British Birds

Vol. 55 No. 2

FEBRUARY 1962

Birds with abnormal bills

By D. E. Pomeroy

(Plate 9)

INTRODUCTION

CLOSE CORRELATION of the shape and size of a bird's bill with its feeding preferences has been demonstrated even within a species (see Lack 1947, Snow 1954). But individuals with bills differing considerably from the normal also occur, even though rarely, and prompt certain questions. How do these abnormalities arise? Do they survive and, if so, how in view of their marked divergence from the type produced by selection? Many birds with abnormal bills are unable to feed in the usual way and, at least in some cases, they acquire feeding mechanisms appropriate to the beaks which they possess. Thus it may be that, in normal birds too, the feeding mechanisms which are seen are acquired as a result of having a particular type of bill; and the fact that normal members of a species show a "lack of individual variation in the motor pattern can . . . be ascribed in part to lack of variation in the relevant effectors" (i.e. bills) (Hinde 1959).

It was shown by Spalding, as long ago as 1873, that the motor patterns of a chick in pecking at small objects are well organised at the first peck; but later work has revealed that these patterns are improved with practice (Koenig 1951). Thus a learning process is involved. It has only recently been accepted (e.g. Hinde 1959) that birds' behaviour does show plasticity; in other words, it is less stereotyped than was once thought. The adaptability now suggested enables birds to survive even with abnormal bills. It also makes

PLATE 9 (*opposite*). Upper, juvenile male Hawfinch (*Coccothraustes coccothraustes*) with incomplete bill, Switzerland, August 1949. Although its two mandibles met only at the base, an apparently congenital deformity, its weight was normal and it covered 460 km. in 43 days (page 65) (*photo: Willy Pfeiffer*). Lower, adult male Starling (*Sturnus vulgaris*) with elongated and down-curved bill 42 mm. long; this symmetrical deformity is not uncommon among Starlings, lengths up to as much as 2½ inches (over 60 mm.) having been recorded (page 57) (*photo: Eric Hosking*)

possible the acquisition of different feeding mechanisms within a species, which may be of importance in enabling birds to take advantage of locally abundant food supplies. Hence, plasticity in feeding mechanisms may have a positive evolutionary value—unlike, for instance, reproductive mechanisms, where selective pressures will tend to favour uniformity within the species.

Thorpe (1956a and b) has shown that individual Passerines may acquire unusual feeding methods; these are more easily acquired by some species than others. There is some evidence that the ability to acquire new feeding mechanisms also varies from species to species: examples will be given in which the behaviour varies considerably from the normal. The Starling (*Sturnus vulgaris*) shows considerable adaptability, but this may be correlated with the wide range of foods taken by normal members of this species.

Deformities may develop slowly—over a period of a year or more in some cases—or rapidly, as the result of an accident. Clearly the latter type requires much greater plasticity of behaviour if the bird is to survive, and this must be taken into account in the interpretation of differences in behaviour. The number of deformities due to injury is rare, however, and when behaviour is mentioned it may be assumed that the abnormality was not the result of a sudden injury unless otherwise stated.

The information in this paper is derived mainly from the results of an enquiry published in four ornithological and agricultural journals, from published records, and from correspondence. Full acknowledgements are given at the end or in the body of the text.

THE NORMAL BILL*

The underlying bony structure of the normal bill is shown in Fig. 1. This differs considerably in shape in different species, but the basic structure does not vary. Immediately overlying the bones is a cutaneous layer, or dermotheca, which is continuous with the skin or epidermis over other parts of the bird. The dermotheca is thin, and contains blood vessels and nerves. From it arises the horny sheath, or rhamphotheca, which forms the externally visible part of the bill. The rhamphotheca is produced from proliferating cells in the dermotheca which, as they divide, move outwards, at the same time becoming keratinised and, therefore, hard (Rawles 1960). The rhamphotheca may form a continuous sheath, as in most birds, or be made up of a number of separate plates, as in the Procellariiformes and some other groups. There are also differences in the degree of hardness found in the rhamphotheca: in a few species (e.g. some parrots)

*The author is very grateful to Sir A. Landsborough Thomson for help with the information contained in this section.

