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Factors affecting pot-fishing of Norway lobster (*Nephrops norvegicus* L.) and pink shrimp (*Pandalus borealis* Krøyer), studied in fishing and behaviour experiments. [Faktover som pavirker teinefangst av sjøkreps (*Nephrops norvegicus* L.) og dypvannsreke (*Pandalus borealis* Krøyer), undersøkt ved fiske- og atferdsforsøk.]

by

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Thesis, Institutt for Fiskeribiologi, University of Bergen, Spring, 1979.

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# FACTORS AFFECTING POT-FISHING OF NORWAY LOBSTER (*Nephrops norvegicus* L.) AND PINK SHRIMP (*Pandalus borealis* Krøyer), STUDIED IN FISHING AND BEHAVIOUR EXPERIMENTS.

- by Jon Asmund Bjordal

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Poor catch results for pink shrimps can be attributed to a number of different factors: type of pot, bait, seasonal variation, depth, population density, behaviour and nutrition. Several types of pot were tested, including three giving catches of pink shrimps in an aquarium and one that provided worthwhile catches of the same species in Alaska (BARR 1970). In Alaska some of the catches were obtained at the bottom (90 m) and some were pelagic catches from different depths, with herring as bait. Trawling operations in the same area yielded catches of pink shrimps amounting to about 50 kg per trawling hour. The same type of pot that was used in Alaska was tested in Lyngen, where trawling catches of shrimps came to 15–20 kg per hour of trawling in the same period. Typical trawl catches of shrimps in Romsdalsfjord and in the Bergen area were even less (normal trawl catches in Raunefjord are 8–10 kg per hour (B. Myntevik, Institutt for marinbiologi, Espegrend, personal communication)). So a relatively low population density may have been an important factor with regard to the poor catch results. But the insignificant pot catches, compared with the results from Alaska, are out of all proportion to the difference in trawl catches.

Herring were used as bait for the fishing experiments in Lyngen. Other types of bait were also tried, but this did not result in better catches. There was no tendency for catches to increase at different times of year. The fishing experiments were carried out at greater depths than the corresponding trials in Alaska, and this may have had a certain effect on catch results.

BARR (1970) suggested that the extensive vertical migration observed in the case of pink shrimps in Kachemak Bay was mainly a feeding migration. He showed that the diet of shrimps in the area largely consisted of zooplankton, especially crab larvae. Analysis of stomach contents from pink shimps in Norwegian waters points to a more bottom-orientated basic diet: parts of copepods, annelids, holothurians, Radiolaria, Foraminifera, sponges, green algae, Diatoms, Peridinia and Tintinnidae, all mixed with mud (WOLLEBEAK 1903). These studies possibly indicate that difference in diet and behaviour in connection with food intake may be relevant to the low catch results obtained for pink shrimps on the Norwegian coast, compared with those in Alaska.

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## 4. DISCUSSION (pp. 71-89):

### 4.1. Grounds

The Norway lobster has, geographically, a wide area of distribution, with a depth range of from 20 to 800 m (FIGUEIREDO & THOMAS 1967). This means that the species possesses relatively large tolerance thresholds in respect of such hydrographic indices as temperature, salinity and oxygen content. The Norway lobster also has an extremely varied diet, with polychaetes, crustaceans and molluscs as its main food (THOMAS & DAVIDSON 1962).

The Norway lobster digs tunnel-shaped burrows in the bottom substrate and stays inside them when it is not moving about on the bottom (DYBERN et al. 1965, FARMER 1974, RICE & CHAPMAN 1971).

During the fishing experiments Norway lobsters were only caught at grounds where the bottom was soft (clay/mud bottom). Analysis of sediment from a bottom sample taken from Raunefjord showed that the bottom substrate at a Norway lobster ground consists mainly of silt. This is in agreement with similar studies relating to Norway lobster grounds in the Irish Sea (FARMER 1975).

The Norway lobster appears to be dependent on that type of bottom, especially for the purposes of being able to dig burrows, and the other factors affecting distribution are probably of minor importance, compared with the composition of the bottom substrate.

### 4.2. Factors affecting catching efficiency

BRANDT (1972) describes the characteristics of pot/trap gear as follows: "These are implements in which the fish enters voluntarily but is hampered from coming out."

A few sets of pot gear are based on the idea of the victim going in with the assistance of the leading net or owing to the presence of structures simulating its habitat, whereas others are equipped with stimulus sources, such as bait, light, etc., that can lure the victim over relatively large distances. In this study pots were used with bait as the stimulus to attract Norway lobsters. The fishing method was made up of two components: bait (as lure) and pot (as fishing gear).

The catching process with this method of fishing can be divided up into three stages:

1) Luring stage - the Norway lobster is lured to the pot by the bait acting as stimulus.
2) Entry stage - the Norway lobster is in the immediate proximity of the pot and possibly enters it.
3) Escape stage.

The catch (C) is the difference between the number of Norway lobsters going into and escaping from the pot: $C = I - E$, both I and E (in and escape) being in proportion to the number of Norway lobsters attracted to the pot (N). The catch equation can therefore be converted as follows: $C = (i) \cdot N - (e) \cdot N = (i-e)N = c \cdot N$, where $(i) = \frac{I}{N}$, $(e) = \frac{E}{N}$ and c expresses the combined catching efficiency of pot and bait.

The characteristics of the bait and the pot are factors that can be controlled, but catch and catching efficiency also depend on "external" factors, such as the current and the behaviour pattern of the Norway lobster. The current is very important indeed from the point of view of the size of the area that can be covered by the spreading aroma of the bait, whereas the likelihood of a response to a bait stimulus of a particular strength depends on the Norway lobster's degree of motivation (factors such as season, time of day and nutritional state being involved).

I will now try to evaluate the individual factors that can be presumed to be of importance during the 3 stages of the catching process.

4.2.1. Factors relating to Norway lobster

The Norway lobster spends considerable parts of the day (i.e., the 24 hours) in its burrow, and activity outside the burrow can be mainly linked with its search for food (CHAPMAN & RICE 1971, CHAPMAN, JOHNSTONE & RICE 1975). Catching of Norway lobsters in pots will probably be confined to periods of active searching for food.

Time of day (i.e., 24-hour day): CHAPMAN et al. (1975) and CHAPMAN & HOWARD (1979) state that the Norway lobster's periods of diurnal activity can be related to optimum light intensity of from 1 to $10^{-5}$ lux (on the bottom). This optimum level of illumination will occur at different depths at different times of day, so the Norway lobster will display nocturnal activity in relatively shallow water (30 m), daytime activity at fairly considerable depths (> 100 m) and twilight activity (two separate periods of activity) at intermediate depths.

However, the Norway lobster stocks investigated in Lysefjord in July at a depth of 115 m showed a marked pattern of nocturnal activity, and this is not in keeping withthe theory of daytime activity in fairly deep water. It is therefore reasonable to assume that activity of Norway lobsters is low in the daytime, even at considerable depths. According to studies of behaviour (in July), catching of Norway lobsters in pots will be confined to the period between 16 hours and 07 hours, with strongest probability of capture between sunset and sunrise.

Season: Light intensity on the bottom will vary according to season of the year. Long diurnal periods with a relatively high illumination level will probably result in low activity of Norway lobsters in the summer semester compared with the winter semester. This may be the reason for reduced catches in summer.

Nutritional state: MACKIE & SHELTON (1972) showed that underfed lobsters displayed a significantly greater response to different concentrations of bait material than lobsters having access to an abundant food supply. The same could be assumed to be true of Norway lobsters, so the degree of motiviation for a response to the bait stimulus increases as the feeling of starvation increases.

Inhibiting factors: If the Norway lobster feels motivation inducing it to search for food, it will react positively to a bait stimulus by moving towards the source of the stimulus. At the luring and entry stages the level of motivation can be reduced by the influence of a variety of disturbing factors, in the form of inter- or intraspecific influences or a scaring effect produced by the pot structure, etc. An intraspecific influence was observed during the behaviour study when Norway lobsters were on several occasions driven out of the field of vision by others. Such confrontations would seem to be commonest among Norway lobsters of approximately the same size. Even the pot itself can have a scaring effect which will reduce the level of motivation, so the Norway lobster will not try to go any closer to the bait (go into the pot). This can be attributed to the repellent effect of aromatic substances emanating from the pot material (preparations with which the netting is impregnated, "smell of plastic", etc.).

When a predator is faced with an unfamiliar prey there is often a latent period of varying length (time between location of prey and successful attack). WARE (1971) and GODIN (1978) indicated that such latent periods occurred in the case of salmon. Typical predator reactions when confronted with an unusual prey are fear and approach/retreat responses.

Smell of bait (from the different types of bait tested) is probably not felt as unusual by the Norway lobster. The pot, on the other hand, is an unaccustomed structure in connection with the prey (= the bait). Reactions of fear were observed in relation to the pot (spreading of the large pincers). Approach and retreat responses were also common, and a large proportion (43%) of the Norway lobsters under observation kept at a distance from the pot and were not in physical contact with it. This could be a reaction to unfamiliar prey and may be regarded as a vital inhibiting factor affecting the catching process.

### 4.2.2. Factors relating to current

Spread of the bait aroma determines the size of the area round the pot where the Norway lobster can be affected by chemical stimuli from the bait. Bait aroma material is spread in two different ways: 1) by diffusion and 2) by the current. Spreading by means of diffusion is a slow process and is probably of little practical importance. The distance over which the bait aroma material is spread would therefore be dependent on the current.

Speed: The number of Norway lobsters lured to the pot (N) will be in proportion to the area over which the bait aroma material is spread. That area will increase with increasing speed of current. The concentration of bait aroma material per unit of volume of sea water passing the bait will, on the other hand, diminish as the speed of current increases.
Assuming that the Norway lobster shows a response to a bait stimulus at a particular threshold value for the concentration of bait aroma material, it is reasonable to suppose that there is an optimal speed (rate) of current for a maximum N value.

Direction: Direction of the current has an effect on catching efficiency when several pots are put out in a string or line. The current along the string of pots is the least favourable, as the individual pots in each set will overlap one another as far as spreading of bait aroma material is concerned. The degree of overlapping depends on pot distance and the size of the effective fishing area of the individual pot.

At grounds with a relatively uniform current direction it is therefore an advantage if the string of pots is placed across the current in order to achieve a maximum effective fishing area. Studies on behaviour in Lysefjord showed that positioning of a string of pots at that ground in relation to direction hardly mattered as variations in current direction were quite considerable.

Constancy of direction: If the current changes direction in the course of the fishing period, there is an increase in the area over which the bait aroma spreads. So variation in the direction of the current will result in an increase in the effective fishing area and consequently a higher value for the number of Norway lobsters that can be lured to the pot. But the current should show a certain constancy and persist in a particular direction, so that most of the Norway lobsters reacting to the bait stimulus will manage to reach the pot before any change in current occurs.

### 4.2.3. Factors relating to bait

Studies in behaviour have shown that most Norway lobsters approached the pot by going against the current. It could therefore be assumed that the bait plays a vital part in luring the Norway lobster to the pot and that, by and large, Norway lobsters must make their way against the current in order to locate the source of stimulation.

CHAPMAN & HOWARD (1979) also drew attention to the importance of the bait for luring Norway lobsters. They showed that the bait does not stimulate the Norway lobster, inducing it to leave its burrow, during periods when it is normally not active, but attracts the Norway lobster when it is already out of its burrow.

Before a Norway lobster can respond to a bait stimulus at a distance that we could refer to as (d) from the pot, the strength of stimulation at (d) must exceed a certain minimum value. The strength of stimulation is determined by the power of attraction of the bait (i.e., the extent to which baits arouse its appetite) and the concentration of bait aroma material.

Power of attraction: The power of attraction is quite independent of the concentration, as it is possible for an attractive bait to produce the same strength of stimulation with small concentrations as a rather unattractive bait having large concentrations of bait aroma material.

In experimentation with lobsters, MACKIE (1973) indicated a higher response to stimuli from cuttlefish extract than for different synthetic components of the same extract (at a concentration of $2 \times 10^{-4}$ g/l). As the concentration of bait aroma material was the same, disparities in response/strength of stimulation can only be explained by a difference in the power of attraction.

The power of attraction possessed by the bait would seem to be particularly important at the entry stage. Just beside the pot the concentration of bait aroma material is approximately at its maximum, and so any increase in the strength of stimulation can only be achieved by an increase in the power of attraction. Only 9% of the Norway lobsters observed during the studies on behaviour were caught. This low entry percentage can partly be accounted for by technical factors concerned with the construction of the pots. But a reduced level of motivation is probably another important cause, as 35% of the Norway lobsters under observation were not in physical contact with the pot. We can blame the scaring effect produced by the pot's structure and possible disturbing factors (mentioned in the section on "Factors relating to Norway lobster"). A bait possessing a high power of attraction is therefore essential if such a deficiency in motivation is to be overcome.

Keeping quality: The different substances in the bait will alter as a result of chemical processes. After a certain time in the sea the bait will "turn sour", and there will therefore be a change in its power of attraction. It is not clear whether an alteration of this kind in the qualitative composition of the bait affects its power of attraction for the Norway lobster.

Solubility: The amount of the particles from the bait aroma material that is released depends mainly on the solubility of the bait. A bait of high solubility will provide relatively large concentrations of bait aroma material and consequently a larger area in which the strength of stimulation is sufficiently high to produce a response in the Norway lobster.

Amount: The concentration of bait aroma material must be presumed to be in proportion to the amount of bait, as a large quantity of bait will have a larger surface for the release of bait aroma particles. I have not carried out any experiments with different amounts of bait. The practical significance of different amounts of bait from the point of view of catching efficiency is not very clear, but in fishing trials with sea traps for catching rusk (Brosme) there were indications that catch was increased when the quantity of bait was larger (VALDEMARSEN 1977).

Baiting method: When pot-fishing for Norway lobsters (at the grounds included in these investigations) it was necessary to use perforated bait receptacles to prevent the bait from being eaten up by hagfish. When a bait container is used, the bait can be finely chopped to give it a large surface and increase the separation of bait aroma particles. But in spite of plenty of perforations the surface of contact between the bait and the water flowing past the bait container is small, and this leads to a reduction in the concentration of bait aroma material. No experiments were carried out to test that effect. Experiments adopting a combined baiting method (unprotected bait and bait in a bait container) during studies on behaviour did, however, result in a considerably higher value for the number of lobsters observed per hour than was the case in experiments with a bait container.

Siting: The speed of the current is often reduced to some extent in the layer just above the bottom owing to the creation of turbulence. The spread of the bait aroma may therefore be less if the bait is placed on the bottom of the pot. Normally the bait should be placed far enough away from the tunnel(s) for the Norway lobster not to be able to reach it from the inside opening of the tunnel.

All types of bait that were used proved to be effective for luring Norway lobsters, so the strength of stimulation at the luring stage may be described as being relatively good. Strength of stimulation at the entry stage, on the other hand, is not very satisfactory, judging by the low entry rate. So types of bait possessing a greater power of attraction will be essential if catching efficiency is to be increased.

Findings from the fishing trials do not indicate any significant differences in strength of stimulation between the different types of bait. The results revealed better catches for pots baited with mackerel than for pots baited with trout food (feed meal). MASON (1965) carried out comparative baiting trials with herring meal, salt mackerel, skate and plaice, with herring meal giving significantly poorer catch results (for crabs) than "natural" bait types. Artificial bait in the form of feed meal is therefore not a substitute for natural bait, but it is of good keeping quality and easy to store on board ship, so it could be an ideal thing to use as "reserve bait".

4.2.4. Factors relating to pot

In assessing the importance of factors relating to the pot, I have divided up the pot into two component parts:

a) the "pot housing or casing" and b) the tunnel.

a) The pot casing

Covering material: The pots used in the investigation can be divided into two types according to the covering material:

1) Closed pots - pots covered in a solid material (except in the tunnels).

2) Open pots - pots covered with netting.

One condition governing the choice of covering material is that it should give hagfish a good opportunity of escaping. If not, the gear and the catch will become soiled with the slime secreted by the hagfish when the pot is hauled in. This was often a problem in the case of pot 17 (closed pot).

Closed pots can be an advantage under special conditions, e.g., in tropical regions where fish and crustaceans enter covered traps in search of protection from the strong light of the sun. BUTLER (1963) showed that pots covered with metal plates (sheets of metal) on the sides and with a netting tunnel at each end gave better catch results for spot shrimps, (*Pandalus platyceros*) than either completely open or completely covered pots. His conclusion is that the shrimps do not enter a covered pot in search of protection, but that the good catch result for tight pot/open tunnel is due to the fact that the bait aroma is concentrated in the tunnel openings, so shrimps will more readily find their way into the pot. Studies on behaviour showed that that effect would hardly be of any great importance as far as pot-fishing for Norway lobsters is concerned, as the Norway lobsters observed beside pot 17 did not display any particular inclination to make for the tunnel opening.

The covering material can, on the other hand, have an important effect on the spreading of bait aroma, as open pots have a relatively good through-flow of water, compared with closed pots, under otherwise similar current conditions.

Apart from pot 22, the closed pot No. 17 achieved poorer catch results than open pots. Experience from the Faroes also showed closed pots to be less efficient than open ones (H. Høghammer, fisherman, personal communication).

It must therefore be assumed that pots having a dense covering material possess a lower catch efficiency rating.

Shape: The shape of the pot would seem to have little effect on catching efficiency. Generally speaking, any scaring effect (shown by a pot) will be independent of pot shape.

Size: Pot size will notplay any vital part either from the point of view of catching efficiency. There has to be a certain minimum size for the inside volume of the pot to prevent saturation of the pot (point of saturation: asymptotic value for number of Norway lobsters that will enter the pot). The maximum catch in fishing trials was 8 Norway lobsters in one pot (pot 20). During the studies on behaviour a Norway lobster entered the same type of pot after there were 12 specimens (individuals) in the pot, placed there in advance. In the Faroes a catch of 45 Norway lobsters has been achieved in a pot of type 24 (slightly less than a pot of type 20), and catches of around 20 individuals per pot are not uncommon (H. Høghammer, fisherman, personal communication). 45 Norway lobsters in pot 24 would correspond to about one individual per $dm^2$ pot base.

The point of saturation will probably vary in the different types of pot, and it is difficult to estimate exact values. But as far as the catch result obtained in this investigation is concerned (maximum of 1 Norway lobster per 5 $dm^2$ of base), the pot saturation effect has probably had no impact on catching efficiency.

b) Tunnel

The tunnel is the functional part of the pot, intended to give the Norway lobster easy access to the inside of the pot and at the same time act as an effective barrier, preventing escape.

Shape: Most pots had funnel-shaped tunnels, whereas pot 23 had a top tunnel. However, studies on behaviour showed that Norway lobsters normally go up along the tunnel "floor" when they enter the pot. The tunnel "floor" can therefore be regarded as the functional part of the tunnel at the entry stage and can be viewed as an inclined plane with a differing angle of inclination. Pot 23 can be compared on that basis with the other pot types.

Norway lobsters usually travel over relatively flat and level surfaces. The studies on behaviour indicated that Norway lobsters usually avoid tackling steep obstacles, although isolated observations have revealed that they do possess fairly good climbing abilities. It can therefore be assumed that catching efficiency increases as the angle of inclination for the tunnel floor diminishes. Catching efficiency would seem, moreover, to be inversely proportional to the length of the tunnel floor. This was most clearly evident during behaviour studies with pot 23, which has a relatively long tunnel floor, 35 cm, as19 of 25 Norway lobsters that began to go up along the tunnel floor turned back before they reached the tunnel opening. To reduce the likelihood of escape, the inside tunnel opening should be a certain height above the tunnel floor. An optimum "inclined-plane tunnel" will therefore be a compromise between a minimum angle of inclination for the tunnel floor and a minimum tunnel floor length.

Material: THOMAS (1953) showed that the mesh width in the tunnel affected catching efficiency as far as lobsters were concerned. Pots with fine-meshed netting (mesh width of 17 mm) in the tunnel floor provided better catches than pots with a mesh width of 75 mm. Most pots in the study (in this investigation) had netting with a mesh width of 30 mm in the tunnel floor. However, the studies of behaviour showed that mesh width could hardly be a limiting factor with regard to catching efficiency in the pots that were under examination, as Norway lobsters move about with ease both on netting having a mesh width of 30 mm and netting of 10 mm (pot 23).

On the other hand, rigidity in the material used for the tunnel can have an effect on the catching of Norway lobsters. Pot 23 was kept distended by means of a float and so the netting is not completely taut. We get the impressinn that Norway lobsters often reacted by retreating when theyfelt the surface giving under them (slack netting). It is therefore reasonable to assume that taut netting or a rigid material in the tunnel would be an advantage.

**Siting:** According to experience gained from behaviour trials, the tunnel should be placed low enough to allow the tunnel floor to slant right up from the undersurface (base).

**Number:** Pot types 20 and 21 were constructed with 4 tunnels so that the Norway lobster would be sure to come across a tunnel irrespective of the angle of incidence. However, observations of behaviour showed that Norway lobsters seldom entered "the first and best" tunnel, but went on a number of detailed exploratory trips round the pot before possibly making their way inside.

It would therefore appear that the positioning of the tunnel in relation to the angle of incidence (direction of current) is not of any vital importance. For all that, judging by the search pattern observed in Norway lobsters, it would be an advantage to have several tunnels, as the probability of coming across a tunnel while roving round the pot increased in proportion to the number of tunnels.

**Entrance length:** If the Norway lobster is in the entrance area of the pot (the part of the pot periphery that is covered by the outside opening of the tunnel) there is a certain degree of probability (depending on the shape of the tunnel) that it will go inside the pot. At all other positions along the periphery of the pot the probability of entry is nil. The probability of entry in respect of a particular type of pot will therefore be proportional to the relative entrance length of the pot (length of entrance area in relation to total circumference of the pot). We have attempted to illustrate this in Fig. 41 for pot types 17, 20 and 23.

Length of entrance as a proportion of total periphery (circumference) ranges from 10 to 100% for the various types of pot (Table 16).

Table 16: Relative entrance length (length of outside tunnel opening) in relation to the circumference of the pot.

| Pot type | 11 | 15 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|
| Entrance length(%) | 80 | 100 | 21 | 27 | 10 | 33 | 33 | 18 | 100 | 12-17[a)] |

a) 1 and 2 tunnels, respectively.

Basing ourselves on the typical search pattern of the Norway lobster (searching round the pot), it is reasonable for us to assume that catching efficiency increases as the entrance length increases.

Summing up

The studies on behaviour showed that the escape rate was relatively low, whilst the entrance rate (i)(= in) appeared to be the limiting factor as far as catching efficiency was concerned. So the prerequisite for increased catches is an improvement in the factors influencing catching efficiency at the entry stage.

## 4.3. Significance of factors relating to the pot from point of view of the relative catching efficiency of the various types of pot

Open pots

Spreading of bait aroma is probably satisfactory in the case of all the open pots (pots covered with netting). So what decides the catching efficiency of pots of this type will be the characteristics of the tunnel.

Pot 11 : That pot was only used 4 times in fishing trials for the capture of Norway lobsters. Several factors should make this an ideal pot for catching Norway lobsters, e.g., its considerable entrance length (80%), the low position of the tunnels and the small angle of inclination for the tunnel floor. However, pot 11 was constructed as a shrimp pot, and the inside (rectangular) tunnel opening was relatively small (6 x 7 cm) and not very flexible (steel wire). My assumption is therefore that the size of the inside tunnel opening, especially the width, was a limiting factor for that type of pot.

