The Calls of the Starling (*Sturnus vulgaris*)

By
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(Med et dansk resumé: Stærens *(Sturnus vulgaris)* lyde).

INTRODUCTION

On the initiative of professor S. DALBRO, The Royal Veterinary and Agricultural College, Copenhagen, experiments on the reactions of Starlings *(Sturnus vulgaris)* to tape-recordings of their species-specific alarm calls were made in a cherry plantation belonging to the Agricultural School.

In addition to these experiments, Dr. H. POULSEN, Zoological Institute, University of Copenhagen, suggested that a study should be made of the calls of the Starling, in particular the alarm calls or danger calls, by observations of wild and caged handreared Starlings.

From summer 1964 until summer 1965 hand-reared Starlings were kept in a cage, from where they were allowed to fly about in the room several times during the day. From June 1965 until February 1966 tame Starlings were kept in an aviary, 3 metres long, 2 metres wide, and 1½ metres high. A wild-captured old male Starling was with the tame birds from October 1964 until February 1966.

Observations of wild Starlings were made during the breeding time at nest-boxes in Zealand and in West-Jutland, in early spring (end of February–beginning of April) in South-Germany and the British Isles, and during autumn in Denmark and England.

The statistical analysis has been carried through in collaboration with cand. real. J. STENE, Statistical Institute, Copenhagen.

The alarm calls were recorded by means of a Maihak tape-recorder, the other calls by an UHER 4000. The fear squeals were kindly given to me by mr. CARL WEISSMAN.

Sound spectrograms of the calls were made by means of a sound spectrograph "Sonagraph" at Bio-Accoustical Laboratory, Museum of Natural History, Aarhus.

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BEGGING CALLS OF YOUNG STARLINGS

Young Starlings utter begging sounds for the first time 1 or 2 days after hatching. At that time they have only one begging call (fig. 2 a), which is always given with the mouth wide open, the chick being thus ready to receive food. The begging

call is given during feedings, and – less frequently – between feedings when the chicks are hungry.

As the young develop the begging call alters, and gradually develops into two distinctly different begging calls, the distant begging call and the close begging call. Fig. 2 b shows the two calls in 10 days-old chicks: the distant begging call (left) given mostly between feedings, and the close begging call (right) given during feeding.

At the age of 16–18 days, when the young are able to fly a short distance, though usually they do not leave the nest, until they are 20 days old, the two calls achieve their final form (fig. 2 c), which is retained during the time the young are fed by their parents.

The distant begging call of fledglings. Fig. 2 c shows that the distant begging call (left) has a wider frequency range and on the whole is of lower frequencies than the close begging call (right). In the Yellowhammer *(Emberiza citrinella)* and the Reed Bunting *(Emberiza schoeniclus)* too (ANDREW 1957) wider frequency range and lower frequencies are characteristic of the distant begging call as compared to the close begging call. The distant begging call of fledged starlings compared to that of the nest-young is also of lower frequencies and wider frequency range. As low frequency sounds are easier to locate (by means of phase difference of the sound waves reaching the two ears) than high frequency sounds, the distant begging calls of fledged starlings provide better cues for the parents to find the young after the latter have left the nest. The segmented structure of the call, which is, however, characteristic of most of the vocalisations of the starling, and which gives a rolling or creaky quality to the sounds, also provides cues for location (by means of time difference of arrival of the sounds at the two ears). The descending top frequencies is a special character of the call, making it easily distinguishable from other sounds.

The distant begging call is elicited by the sight of the parent (or the human foster parent), but may also be uttered by hungry starlings when the parents are out of sight.

Young handreared Starlings, who had been fed as much as they could eat (a situation which probably seldom occurs in nature), would be silent for about 15 minutes after the meal, during which time they would preen or sleep. Then, if the foster parent was present, distant begging calls would start, the Starlings at the same time becoming restless, flying or hopping to and fro. When I left handreared Starlings in this state they became silent 25 seconds after I had closed the door behind me. At my return a minute after, begging calls started explosively, as soon as the door handle was touched. Very hungry Starlings, however, would continue uttering distant begging calls even if they are alone.

During utterance of the distant begging call the bill is never opened more than about 50–60° (fig. 1 a), which is not enough for food to be propped down the throat. In fully fledged Starlings the bill is hardly opened, or just a few degrees.

The close begging call of fledglings. The high-frequency begging call (fig. 2 c right) is uttered by young Starlings as a reaction to the sight of food being actually presented to them. The bill is nearly 90° open during this call (fig. 1 b), the bird being thus ready to receive food.

a. b.

Fig. 1. Gaping in 16 days old Starlings, a. giving the distant begging call, b. giving the close begging call.

Fig. 1. Spærren hos 16 dage gamle stæreunger, a. under udstødelse af den fjerne tiggelyd, b. under den nære tiggelyd.

Stimuli eliciting begging calls

Wild nestlings. The begging calls of wild nestlings – from newly hatched to nearly fledged ones – could be released by lightly scratching the nest-box, but habituation took place after a few trials. Darkening the entrance by means of the hand had no releasing effect, possibly because enough light entered through crevices in the box for the chicks to see my hand. It sometimes happened that non-breeding Starlings looked into or entered a nestbox. These strange Starlings released begging calls, apparently as strongly as the parents, at least till the young were 10 days old, and after they had become habituated to my touching the nestbox.

Starlings reared by hand from the age of 9 days. It is known that in order to be quite tame, Starlings should be handreared from no later than 9 days after hatching. At this time the young show no fear reactions when taken from the nest. In 1964 two 9-days-old Starlings together with one 10-days-old Starling were taken from 2 nests and hand-reared together in a cardboard box, and in 1965 five Starlings were reared together in the same way from the age of 9 days.

At the first two or three feedings after the removal the chicks only occasionally showed begging reactions to my scratching or handling the box, whereas begging could always be released after lightly touching the backs of the young for a few seconds. On the second day in the cardboard box all these Starlings had learned to beg at the opening of the box, and they soon learned to use various accoustic and other stimuli as signals for feeding, like the sound of my voice or the door handle being pressed down, and lifting of the box. When the young were fledged the distant begging call was released by my appearance and by signals of feeding, and the close begging call was given when food was presented to the chicks.

Starlings reared by hand from the age of 10 *days.* The first Starlings I tried to hand-rear were 3 young ones, who – according to the development of their feathers (KESSEL 1957) – were 10–11 days old when they were taken from their original nest. They showed some fear reactions by the removal. As in the other two groups of nestlings, begging on the first day of hand-rearing could be released most consistently by touching their backs. From the second to the fifth day two of them begged somewhat irregularly at the opening of the box and presentation of food. The third chick responded more often to closing of the box than to opening. Though begging, when other stimuli failed, could often be elicited by touching the back of the chicks, they were all undernourished: the latter individual died after only 5 days of hand-rearing, and the two others on each of the following two days.

On the fifth day after removal from the nest, when the plumage was so far developed that the chicks were able to fly about 1 meter, they struggled so violently to get out of the cardboard box that they were let into a cage. The distant begging calls had been increasing in frequency for some days, and were given consistently also when nobody was in sight. The close begging call, however, was only rarely given: the chicks usually shook their heads when I tried to feed them, and continued uttering the distant begging calls. Some fear reactions were

still shown towards me after fledging, like hiding on the floor under furniture, (which was never done by the tame Starlings, but consistently by a wild captured old Starling, who was very shy). The reason for the refusal of food may partly have been wrong treatment by the inexperienced foster parent, but this seemed not to be the only reason.

When two of the young ones were dead, a stuffed adult Starling in spring plumage was held with its bill pointing obliquely down towards the bill of the living chick, who had been uttering distant begging calls, but had failed for many presentations of food to give anticipatory reactions. The chick at once responded by giving close begging calls opening the bill widely. The same reaction was obtained when the body of the stuffed Starling was covered by a white cloth so that only the bill was visible.

The same stuffed Starling was presented to two newly fledged young Starlings, who had been hand-reared from the age of 9 days. The young Starlings showed violent fleeing reactions and no trace of begging to the stuffed bird. This suggests that some learning or imprinting takes place between the 9th and the 10th day after hatching.

Dayly begging time

In the early morning until about one hour after sunrise, and in the evening after about one hour before sunset, neither the distant nor the close begging call could be elicited in fledged Starlings. They refused all kinds of food, flying or hopping back and forth uttering flight sounds (see below). In the aviary they flew up towards the window side of the netting. When an electric bulb was lit in the opposite direction, they often flew towards this side. These periods roughly correspond to the time when wild starlings fly to and from their roosts.

When the young grew up and ate by themselves they still did not eat during this early and late period, unless they were regularly exposed to artificial light.

End of begging.

Whereas the Starlings that had been hand-reared from the age of 9 days, did not start pecking at food until they were 19 days old, all the Starlings that had been hand-reared from 10 days of age started already when they were 14 or 15 days old pecking occasionally at food that was offered to them. This applied to the group of 3 Starlings of the same age as well as the older individual who was brought up together with 2 younger ones, and presumably through their influence became quite tame.