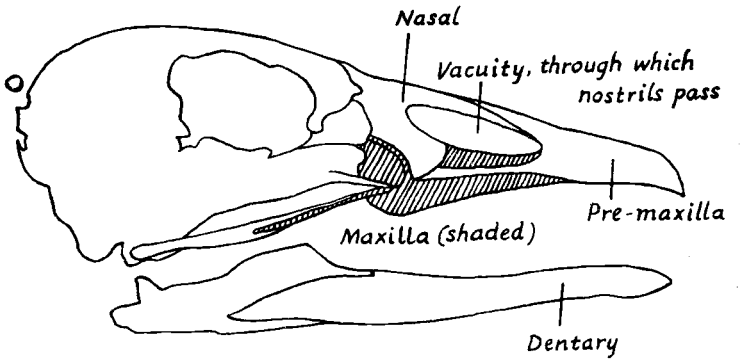

FIG. 1. The bones of a bird's bill (after Young 1950)

the cere appears to be ordinary skin, and may even bear feathers. In the Puffin (*Fratercula arctica*) the outer part of the rhamphotheca is grown and shed seasonally.

As far as is known, the bill grows throughout life (Rawles 1960), although the rate at which this occurs must vary from species to species. Moreover, there appears to be some individual variation within the species. Fox (1952), Moltoni (1949, 1950) and others have suggested that in most birds the growth of the bill is opposed by wear and tear, and by the opposition of the mandibles to each other; provided that both processes occur at an equal rate, the correct form of the bill will be maintained. This mechanism appears to explain some of the commoner abnormalities which occur (see later).

However, it should be mentioned that in some species the ends of the mandibles (where most growth occurs) are never opposed to each other. This happens in the majority of birds of prey and in all psittacine birds, as well as a few members of other groups, e.g. the adult Scissor-bill (*Rynchops flavirostris*).

It is well known that the range of bill types found amongst the ten thousand or so living species of birds is considerable. However, as will be seen, the range found in abnormal bills is even more remarkable. Various attempts have been made to classify normal bill types, perhaps the most satisfactory being that given by Van Tyne and Berger (1959).

Finally, it should be mentioned that variation of bill, other than that dependent on age, can occur within the species. The seasonal dimorphism of the Puffin has been mentioned; in the New Zealand wattle-birds (*Neomorpha*) there is a sexual dimorphism (the bill of the male being longer and more decurved than that of the female). Colour differences also occur, e.g. seasonal changes and sexual differences in the Starling and Blackbird (*Turdus merula*).

TABLE 1—VARIATION IN THE DIRECTION OF THE CROSSING OF THE MANDIBLES OF THE CROSSBILL (*Loxia curvirostra*)

Country	Lower mandible crossed left	crossed right	% left	% right
France (Mercier and Poisson 1924)	10 (7♂ 3♀)	5 (3♂ 2♀)	67	33
Norway (P. P. G. Bateson *in litt.*)	34 (18♂ 16♀)	25 (14♂ 11♀)	58	42
	44	30	59	41

The bill of the Crossbill

Only two genera of birds normally have crossed bills—the crossbills of Eurasia and North America and the *Loxops* of Hawaii (Landaeur 1938). In the young Crossbill (*Loxia curvirostra*) the tips of the mandibles are coincident (Witherby *et al.* 1941), and in the adult the direction of crossing varies. This is illustrated in Table 1 (see also Ludwig 1932); the apparent preponderance of those with the lower mandible going to the left (59% of the total) might well disappear if a larger sample were available. The fact that the ratio is similar in both sexes shows that the direction of cross is not a sex-linked character.

OCCURRENCE OF ABNORMALITIES

An abnormality may be defined as any irregularity in the bird's bill which is sufficiently different from the normal to attract the observer's attention. Such abnormalities are those which are likely to affect the bird in some way. Birds with abnormal bills are rare in the wild state (see Table 2). This could be due either to a low incidence of the causes of abnormality, or to a low survival of birds with abnormal bills.

Deformities that are not the result of injury have been recorded in about sixty species of wild birds, but their actual occurrence is doubtless much wider. There are, of course, more records for those species which are more readily observed, e.g. the House Sparrow (*Passer domesticus*), or trapped and handled in large numbers, e.g. the Starling. It is tempting to suggest that deformities occur more frequently in some species or families than others, but this would be very difficult to prove and, on the whole, there is little evidence to support it, except possibly in the case of the Starling. Over sixty cases have been recorded in this species—the next largest number in any one species being fifteen. Nevertheless, Table 2 (which contains all the available information) suggests that the occurrence is not significantly higher in the Starling than in other species. With regard to frequency of deformity, then, all that can be said is that it is well below 1% in wild birds. In cage birds, however, deformities appear to be much more frequent—although no accurate quantitative information is available.