Pot 15 : That pot was also constructed for the capture of shrimps, but achieved relatively good catches of Norway lobster. Like pot 11, pot 15 has a large entrance length (100%), quite a low angle of inclination for the tunnel floor and a low tunnel position. The inside tunnel opening is extremely wide (35 cm). That probably has a positive effect on catching efficiency, whereas the tunnel height (4 cm) must be regarded as a limiting factor as far as entry rate is concerned. The catching efficiency of pot 15 could probably be increased by making the inside tunnel opening higher.

Pot 19 : Of all the open-type pots, apart from pot 22, pot 19 gave the poorest catch results. The pot had only one tunnel. The small angle of inclination for the tunnel floor and the low position of the tunnel should have made it ideal for catching Norway lobsters. But the entrance length of the pot was small (10%), and that probably had a negative effect on the entry rate. This pot was collapsible so that it would take up less space on board, when folded. However, the collapsing mechanism proved to be rather awkward to use and the frame was often slightly bent, so the tunnel was not properly extended. Slack netting in the tunnel portion may therefore have reduced its catching efficiency.

Pot 20 : That was the pot that gave the best results during the fishing trials. But studies on behaviour showed that only 5 of 61 Norway lobsters that were observed went inside the pot. So, in spite of having a high catching efficiency compared with the other types of pot, pot 20 has a low rating as far as absolute catching efficiency is concerned. The main reasons for this would appear to be its rather small entrance length (33%) and the excessively large angle of inclination in the outer part of the tunnel floor. But that type of pot nevertheless gave better catch results than the other open types of pot. This may be due to the following points:
1) The size of the inside tunnel opening did not appear to be a limiting factor, as in the case of pots 11 and 15, and 2) a larger entrance area (4 tunnels) than pot 19 (1 tunnel).

Pot 21 : That type of pot is a collapsible version of pot 20, and no difference was detected between those types as far as catching efficiency was concerned. Pot 21 takes up much less space on board and is easier to handle than pot 20. But pot 21 could probably not be used at grounds having a fairly strong bottom current, which might affect the float system, so preventing the pot from being properly extended. Discrepancies in the speed of current might be a possible reason for the lower average catches obtained with pot 21, compared with pot 20, at the ground in Romsdalsfjord, whereas the opposite was the case in Lysefjord.

Pot 22 : Only 1 Norway lobster was caught in the course of 20 hauls using that type of pot (at(a) relatively good Norway lobster ground(s)). That result is much poorer than we might have expected from an assessment of the pot's characteristics (with regard to covering material, shape of tunnels, entrance length, etc.). However, pot 22 is collapsible and is kept extended by a float and sinker. The sinker was attached to the bottom of the pot (it was covered with fairly slack netting, see Fig. 22), and this may have meant that the pot was not right down on the bottom. That may have been the probable cause of the poor catch result.

Pot 23 : That type of pot was constructed for studies on behaviour on the basis of previous experience gained from fishing trials.

A maximum (very high) coefficient for entrance area, a small angle of inclination for the pot floor and a relatively large inside tunnel opening were all factors that would have led us to expect a high entry rate for that type of pot. However, the studies on behaviour showed that the inclined plane up towards the tunnel opening was too long and the material used for the inclined plane was probably too slack. The pot should therefore have had a firm frame construction or a more powerful float system with a heavier bottom frame and more buoyancy in the float. In addition, the length of the inclined plane should probably be reduced to some extent (at the expense of an increased angle of inclination).

The studies on behaviour also showed that it was too easy to escape from the pot. That can be attributed in part to the special conditions operating during the behaviour trials (contact between float and camera mounting, etc.), as pot 23 did catch Norway lobsters during the fishing trials.

Pot 24 : That type of pot has made extremely good catches of Norway lobster in the Faroes. But results of the comparative fishing experiments indicated a somewhat lower catching efficiency for that pot than for pot 20. That may be due to the fact that there are fewer tunnels (reduced entrance length) in pot 24. On the other hand, rigid tunnel material, together with low tunnel position, should have a positive effect on catching efficiency in comparison with pot 20.

Closed pots

Studies on behaviour showed that the number of Norway lobsters attracted per unit of time was less for closed than for open pots.

Pot 17 : An assertion has been made (by experienced pot-fishermen, amongst others) that closed pots are beneficial because the bait aroma will be concentrated at the tunnel opening, so it will be easier to bring the prey to the tunnel. No such effect was observed in the course of the behaviour trials. Norway lobsters displayed the same behaviour pattern during the searching stage with pot 17 as they did in presence of open-type pots (search or exploration round the pot without any special attraction effect noted in front of the tunnel opening).
In addition to poor spreading of bait aroma, pot 17 is characterized by a rather small entrance length (21%). The small angle of inclination for the tunnel floor has probably been a positive factor from the point of view of catching efficiency.

Pot 18 : Pot 18, like pot 17, is covered with a dense material, but it has a tunnel at each end. The fact that it provides better spreading of bait aroma and has a greater entrance length (27%) has probably led to the somewhat higher catching efficiency of pot 18.

4.4. Fishing time

Results of trials involving different periods of fishing (pot 20) revealed the greatest increase in catches in the first 1-2 days (24-hour periods, and a relatively modest increase in catch per day during the remainder of the fishing time. This is probably due to reduction in the strength of the bait stimulus after about 2 days of fishing time because it had been washed away or the bait had been eaten by fish-lice, hagfish, etc. A rise in catches beyond a 2-day period ((for) up to 9 days) indicates that the bait may have a reduced effect for a relatively long time and that the escape rate for pot 20 is fairly low (according to the studies on behaviour).

4.5. Distribution according to size and sex

The difference in average size of males and females in the catches of Norway lobsters may be regarded as representing a real difference in distribution according to size within the population. The smaller average size of females is due to reduced growth rate of sexually mature females when they are carrying eggs (STORROW 1912).

SØGAARD-ANDERSEN (1962) and CHAPMAN & HOWARD (1979) have shown that large Norway lobsters spend longer periods of activity involving migrations for food outside their burrows than small specimens. That is probably due to wider limits of tolerance for light intensity and reduced predation stress in the case of large Norway lobsters. My own studies on behaviour confirm it - small Norway lobsters were only observed at night, whereas specimens observed in the daytime (between sunrise and sunset) were relatively large.

Large Norway lobsters (chiefly males) are therefore more exposed to possible capture than small ones. This accounts for the predominance of males in catches for the summer semester. There was a more even distribution according to sex in the catches for the winter semester. That may be due to the relatively longer periods of activity for small Norway lobsters attributable to a reduction in light intensity.

## 4.6. Tagging

Tagging trials showed that the tagging method was working satisfactorily, as all the Norway lobsters that had moulted (2 at the fishing grounds and 1 in the aquarium) retained the tags after ecdysis.

JENSEN (1965) carried out comprehensive tagging experiments in the Skagerrak/Kattegat area which showed that Norway lobsters do not undertake any important migrations. My own tagging trials would appear to confirm this, as 2 repeat catches were made just beside the tagging site, whereas one Norway lobster had travelled about 500 m.

Two of the Norway lobsters caught twice had moulted. Length of carapace had increased by 11% in the case of both specimens. FARMER (1973) quotes the following as the relation between carapace length before and after moult: $y = 1.0144 + 0.1848$ cm, and gives the increase in carapace length per moult for relatively large males (carapace length of 55 mm) as 6.1%. According to Farmer's equation for the increase in length per moult, one Norway lobster would have moulted twice and the other 3 times, both of them in the course of 15-16 months. However, the percentual increase in length indicated by him would point to 2 moults for both. SØGAARD-ANDERSEN (1962) indicated that 75% of males underwent ecdysis every year (in the Faroes). It is therefore reasonable to assume that the 2 Norway lobsters may have moulted twice before they were caught for a second time; 3 moults within that spaceof time would seem rather unrealistic.

## 4.7. Stocks (Population)

The average catch for pot 24 in Lysefjord (grounds L2 and L3) was 2.2 Norway lobsters per pot haul, as against 9.4 for the same type of pot in the Sounds in the Faroes (BJORDAL 1978).

The density of the Norway lobster population $\geq$ 16 cm in the Sounds in 1937 was estimated at 118 kg per trawling hour (SØGAARD-ANDERSEN 1962). Although those investigations took place a long time ago, there is reason to believe that the population density at that ground is quite considerable.
The difference in pot catches indicates that the population density is about 4 times greater than in Lysefjord. However, the Norway lobster ground in the Sounds is relatively shallow compared with Lysefjord (40-50 as against 115-170 m). The smaller catches in Lysefjord can therefore be ascribed to differences in basic diet and pattern of behaviour in conjunction with food intake (feeding) of Norway lobsters at greater depths.

## 5. SUMMARY

Norway lobsters were caught both at traditional shrimp grounds and at grounds that had not been tried before. Catch results were best at grounds with a soft bottom at a depth of from 115 to 170 m. The highest average catch per pot haul for a single set of pots was 3.4 Norway lobsters. The maximum catch per pot haul was 8 (individuals).

Fishing trials were carried out to compare 8 different types of pot. Catching efficiency was significantly improved with a pot covered in netting and having 4 entrances, compared with a traditional box-pot equipped with one tunnel.

Different types of bait were tested, and all of them appeared to exert an adequate power of attraction as far as Norway lobsters were concerned. From the available material it was not, however, possible to show any difference between the different types of bait.

The best catches were obtained in February-March-April.

Tagging trials were carried out. The tagging method used appeared to work satisfactorily, as Norway lobsters caught for a second time had retained the tags after 2 moults. The tagging trials indicated, furthermore, that the Norway lobster is a relatively stationary creature.

Males were predominant in the catches for the summer semester. Females with eggs were caught in the period from July to March. They made up only 3% (on numerical basis) of the catches per annum.

Biometric relations between carapace length, overall length and total weight were calculated.

Underwater television apparatus was used to study the behaviour of Norway lobsters in relation to the pot gear at the grounds. The diurnal rhythm of Norway lobsters was indicated, with activity at night. 90% of the Norway lobsters observed approached the pot against the current ((in) 180° sector to the current), a point that illustrates the importance of the bait as a source of stimulation. Studies on behaviour showed that the type of pot giving the best result during fishing trials only caught 5 of 61 Norway lobsters that had been observed.

Increased catching efficiency can probably be achieved by:

1) Using bait with a greater power of attraction;
2) Increasing the entrance length of the pot (the part of the pot circumference that is covered by the outside tunnel opening);
3) Reducing the angle of inclination and/or length of tunnel floor.

ILLUSTRATIONS (41)

Fig. 6 (p. 11): Shrimp behaviour in relation to pot 05 (fig. 4). ⟶ ⟶ route taken by shrimp in towards the pot (swimming steadily), ⟶ ⟶ ⟶ route taken by shrimp away from the pot (rapid withdrawal with shock of hauling) "TV" = pot wall, "K" = tunnel.

Fig. 7 (p. 13): Pot type 10. Circular construction with 4 tunnels. All measurements in cm. 1) Top view. 2) Side view. "A" = bait position, "K" = tunnel. Frame : polyethylene tubing (external diam. 2 cm), joined by means of T-joint of PVC, Covering: netting (32 mm mesh width, also some pots with 14 mm mesh width), Tunnel: netting and nylon rings, Source: American shrimp pot (McBRIDE & BARR 1967).

Fig. 8 (p. 14): Pot type 12. Conical pot (plastic tub) with 5 tunnels. All measurements in cm. 1) Top view. 2) Side view. "A" = bait position, "K" = tunnel. Covering : hard plastic, netting (26 mm mesh width) in bottom, Tunnel: conical plastic tunnels, Source : Own construction.

Fig. 9 (p. 15): Pot type 13. Cylindrical pot with one tunnel. The pot is collapsible and is kept in its extended state by means of float and sinker. All measurements in cm. 1) Top view. 2) Side view. "A" = bait position, "K" = tunnel, "L" = sinker, "F" = float. Frame: polyethylene tubing (diam. 2 cm) at top and bottom, Covering: plastic sacking (Cotiso), Tunnel: conical plastic tunnel, Source: Own construction.

Fig. 10 (p. 16): Pot type 14. Shrimp pot with 2 split (slit) tunnels. All measurements in cm. 1) Top view. 2) Side view. "A" = bait position, "K" = tunnel. Frame: 8 mm round iron rods, Covering: netting (20 mm mesh width), Source: Constructed by E. Bruarøy, Nordstrøno.

Fig. 11 (p. 17): Pot type 15. Square, prism-shaped construction with slit-shaped "waist tunnel". All measurements in cm.
1) Top view. 2) Side view.
"A" = bait position, "K" = tunnel.
Frame: 12 mm round iron rods, Covering: netting (18 mm mesh width), Source: Constructed by E. Bruarøy, Nordstrøno.

Fig. 12 (p. 18): Pot type 16. Quadrangular regular pyramidal construction, with continuous slit tunnel. All measurements in cm.
1) Top view. 2) Side view.
"A" = bait position, "K" = tunnel.
Frame: 14 mm round iron rods, Covering: chicken wire (hexagonal), 17 mm diagonal).
Source : Constructed by E. Bruarøy, Nordstrøno.

Fig. 13 (p. 19): Positions for shrimp-pot trials, Lyngen district.
"Ø" = east; "N" = north.
1) Ullsfjord, 2) Spenna, 3) Lattervika.

Fig. 14 (p. 24): Sites used in fishing trials with shrimp and Norway lobster pots, Bergen/south.
"BF" = Bjørnefjord
"BS" = Bjørnarøy/Skorpo
"FI" = Fanafjord, inner
"FM" = Fanafjord, middle
"FR" = Fanafjord, off Rød
"FY" = Fanafjord, outer
"GO" = Goltastein ground
"HA" = Havreholm
"L1", "L2", "L3" = Lysefjord 1, 2, 3
"RV" = Raunefjord, west
"RØ" = Raunefjord, east.
"Ø" = east; "N" = north.

Fig. 15 (p. 25): Sites used in fishing trials with Norway lobster pots, Bergen, north.
"EO" = Eideos ("os" = mouth, outlet)
"HE" = Herdlafjord
"HJ" = Hjeltefjord
"LO" = Landros-os ("os" = mouth, outlet)
"RD" = Radfjord
"TR" = Treatteos ("os" = mouth, outlet).
"Ø" = east; "N" = north.

Fig. 16 (p. 26): Sites used in fishing trials with Norway lobster pots, Romsdal area.
"FA" = Faksen
"FF" = Flatflesa
"IL" = Indreleia ("indre" = inner)
"JE" = Julsund off Eikrem ("sund" = sound)
"JH" = Julsund off Harøy ("sund" = sound)
"RN" = Rødvenfjord
"SV" = Sekken, west
"SØ" = Sekken, east
"TØ" = Tautra, east
"VH" = Veøy/Hestholm.
"Ø" = east; "N" = north.

Fig. 17 (p. 29): Box pot with one tunnel. All measurements in cm.
1) Side view. 2) View from end of tunnel.
"A" = bait position, "K" = tunnel.
Covering: wooden boards (thickness 1.5 cm),
Tunnel: netting (30 mm mesh width),
Source: Traditional lobster pot, made by E. Bruarøy.

Fig. 18 (p. 30): Pot type 18. Box pot with 2 tunnels. All measurements in cm. 1) Side view. 2) End view (end on).
"A" = bait position, "K" = tunnel. Covering: tight covering of wooden boards, Tunnel: netting (30 mm mesh width), Source: Traditional crab pot, loaned by K.R. Gundersen, FHi.

Fig. 19 (p. 31): Pot type 19. Tunnel-shaped construction with 1 tunnel (eye). All measurements in cm. 1) Side view. 2) End view. "A" = bait position, "K" = tunnel (eye). Frame: 10 mm (galvanized) round iron rods, Covering: netting (30 mm mesh width), Source: Scottish lobster pot, loaned by K.R. Gundersen, FHi.

Fig. 20 (p. 32): Pot type 20. Square construction with 4 tunnels. All measurements in cm. Frame: 8 mm round iron rods, Covering: netting (28 mm mesh width), Source: Constructed in conjunction with this investigation.
"SETT FRA SIDA" = side view;
"SETT OVENFRA" = top view;
"A" = bait position; "K" = tunnel (eye).

Fig. 21 (p. 33): Pot type 21. Collapsible construction. Identical to pot type 20, but without corner posts. It is kept in its extended form by means of a float. All measurements in cm.
"A" = bait position; "K" = tunnel.
Source: Constructed in conjunction with this investigation.
"SETT FRA SIDA" = side view;
"SETT OVENFRA" = top view;
"FLOTTØR" = float.

Fig. 22 (p. 34): Pot type 22. Collapsible circular construction with 2 tunnels. All measurements in cm.
1) Top view. 2) Side view.
"A" = bait position, "F" = float,
"K" = tunnel, "L" = sinker.
Frame: "fish-trap rings" (hard PVC),
Covering: netting (30 mm mesh width),
Source: Experimental lobster pot, loaned by K.R. Gundersen, FHi.

Fig. 23 (p. 35): Pot type 23. Conical pot with top tunnel. Kept in its extended form by means of float. All measurements in cm. "A" = bait position, "K" = tunnel.
Frame: 7 mm round iron rods,
Coverings: "S" = netting with large meshes (30 mm mesh width),
"s" = netting with small meshes (10 mm mesh width),
Source: Constructed in conjunction with this investigation.
"SETT FRA SIDA" = side view;
"SETT OVENFRA" = top view;
"FLOTTØR" = float.

Fig. 24 (p. 36): Pot type 24. Square construction with 2 (alternately 3) tunnels. All measurements in cm.
1) Top view. 2) Side view
"A" = bait position, "K" = tunnel,
"T" = emptying hatch, "X" = tunnel position with 3 tunnels.
Frame: 8 mm round iron rods,
Covering: netting (28 mm mesh width), put up absolutely straight,
Tunnels: plastic netting (polyethylene), 1 x 1 cm lozenges,
Source: Constructed by H. Høghammer, Faroes.

Fig. 25 (p. 37): Arrangement of string of pots. Pots connected by means of short (lanyards) to ground rope, sinker line and float.
Distance between pots about 35 m. (Pot distance)

Fig. 26 (p. 39): Measuring the length of a Norway lobster.
"L" = overall length,
"C" = carapace length.

Fig. 27 (p. 40): Norway lobster with tag.

Fig. 28 (p. 41): Circular structure covered in netting.
All measurements in cm.
"A" = bait position.
Frame: polyethylene tubing (external diam. 2 cm),
Covering: netting, 130 mm mesh width,

Fig. 29 (p. 42): Mounting of camera equipment for observation of behaviour.
"A" = camera frame, "B" = camera/pot stand or tripod,
"1" = camera, "2" = source of light,
"3" = picture/light transmission cable,
"4" = "buoyancy spheres",
"5" = rope for hauling up, "6" = pot.

Fig. 30 (p. 45): Analysis of sediment.
"LEIR" = clay; "GRUS" = gravel;
"STEIN" = cobbles;
"Vektprosent" = % by weight;
"Kornstørrelse" = size of grain or particle;
"PRØVE NR." = sample no.
"STED" = place;
Rauneford; Irish Sea;
Analysis of sediment carried out at the Geol. Inst.,
Univ. Bergen.

Fig. 31 (p. 50): Seasonal variation in Norway lobster catches, grounds L1, L2 and L3 (Lysefjord), ——— pot type 20,
— -- -•- pot type 17.
"FANGST PR. TEINE" = catch per pot;
"J" – "D" = months from January to December.

Fig. 32 (p. 51): Catch with differing fishing time (pot type 20).
○ Romsdalsfjord (ground FA) in July;
● Lysefjord (grounds L1, L2 and L3) in May;
▲ Lysefjord (grounds L2, and L3) in August;
△ Lysefjord (grounds L2 and L3) in March.
"FANGST PR. TEINE" = catch per pot;
"NETTER" = nights.

Fig. 33 (p. 52): Distribution of Norway lobsters in catches according to sex.

"m. utrogn" = with eggs;
"n" = number;
"MARS" = March; "MAI" = May; "JULI" = July;
"AUG.-SEP." = Aug.-Sept.;
"NOV.-DES". = Nov.-Dec.

Fig. 34 (p. 54): Distribution according to length (No. = 226, experiments 5F, 6F and 7F).

Minimum measurements (M), also average lengths for males, females and male + female are indicated on x axis. o = females with eggs.
"ANTALL" = number;
"TOTAL-LENGDE" = overall (total) length.

Fig. 35 (p. 55): Distribution according to weight (No. = 226, experiments 5F, 6F and 7F).

"ANTALL" = number; "TOTAL-VEKT" = total weight.

Fig. 36 (p. 57): Relation between carapace length and overall (total) length.

⊛ = males (No. = 176),
△ = females (No. 46).
"TOTAL-LENGDE" = overall (total) length;
"CARAPAX-LENGDE" = carapace length.

Fig. 37 (p. 58): Relation between overall (total) length and total weight.

⊛ = males (No. = 174),
△ = females (No. = 46).
"TOTALVEKT" = total weight;
"TOTAL-LENGDE" = overall (total) length.

Fig. 38 (p. 59): Distribution of bycatch species in pots with catches of Norway lobsters.

"ANTALL TEINER" = number of pots;
"HAGJEL" = black-mouthed dogfish;
"KOLMULE" = blue whiting;
"LANGE" = ling;
"UER" = Norway haddock;
"DYPVANNSKRABBE" = deep-sea crab;
"SVØMMEKRABBE" = swimming crab;
"RØDPØLSE" = *Stichopus tremulus*; (See Table 13, p. 60)
"SYPIKE" = poor cod;
"REKE" = shrimps;
"TASKEKRABBE" = rock crab;
"TROLLKRABBE" = lithodes crab;
"TROLLHUMMER" = *Munida* sp.
"UTEN BIFANGST" = no bycatch.

Fig. 39a (p. 65): Activity of Norway lobsters in relation to time of day (i.e., 24-hour day) (number of Norway lobsters observed per hour, based on 13 observation days in May and July 1978 (ground L2, Lysefjord). Unbroken (continuous) line indicates observation time for each day. The black portion in the histogram represents Norway lobsters that entered the pot

"SN" = sunset; "SO" = sunrise.
"SJØKREPS PR. TIME" = Norway lobsters per hour;
"TID" = time; "MAI" = May; "JULI" = July.

Fig. 39b (p. 66): Activity of Norway lobsters in relation to time of day (i.e., 24-hour day), expressed as the average number of Norway lobsters observed per hour (No. = 136), based on 13 observations in May and July 1978 (ground L2, Lysefjord).

"SN" = sunset; "SO" = sunrise.
"SJØKREPS PR. TIME" = Norway lobsters per hour;
"TID" = time.

Fig. 40 (p. 66): Number of Norway lobsters that approached the pot, distributed according to angle of incidence (angle between direction of current and route followed by Norway lobster on the first occasion that it came in towards the pot).
"ANTALL" = number.

Fig. 41 (p. 82): Entrance length (broken line) in relation to total circumference (entrance length: length of pot circumference that is covered by the outside tunnel opening).
"TEINETYPE" = pot type;
"INNGANGSLENGDE" = length of entrance, entrance length.