The willingness to give close begging reactions depend on the type of food offered. When the Starlings for several successive feedings had been given an overweight of one type of food, (because they had reacted specially well to this kind of food) the readiness to accept this particular kind of food decreased, whereas the willingness to accept other kinds of food, which they had not long been given, increased. Thus they had periods of accepting and periods of refusing cherries, cheese, meal worms, earthworms etc.

Long after the tame Starlings had started eating by themselves I kept offering food to them. The group of 5 Starlings gave some close begging reactions at all trials until they were 37 days old. In the group of 3 Starlings 1 died when it was 38 days old. The other 2 Starlings were offered food from my fingers long after they had refused at some feeding attempts to give any begging calls. The last time they gave close begging reactions was at the age of 53 and 55 days. One of them (the 53 days-old) gaped only, but did not give the call.

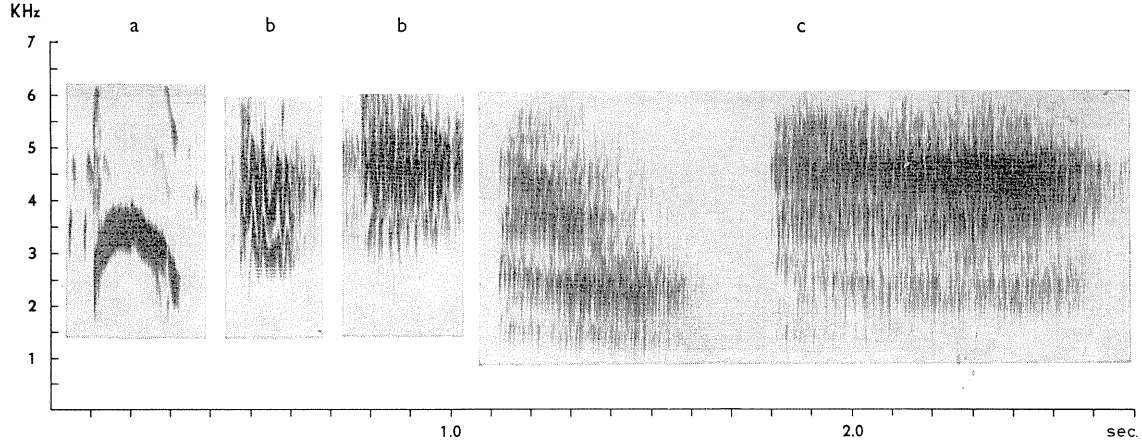

Fig. 2. Begging calls of young Starlings. — a. 2 days old Starling. — b. 10 days old Starling. Left: distant begging call. Right: close begging call. — c. Fledged starling (19 days old). Left: distant begging call. Right: close begging call.
Fig. 2. Stæreungers tiggelyde. — a. 2 dage gammel stær. — b. 10 dage gammel stær. Til venstre: den »fjerne tiggelyd«. Til højre: den »nære tiggelyd«. — c. Flyvefærdige stære (19 dage gamle). Til venstre: den »fjerne tiggelyd«. Til højre: den »nære tiggelyd«.

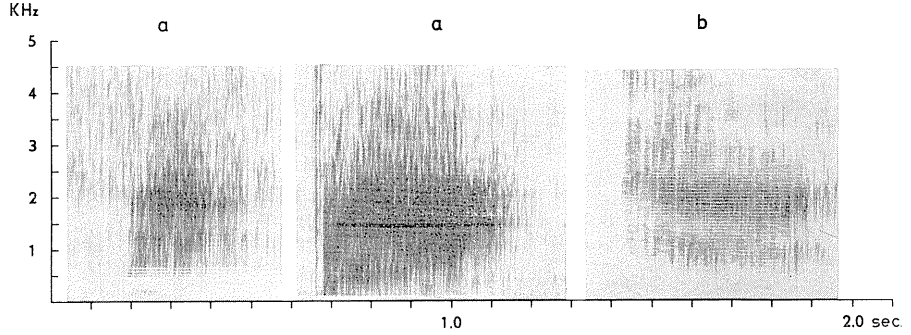

Fig. 3. Flight calls. — a. 5 months old Starling. Left: low intencity call. Right: flight call at take-off. — b. newly fledged Starling (26 days old).
Fig. 3. Flyvelyde. — a. 5 måneder gammel stær. Til venstre: lyd af svag intensitet. Til højre: flyvelyd, idet stæren letter. — b. 26 dage gammel stær.

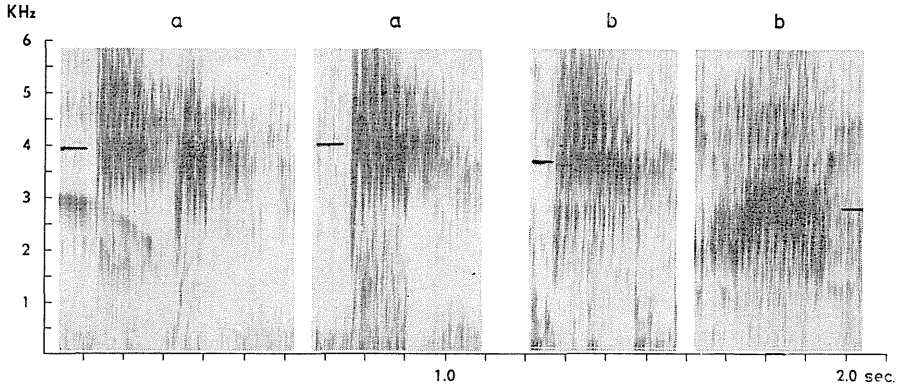

Fig. 4. Flock calls, recorded from non-breeding Starlings, May 1967. — a. Fully developed calls, recorded on the 14th May. Left: double call. Right: single call. — b. Flock calls of lower pitch (developmental stages), recorded on the 13th May. Horizontal line shows centre of highest intensity.
Fig. 4. Flokkald fra ikke-ynglende stære, maj 1968. — a. Fuldt udviklede lyde, optaget den 14. maj. Til venstre: dobbelt kald. Til højre: enkelt kald. — b. Flokkald af lavere tonehøjde (udviklingsstadier), optaget den 13. maj. Vandrette streger markerer midtpunktet for den højeste intensitet.

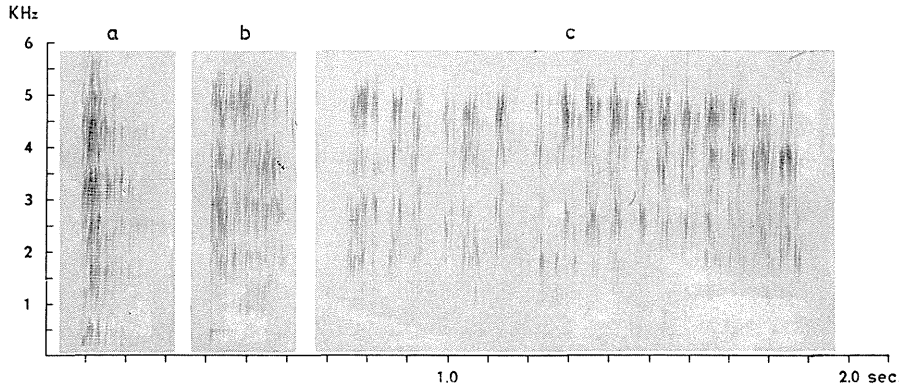

Fig. 5. Threat calls. — a. Short b. Long c. Rattle.
Fig. 5. Truelyde. — a. Kort b. Lang c. Klapren.

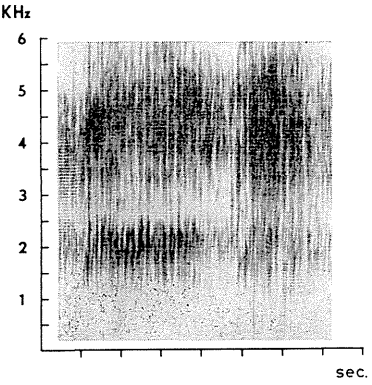

Fig. 6. Attack calls.
Fig. 6. Angrebslyde

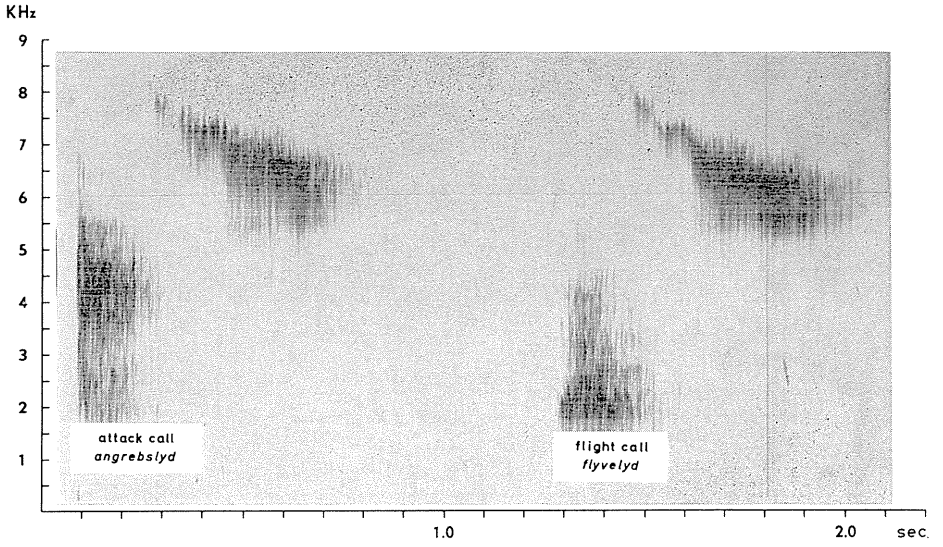

Fig. 7. Threat screams (the 2 calls of high pitch).
Fig. 7. Trueskrig (de 2 højfrekvente lyde).

