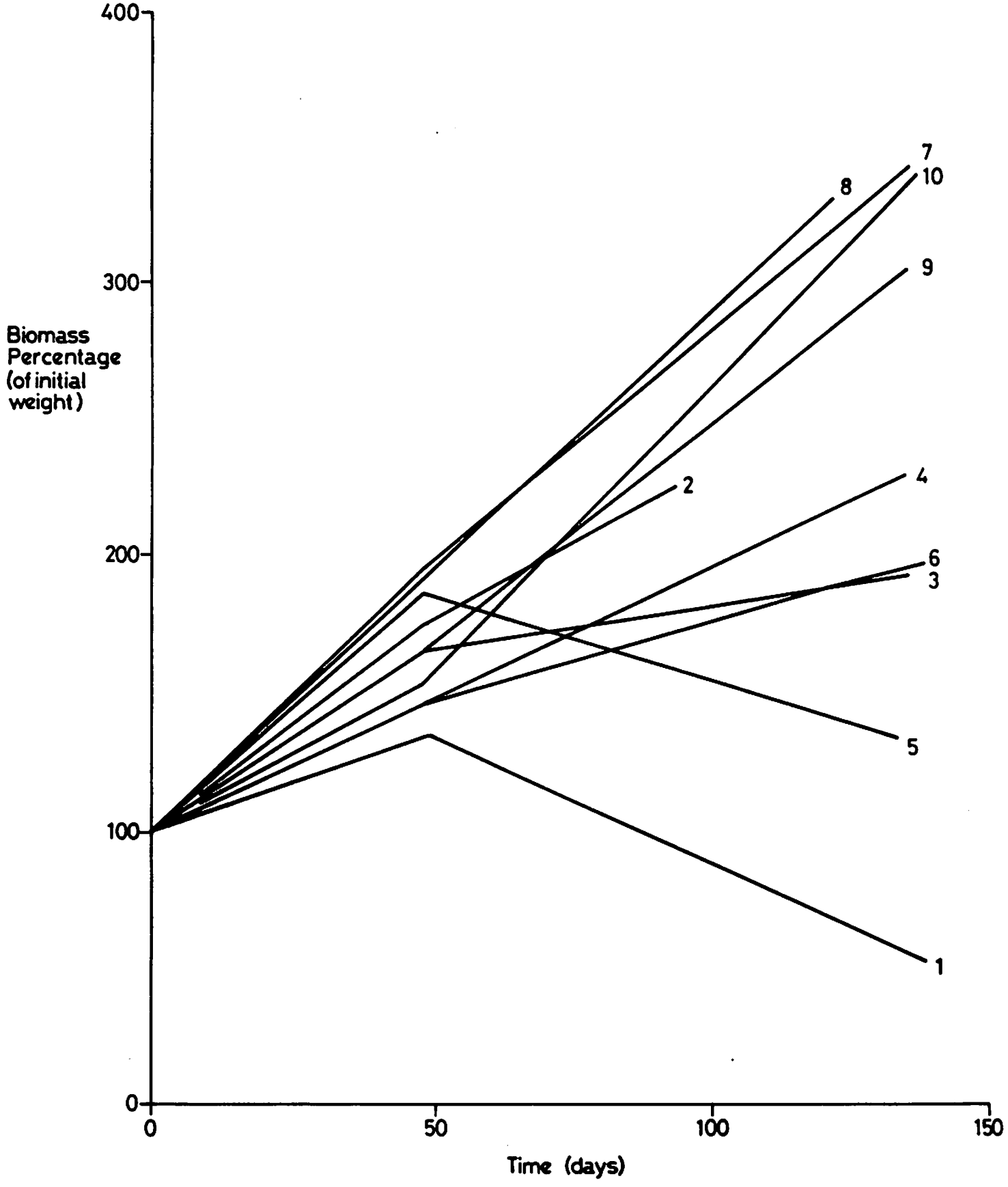


Survival of ten groups of juvenile Homarus gammarus fed various diets. Fig. 1



Change in growth rates of ten groups of juvenile Homarus gammarus fed various diets

Fig. 2



Change in biomass of ten groups of juvenile Homarus gammarus fed various diets

Fig. 3