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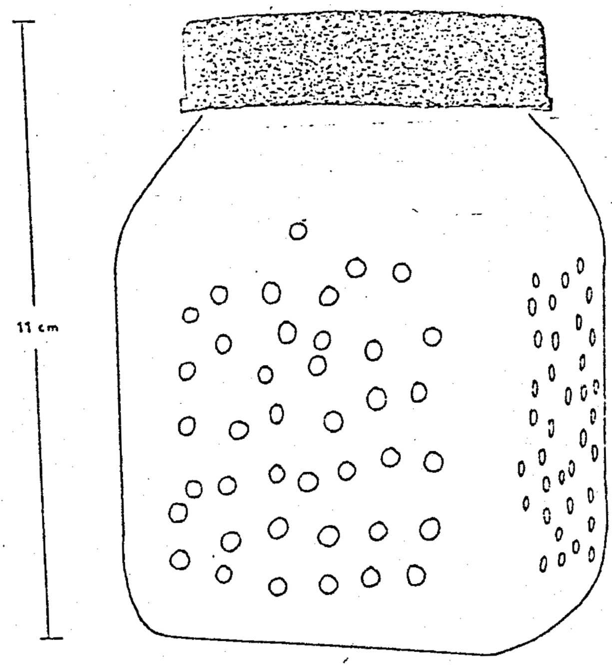



Fig. 1. Agnbeholder av klar plast, volum 0,5 l.

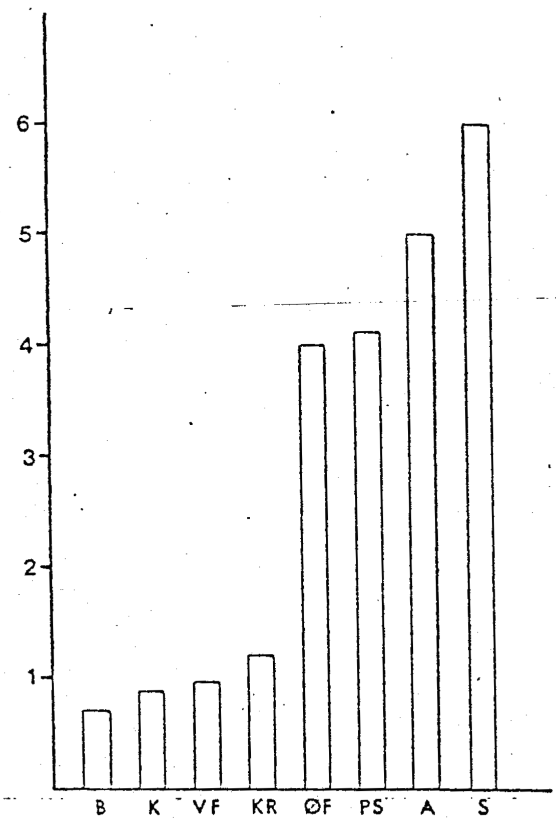



Fig. 2.

Gjennomsnittlig antall reker på agnboksen pr. minutt for ulike agntyper.

B = blindforøk (uten agn)
K = kvalkjøtt
VF= vannløselig fiskemelekstrakt
KR= krill
ØR= ørretfôr (fôrmel)
PS= pangestinbehandlet sild
(fordøyelsesenzym)
A = akkar
S = sild

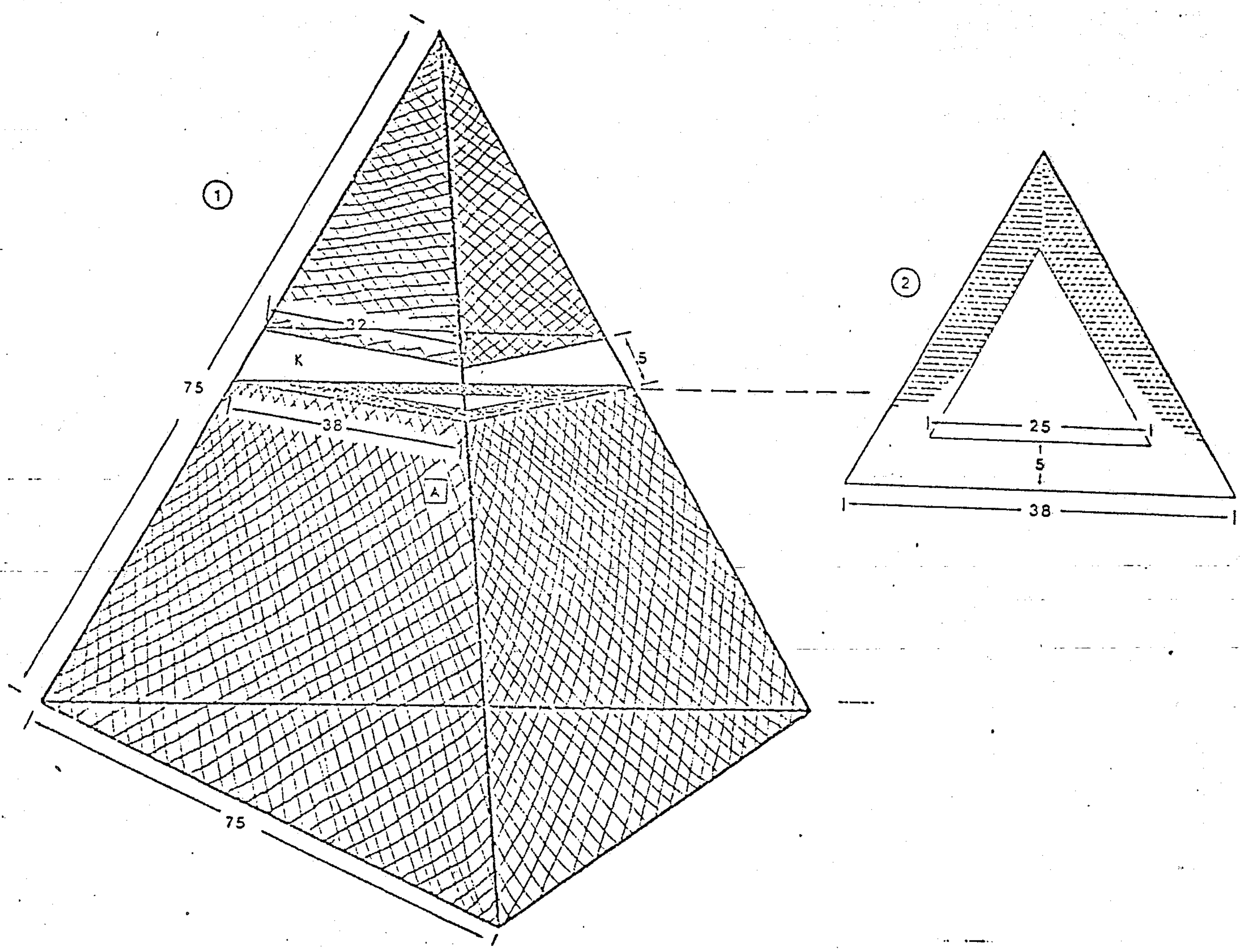



Fig. 3. Teinetype 01. Regulær tetraederform med spaltekalv.
Alle mål i cm.
1) Perspektivskisse 2) Horisontalsnitt i kalvplanet
A = agnplassering, K = kalv
Ramme: 10 mm rundtjern,
Kledning: Not (20 mm maskevidde),
Opprinnelse: Modifikasjon av amerikansk reketeine.

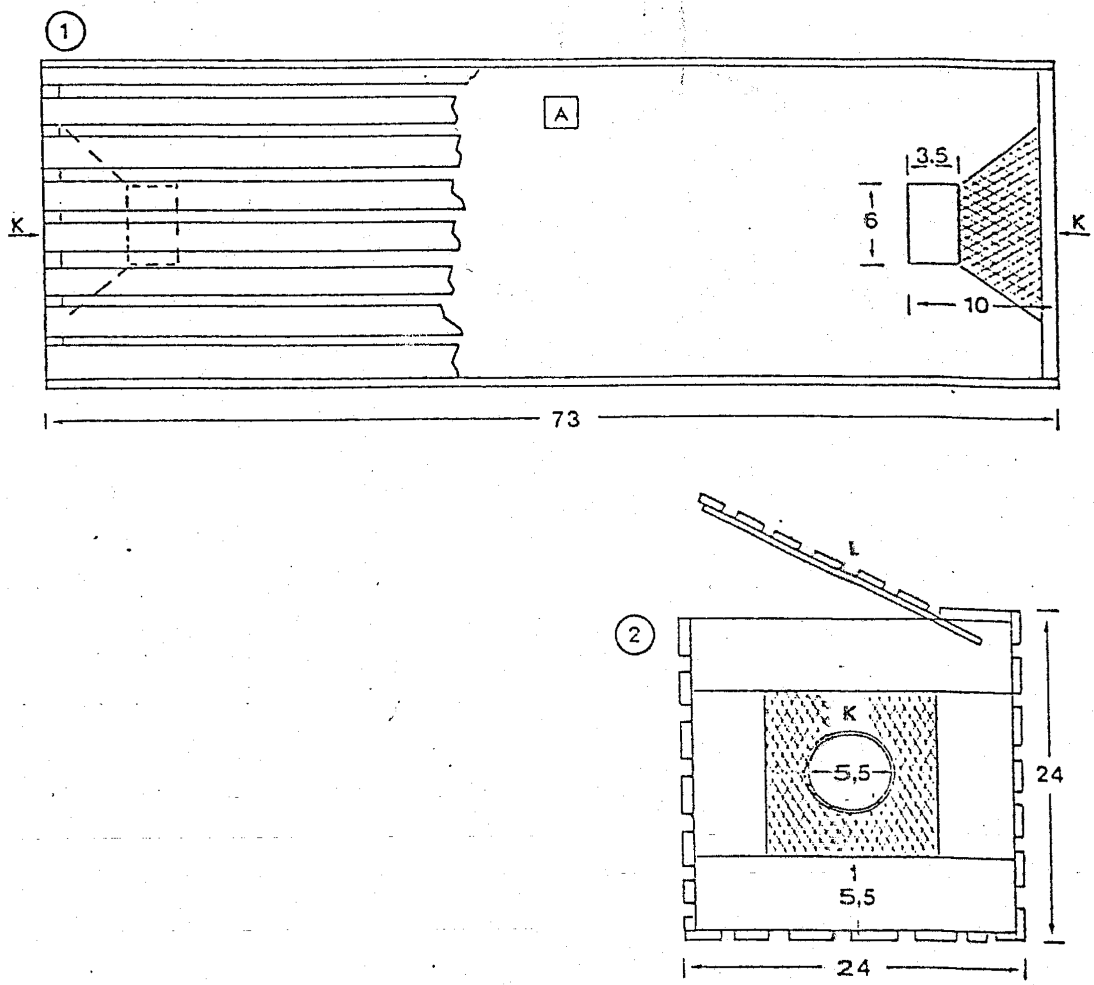



Fig. 4. Teinetype 05. Rektangulær "kasseteine" med 2 trakt-formete kalver. Alle mål i cm. 1) Sett fra sida 2) Sett fra enden A = agnplassering K = kalv
Ramme: Doble 6 mm tre-lekter, Kledning: Tre-lekter (6mm tykke) m. 3-6 mm mellomrom, Kalv: Not (28 mm maskevidde) og PVC-rør.
Opprinnelse: Modifisert amerikansk reketeine (RONHOLT 1974).

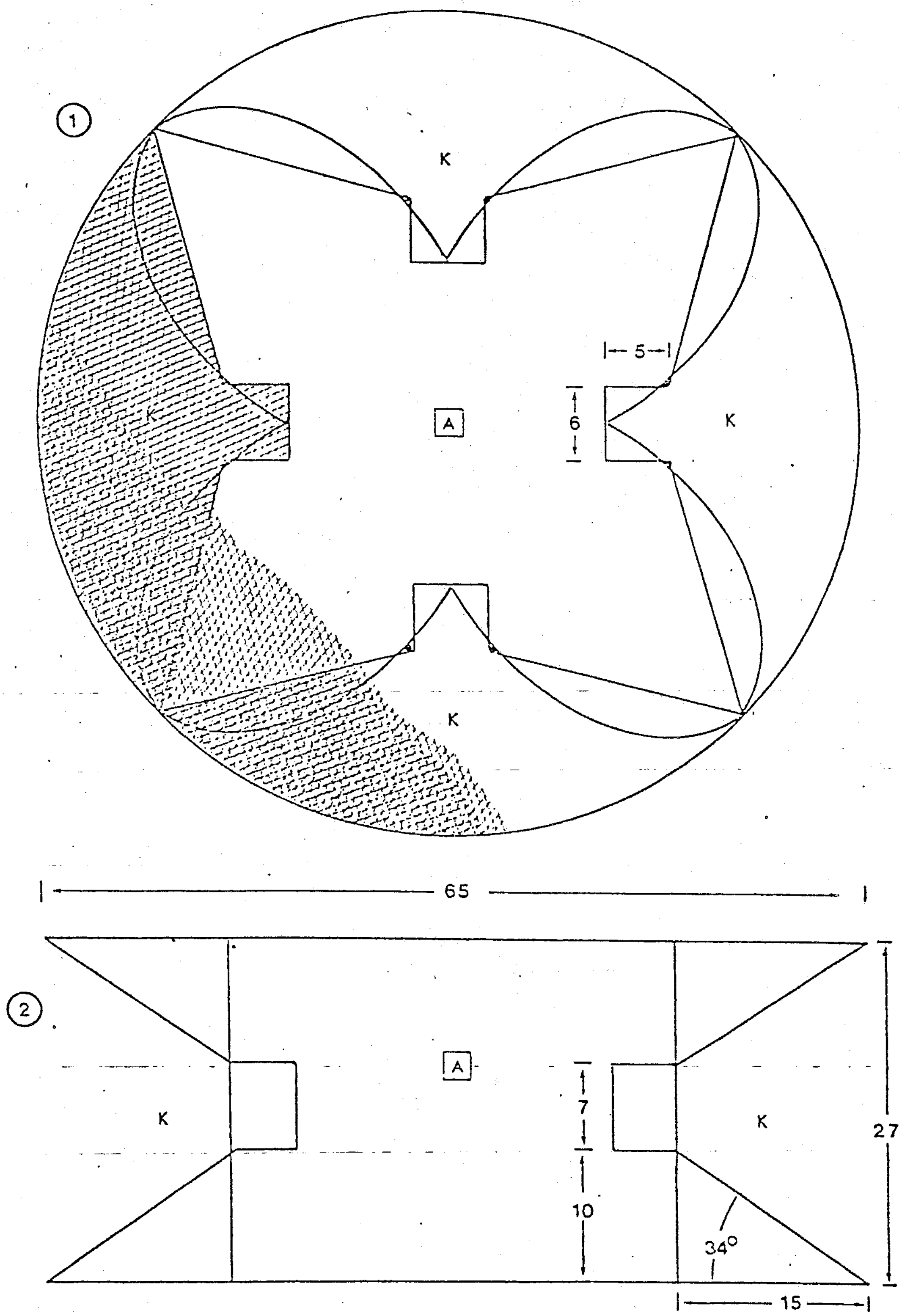



Fig. 5. Teinetype 11. Sirkulær konstruksjon med 4 trakteformete kalver. Alle mål i cm. 1) Sett ovenfra 2) Tversnitt A = agnplassering, K = kalv,
Ramme: 8 mm galvanisert rundtjern Kledning: not (18mm maskevidde), Opprinnelse: Konstruert av E. Bruarøy, Nordstrøno.

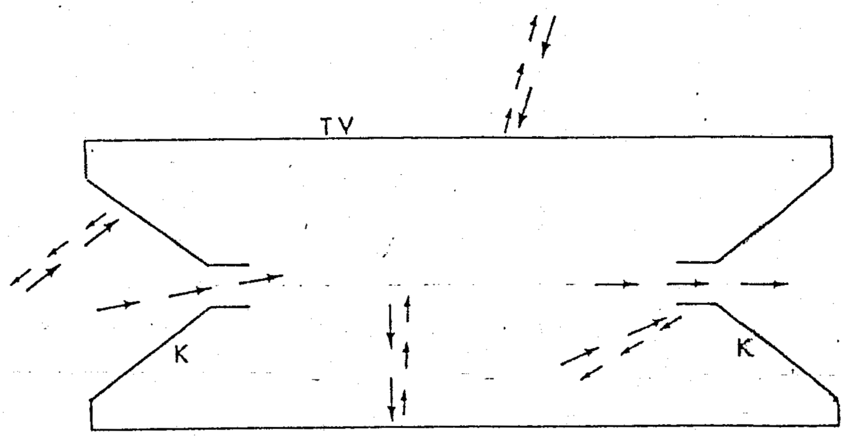



Fig. 6. Reke-atferd i forhold til teine 05 (Fig.4).

→ → rekas kurs inn mot teina (rolig svømming)

-→ -→ -→ rekas kurs ut fra teina (rask tilbaketrekning ved haleslag)

TV = teinevegg, K = kalv

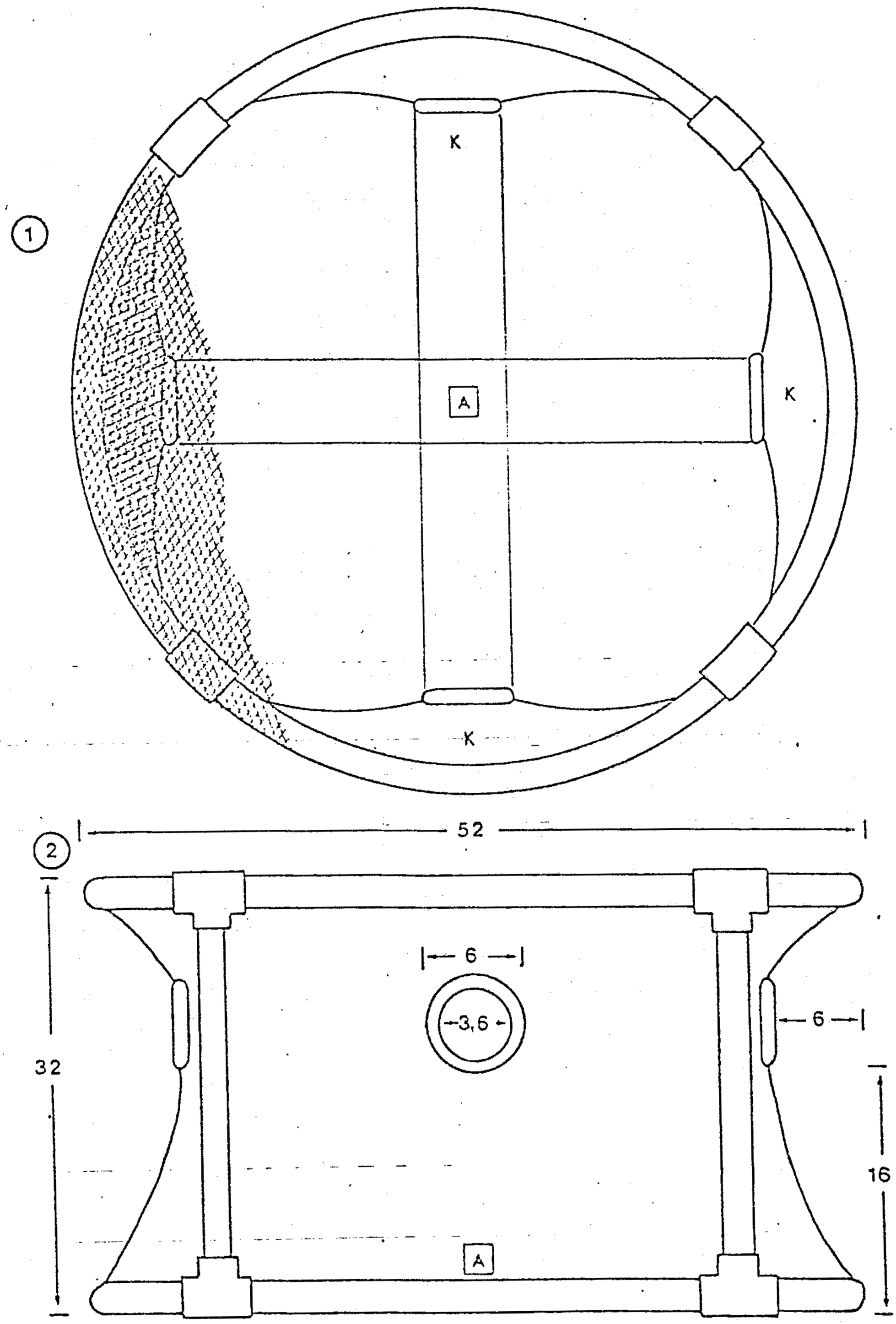



Fig. 7. Teinetype 10. Sirkulær konstruksjon med 4 kalver.
Alle mål i cm. 1) Sett ovenfra 2) Sett fra sida.
A = agnplassering, K = kalv,
Ramme: Polyetylen-slange (ytre diam. 2 cm), sammenføyd med T-ledd av PVC, Kledning: Not (32 mm maskevidde, samt noen teiner med 14 mm maskevidde, Kalv: Not og nylon-ringer, Opprinnelse: Amerikansk reketeine (McBRIDE & BARR 1967).

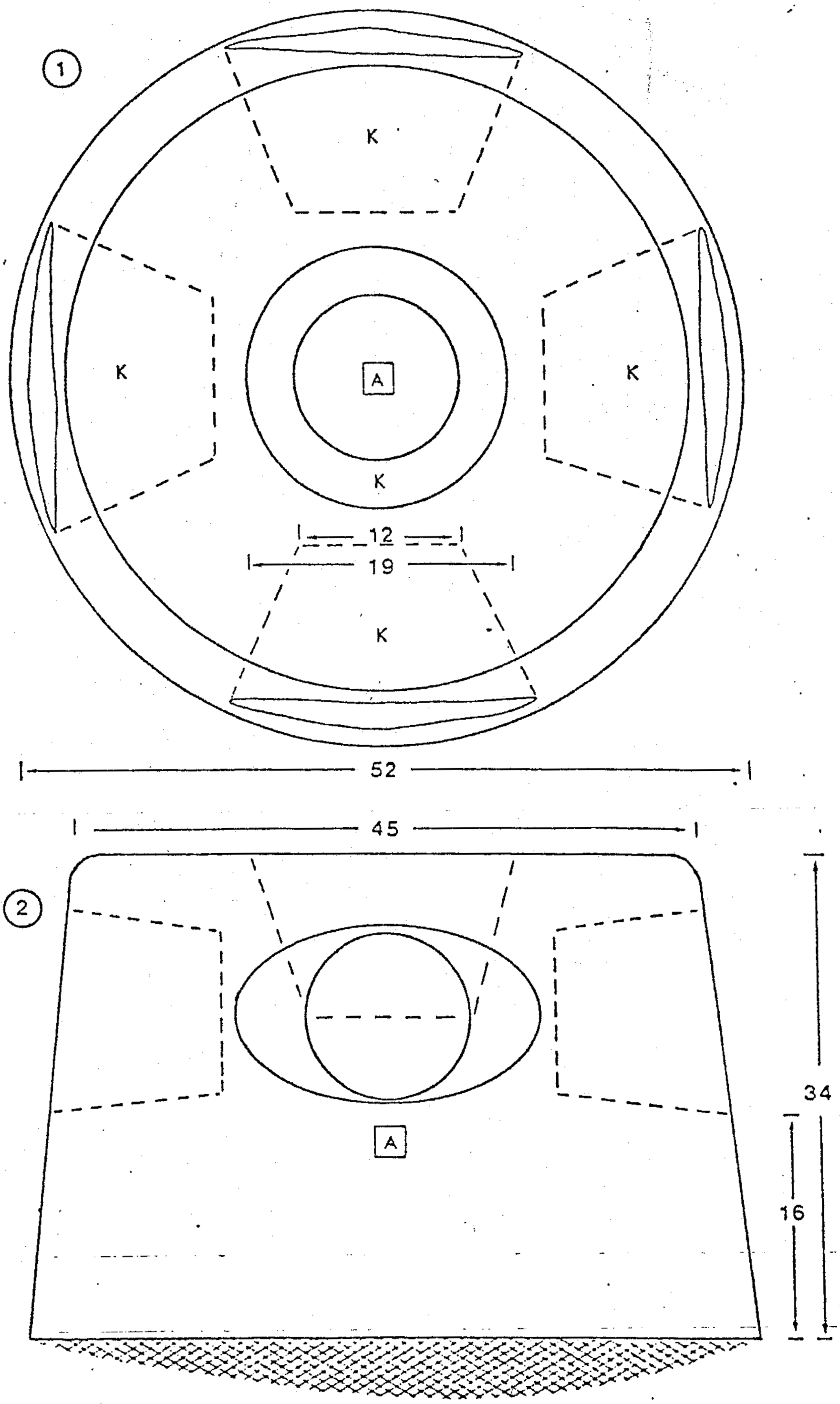



Fig. 8. Teinetype 12. Konisk teine (plast-stamp) med 5 kalver.
Alle mål i cm. 1) Sett ovenfra 2) Sett fra sida.
A = agnplassering, K = kalv,
Kledning: Hard plast, not (25 mm maskevidde) i bunn,
Kalv: Koniske plast-kalver,
Opprinnelse: Egen konstruksjon.