TABLE 2—THE PROPORTIONS OF DIFFERENT SPECIES OF BIRDS WITH ABNORMAL BILLS

This information is mainly derived from ringing records supplied to the author by the people named, it being likely that any bird with an abnormal bill will be noticed as it is being handled. Samples of less than 100 individuals have been excluded. Note that none of the records of deformities in this table refers to non-Passerines (although there were two in the small samples omitted). This could mean that Passerines with abnormal bills adapt their behaviour more readily than many non-Passerines, thus being more likely to survive and be recorded

Species	Locality	Size of sample	Deformities No.	Deformities %
Manx Shearwater (*Procellaria puffinus*)	Irish Sea area (H. Dickinson)	3,000+	0*	0.0
Pheasant (*Phasianus colchicus*)	England (I. F. Keymer)	325	0	0.0
Herring Gull (*Larus argentatus*)	South Wales (H. Dickinson)	200+	0	0.0
Razorbill (*Alca torda*)	Skokholm (H. Dickinson)	*c.* 100	0	0.0
Puffin (*Fratercula arctica*)	Skokholm and Great Saltee (H. Dickinson)	1,250+	0	0.0
Wood Pigeon (*Columba palumbus*)	England (I. F. Keymer)	129	0	0.0
	Non-Passerine total	*c.* 5,004	0	0.0
Great Tit (*Parus major*)	Cheshire (W. T. C. Rankin)	130	1	0.77
Blue Tit (*Parus caeruleus*)	South Wales (H. Dickinson)	200	0	0.0
	Kent (D. E. Pomeroy)	269	2	0.74
	North Yorkshire (I. F. Stewart)	271	5	1.84
	Dumfriess-shire (I. F. Stewart)	300	1	0.33
Wheatear (*Oenanthe oenanthe*)	South Wales (H. Dickinson)	*c.* 100	0	0.0
Sedge Warbler (*Acrocephalus schoenobaenus*)	Bardsey (H. Dickinson)	*c.* 150	0	0.0
Willow Warbler (*Phylloscopus trochilus*)	Irish Sea area (H. Dickinson)	700+	0	0.0
Chiffchaff (*Phylloscopus collybita*)	Irish Sea area (H. Dickinson)	700+	0	0.0
Starling (*Sturnus vulgaris*)	Staffordshire (G. A. and M. A. Arnold)	463	4	0.86
	——— (Boyd 1951)	300	1	0.33
	U.S.A. (Hicks 1934)	*c.* 10,000	38	*c.* 0.38
	Kent (D. E. Pomeroy)	105	0	0.0
	Cheshire (W. T. C. Rankin)	2,509	6	0.24
	North Yorkshire (P. A. Rayfield)	*c.* 3,000	1	*c.* 0.03
House Sparrow (*Passer domesticus*)	England (I. F. Keymer)	117	0	0.0
	North Yorkshire (I. F. Stewart)	113	1	0.88
	Passerine total	*c.* 19,427	60	*c.* 0.32

*Since these birds are mostly ringed at night, only gross deformities would be noticed

TYPES OF DEFORMITY

The most satisfactory classification of deformities would be one based on their causes, but these are often unknown. Hence the system used here is mainly morphological, but inevitably there are some examples which do not fit into anything but a "miscellaneous" section.

(*a*) *Temporary*

According to Wilkinson (1953), temporary deformities have been recorded several times amongst cage birds. He attributed this to faulty feeding, but gave no actual examples. The only specific record which I have found concerns a Zebra Finch (*Taeniopygia castanotis*) in which the cock "continually developed the upper mandible until it had increased by nearly a quarter of an inch, in a downward curve. The abnormal part would then drop off, and growth continue as before" (Rankin 1953). A wild male Great Tit (*Parus major*) observed by Howard (1951) had a bill which was normal up to the age of four years; the upper mandible then began to grow until after four months it was double the length of the lower, which remained normal. Exceptionally fierce bill-wiping (which had not been seen before) took place on the two days before the young of this bird were due to hatch; when they did hatch, the bird's bill appeared to be normal again. However, the upper mandible began to grow again a few months later, and in six months had reached the same size as before.