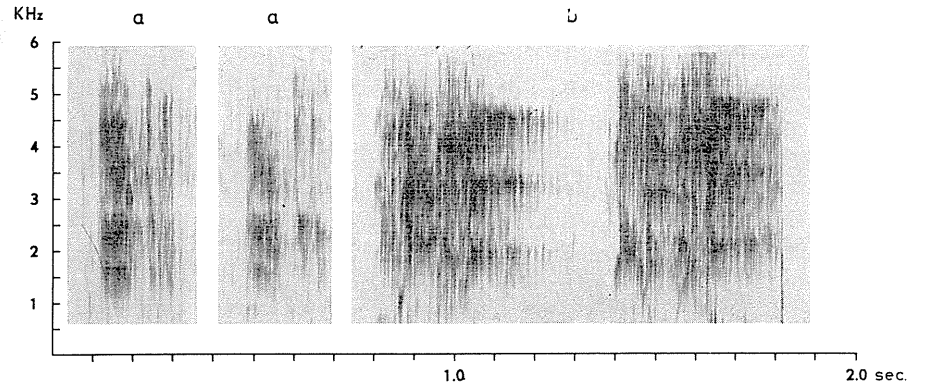

Fig. 8. Mixed aggresive calls.
a. 2 calls from one (wild) individual.
b. 2 calls from another (handrearded) individual.
Fig. 8. Blandingslyde (aggressive).
a. 2 lyde fra et individ, (vildt).
b. 2 lyde fra et andet individ (tam burfugl).

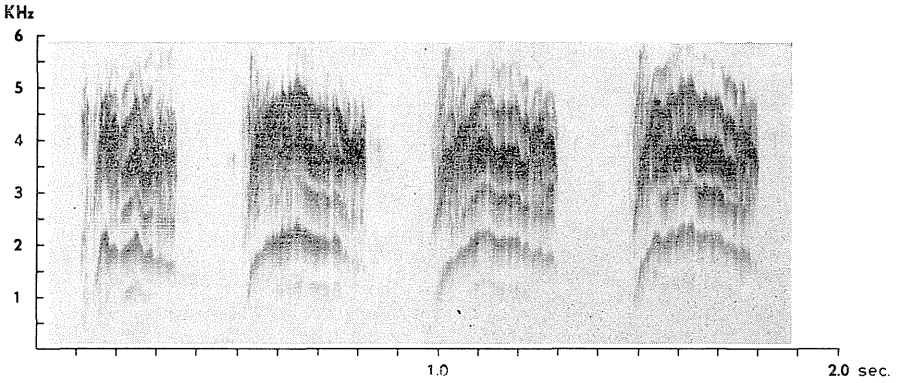

Fig. 9. Fear squeals (Recorded by *Carl Weissman*).
Fig. 9. Angstskrig (optaget af Carl Weissman).

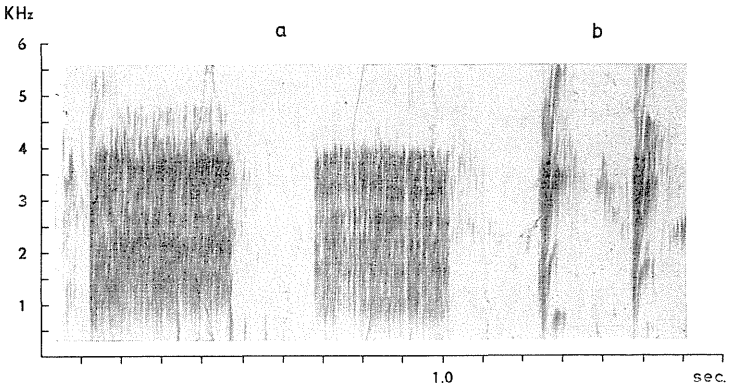

Fig. 10 a. Snarling sounds. — b. Warning calls (mobbing calls).
Fig. 10 a. Snerrelyde. b. Advarselslyde.

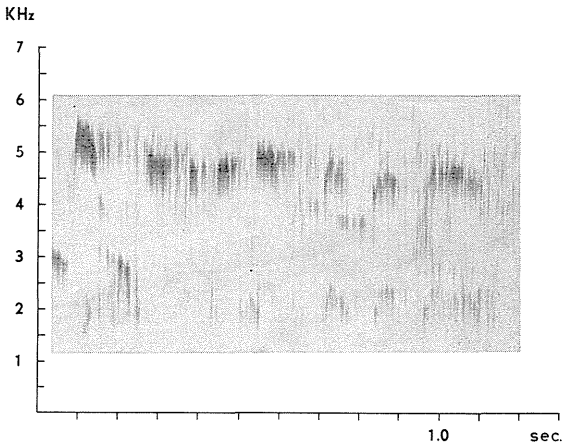

Fig. 11. Copulation calls of female Starling.
Fig. 11. Stærehunnens kopulationslyde.

THE FLIGHT CALL

The flight call (fig. 3) is similar to the lower part of the frequency spectrum of the distant begging call (fig. 2 c left), from which it seems to develop. It starts appearing in nestlings a few days after the distant begging call and the close begging call are fully developed, at the time when the young leave the nesthole. At first the flight call bears likeness to the distant begging call, as a recording from a 26 days old starling shows (fig. 3b). It develops and becomes more frequent as the flying tendency of the young increases during the first few weeks out of the nest. The flight call is uttered with the bill closed or nearly so.

It is given when a Starling for some reason has a tendency to fly, for instance in the following cases:

When a Starling flees after a fight with another Starling (but usually not when it is chased, in which case it will give threat sounds).

When a human being approaches from a distance, not too suddenly.

When a Starling flies to join his fellows (also when tame Starlings fly or try to fly to the foster parent).

When Starlings fly to feed,

When Starlings fly to nestboxes,

When Starlings fly to or from roosts.

The above applies to single Starlings as well as lesser flocks of Starlings. Large flocks usually fly without calling.

The flight call is typically uttered just at take off, when it is longer than in other situations. Shorter flight calls may by given before or during flight. It is most often given singly, but at take off two or three calls may occur in succession, the later calls being shorter than the first one. If the Starling is going to fly no more than a few metres, the flight sound tends to be shortened, or a call may not be given at all.

In a small flock of Starlings, perched or on the ground, flight calls may be uttered infrequently for some time, without any bird taking wing. Presumably the tendency to stay with other starlings prevents the birds with a flying tendency from flying away. Do the flight calls become more frequent, the probability of the flock taking off increases.

No reaction to flight calls played back for 1–5 minutes was observed in the tame Starlings. An effect might of course have been established, if the experiments had been carried further, and if the Starlings already had a greater tendency to fly.

THE FLOCK CALL

During migration times the flock call, which is a harsh note of rather high intensity, is given, either one at a time (with intervals of more than a second), or two in rapid succession with an interval of rather constant length of about 70 miliseconds, the last sound tending to be somewhat shorter than the first one (fig. 4 a).

This call is most frequently heard in the end of May and in June, that is the time when the young appear, are fed by the parents, and when the post-breeding flocks are formed. The interpretation of this call by human observers differs. For instance SCHÜZ (1942 and 1943) thinks the »schrä« has to do with care of the young, whereas DAVIS (1959) interprets it as a

flocking call "given by adults and juveniles, when they form the post-breeding flock".

From about the middle of April till the end of June observations have been made in the bird reserve Tipperne, an area of about 450 hectares of meadows without any trees except near the only house. On a wooden tower near the house are 3 nest-boxes, where 3 pairs of Starlings breed every year. All through spring, especially in the morning, small numbers of non-breeding Starlings are seen near the nest-boxes and in the trees, often inspecting the nestboxes and looking for breeding places.