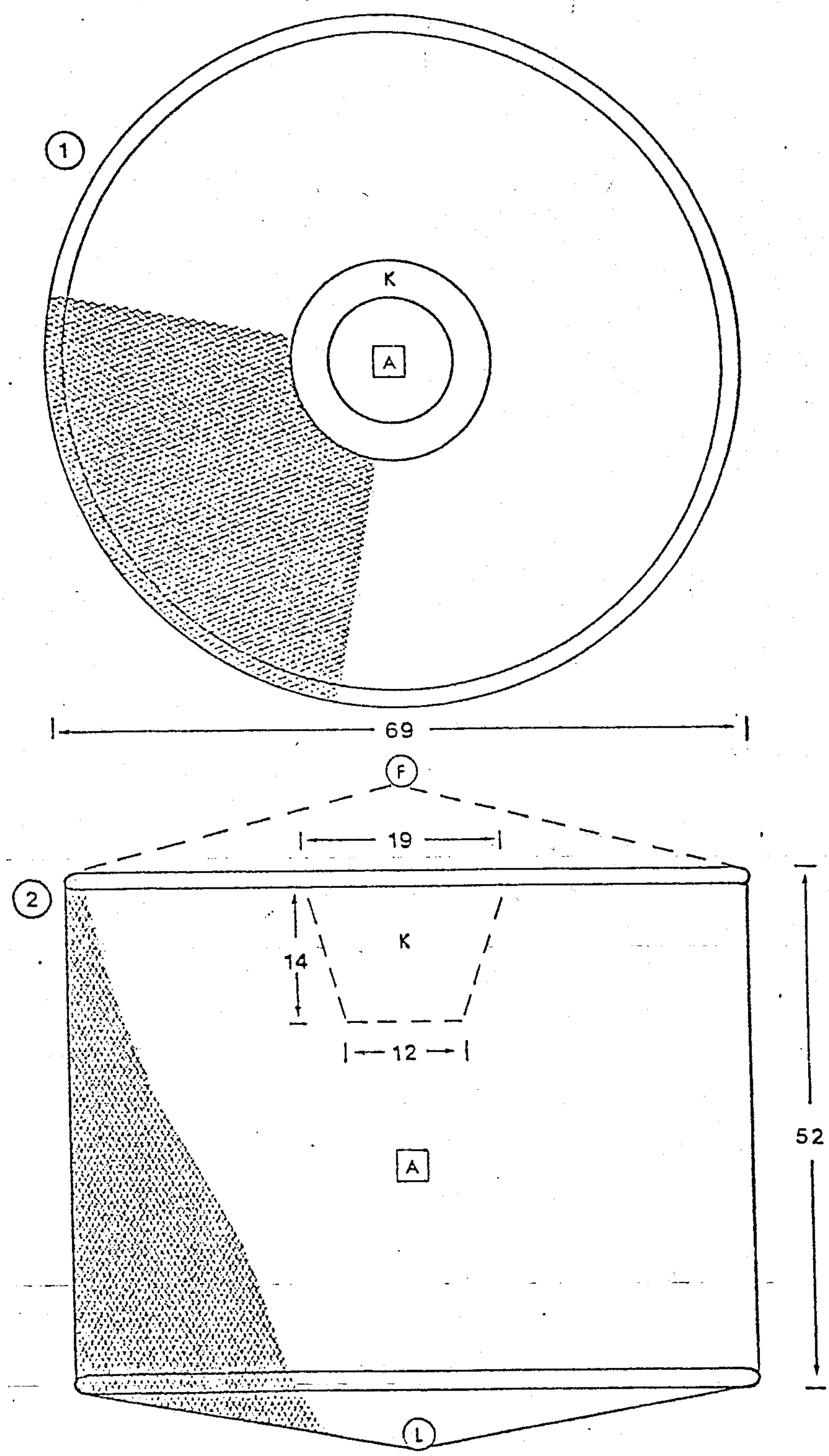



Fig. 9. Teinetype 13. Sylinderformet teine med en kalv. Teina Teina er sammenleggbar og holdes oppspilt ved lodd og flottør. Alle mål i cm. 1) Sett ovenfra 2) Sett fra sida. A = agnplassering, K = kalv, L = lodd, F = flottør.
Ramme: Polyetylen-slange (diam. 2 cm) i topp og bunn, Kledning: Plast-strie (Cotiso), Kalv: Konisk plast kalv, Opprinnelse: Egen konstruksjon.

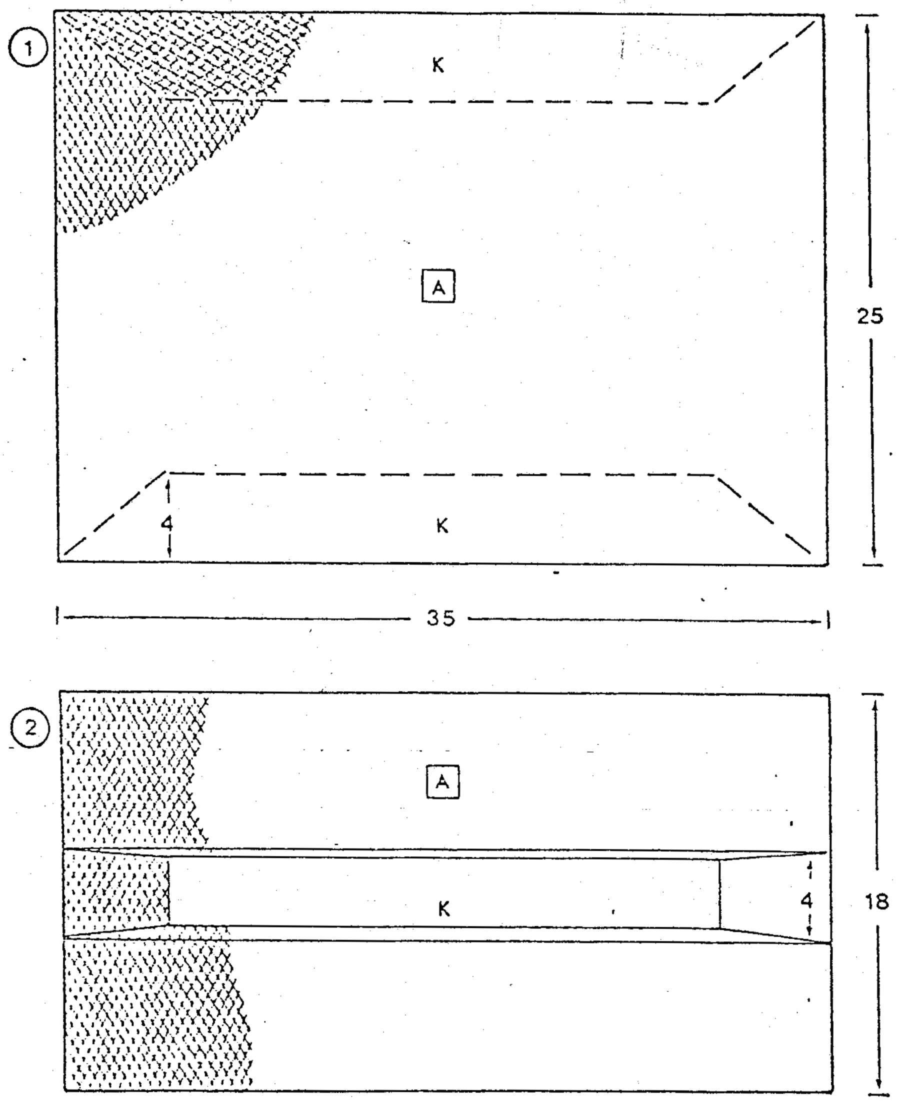



Fig. 10. Teinetype 14. Reketeine med 2 spalte-kalver.
Alle mål i cm. 1) Sett ovenfra 2) Sett fra sida.
A = agnplassering, K = kalv,
Ramme: 8 mm rundtjern
Kledning: Not (20mm maskevidde)
Opprinnelse: Kontruert av E. Bruarøy, Nordstrøno.

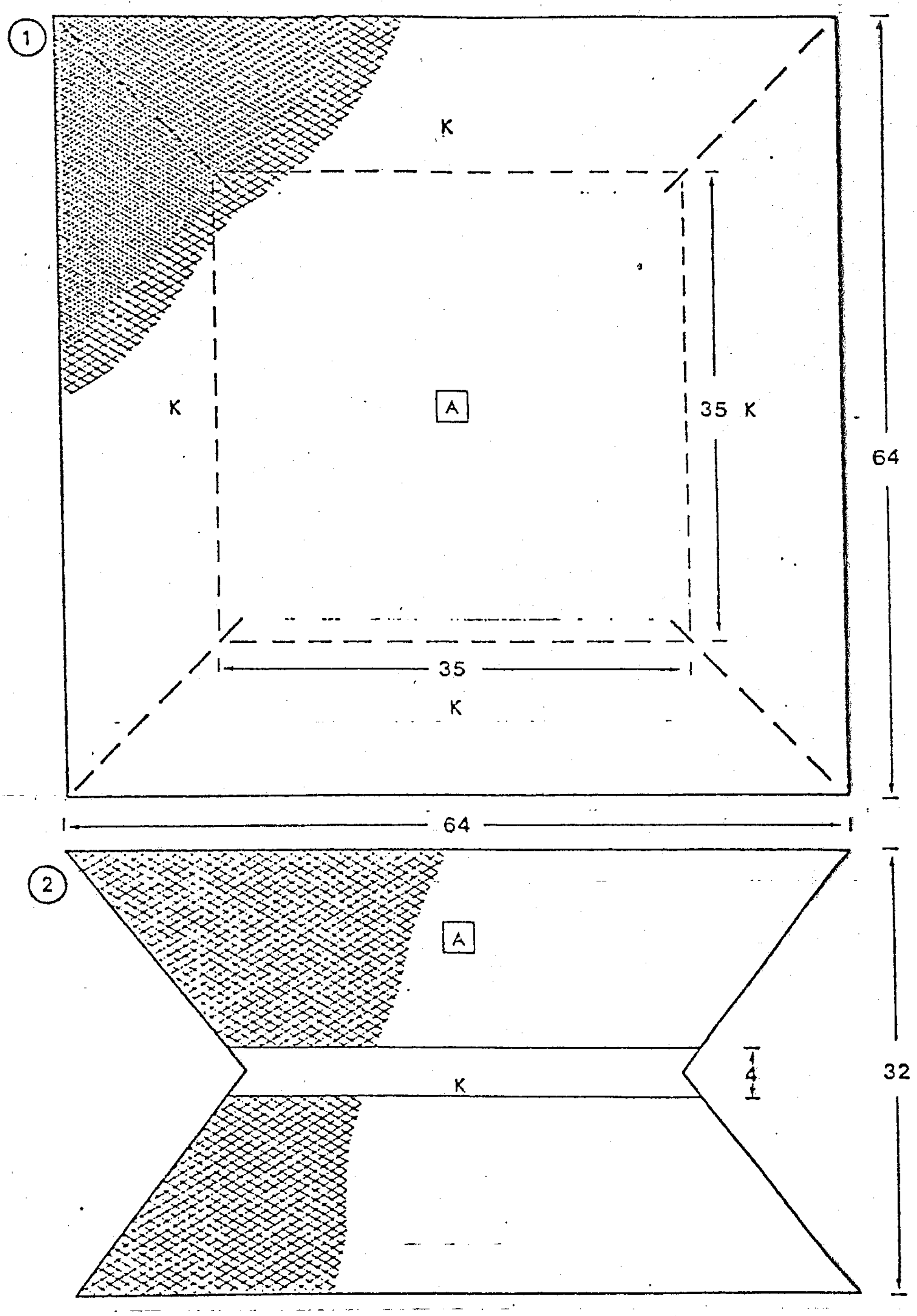



Fig. 11. Teinetype 15. Kvadratisk, prismeformet konstruksjon med spalteformet "midjekalv". Alle mål i cm.
1) Sett ovenfra 2) Sett fra sida
A = agnplassering, K = kalv,
Ramme: 12 mm rundtjern,
Kledning: Not (18 mm maskevidde),
Opprinnelse: Konstruert av E. Bruarøy, Nordstrøno.

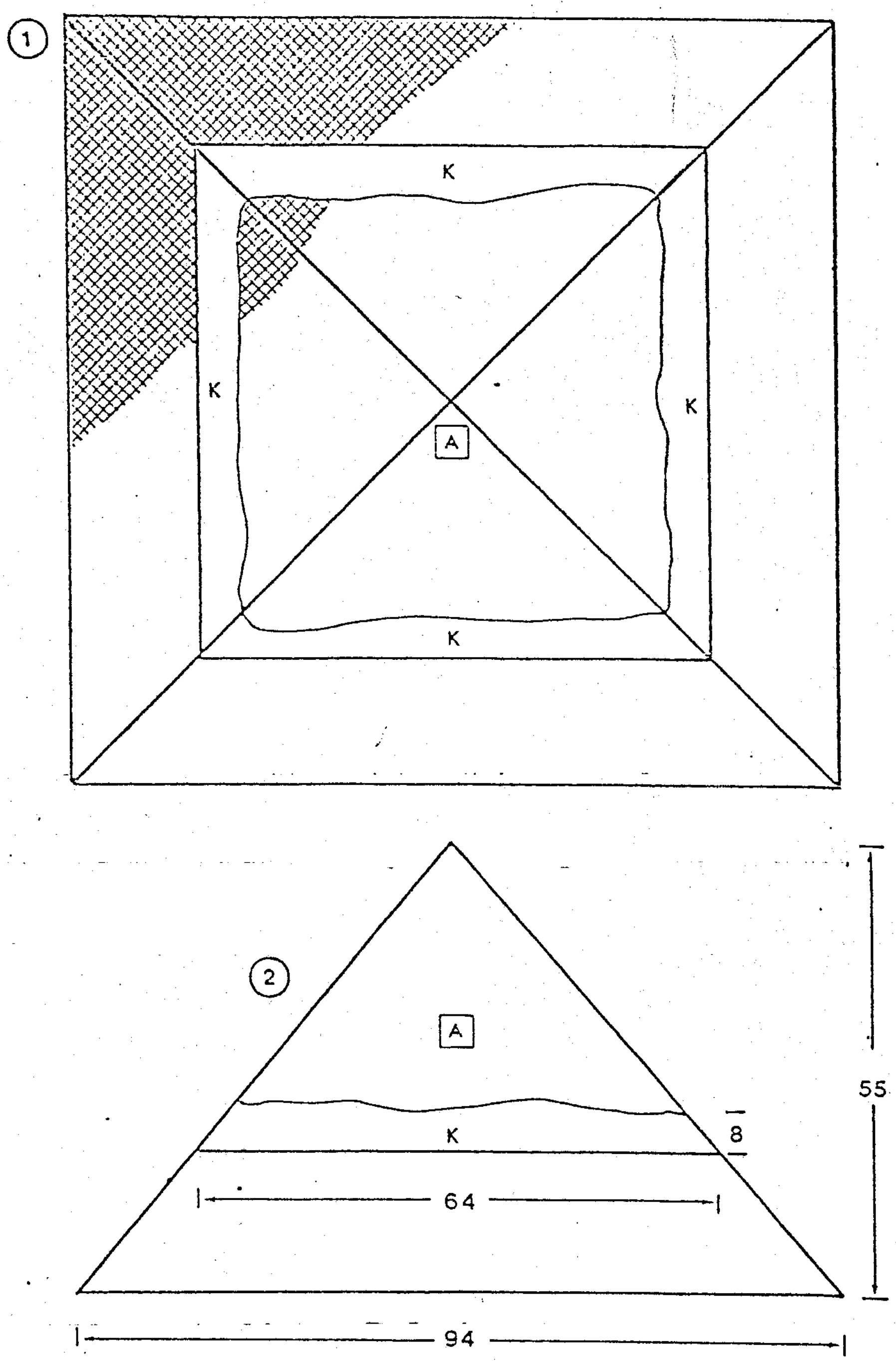



Fig. 12. Teinetype 16. 4-kantet regulær pyramide-
konstruksjon, med sammenhengende spaltekalv.
Alle mål i cm. 1) Sett ovenfra 2) Sett fra sida.
A = agnplassering, K = kalv,
Ramme: 14 mm rundtjern,
Kledning: Hønsenetting (6-kantet, 17 mm diagonal),
Opprinnelse: Konstruert av E. Bruarøy, Nordstrøno.

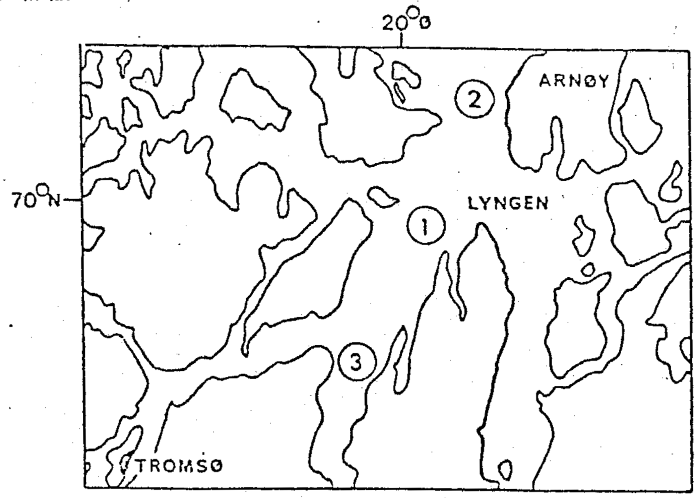



Fig. 13.

Posisjoner for reketeine-forsøk, Lyngen-distriktet.
1) Ullsfjord 2) Spenna
3) Lattervika

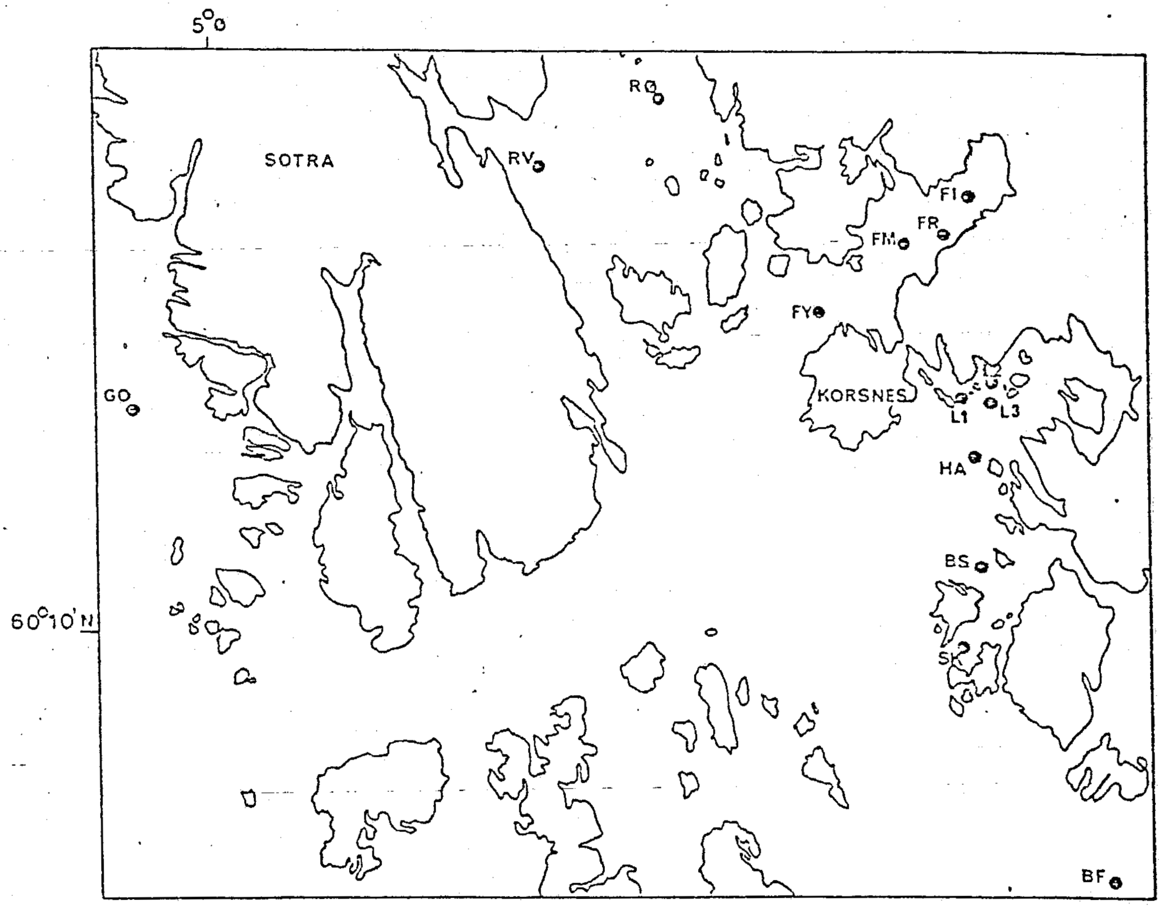



Fig. 14. Lokaliteter for fiskeforsøk med reke- og sjøkrepsteiner, Bergen/syd.

BF = Bjørnefjorden
BS = Bjørnarøy/Skorpo
FI = Fanafjord, indre
FM = Fanafjord, midtre
FR = Fanafjord, v/Rød
FY = Fanafjord, ytre

GO = Goltastein-feltet
HA = Havreholmen
L1, L2, L3 = Lysefjorden 1,2,3
RV = Raunefjord, vest
RØ = Raunefjord, øst

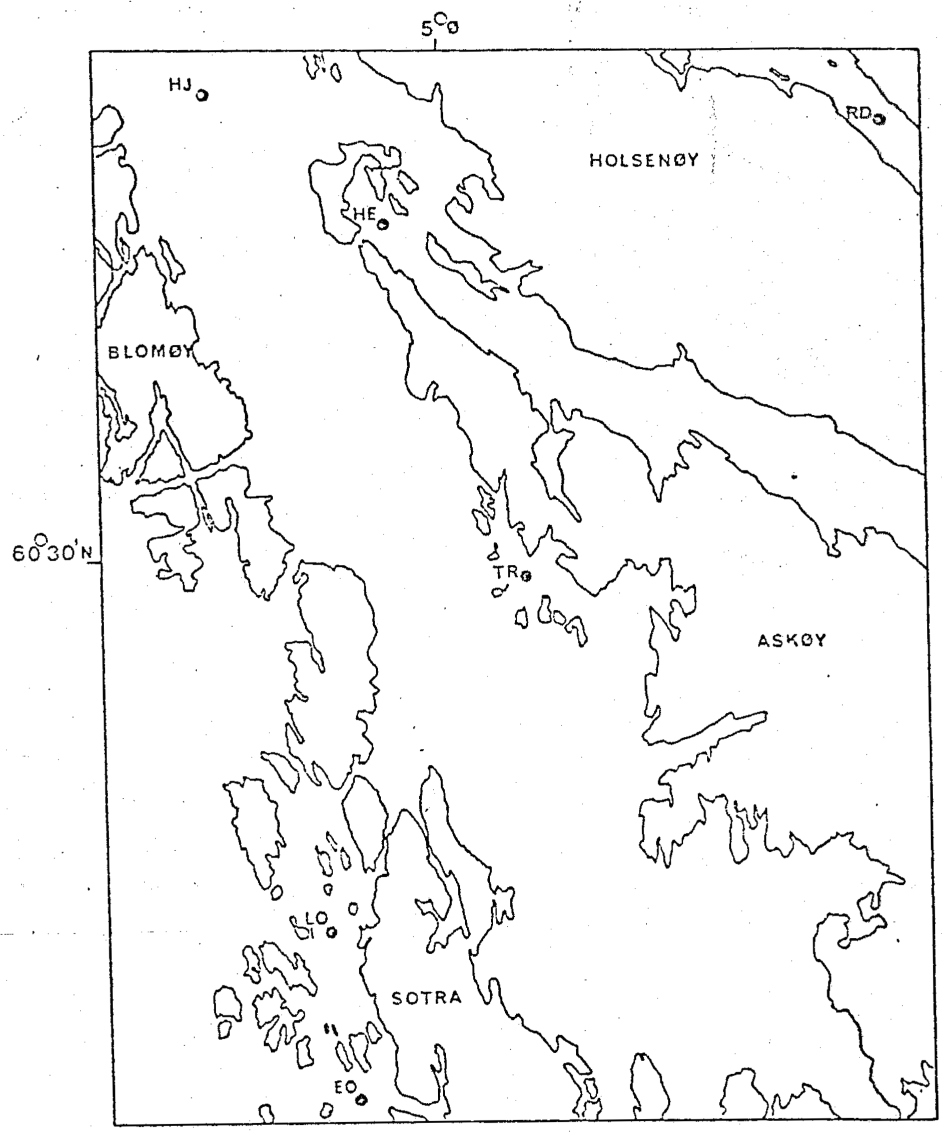



Fig. 15. Lokaliteter for fiskeforsøk med sjøkrepsteiner, Bergen, nord.

EO = Eideosen
HE = Herdlafjorden
HJ = Hjeltefjorden
LO = Landro-osen
RD = Radfjorden
TR = Trætteosen

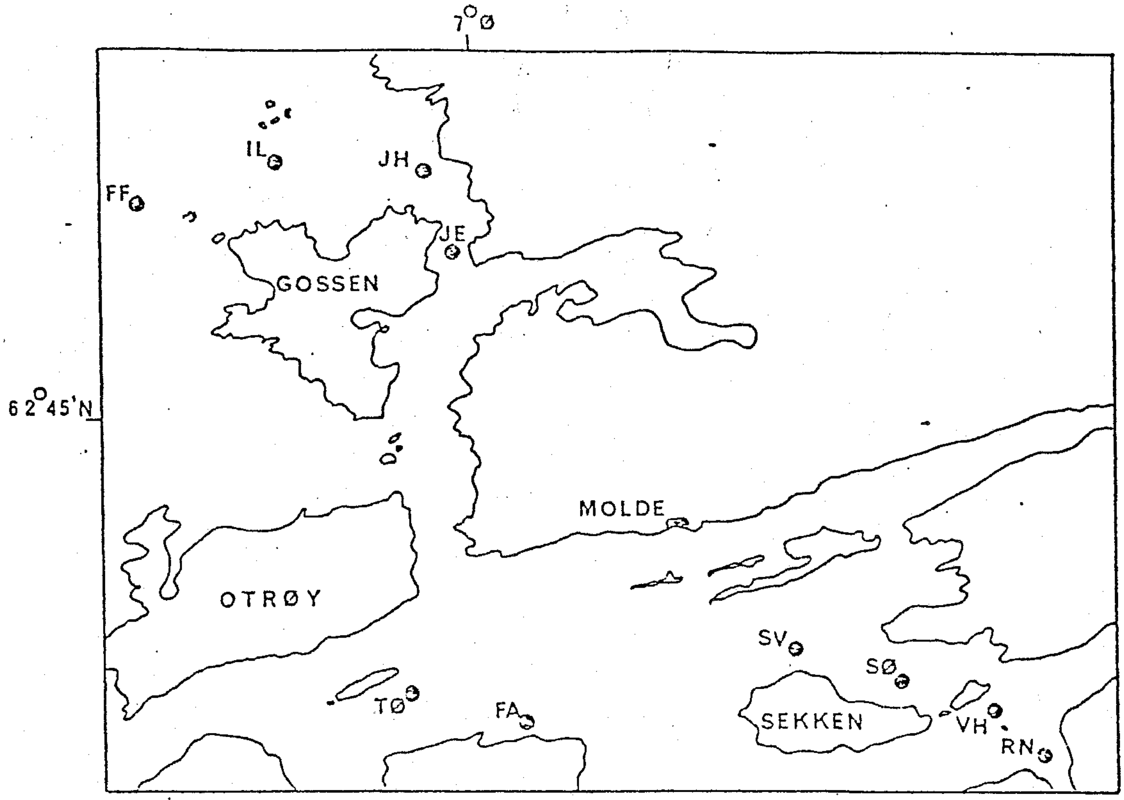



Fig. 16. Lokaliteter for fiskeforsøk med sjøkrepsteiner, Romsdalsområdet.

| | |
|---|---|
| FA = Faksen | RN = Rødvenfjorden |
| FF = Flatflesa | SV = Sekken, vest |
| IL = Indreleia | SØ = Sekken, øst |
| JE = Julsund v/Eikrem | TØ = Tautra, øst |
| JH = Julsund v/Harøy | VH = Veøy/Hestholmen |

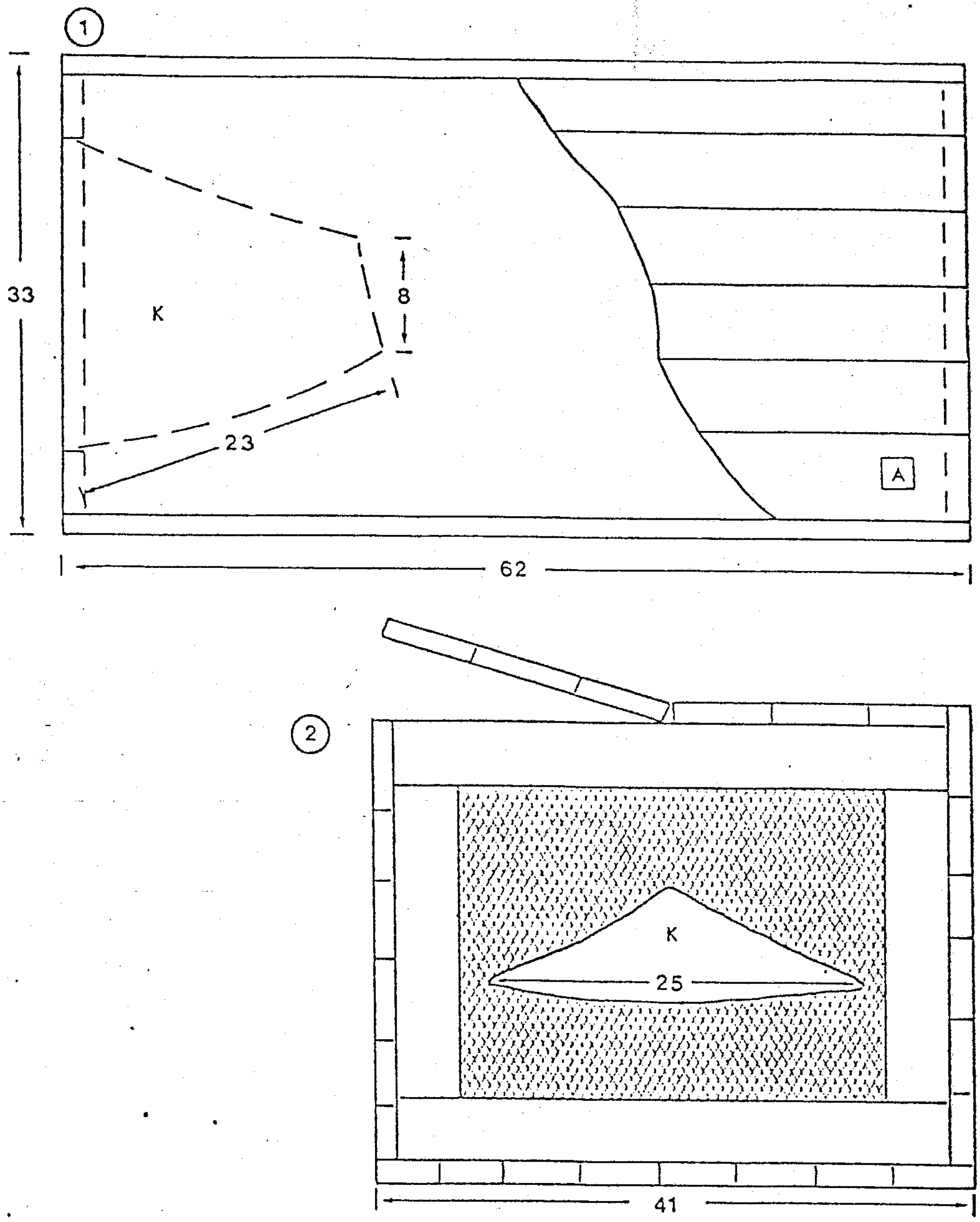



Fig. 17. "Kasseteine" med en kalv. Alle mål i cm.
1) Sett fra siden 2) Sett fra kalv-enden.
A = agnplassering, K = kalv,
Kledning: Trefjøler (tykkelse 1,5 cm), Kalv: Not (30 mm maksevidde), Opprinnelse: Tradisjonell hummerteine, laget av E. Bruarøy.

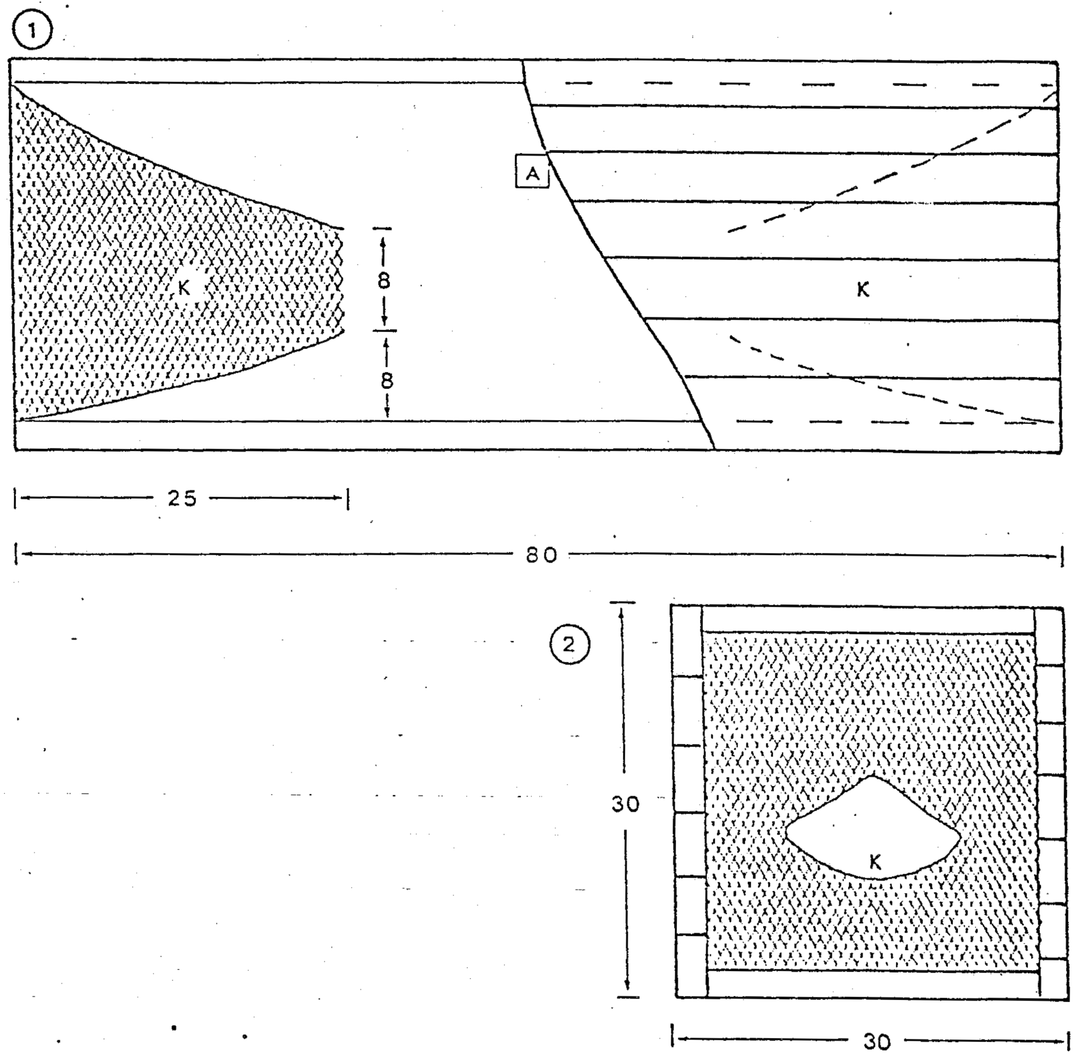



Fig. 18. Teinetype 18. "Kasseteine" med 2 kalver. Alle mål i cm. 1) Sett fra sida 2) Sett fra enden.
A = agnplassering, K = kalv,
Kledning: Tett kledning av trefjøler,
Kalv: Not (30 mm maskevidde),
Opprinnelse: Tradisjonell krabbeteine, ulånt av K.R. Gundersen, FHi.

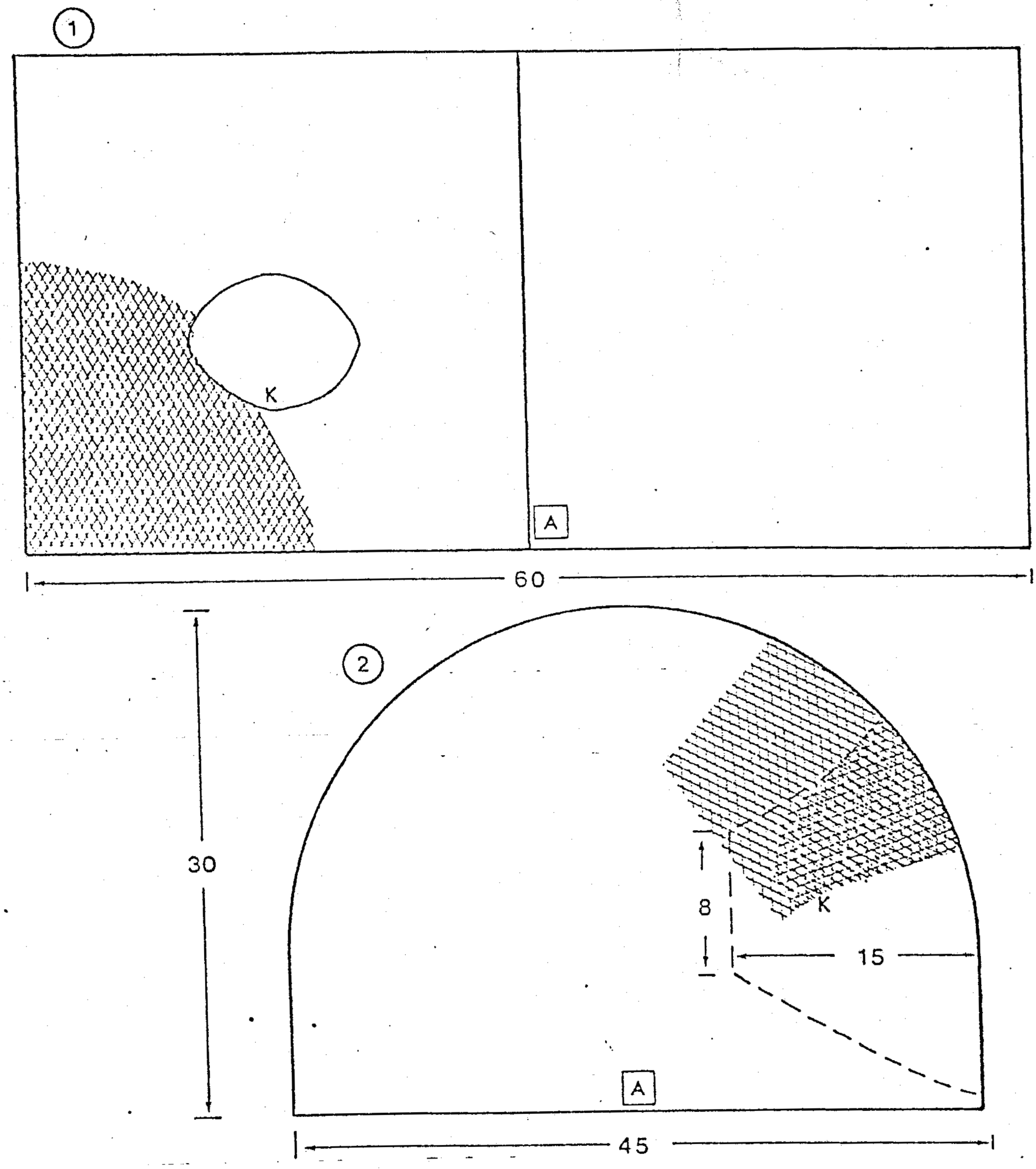



Fig. 19. Teinetype 19. Tunnelformet konstruksjon med 1 kalv.
Alle mål i cm. 1) Sett fra sida 2) Sett fra enden.
A = agnplassering, K = kalv
Ramme: 10 mm galvanisert rundtjern,
Kledning: Not (30 mm maskevidde),
Opprinnelse: Skotsk hummerteine, utlånt av
K.R. Gundersen, FHi.

SETT FRA SIDA

SETT OVENFRA

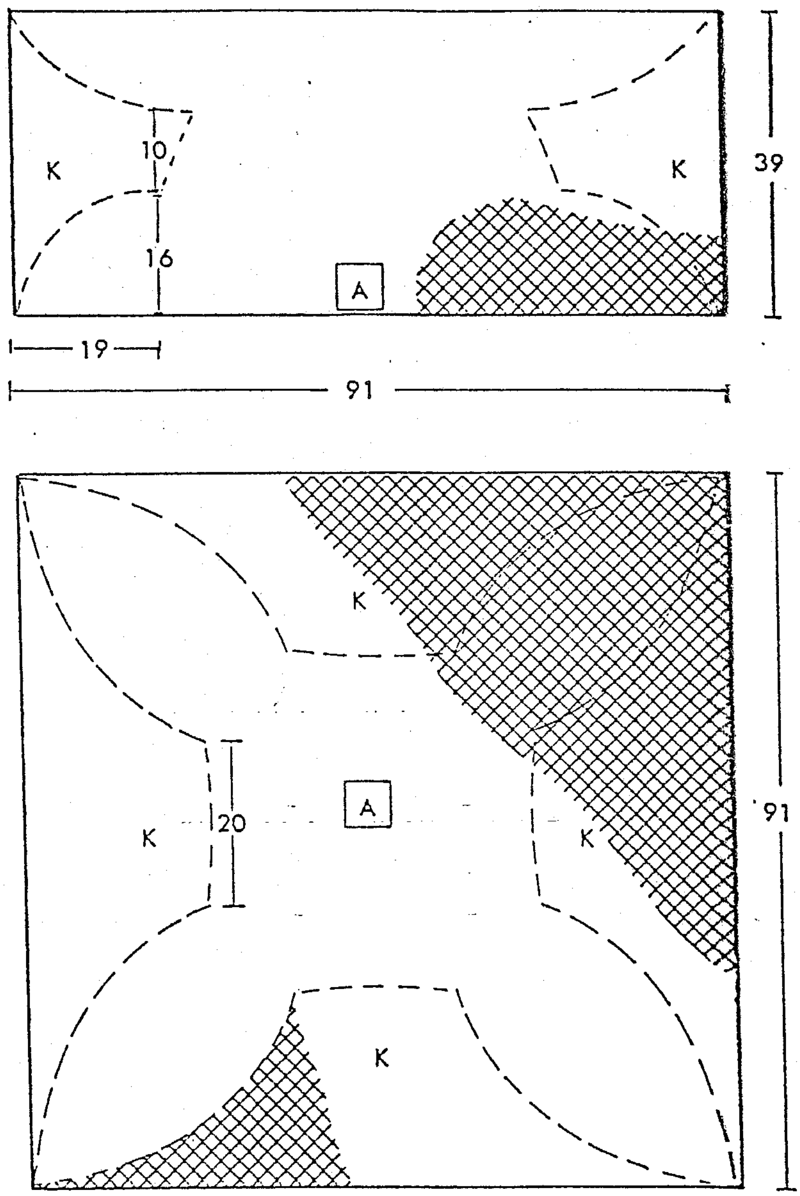



Fig. 20. Teinetype 20. Kvadratisk konstruksjon med 4 kalver.
Alle mål i cm.
Ramme: 8 mm rundtjern,
Kledning: Not (28 mm maskevidde),
Opprinnelse: Konstruert i forbindelse med denne undersøkelsen.