In 1967 the flock call was heard a few times in the beginning of May. Then it was not heard for a week until the 13th May. On that day few real flock calls but many sounds of a similar structure but of varying lower frequency were heard and recorded (fig. 4 b). On the next day many proper flock calls but rather few of the lower frequency sounds were uttered. On both days the calls were heard in the morning only, while a flock of about 20 non-breeding Starlings were flying round over the house and trees, but not during the rest of the day when only the breeding Starlings, none of which had young yet, were present. From this date until the 5th July (when I left) the flock call was heard regularly. It was the call with which single or small flocks of Starlings flew off to feed, and returned from the feeding grounds. When they moved from one feeding area to another the flock call was given alternating with flight sounds. Parents bringing food for the young were also heard uttering the flock call, but not before the young were fledged. Young Starlings gave the call from the age of 4 weeks. It was sometimes given by Starlings perched in trees or on the ground.

Sound spectrograms of 6 flock calls from the morning of 13th May and 6 flock calls from the morning of 14th May show the centres of highest intensity at the following frequencies (double sounds were counted as one):

13*th May*	**14***th May*
2.200 c/sec.	3.700 c/sec.
2.700 -	3.700 -
2.800 -	3.700 -
2.800 -	3.700 -
3.400 -	3.900 -
3.600 -	4.000 -

The centres of highest intensity are marked with horizontal lines in fig. 4.

The table shows that there was much more variation in pitch between the calls on the first day than on the next day. Moreover it shows that the frequencies of the calls on the first day were lower than the frequencies of the calls on the following day (no overlap). Sound spectrograms of flock calls from a tame Starling in September showed 4.100 cycles per second as the centre of highest intensity.

The above suggests that the flock call developed during these few days in non-breeding Starlings, who were already present in the area.

Tame Starlings uttered the flock call as a reaction to the sight of wild Starlings flying past the window, which only happened in July – September and in March. The call was always accompanied by flying up towards the window, or – in encaged birds – by taking up a position of readiness for flight, much more intense than the flight intention movements accompanying flight sounds.

During a short period of about 2 weeks in the end of September and the beginning of October and a similar period in the end of January and the beginning of February, the flock call seemed to be given spontaneously or at least released by sub-optimal external stimuli: every morning, when the blind was drawn, one of the Starlings flew up towards the upper part of the window, bumping against the glass (or, if encaged, towards the window side of the cage), uttering flock calls. (Since the very first days after fledging, bumping

against the window never occurred except in these cases, when the flock calls were uttered). Probably migration tendency in combination with visual stimuli from the sky elicited this behaviour.

When recordings of the flock call were played back to three tame Starlings, only the above mentioned individual reacted, by first taking up an intense flight intention posture and after a few seconds flying up. The flockcall had been played back after a series of various recorded notes from a recorder, to which no reaction, except a certain attention had been shown. This was done medio January. On repetition a few days later, the same reaction occurred, but later on – also 2 years later in Mid-January – there was no reaction at all.

INTRA-SPECIFIC AGGRESSIVE CALLS

A great variety of sounds are uttered during intraspecific fights. Besides the three predator calls (p. 217) and short passages of song, which occur occasionally, the following calls, which are typical of aggressive encounters between Starlings, are heard:

1. threat call (fig. 5)
   a. short form
   b. long form
   c. rattle
2. attack call (fig. 6)
3. threat scream (fig. 7)
4. mixed calls (fig. 8)

Except no. 3, the threat scream, I never observed these calls being used towards a predator. None of them was ever uttered towards the human foster parent.

All the sounds have been heard from wild as well as tame Starlings during fights over food, and from wild starlings during skirmishes at nestboxes.

1. The threat call (fig. 5) is the most frequently heard aggressive call in wild Starlings. The rattling form (fig. 5 c) is the most common one uttered when one or more Starlings alight among other, already perched, Starlings, thereby giving rise to a quarrel.

Some handbooks state that the Starling has a special call when alighting. The rattling call, however, is uttered by birds already perched as well as newcomers.

The short form of the threat call (fig. 5 a) is used in all kinds of mild aggressive conflicts. The long threat call (fig. 5 b) is a slightly more intense form, which is most frequently mixed with other sounds (fig. 8).

Threat calls may be accompanied or followed by a mild attack, as a light peck in the direction of the opponent, or it may be followed by retreat. The rattle and the long threat call are usually accompanied by threat movements, as raising of feathers and wing flapping. A tendency to flee as well as a tendency to attack seems to be present in all cases.

Threat and threat sounds were not only given when the individual distance was passed, but also occurred in starlings who were 1–2 metres away from any other bird. In most such cases the threat was directed towards another starling, who was either eating from the food bowl or had got hold of a nice lump of food. After a few seconds the threat behaviour was usually followed by approach or attack.

Tame Starlings who had plenty of food all the time, fought little over food. Only threat sounds, mostly short ones, were uttered now and then.

2. The attack call (fig. 6). If the tame starlings had only one foodbowl, and only for short periods, violent fighting occurred, as soon as the bowl was placed – or even was being placed – in the aviary. The stronger individuals attacked each other with raised feathers and flapping wings, often flying up nearly vertically against each other as much as 1 metre over the floor. Quickly repeated attack calls accompanied these fights. Attacks and attack calls were not given by the subordinate individuals. There was no evidence of a tendency to flee in starlings uttering attack calls.

Attack calls and attack were less often observed in wild Starlings than in tame ones, but did occur where food was concentrated at a limited space, and at the nest holes. At the nest boxes in the reserve, where observations were made during the breeding time, little actual fighting occurred. Intruders usually flew off, when the owner appeared in the nest hole, without any sound being uttered. ALLARD (1940), however, states that fighting nearly to the death occurred over nestboxes.

3. The threat scream (fig. 7) is a high-frequency sound resembling the high-pitched notes which are part of the song of the Starling. The scream, however, is of slightly lower frequency, and has a more constant form. (Recordings were made in Denmark, England and Ireland). The threat scream is uttered with open bill, fluffed feathers and circling movements of the extended wings, the bird facing the opponent. It seems to be a defensive call, given when a tendency to stay as well as fear are strong. In tame starlings it was uttered at severe fights when food was limited. It was given by a subordinate individual on one occasion, after it had been attacked and trodden several times by another Starling, who, after a minor accident, had redirected its aggression towards the subordinate individual.

In wild Starlings the scream may be uttered during fights over an especially attractive piece of food. More often, perhaps, it is heard from Starlings near their nest boxes, when an intruder, which may be another Starling, a human being, or a cat, approaches.

4. Mixed sounds. Apart from in song, variations of calls and mixtures of different sounds mostly occur in aggressive encounters with other Starlings. The same was found to be the case in the Pied Flycatcher *(Muscicapa hypoleuca)* (CURIO 1959). This is in CURIO's explanation so, because stimuli from a fellow bird may evoke (or not inhibit) other moods than aggression, (whereas the stimuli complex from a predator is so powerful, that all tendencies except alarm and attack are eliminated).

In the case of the Starling, the mixed sounds contain elements of a variety of sounds as well as species specific aggressive calls. Also predator calls may be mixed with intraspecific aggressive calls. Fig. 8 a shows 2 mixed sounds from one wild starling, and fig. 8 b two mixed calls from a tame individual. In the first case other notes were uttered between the two sounds, which suggests that the mixed sounds were not just caused by the momentary balance of two or more tendencies. Though not enough calls have been analysed to draw a conclusion, there are indications of individual calls being maintained for a longer period. This might serve to further individual recognition, which in a colonial species as the Starling is important.

Reactions. When tape recordings of attack and threat sounds were played back, the tame Starlings started singing. This was the most common reaction to played back sounds, including the flight and begging calls of the Starling, and to any kind of noise, human speech or music. Tame Starlings were seen to retreat at the threats of their fellows in cases where either of the threat sounds were uttered, but

may of course have reacted to the whole complex of visual and accoustic stimuli.

As an aggressive sound by the male Starling, DAVIS (1959) mentions "crowing". This will not be treated here as a call, but in a later paper on the song of the Starling. It consists of a great variety of notes, especially imitations, and is given in continuation with other song parts. It is often used in situations where no aggression is shown, for instance before copulations.

Development of aggressive calls.

No signs of aggressive behaviour towards other Starlings were ever shown by nestlings. The tame Starlings left the artificial nestbox at 19 days of age. Except for slight threat postures no aggressive behaviour was seen until they were 22 days old, though pecking in curiosity at the eyes and feathers of the neighbours was common. As wild Starlings usually stay in the nest till they are 21 days old, development of aggressive behaviour before this age would probably be detrimental to the species. Aggressive sounds were not heard until the tame Starlings were 25 days old, when short threat sounds occurred. Attack sounds were first heard when the Starlings were 38 days old, and started eating by themselves and fighting over the food. The rattling threat sound was not used in fights by the tame Starlings during their first year, but it was a regular motive in the sub-song of a young female, who often heard the rattle from a one year older female during fights. The threat squeal occurred, mostly in incomplete form, during the Starlings' first autumn. The first nearly complete squeal was recorded in December.

DANGER CALLS

The Starling has 3 danger calls, or alarm calls, typically released in the following predator situations:

1. The squeal of fear or injury (fig. 9), a cry of wavering pitch, is given by a Starling, who is seized by an enemy, but may also be uttered, if a predator has come very near to a sleeping Starling before being discovered, though the Starling has not been touched. A Starling giving fear squeals always shows a strong tendency to escape.