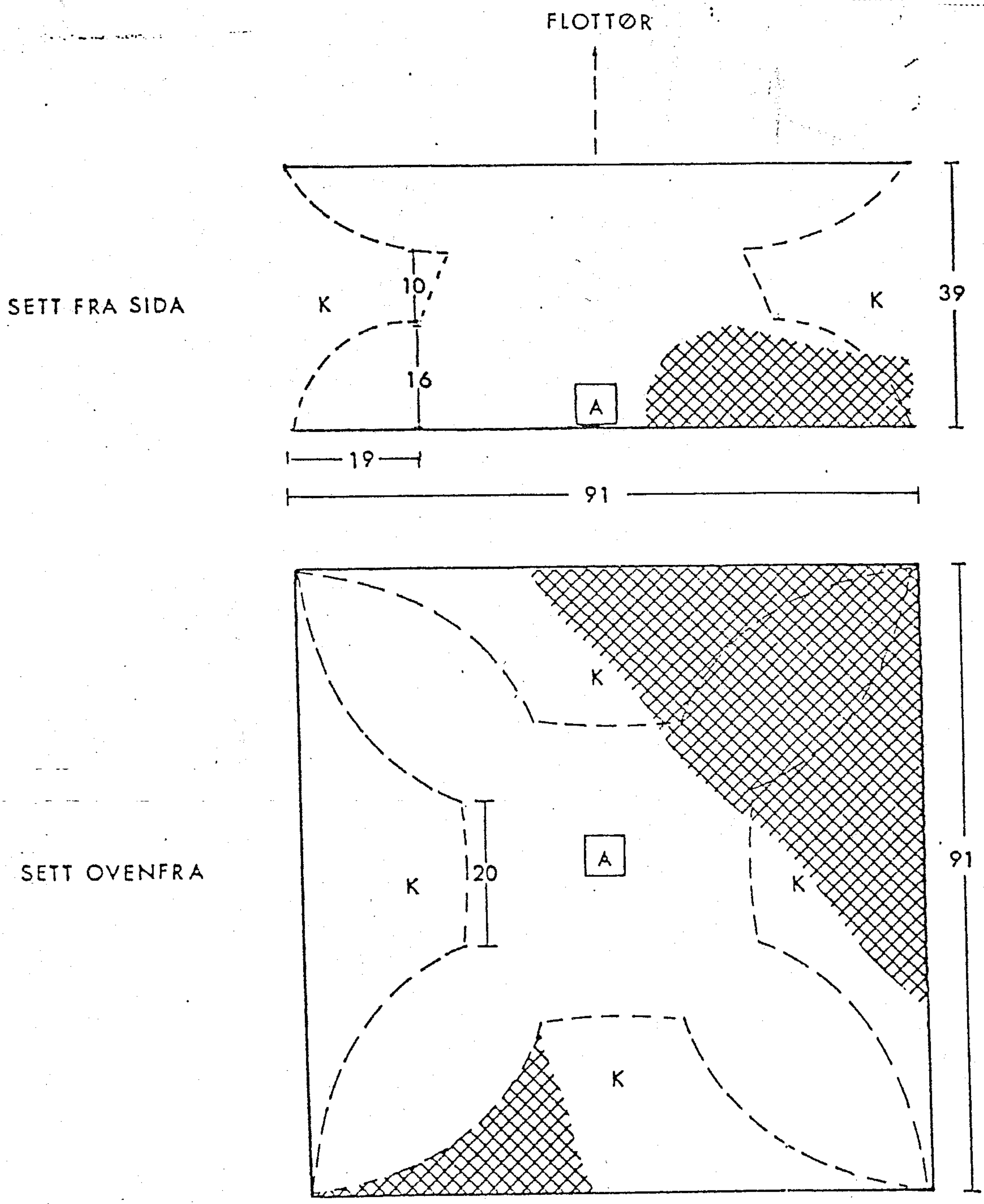



Fig. 21. Teinetype 21. Sammenleggbar konstruksjon. Identisk med teinetype 20, men mangler hjørnestolper. Holdes oppspilt med flottør. Alle mål i cm. A = agnplassering, K = kalv. Opprinnelse: Konstruert i forbindelse med denne undersøkelsen.

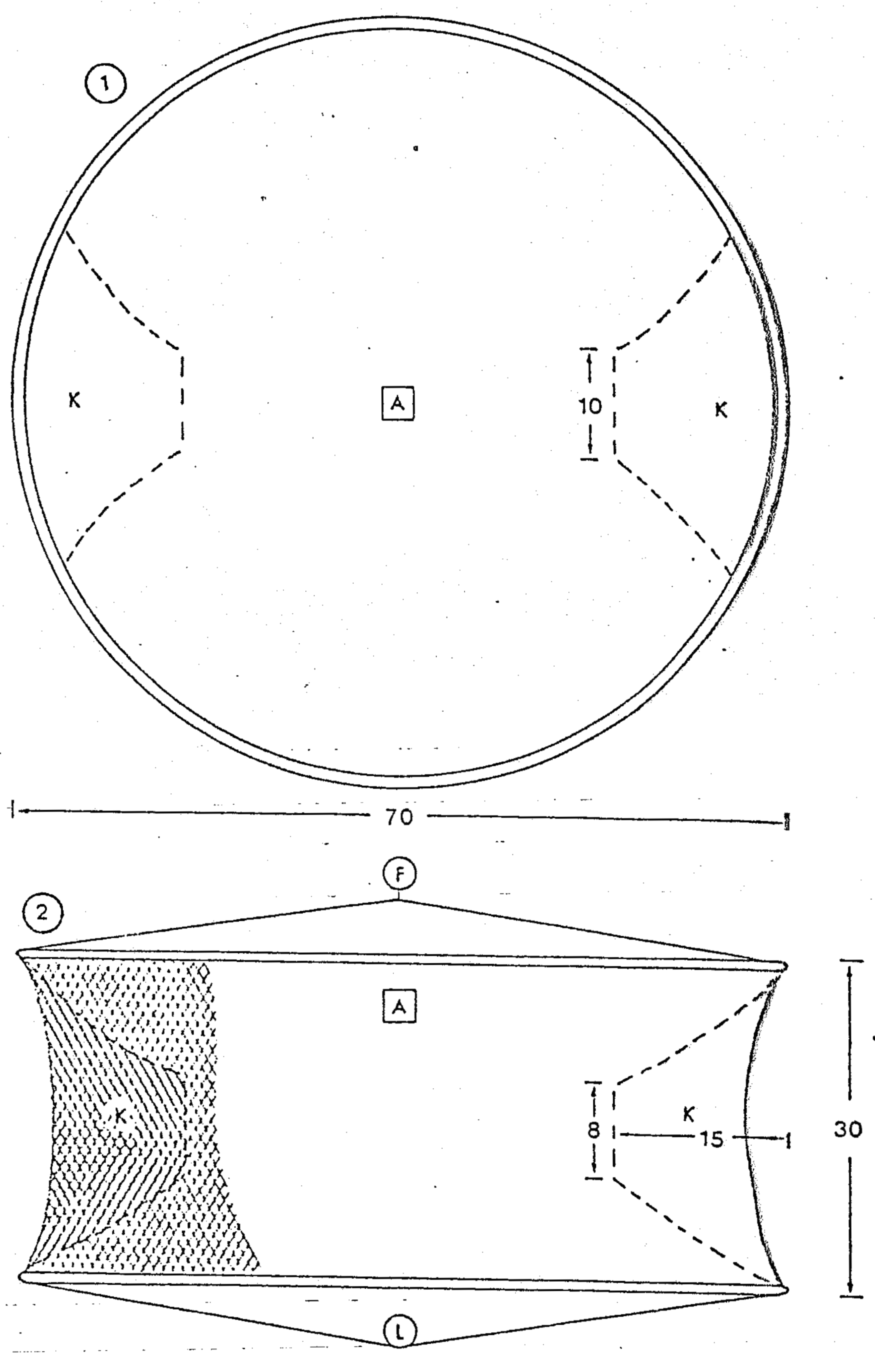



Fig. 22. Teinetype 22. Sirkulær sammenleggbar konstruksjon med 2 kalver. Alle mål i cm.
1) Sett ovenfra 2) Sett fra sida.
A = agnplassering, F = flottør, K = kalv, L = lodd,
Ramme: "Ruseringer" (hard PVC),
Kledning: Not (30 mm maskevidde),
Opprinnelse: Eksperimentell hummerteine, utlånt av K.R. Gundersen, FHi.

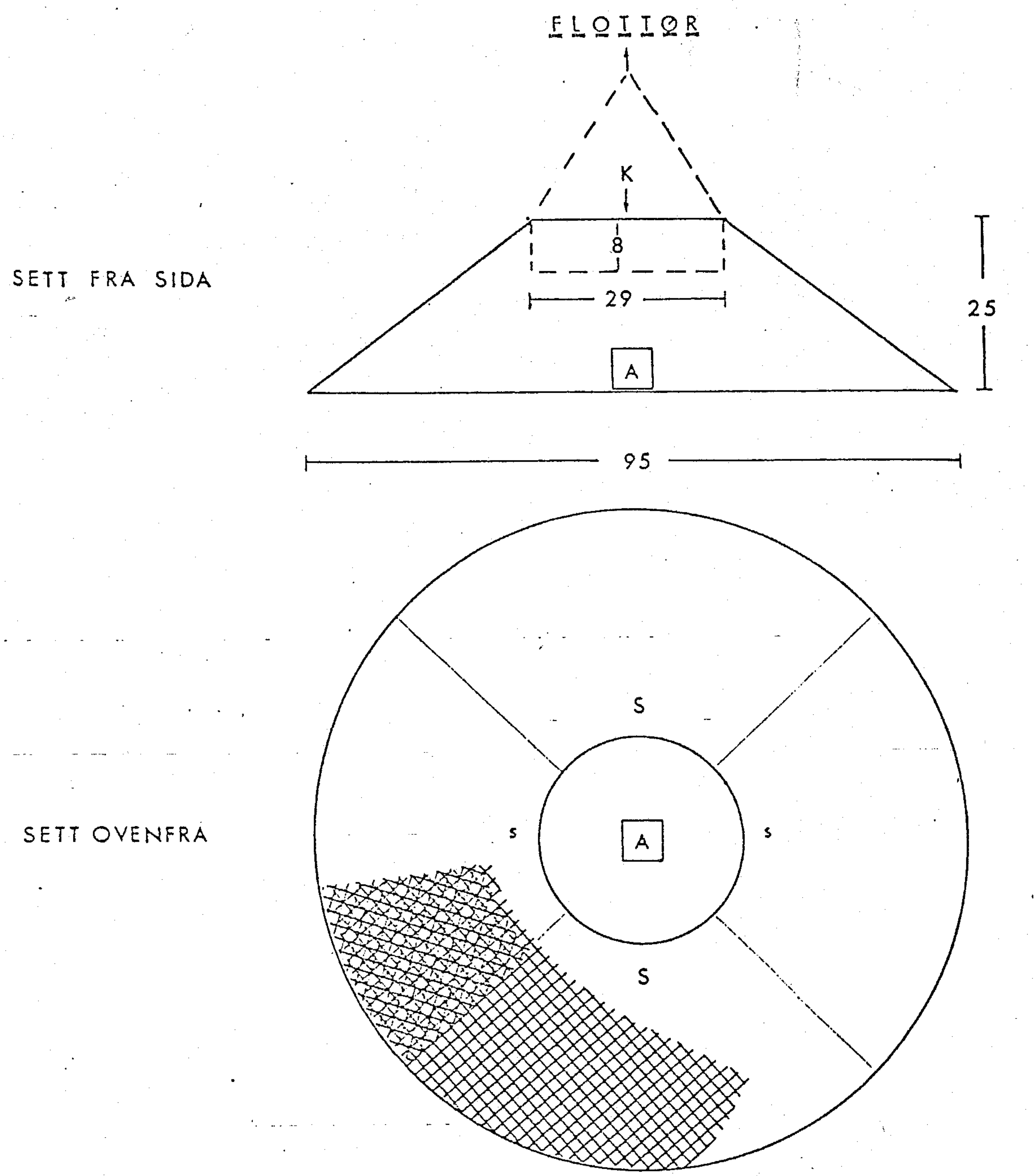



Fig. 23. Teinetype 23. Konisk teine med toppkalv. Holdes oppspilt med flottør. Alle mål i cm.
A = agnplassering, K = kalv
Ramme: 7 mm rundtjern,
Kledning: S = stormaska not ( 30 mm maskevidde)
s = småmaska not (10 mm maksevidde)
Opprinnelse: Konstruert i forbindelse med denne undersøkelsen.

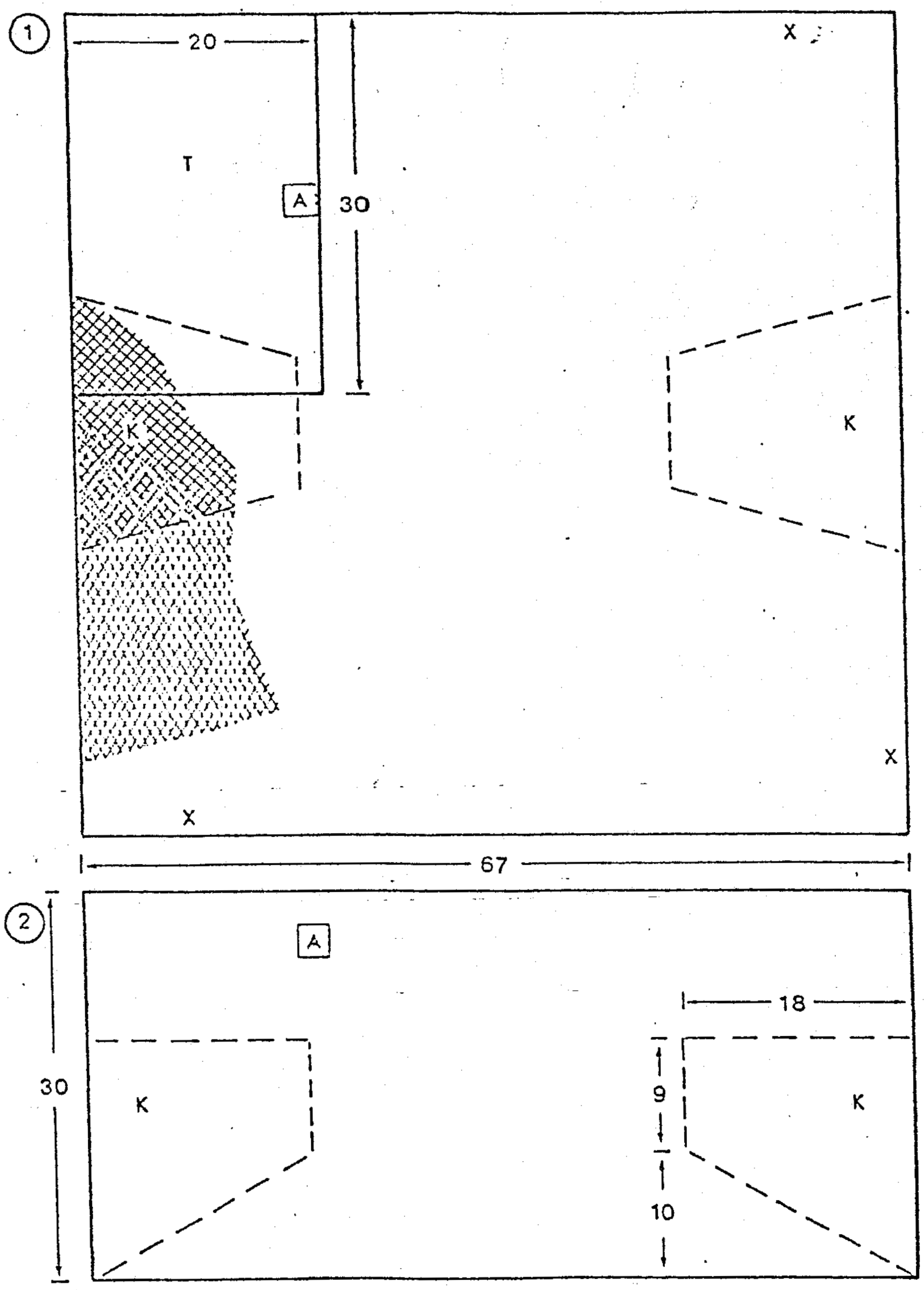



Fig. 24. Teinetype 24. Kvadratisk konstruksjon med 2 (alternativt 3) kalver. Alle mål i cm. 1) Sett ovenfra 2) Sett fra sida. A = agnplassering, K = kalv, T = tømmeluke, X = kalvplassering med 3 kalver.
Ramme: 8 mm rundtjern
Kledning: Not (28 mm maskevidde), montert stolperett,
Kalver: Plastnetting (Polyetylen), 1x1 cm ruter
Opprinnelse: Konstruert av H. Høghammer, Færøyane.

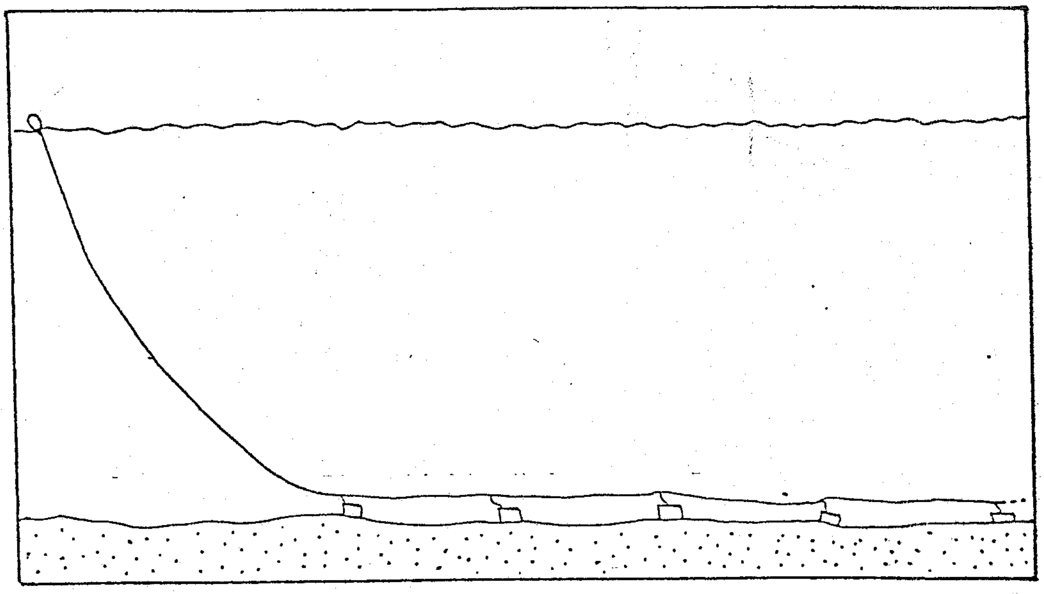


Fig. 25. Setningsarrangement. Teiner forbundet med stjerter til bunnline, ile og blåse. Teine avstand ca. 35 m.

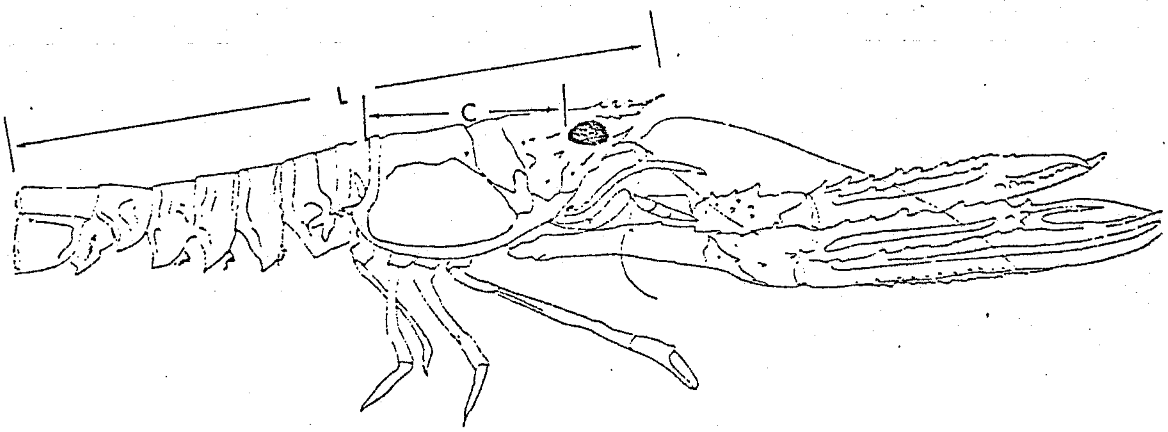



Fig. 26. Lengdemåling av sjøkreps. L = total-lengde, C = carapax-lengde.

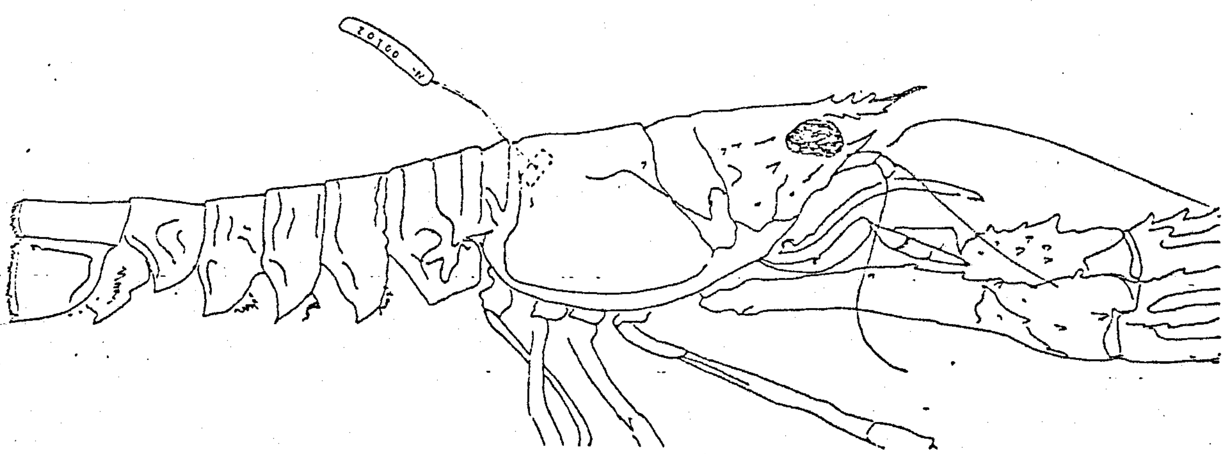


Fig. 27. Sjøkreps med merke.

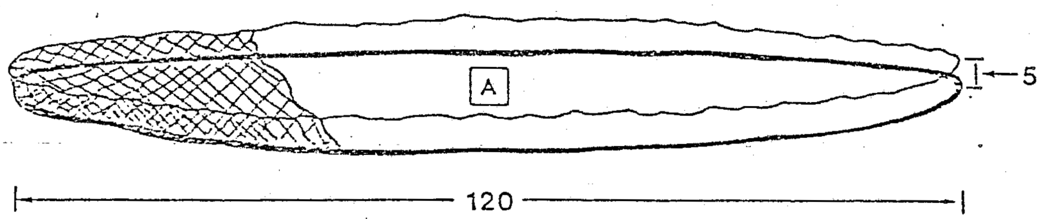



Fig. 28. Sirkulær notkledd konstruksjon. Alle mål i cm.
A = agnplassering
Ramme: Polyetylen-slange (ytre diam. 2 cm),
Kledning: Not, 130 mm maskevidde.

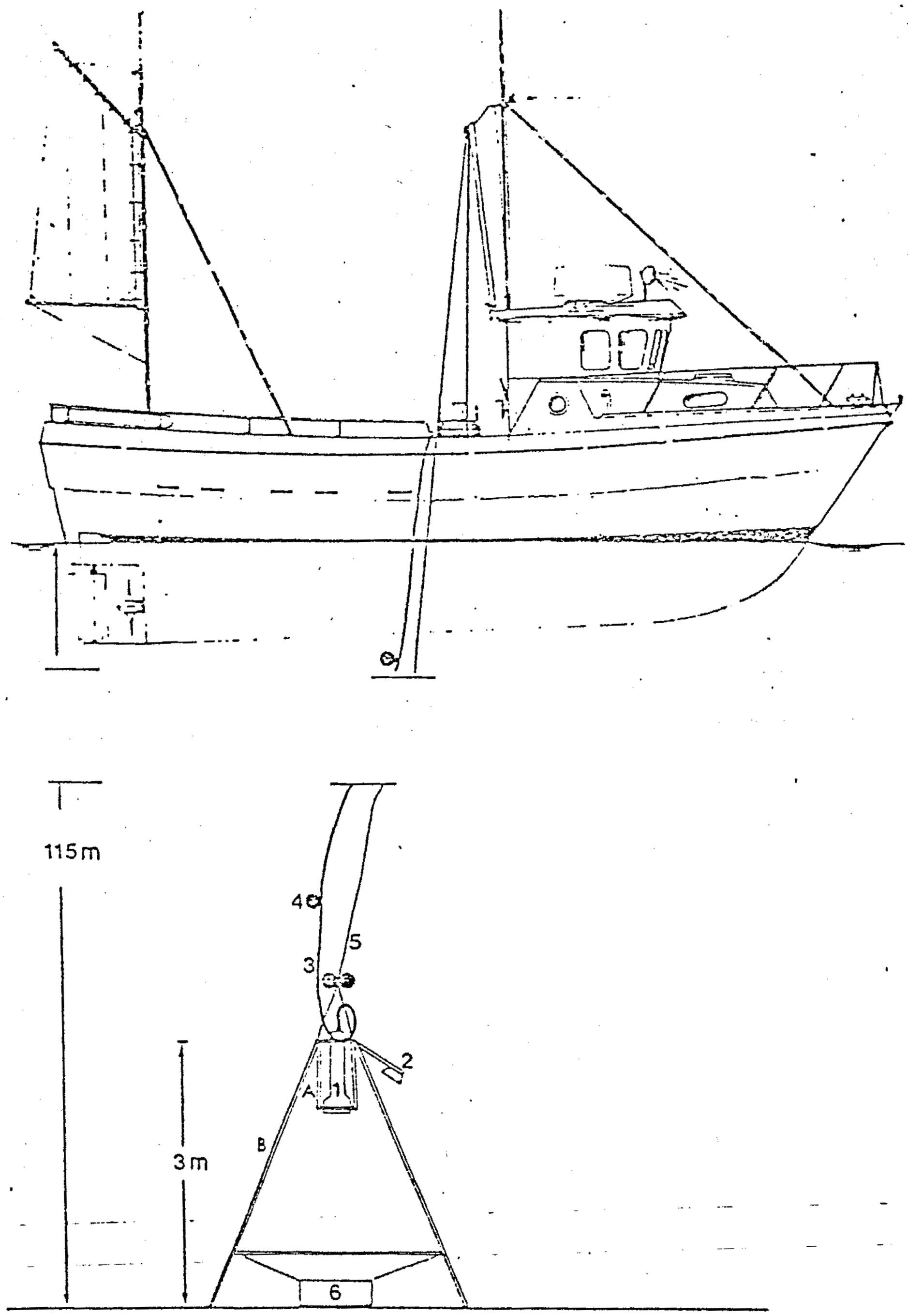
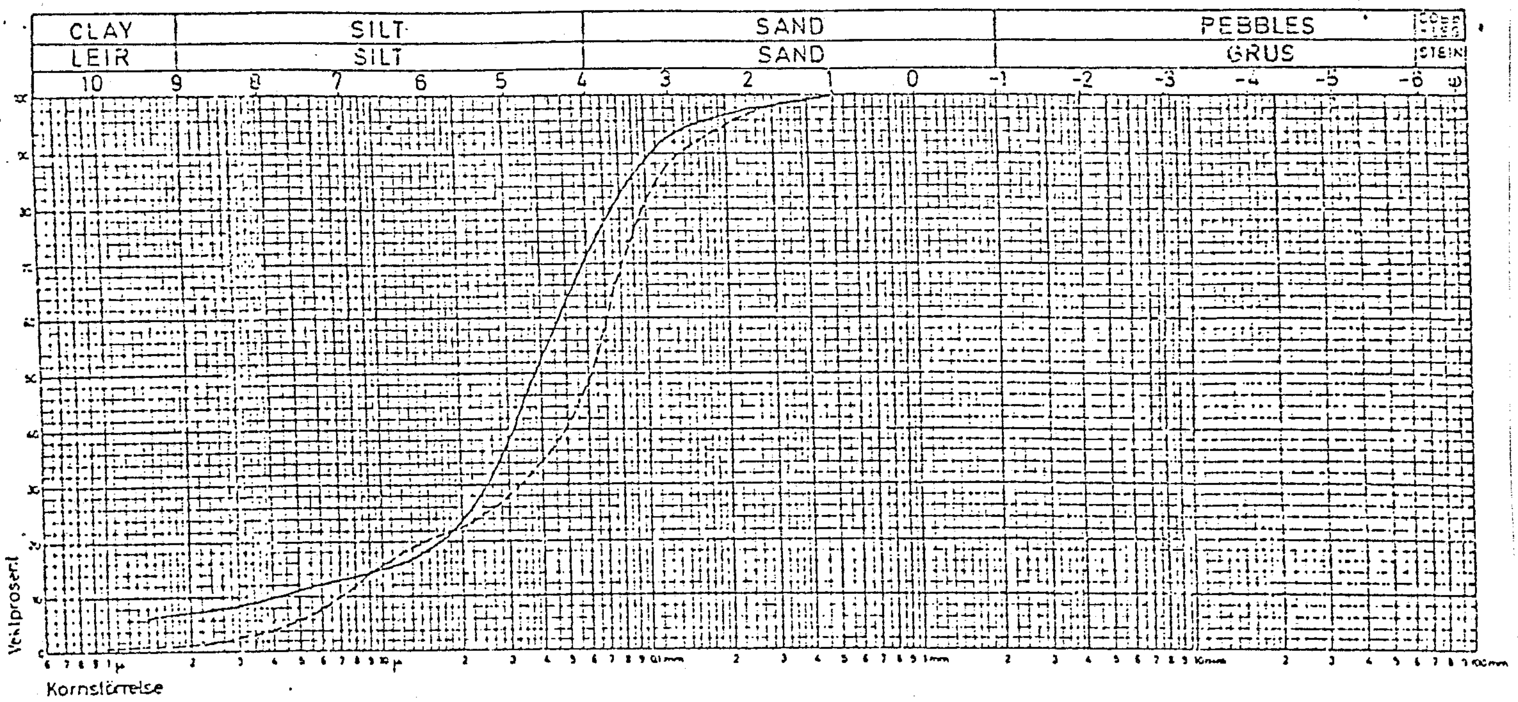



Fig. 29. Rigging av kamerautstyr under atferdsobervasjoner.
A = kameraramme, B = kamera/teine-stativ
1 = kamera, 2 = lyskilde, 3 = bilde/lys-overføringskabel, 4 = oppdriftskuler, 5 = opphaler-tau, 6 = teine




| PRØVE NR | STED | |
|---|---|---|
| | RAUNEFJORDEN ———— | Sedimentanalysen er utført v/Geol.inst.,Univ. i Bergen. |
| | IRSKESJØEN - - - - - - | FARMER (1975) |

Fig. 30. Sedimentanalyse.



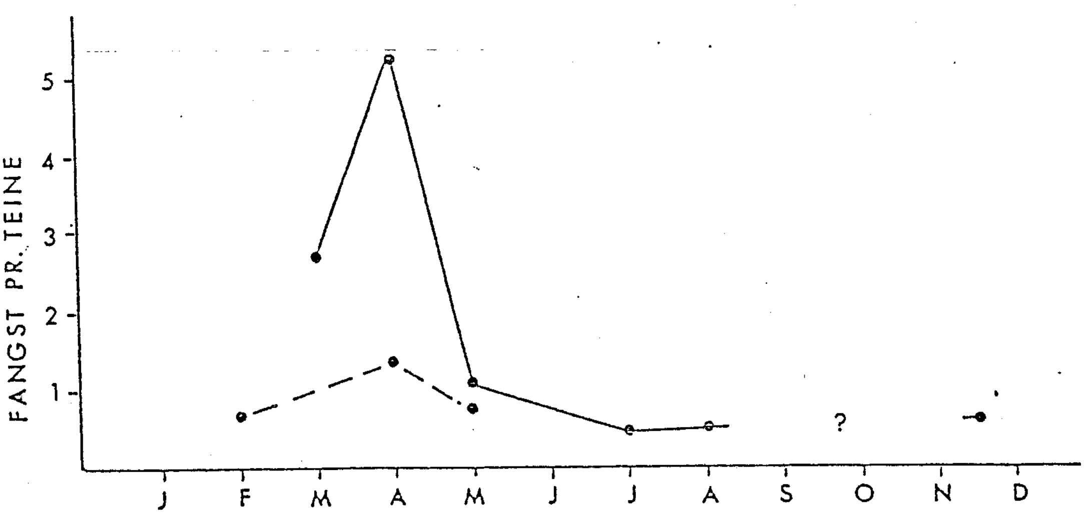



Fig. 31. Sesongvariasjon i sjøkrepsfangster, felt felt L1, L2 og L3 (Lysefjorden).
———— Teinetype 20, - - - - Teinetype 17

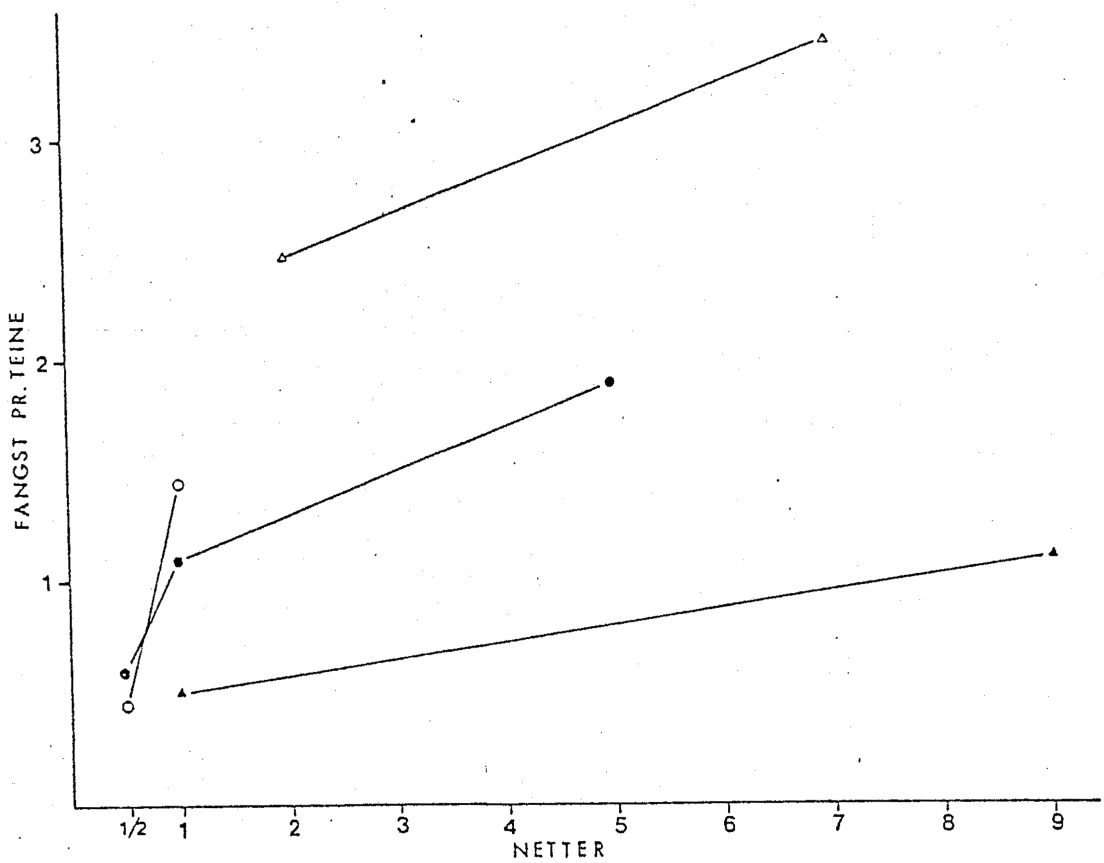



Fig. 32. Fangst med varierende fisketid (teinetype 20).

o : Romsdalsfjorden (felt FA) i juli
● : Lysefjord (felt L1, L2 og L3) i mai
▲ : Lysefjord (felt L2 og L3) i august
△ : Lysefjord (felt L2 og L3) i mars

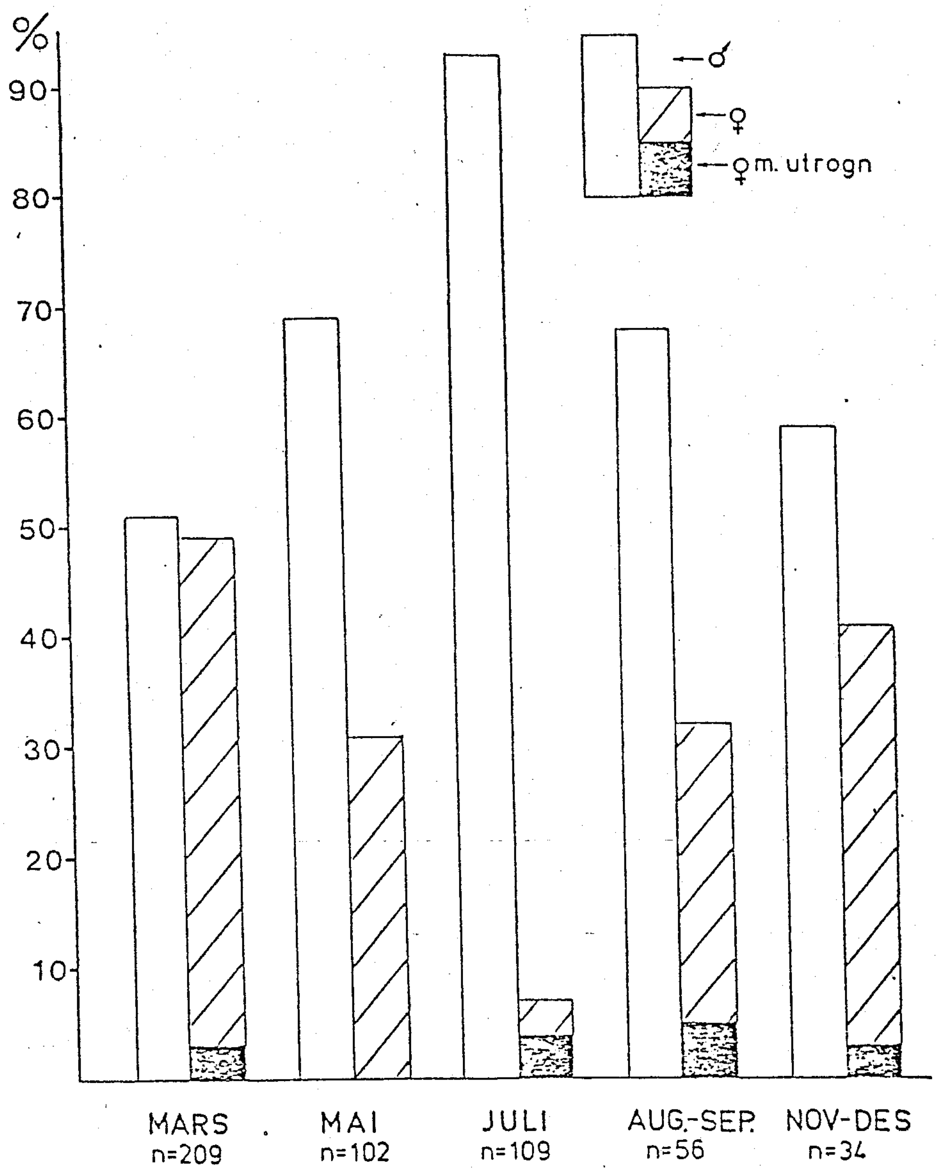



Fig. 33. Kjønnsfordeling av sjøkreps i fangstene.

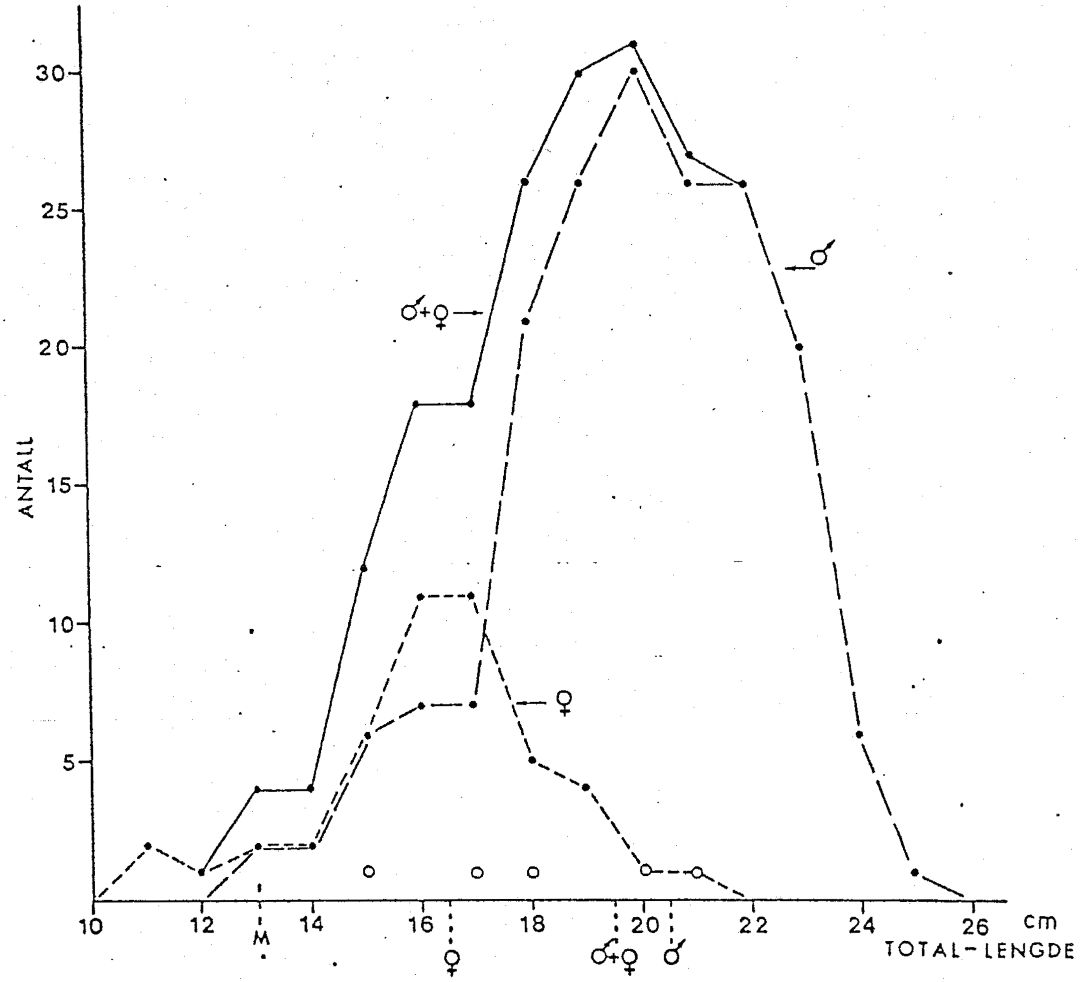



Fig. 34. Lengdefordeling (n=226, forsøk 5F, 6F og 7F). Minstemål (M), samt gjennomsnittslengdene for hanner, hunner og han + hun er angitt på x-aksen. o = hunner med utrogn.

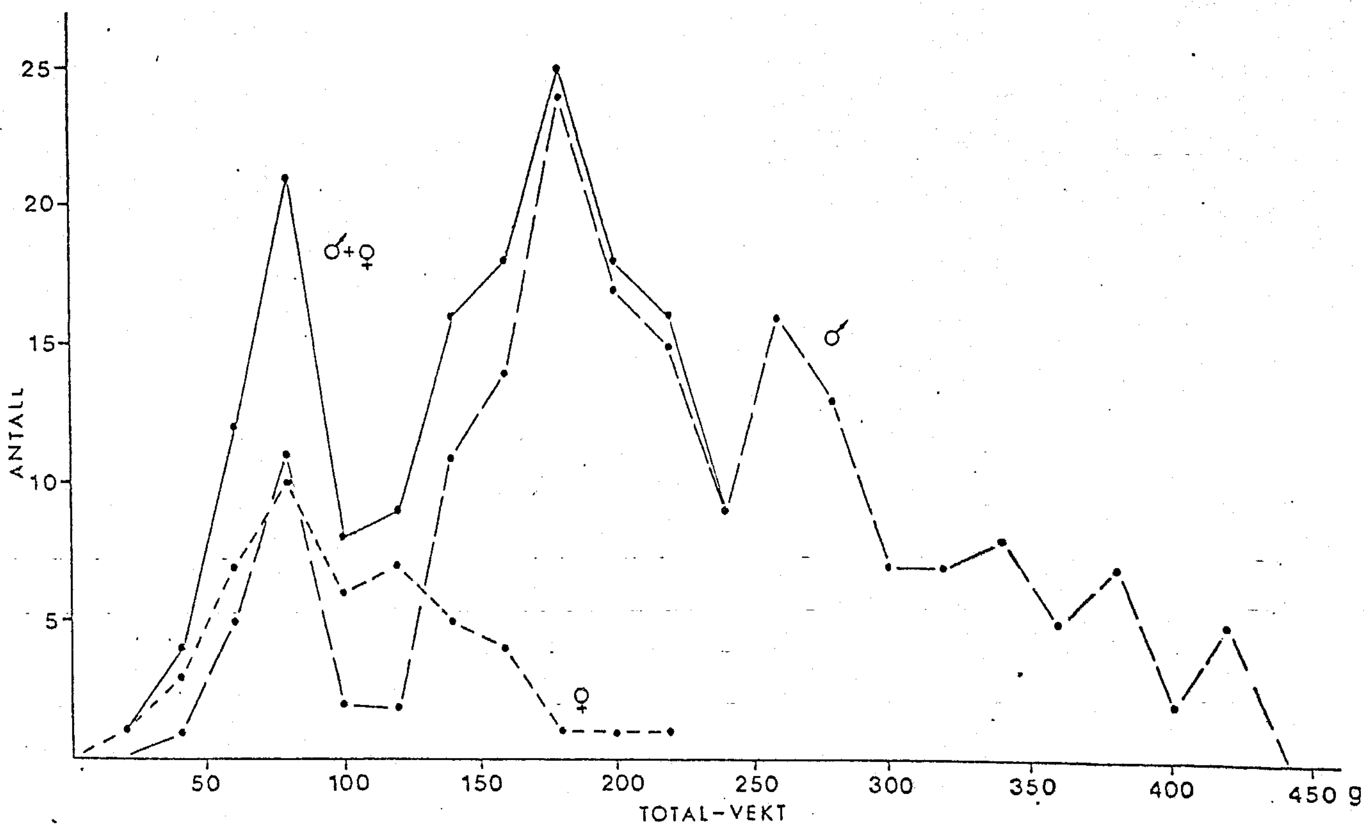



Fig. 35. Vektfordeling (n=226, forsøk 5F, 6F og 7F).