2. Warning call or mobbing call (fig. 10 b), a short note of wide frequency range is released by flying, as well as perched and ground predators. If the predator is near, the Starling will fly up, often joining other Starlings. Warning calls may then be repeated as quickly as 7 calls per second. In case of weaker danger the Starling may stay at its perch, giving less frequent warning calls, or it may approach the predator and mob it (utter mobbing calls near the predator). The calls are often accompanied by concealed wing beats. The feathers are always sleeked.

3. The snarling sound (fig. 10 a), an unpleasant noisy sound (segmented and of rather wide frequency range), is mostly

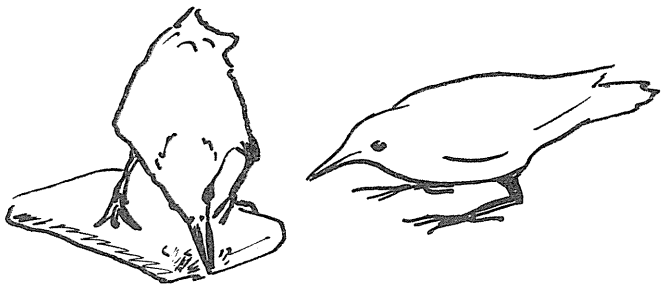

Fig. 12. Right: Submissive individual in "depressed posture", in which case fear squeals were often given.
Fig. 12. Til højre: »hæmmet stilling« hos individ nederst i hakkeordenen. Angstskrig udstødtes ofte i denne situation.

released by predators near a place to which the Starlings are attached, as a breeding place or a roost. The predators may be perched, on the ground, or flying near the place. The snarl is most frequently heard in the breeding season, especially after the young are hatched. While snarling, the Starlings approach the predator to a shorter distance than during mobbing, dependent on their fear of the predator, which is to some extent correlated with the size of the predator. Starlings would follow a weasel *(Mustela erminea)*, flying as low as 30 cm over it, snarling intensely, whereas they were never seen to approach a cat to a distance of less than 1 metre, and always stayed at a distance of several metres from human beings. The only instance of direct attack on a predator I watched, was by one of the hand-reared Starlings towards me on the day after it had had a minor throat operation, and on some later occasions after it had been handled. The Starling flew in zig-zag or ran with zig-zag movements towards and away from my hand, which it attacked with pecks of the bill, flapping its wings and uttering snarling calls.

If the predator does not move away, the Starlings tend to leave the place where the predator is, after having mobbed or snarled for some time, dependent on the distance of the predator from the place to which the Starlings are attached, and the strength of the attachment etc.

When a stuffed Tawny Owl *(Strix aluco)* was placed 50 metres from nestboxes, the Starlings returned to the nestboxes and their immediate surroundings after 5–10 minutes of snarling within 2 metres from the owl. At the breeding place they uttered warning calls, but soon continued their breeding activities, some individuals now and then flying up to the owl for shorter periods. When the owl was placed a few metres from nestboxes, the Starlings would mob and snarl alternatingly. After about half an hour they tended to leave the place, so the owl had to be removed.

Besides being released by predators alarm calls frequently occur in the following situations, where no predator is present:

During song: The warning call and the snarl were often heard from singing Starlings, although the snarl, in this context, was only frequent in the tame Starlings. The fear squeal was never heard from

singing Starlings. Wild Starlings, whose song I have observed in different parts of Europe, often incorporate warning calls into their songs in such a way that the warning sounds appear at fixed places in an individual song. The warning calls appearing in song were never repeated more often than about one sound per second.

During intra-specific fighting: All three alarm calls were frequently uttered during intraspecific fights, as well by Starlings in the field as by caged birds. The warning call and the snarl were mostly given by Starlings, who showed a tendency to flee *and* to attack, whereas Starlings who uttered fear squals showed no tendency to attack, but a strong tendency to flee, which in some cases conflicted with another tendency, for instance to eat. This was the case in a tame subordinate Starling, who used to utter fear squeals while trying to eat from the corner of a slice of bread, on which another Starling was standing. The subordinate bird tried to stand as far away from the other one as possible while eating. Its plumage was tightly sleeked, the legs were strongly bent, the body horizontal (fig. 12). ELLIS (1966) names this posture the "depressed posture", and says that it is common in caged submissive Starlings, but not in wild birds. The above mentioned submissive Starling was never attacked in this posture, and indeed showed no tendency to attack itself.

The fear squeal was also given by Starlings, who were trodden by other Starlings, either by direct attack or incidentally, who were pressed into a corner and pecked at, who had got a foot entangled in the netting etc. Tame Starlings who had been too long in the bath, were quite often observed running out of the basin with a squeal of fear, (also when no other bird had been present near the basin). They seemed to have got too wet, probably because their condition was not quite good. During fights between Starlings, the bouts of alarm calls of any of the three kinds are seldom of more than a few seconds duration.

In novel situations of all kinds, the snarl and especially the warning call occur regularly. Thus the warning call is often uttered by a flock of Starlings just before they alight in high trees about an hour before settling in the roost, and before landing on a feeding ground.

The tame Starlings uttered snarls or warning calls in many situations which were unfamiliar to them, for instance when they were brought into a new room, and when they saw snow outside the window for the first time.

Motivation of the danger calls.

Fear squeal: This call is always caused by strong fear, escape in most cases being prevented by external factors. This is so, when a Starling is being held by a predator, trodden by another Starling, or is stuck in the netting. In case of the tame Starlings having got soaked in the bath, the wet plumage made flying difficult. A Starling being waked up at a roost by a predator may have difficulties in taking wing immediately after sleep. The submissive tame Starling, who gave fear squeals while trying to eat, however, was clearly in a conflict between eating and escaping. It seems then, that inhibition of escape is taking place in all cases of fear squeals, but that the inhibition may be caused by external, or periferal factors, as well as by a conflicting tendency.

Whenever Starlings, *strongly* frightened, fluttered against the side of the cage, because a cat or a strangly moving object or person had come near the cage, they did not utter any sounds at all. These situations resulted in varying degrees of escape

tendency, but only warning calls and snarls occurred, as the escape tendency waned and the starlings stopped trying to escape. It is probable that no fear squeals were given in these cases, because, contrary to the cases where fear squeals occurred, actual flight movements were not prevented, although escape from the predator was thwarted.

Another explanation of the causation of fear squeals may be that physical pain or touch is the proper stimulus, but this leaves a few unexplained cases.

Warning or mobbing calls: A stuffed Tawny Owl was presented to the caged Starlings. The hand-reared birds did not – except for a few snarls by one individual (see below) – utter any alarmcalls at the sight of the owl. So the only experimental bird for the following experiments on mobbing calls was the timid wildcaught male. Apart from one snarling sound, uttered after the removal of the owl, this Starling only responded to the owl by giving mobbing calls.

A. Experiments where the Starling was free to move towards or away from the owl:

The owl was placed at various distances from the Starling. When the distance was more than 2 metres the Starling approached the owl, until the distance was about 2 metres. When the distance was less than 2 metres, it fled and alighted at a distance of about 2 metres. In both cases the Starling gave some mobbing calls before moving, but the tempo of mobbing calls increased in both cases considerably after it had moved to a distance of 2 metres from the owl.

B. Experiments where the Starling was in a 40 cm wide cage, and could not move more than about 30 cm in the direction towards or away from the owl:

The owl was placed at distances of 4, 2 and 0 metres from the cage. The number of mobbing calls was counted for the first 2 minutes of 2 presentations of the owl at each distance:

	4 *metres*		**2** *metres*		**0** *metres*	
1. $^1/_2$ minute	31	7	42	50	0	0
2. - -	25	21	34	38	0	0
3. - -	23	8	29	23	0	0
4. - -	3	0	22	10	0	0

The mobbing response of the Starling like the one of the Chaffinch *(Fringilla coelebs)* (HINDE 1954) waned during the presentations of the owl model, but partially recovered during the time, when no predator was present. The experiments at 2 metres were, however, carried out at a time, when the mobbing response had had less time to recover after the last presentation, than the experiments at 4 and 0 metres. The difference in number of mobbing calls at 2 metres compared to the number at 4 and 0 metres are therefore rather too small.

As far as conclusions can be drawn from these few experiments with a single bird, the experiments A, where the Starling was free to move, show that 2 metres was approximately the distance from the owl, where this starling's tendency to approach and to escape were of equal strength.

The experiments B show, that when the Starling was confined at this distance from the owl, it gave more mobbing calls than at greater or smaller distances.

These findings together suggest that the mobbing calls of the Starling are caused by the balancing tendencies to escape and to approach a predator.

The motivation of mobbing calls has been discussed a.o. by HINDE (1954) and MARLER (1956 a), who agree that mobbing is caused by a conflict between escape and approach. Whether the tendency to approach is of aggressive or exploratory nature or both is more difficult to decide

at present. In case of the Starling, the fact that mobbing calls are used during intraspecific fighting, often accompanied by direct attack (treading and pecking), makes it seem probable that in this bird the approach tendency present during mobbing is at least partly of an aggressive nature.