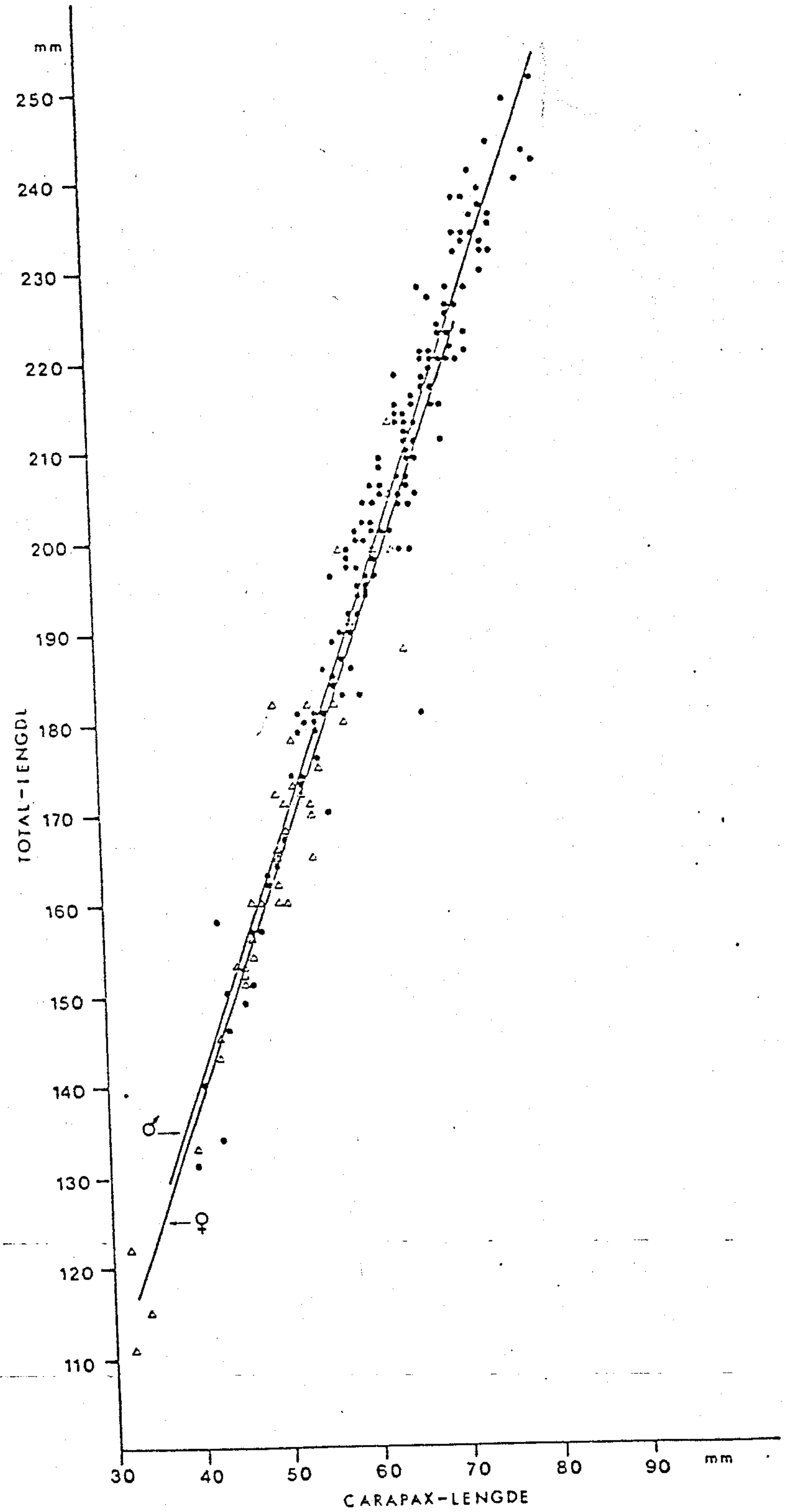



Fig. 36. Forholdet mellom carapax-lengde og total-lengde.
● = han (n=176), △ = hun (n=46)

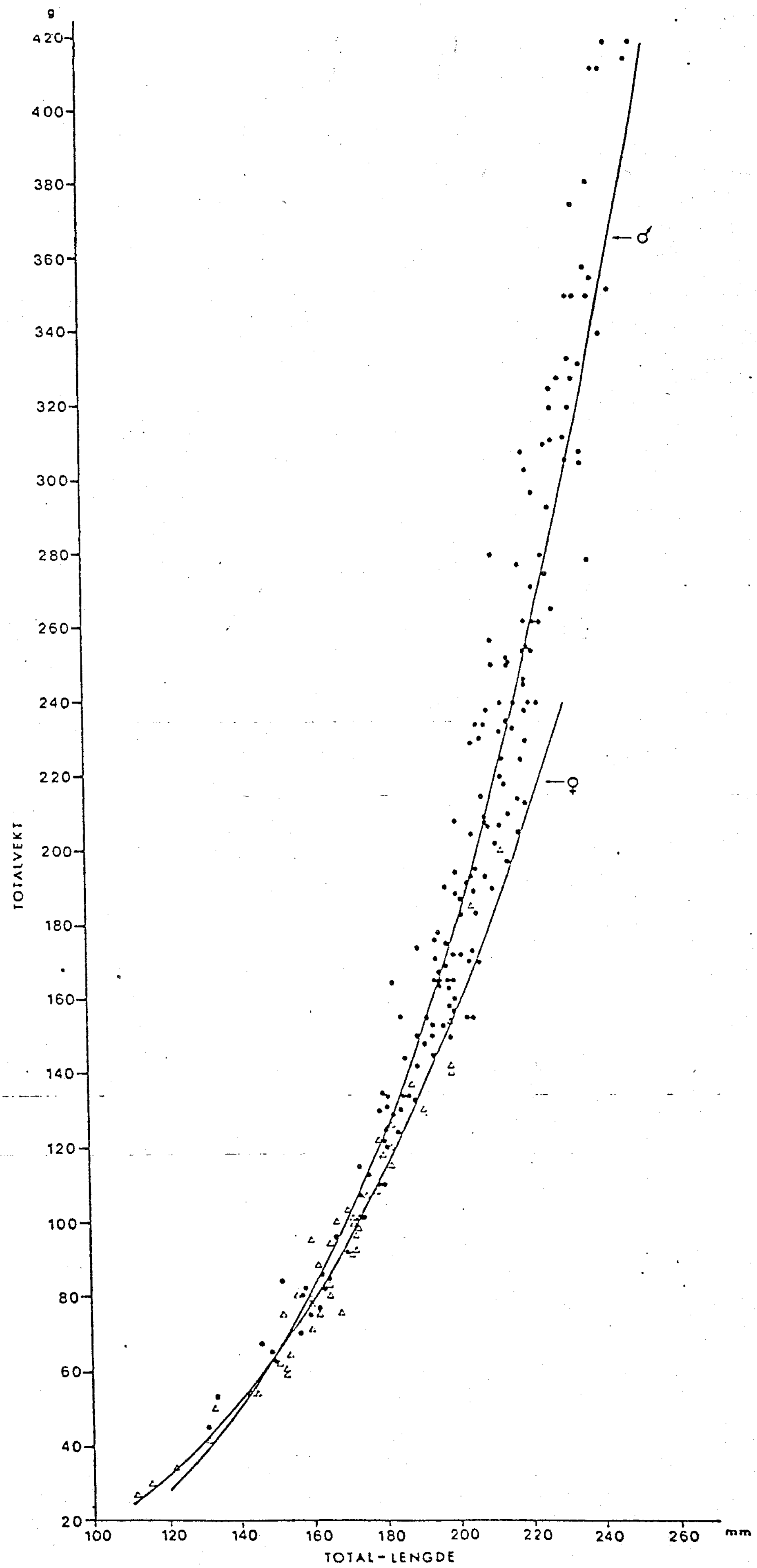



Fig. 37. Forholdet mellom total-lengde og totalvekt.
● = han (n=174), △ = hun (n=46)

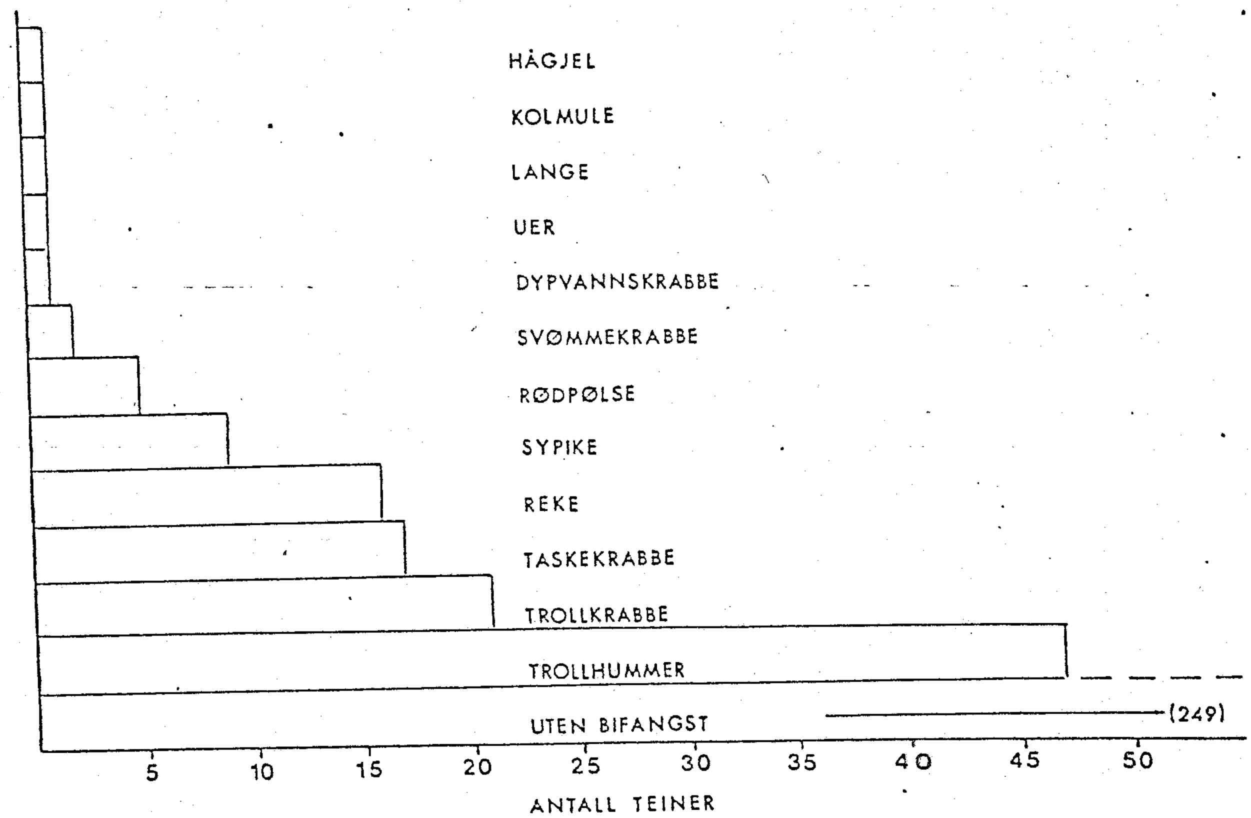



Fig. 38. Fordeling av bifangstarter i teiner med fangst av sjøkreps.

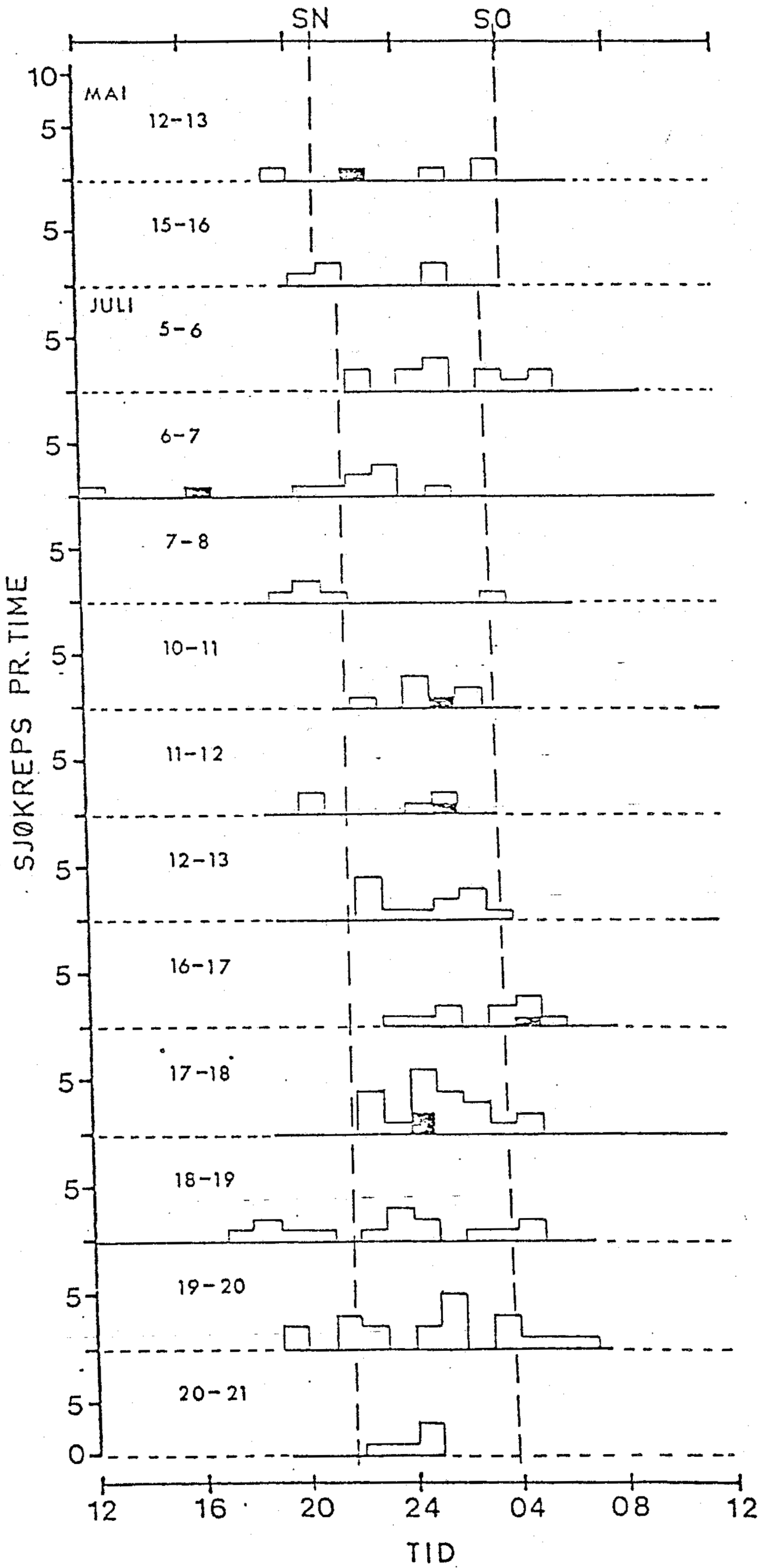



Fig. 39a. Sjøkrepsaktivitet i forhold til døgntid (antall sjøkreps observert pr. time), basert på 13 observasjonsdøgn i mai og juli 1978 (felt L2, Lysefjorden).
Hel strek angir observasjonstida for hvert døgn.
Svart del av histogram representerer sjøkreps som gikk inn i teina. SN = solnedgang, SO = soloppgang.

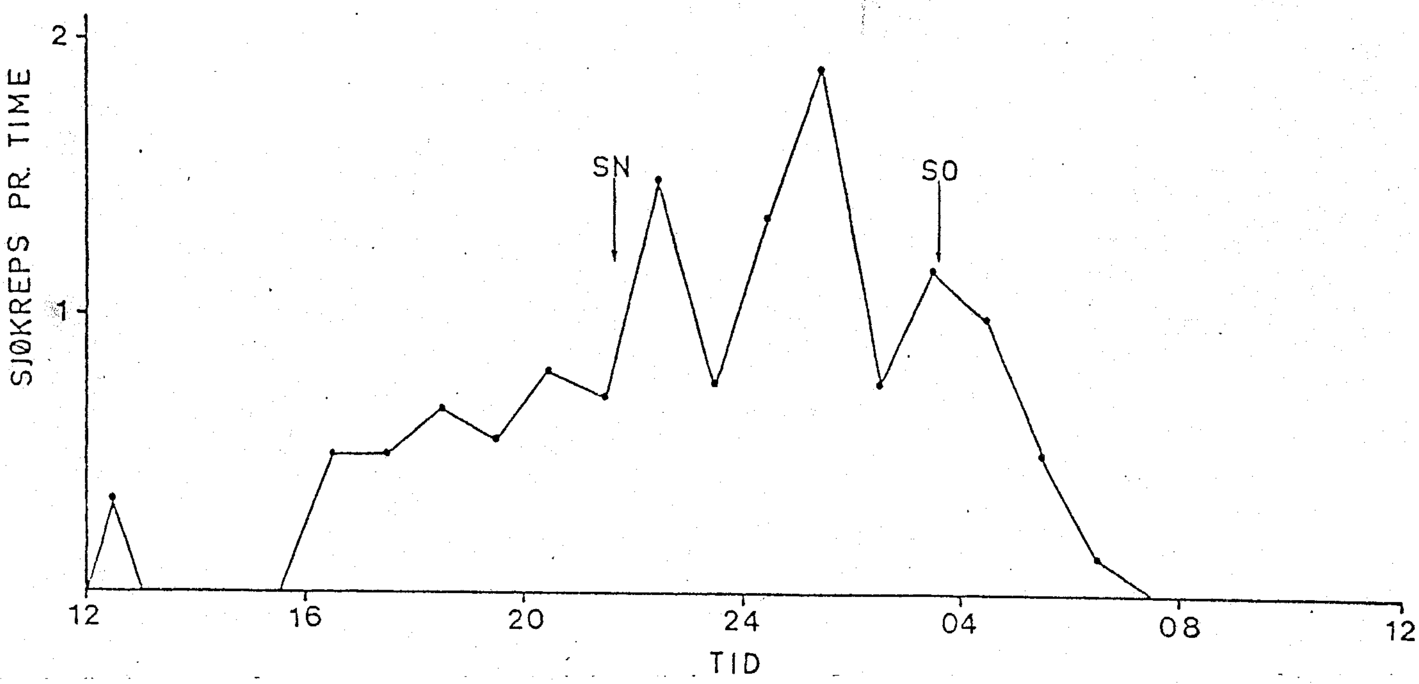



Fig. 39b. Sjøkrepsakitivitet i forhold til døgntid, uttrykt som gjennomsnittlig antall sjøkreps observert pr. time (n=136) basert på 13 observasjoner i mai og juli 1978 (felt L2, Lysefjorden).
SN = solnedgang, SO = soloppgang

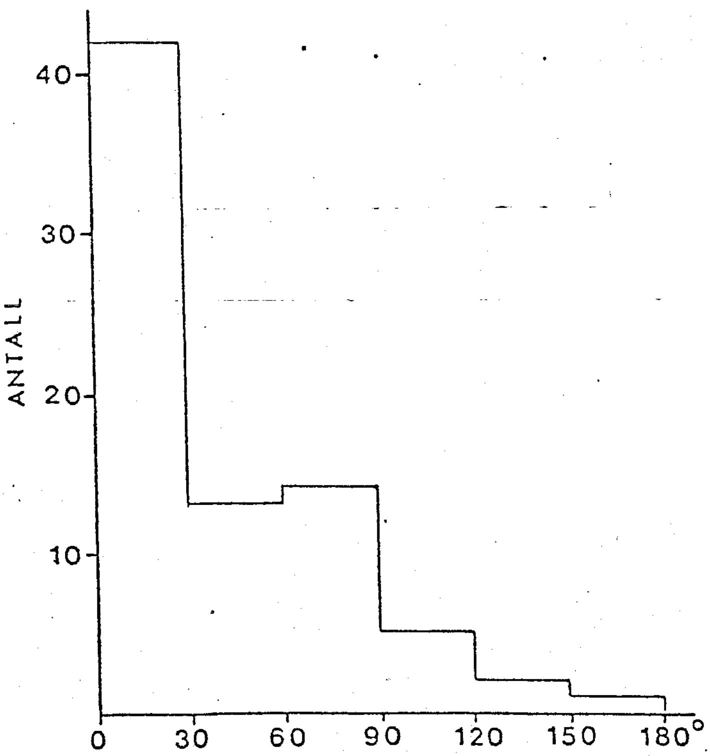



Fig. 40.
Antall sjøkreps som nærmet seg teina fordelt på innfallsvinkel (vinkelen mellom strømretning og sjøkrepsens kurslinje første gang den kommer inn mot teina).

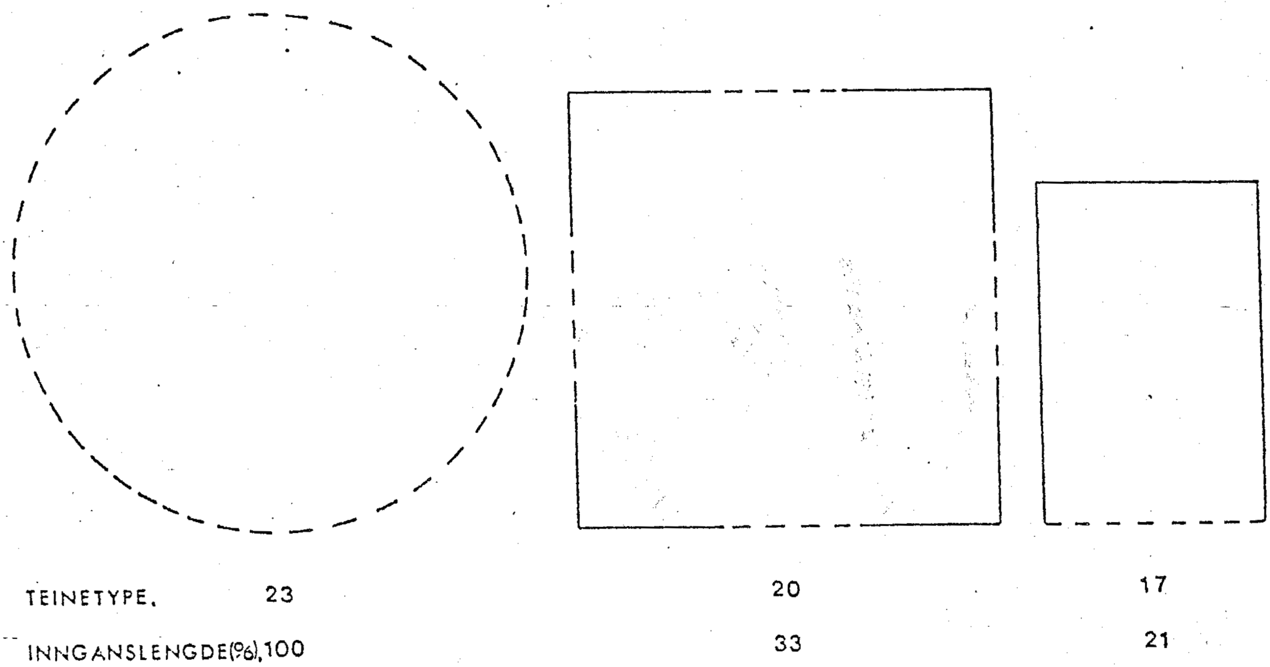



Fig. 41. Inngangslengde (stiplet) i forhold til total omkrets (inngangslengde: lengden av teineomkrets som dekkes av ytre kalvåpning).