The snarl is probably, like the warning call, caused by conflicting tendencies to escape and to attack, but the aggression underlying snarling seems to be stronger, as the following facts suggest:

1) Starlings fly nearer to the predator during snarling than during mobbing.

2) Snarls are most frequent during the breeding season, especially just after the young are hatched, that is the time, when birds are generally most aggressive.

3) The wild-caught Starling, who was very timid and never attacked other Starlings, until the last few weeks of the 17 months I had it, was only observed snarling twice during these 17 months:

It uttered 20–30 intense snarls, when its "mate" (a tame female, with whom it had been alone together in a small cage for two months in spring), had been let out of the cage, and alighted on my lap. As I was 2 metres away from the cage, escape releasing stimuli would not have been stronger than usual. A tendency to explore seems to be out of the question, as the wild-caught Starling had never shown anything but fear towards me, although it had often had the opportunity to approach me before the 2 months of confinement. It is more likely that the sight of a predator near the mate was a strong stimulus for aggression.

The other instance of snarling by the wild-captured Starling took place $^1/_2$ minute after the stuffed owl had been removed after the first presentation, when the Starling uttered one snarl. Otherwise it only gave mobbing calls.

Its tame companion, on the contrary, never uttered warning calls at the presentations of the owl, but 5 snarls at the beginning of the second presentation were the only sounds uttered, apart from ordinary flight calls given when it flew to inspect the owl from various angles. However, also this Starling kept a distance of about 2 metres from the owl, and never attacked.

Though the snarl may be accompanied by direct attack, an escape tendency is probably always present, and must be rising, as the Starling approaches the predator, until the tendencies to escape and to attack are equally strong, and further approach is inhibited. The zig-zag movements during the attack by the tame Starling on me, can most simply be explained as resulting from an alternating dominance of the aggressive and the escape tendency. The bird having been strongly frightened on the previous day, also speaks for the existence of an escape tendency.

Information.

MARLER (1957) pointed out that the mobbing calls of a number of passerine birds have a physical structure giving good clues for location of the sound source, and assumed that these calls have developed as a means of drawing the attention of other birds to a predator.

Comparison of the sound spectrograms of the danger calls of the Starling (fig. 9–10) shows that the warning call and the snarl provide more clues of location than the fear squeal. Firstly the snarl and especially the warning call have a wider and more continuous frequency range throughout the lower frequencies, providing clues of location by means of phase difference. Secondly the segmented structure of the snarl and the abrupt setting in of the warning call give clues of location by way of time difference in the arrival of the sound waves at the two ears. Moreover, the behaviour accompanying these two calls (p. 217f) is such as to make the bird rather conspicuous. It may therefore be assumed that the warning or mobbing

call and the snarl have the biological function of giving information to other Starlings about the presence and location of possible danger.

The fear squeal, although its frequencies are within the range giving location clues by means of phase difference, on the whole gives few location clues, its setting in being rather gradual, segmentation lacking, and the frequency bands narrow. The accompanying behaviour tends to make the bird inconspicuous (fig. 12). Approach by other Starlings therefore is not to be expected as a reaction to this call. However, the fear squeal is a rather loud and far carrying sound. Its wavering but sharply defined frequency bands give the call a high degree of improbability. It seems fit to give special information at a rather long distance, though little information about location.

Reactions to danger calls (non-recorded).

Fear squeal.

Escape reactions to a fear squeal were observed twice in the *tame Starlings:*

By the attack of a 1 month old Starling, another young one got a foot entangled in the netting, and uttered a fear squeal, to which the attacking bird immediately reacted, by flying up to a branch. The second case was similar, but then also a third Starling standing near the others flew up.

In all other cases when fear squeals were heard from tame Starlings, no more than a certain attention and perhaps a decrease of aggression occurred.

Wild Starlings were never seen reacting to fear squeals uttered during intra-specific fighting, except by short retreat, or hesitation. Starlings caught by predators were not observed.

GERSDORF (1966) records that a Sparrow Hawk *(Accipiter nisus)* who had specialized on hunting Starlings at dusk, often sat the whole night through with a live Starling on a post in the reeds where a large flock of Starlings roosted, without any other Starling reacting (the hawk did not eat the Starling until the next morning). GERSDORF presumed that the Starling must have squealed.

Warning calls or mobbing calls.

The handreared Starlings responded as nestlings to various short notes, quickly repeated, like the mobbing call of the Chaffinch or the contact call of the Jackdaw *(Coloeus monedula)*, as well as to the warning call of their own species, by crouching on the floor of the box in which they were kept. Begging chicks stopped uttering begging calls.

Newly fledged Starlings showed escape reactions to warning calls given during song by an old Starling, but habituation soon occurred.

The first time warning calls were heard from the singing Starlings, 4 out of 5 hand-reared Starlings (5 weeks old) flew from the floor up to a branch. The next time they heard the warning sounds, a few minutes later, only one of them flew up, but the feathers of the others were sleeked. After a few days, no visible reaction occurred to warning sounds, when these were given during song.

During intra-specific fights, however, the warning sounds always seemed to have a slight intimidating effect, probably due to reinforcement from attacking birds.

Wild Starlings: When single warning calls are uttered with intervals of about a second or more, perched Starlings usually do not react by flying up, but attention may be shown, singing Starlings stopping their song. A flock of Starlings about to land may hesitate a few seconds or fly round for a short while before alighting. Thus the discovery of a source of danger will be facilitated.

If warning calls are uttered in rapid tempo (5–7 calls per second), perched Starlings will mostly react by flying up. It is of course difficult to decide merely by observations, whether the following be-

haviour is partly a reaction to the calls or only to the sight of the predator. In case of strong danger like a falcon alighting among the Starlings, they will form a close flock flying near, mobbing, and perhaps snarling, at the falcon. It was my impression that warning calls were not given, before the birds had seen the predator themselves.

Snarling sounds.

The *tame Starlings* showed no clear reactions to snarling calls at any age.

Wild Starlings: Wild nestlings continue begging for food, while their parents snarl on the roof of the nestbox.

Adult Starlings seem to react very quickly to snarling calls of other Starlings. by approaching.

When a stuffed owl was placed at a distance of about 50 metres from a breeding colony of 3 pairs of Starlings, where also non-breeding Starlings were present, it lasted a few minutes before any Starling reacted, but as soon as one Starling had started to snarl, flying towards the owl, other Starlings joined, and within half a minute about 30 Starlings were flying round the owl within a radius of 2 or 3 metres, loudly snarling.

REACTIONS TO PLAYED-BACK DANGER CALLS

Attempts to scare Starlings away from buildings and fruitplantations by means of tape-recordings of alarm calls of the Starling were first made by FRINGS & JUMBER (1954), who used the fear squeal with partial success. The procedure was carried on and elaborated in France and Germany with varying success (BRUNS 1959 and 1960, BUCHMANN & MÜLLER 1957, CREUTZ 1956, GAUDECHAU 1959, SCHMITT 1959, summary by HARTBY 1966). Also the snarling call and the warning call were tried (PFEIFER & KEIL 1961, TEMPEL und BOHN 1962). However, though the technical apparatus was improved, habituation soon occurred, except in places where the Starlings could find sufficient food in neighbouring areas, and therefore did not return to the places from where they had been scared away. Some experimenters found that the oldfashioned methods of scaring Starlings away by means of detonations were more effective (REICH 1955, REICH & VAGT 1963).

The following experiments were made in a cherry plantation belonging to the Agricultural School of Copenhagen on the initiative of professor S. DALBRO. This plantation, which primarily serves an educational purpose, differs from most commercial fruit plantations in having a greater variety of cherry species. This means that the season where *some* trees in the plantation have ripe cherries is much longer than in an ordinary cherry plantation, and so is the time during which Starlings may become habituated to the means used to scare them away.

The 3 alarm calls of the Starling were recorded on tape, played back on a Telefunken taperecorder Magnetophon 85 and emitted through an amplifier and loudspeakers hanging in cherry trees.

At first only one set of loud-speakers was placed in the middle of the plantation. This was done by CARL WEISSMAN in collaboration with Telefunken AEG Danish Electricity Ltd. However, it was soon found, that although the sound was audible (to a human ear) all over the cherry area, which is 165 metres long and 30 metres wide, it was not effective in scaring the Starlings away, when the latter were more than about 50 metres from the loudspeaker set. It was evident that the Starlings learned where to find peace, for during the first few days of experiments, they fled to the neighbouring fields, if they happened to sit in a tree near the loudspeakers, when the sounds started, but soon they

were found to fly down to the quiet ends of the cherry plantation, when alarm sounds were given. Here they showed no overt reactions to the sounds, but continued to eat as well during as between the bouts of alarm calls. Therefore the loudspeaker set, consisting of 6 separate loudspeakers, was divided into 3 parts, which were placed in such a way that no cherry tree was more than about 40 metres from a loudspeaker. This of course had the unfortunate effect, that the sounds, having unequally long way to go to the ear from the different loudspeakers, seemed to be repeated after a fraction of a second from the more distant loudspeakers. However, even if the perception of the calls was thus disturbed, this arrangement was much more effective than the system of a single sound source.

In July and August 1965 experiments were made to compare the reactions of Starlings to the three different alarm calls. These were given in equally long bouts (of 20 seconds) of the same intensity equally often (one bout per minute) and thus with the same interval. The same call was always played in 3 successive bouts, followed by 3 bouts of either of the other two calls. No other experiments were made that summer.

The Starlings reacted in various ways to the alarm calls:

They might flee in a straight line.

They might fly up and alight on telephone wires, which (unfortunately) were extended over the cherry plantation.

They might circle for a few minutes over the tree tops, after which they might either flee, alight on the wires, or land in the cherry trees again.

They might not react overty at all.

As it could not be established when new Starlings had arrived in the plantation, it was only at the very first experiment each year that it was reasonably safe to assume, that the Starlings present were not already habituated to the sounds. In both years the very first reaction (to a fear squeal, resp. a fear squeal played back at twice the normal speed) was that of some Starlings fleeing straight away, the others circling for not more than half a minute over the tree tops, after which also most of the latter birds flew away, while a few of them alighted on the wires.

Many of the Starlings returned sooner or later to the cherry plantation. By repetitions of the experiment escape reactions waned, at first less Starlings flying away and more alighting on the wires, later on more and more Starlings showing no overt reactions at all (HARTBY 1967).

During the experiments flying away from the cherry plantation was counted as an escape reaction, circling over the cherry trees for at least ½ minute was counted as an investigatory reaction. Alighting on the telephone wires was considered intermediate between, or a mixture of, escape and orientation reactions, and was not counted.

Escape Reactions:

The difference between the number of Starlings fleeing at the 3 different danger calls was not statistically significant (*Hartby* 1967) though more Starlings in fact fled as a reaction to the fear squeals than to theother sounds. There was no significant difference in the relative number of escape reactions (of any of the sounds) during the first part of the season (July) compared to the last part (August).

Habituation: When the reactions to the last bout of a series of 3 bouts of the same sound, were compared to the reactions to the following first bout of a new sound, it was found, that statistically more Starlings fled to the new sound, $P < 0{,}05$ (*Hartby* 1967). This of course, could be explained either as a case of habituation or as the result of individual differences in the threshold of the innate releasing mechanism of the different calls.

Another experiment, which clearly showed habituation, was made during the summer 1964. Bouts of either fear squeals alone or a mixture of warning sounds and snarls (recorded from a wild Starling mobbing an owl), were played back for a varying number of hours (6–24),

until no Starling was seen to react to 3 successive bouts. Then, after the same interval as between the previous bouts, the other alarm sound (or mixture of sounds) was given. In 12 out of 14 cases all Starlings immediately fled from the plantation to the fields (100–400 birds). $P < 0{,}05$ for each sound (group of sounds). This experiment also suggests that habituation decreases after a while.

Investigatory reactions

A. Investigatory reactions by way of circling over the plantation (for at least ½ minute) by Starlings present in the cherry plantation at the start of the sounds:

Comparison between the number of investigatory reactions to the three different predator calls, showed no statistically significant differences, when the reactions were counted for the whole summer.

However, the ratio of the number of orientation reactions to the fear squeal divided by the number of orientation reactions to the warning call was significantly lower during the first part of the season (July) than during the last part of the season (August), $P < 0{,}025$. The increasing proportion of investigatory reactions to the fear squeal may, if real, have been caused by a kind of association or conditioning, the fear squeal becoming a conditioned stimulus for approach, for which warning call and snarl may be unconditioned stimuli. HINDE (1954) found that the mobbing behaviour of the Chaffinch as a reaction to a particular model could be enhanced, if the model was presented shortly after a model having more strongly releasing stimuli, and more so, if the two models were presented at the same spot. HINDE suggested that a kind of conditioning was taking place.

B. Arrival in the plantation of Starlings from neighbouring areas:

It happened during as well as between bouts of alarm calls, that Starlings flew *to* the cherry plantation. Some of these birds must have been newcomers, but most of them were probably Starlings who had previously been scared away or had flown away. (It was often possible by means of field glasses to follow Starlings from the cherry plantation to the neighbouring fields and back again). Upon arrival the Starlings most often alighted on the telephone wires.

There was no significant difference in the number of Starlings arriving in the plantation during the three different calls though less Starlings in fact approached during fear squeals than during the two other calls.

By emitting sounds every minute one could not tell of course, if the Starlings actually reacted to the sounds. In August 1966, when there were rather few Starlings in the cherry plantation, because there were no ripe cherries of the sweet sorts, which the Starlings prefer, the following experiment was made with the fear squeal, the call during which least arrivals had taken place:

Fear squeals were played for a period of about one minute every 7 minutes. The number of Starlings flying up to the cherry plantation was counted for the first 3 and the last 3 minutes of each 7 minute period following the start of the sounds. Significantly more Starlings arrived in the cherry plantation during the first 3 than during the last 3 minutes of the periods. $P < 0{,}005$. In most cases it could be established that the arriving Starlings were not birds who had fled during the last bout of sounds.

Whether the Starlings were attracted by the sounds because they associated them with the cherries or the other sounds, or whether the fear squeals more directly elicited approach, can only be decided by experiments in places where there are no other "attractions" than the calls.

Orientation reactions occurred in Mallard *(Anas platyrhynchos)* ducklings to a cardboard model resembling a hawk in flight primarily eliciting fleeing, when after about 20–30 presentations of the model, fleeing reactions had ceased, and these orientation reactions had not habituated after more than 2000 presentations of the hawk model (MELZACK 1961). Investigatory responses may take place in Chaffinches, when either the external or the internal stimuli for mobbing are low (HINDE 1954).

THORPE in his book "Bird Song" (1961) mentions that distress squeals of many birds have a very strong attractive effect on members of the same species, who will gather to mob an enemy. However, I have not found any mention in litterature of Starlings approaching as a reaction to fear squeals.

Reactions to other sounds: Various tones and noises were emitted through the loudspeakers. The first reaction of the Starlings to loud noises was immediate escape, but habituation seemed to occur even faster than to the alarm calls. This may, however, be due to the Starlings already being habituated to "sounds from the loudspeakers". Escape reactions to tones from a recorder did not occur, except when 2 not harmonizing notes were played simultaneously, but also in the latter case habituation occurred very quickly (after 2 or 3 emissions). No overt reactions occurred to played back flight sounds and attack calls.

COPULATION CALL OF THE FEMALE STARLING

In the Starling the very complex song of the male has the function of inviting and stimulating the female to copulations, as well as attracting a female to the nest-site in the first place. So the male does not need a special nest-site call or other courtship calls, as they are found in many species of birds.

However, DAVIS (1959) mentions a nest-site call "whew" by the male Starling, but as his studies were mainly based on observations of a single colony, this call may be a local imitation. Imitations of glissando sounds are specially frequent in the prenuptial phase. Variations between populations are greater than between individuals of the same colony.

The female Starling on the other hand sings very little during the mating time — I only heard a few notes while the male was away.

Opinion differ, however, about the amount of singing of the female. Thus BULLOUGH (1946) states that "in autumn some females also sing", but interprets it as male behaviour, whereas SCHÜTZ (1942) mentions singing of females as common in the early part of the breeding season.

The female Starling is attracted to the copulation place on the ground or a low branch by the song of the male, which starts with a glissando note, a relatively far-carrying note. She alights at his side, stands parallel to him with slightly drooped wings, and after a period of low-intensity comb-sounds from the male (2–8 seconds in the 15 cases I watched), she gives a series of very delicate notes (fig. 11), after which the male mounts. He may try to mount before she has uttered the copulation calls, in which case she will give threat calls.

KLUIJVER (1933) quoted WALLRAFF, and WALLRAFF (1953) mentions a soft copulation song of the male Starling, but WALLRAFF reports that females with a very strong drive may elicit copulation without singing of the male. No mention of copulation calls of the female Starling has been found in litterature, probably because the sounds have very little carrying power.

SCHNEIDER (1960) in his book "Der Star" has a photograph with the title "Gemeinsamer Gesang eines Starpaares vor der Paarung" (communal singing of a pair of Starlings before the copulation). The male is in the typical posture of intense singing, with the bill pointing obliquely upwards, and fluffed throat feathers, whereas the throat feathers of the female are sleeked, the head more horizontal, and the wings slightly drooping. The bills of both are open. The posture of the female is that of inviting for copulation while giving copulation calls. The latter may with some right be termed song, as they consist of quite a melodic series of notes of very restricted frequency range, differing somewhat in pitch from one another. However, these notes are heard only immediately before a copulation and only from the female Starling, and therefore functionally are quite different from song.

MARLER (1957) suggests that in densely colonial birds visual communication is likely to be more efficient than auditory, because the latter may cause confusion by always being audible to many individuals. Voice therefore tends to be simple and soft. This may apply to some extent to the Starling, which is in most places a colonial bird,and in some places densely colonial. The song consists of notes of greatly varying intensity and carryingpower, but even the loudest notes are relatively soft compared to the song notes of birds of the same size (for instance the *Turdidae*).

However, the vocal and auditive abilities are highly developed in the Starling: MISKINEN (1951), who examined the vocal apparatus of over 30 species of song-birds, found that, beside the crows, the Starling has the most movable syrinx, because of specially complex muscle attachments. The upper frequency limit of hearing in the Starling, though varying, can be as high as 28 Kilocycles per second (FRINGS & COOK 1964).

In the present paper were described 11 calls of the Starling, which, compared to the vocabulary of 15 or 17 calls found in some passerines, are relatively few (for instance Chaffinch (MARLER 1956 b, POULSEN 1958), Whitethroat *(Sylvia communis)* (SAUER 1954), Song Sparrow *(Melospiza melodia)* (NICE 1943, quoted THORPE 1961). The lack of a call specifically signalling danger from a flying predator (and of the accompanying concealing behaviour) is probably an adaption to the colonial life of the Starling – also in other groups of birds (for instance the Charadriiformes) colonial species (gulls, terns, avocets) depend more on demonstration and attack than on concealment. Functions, which in many species of songbirds are served by special courtship calls, are in the Starling served by the song, which is in this species of special complexity and variation, and therefore will be described in a separate paper.

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SUMMARY

Observations were made of wild and hand-reared Starlings. Apart from song, which is not described here, the vocabulary of the Starling consists of:

Begging calls of young Starlings:

1. distant begging call
2. close begging call

contact calls:
3. flight call
4. flock call

intra-specific aggressive calls:
5. threat call (short, long, and rattle)
6. attack call
7. threat squeal
   mixed calls

danger calls:
8. fear squeal
9. warning call (mobbing call)
10. snarling sound

female sexual call:
11. copulation call.

Sound spectrograms are given of all calls, together with account of the situations, releasing stimuli, accompanying behaviour, and reactions of other starlings. Motivation and function are discussed.

Experiments on reactions of Starlings to tape-recorded, played back and amplified danger calls were made in a cherry plantation. Escape as well as approach occurred to all 3 danger calls. Habituation of escape reactions was established.

DANSK RESUME

Stærens (Sturnus vulgaris) *lyde.*

Ved observationer af vilde og tamme Stære hørtes (foruden sang) følgende 11 lyde:

1–2*) Ungernes tiggelyde:* Fra de første tiggelyde (hos 1–2 dage gamle stæreunger – fig. 2a) udvikles gradvist 2 forskellige tiggelyde: Den nære og den fjerne tiggelyd, der når deres endelige form hos flyvefærdige unger (16–18 dage gamle), og bruges i 3–5 uger, hvis ungerne stadig fodres. *Den nære tiggelyd* (fig. 2c til højre) udstødes ved synet af maden; munden er vidt åben. *Den fjerne tiggelyd* (fig. 2c til venstre) udstødes af sultne unger, der er alene, men tiltager i hyppighed ved synet af forældrene (hos tamme håndfodrede unger fosterforælderen); næbbet er mindre åbent end ved den nære tiggelyd (fig. 1).

Hos flyvefærdige stæreunger kan tiggelyde ikke udløses før ca. 1 time efter solopgang og ikke efter ca. 1 time før solnedgang. Tamme Stære fløj meget omkring og afslog at spise i denne tidlige og sene periode, der omtrent svarer til den tid, hvor vilde Stære flyver henholdsvis fra og til deres sovepladser. Heller ikke når de blev ældre, spiste Stærene i disse perioder.

Når stæreunger er ca. 5 uger gamle, foretrækker de at spise selv, men fortsætter man at tilbyde dem føde, kan de udstøde tiggelyde og lade sig fodre så sent som 55 dage efter klækning.

3–4*) Kontaktlyde:* **3***) Flyvelyd* (fig. 3) udstødes især, idet Stæren letter. Kortere flyvelyde kan udstødes, før den letter (eller uden at den letter), samt idet den letter for at flyve et kort stykke. Bruges hele året af voksne og af unger, fra de er flyvefærdige. Udstødes, når Stæren af en eller anden grund har en tendens til at flyve, dog ikke under *stærk* flugt- eller angrebstendens. **4***) Flokkald* (fig. 4a) høres uden for yngletiden. Forekom hos ikke ynglende Stære fra midten af maj; hos ynglende, når ungerne var flyvefærdige; hos ungstære fra de var ca. 4 uger gamle. Især hos flyvende Stære. Udstødtes af tamme Stære ved synet at forbiflyvende vilde Stære – i et par uger omkring 1. 10. og 1. 2. også "spontant" – samtidig med at Stæren fløj op eller indtog intens flyveberedskabsstilling. Lyde, der mindede om flokkald, men var af varierende lavere tonehøjde (fig. 4b), forekom hos en flok ikke ynglende stære i midten af maj, dagen før de rigtige flokkald begyndte, (antagelig udviklingsstadier af flokkald).

5–8*) Intra-specifikke aggressive lyde:* **5***) Truelyd* (fig. 5) motiveret af ret svag konflikt mellem angreb og flugt. 3 former: a) kort, b) lang (ofte sammensat med andre lyde jfr. punkt 8), c) klapren. Sidstnævnte er den hyppigste lyd ved skænderier om siddepladser. **6***) Angrebslyd* (fig. 6) under dominerende angrebstendens, hørtes især hos tamme Stære, når føden var begrænset. **7***) Trueskrig* (fig. 7) ved stærk konflikt mellem flugttendens og tendens til at forblive på stedet. Især ved redehullerne. **8***) Blandingslyde* er særlig hyppige ved kamp mellem artsfæller (jfr. Curio 1959). Hos Stæren forekom såvel lyde sammensat af forskellige intraspecifikt aggressive lyde som blandinger af sådanne med farelyde og andre lyde. En bestemt blandingslyd kan bruges flere gange af et bestemt individ og tjener måske som middel til individuel genkendelse. (fig. 8 viser 2 lyde fra hvert af 2 individer).

8–10*) Farelyde:* **8***) Angstskrig* (fig. 9) udstødes under

stærk flugttendens, når Stæren er forhindret i at flyve – især på grund af ydre kræfter (hvis Stæren er kommet i klemme eller er grebet af en fjende), men også på grund af konflikt mellem flugttendens og en anden tendens f. eks. til at æde (fig. 12, Stæren til højre). I fangenskab især hos Stære nederst i hakkeordenen. **9)** *Advarselslyd* (fig. 10b) under konflikt mellem flugttendens og en modstridende tendens, som i hvert fald i nogle tilfælde er angrebstendens. **10)** *Snerrelyd* (fig. 10a) under stærkere konflikt mellem angrebs- og flugttendens, især i ruge- og unge-fodringstiden. Både advarselslyden og snerrelyden kan rettes mod fjender, men Stæren nærmer sig fjenden mere under snerrelyde og kan i nogle tilfælde angribe. Begge lyde kan udløses af fjender på jorden, eller i luften, ændringer i de vante omgivelser og pludselige kraftige stimuli. Begge forekommer også under sang og under kamp med andre stære.

Reaktioner: Redeunger trykkede ved advarselslyde, men ikke ved snerrelyde. Tamme flyvefærdige Stære reagerede i begyndelsen på angstskrig og advarselslyde fra deres kammerater ved at flyve op til de højeste pinde; men efter nogle få gange reagerede de ikke synligt undtagen med en vis opmærksomhed eller tøven. På snerrelyde viste de ingen tydelig reaktion. Vilde Stære flyver ofte op, når advarselslyde udstødes i hurtigt tempo (5–7 pr. sek.). Ved lyde i langsomt tempo vises som regel kun opmærksomhed. Begge reaktionsmåder letter antagelig opdagelsen af en fjende. Opdages en sådan, slutter Stærene sig tættere sammen. Lignende reaktioner på snerrelyde.

Reaktioner på afspilning af farelyde i en kirsebærplantage: Såvel flugt fra plantagen som kredsen over træerne, hvori højttalerne var ophængt, og tilflyvning til plantagen forekom som reaktion på alle 3 lyde, men under forsøgsbetingelserne var der ingen signifikant forskel i antallet af reaktioner (hverken flugt eller tilnærmelse) på de 3 lyde. Det er uvist, i hvor høj grad association mellem lydene indbyrdes og mellem disse og kirsebærrene har gjort sig gældende. Tilvænning til de enkelte lyde blev påvist i form af ophør af flugtreaktioner på en enkelt lyd efter længere tids afspilning af denne.

11) *Hunnens kopulationslyde:* (fig. 11) En række meget fine lyde, der udstødes umiddelbart før parringen, efter at hannen har sunget med kamlyde nogle sekunder ved siden af hunnen. Både kamlyde og kopulationslyde er af meget kort rækkevidde.

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