(*b*) *Permanent*

Crossed mandibles. This is a relatively common abnormality which has been recorded in a wide range of species—for example, the Linnet (*Carduelis cannabina*), Hooded Crow (*Corvus corone cornix*), House Martin (*Delichon urbica*) and Robin (*Erithacus rubecula*), to name but a few. Typically, the bill appears as in the Crossbill with the upper mandible decurved, the lower mandible upcurved, and the two crossing towards the tip, but without any significant elongation. However, elongation does occur in some instances, the Blue Tit (*Parus caeruleus*) shown in Fig. 2 being an example. As in the Crossbill itself, crossing may be left to right or right to left (see page 52). It is interesting to note that

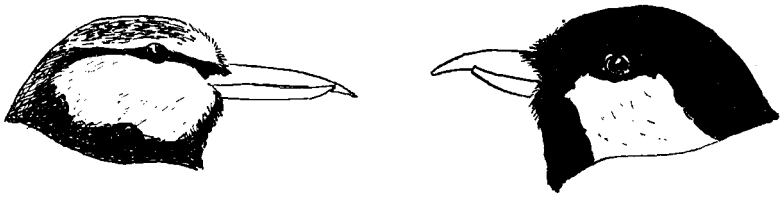

FIG. 2. Blue Tit (*Parus caeruleus*) with crossed mandibles and some elongation. Great Tit (*Parus major*) with the upper mandible slightly decurved

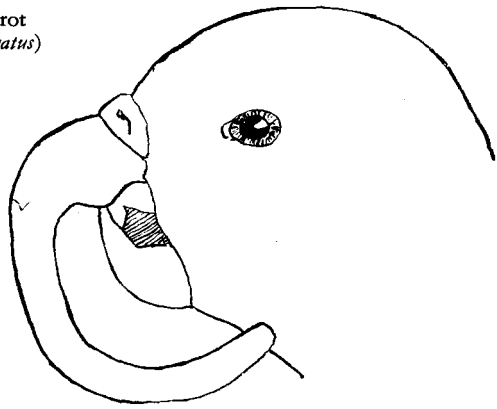

FIG. 3. Twenty-eight Parrot (*Barnardius zonarius semitorquatus*) with the upper mandible extremely decurved

a straight bill has been observed as an abnormality in the Crossbill (Rzehak, quoted by Duerst 1909).

Upper mandible decurved. This too is a fairly common deformity, affecting such varied species as the Rook (*Corvus frugilegus*) and Corn Bunting (*Emberiza calandra*), and the Feral Pigeon (*Columba livia* var.), in the last of which it is particularly common (D. Goodwin). The extent of the overgrowth of the upper mandible varies considerably: in the Continental Great Tit (*P. m. major*) shown in Fig. 2, it was only slight (15 mm; 10-11 mm. being the normal length for this race); in the Australian Twenty-eight Parrot (*Barnardius zonarius semitorquatus*) shown in Fig. 3, however, it was extreme. This bird suggests that the overgrown part continues on the same curve as the normal part of the bill. In Passerines, therefore, one would expect the curvature to be slight, as it was in the Great Tit already mentioned; and this appears to hold good in most cases (*cf.* Engels 1940). In Feral Pigeons, however, overgrown upper mandibles appear to be strongly hooked in most instances (D. Goodwin, W. Shipp). In most cases where definite information is available, overgrowth and downcurving of the upper mandible is associated with the tip of the lower mandible being broken off or otherwise damaged (e.g. the Starling in Fig. 4); or,

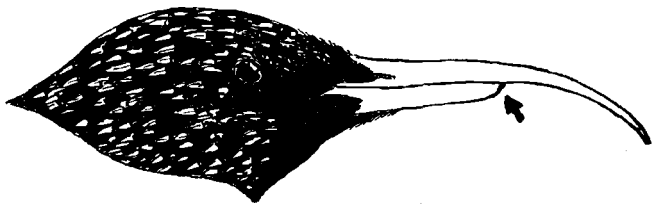

FIG. 4. Starling (*Sturnus vulgaris*) with the upper mandible decurved, probably because the tip of the lower has been broken off

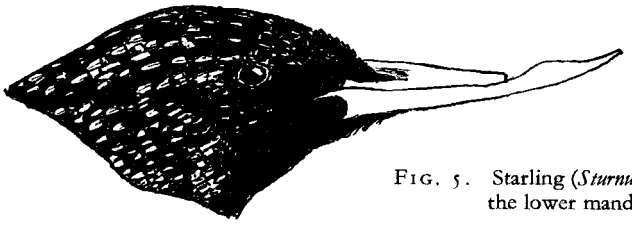

FIG. 5. Starling (*Sturnus vulgaris*) with the lower mandible upcurved

alternatively, the two mandible tips not corresponding (e.g. the Blue Tit and Great Tit in Fig. 2). In other words, this type of overgrowth occurs when the tips of the two mandibles do not approximate (see below) and a rather unusual illustration of this fact was the recent case of a female Rook whose lower mandible had become stuck through the skin of her upper breast, with the result that she could not close her bill and both mandibles became elongated and slightly curved (Nevin 1962). The exceptions to all this are those species in which the tips do not approximate normally—e.g. Psittacines and raptors, in which no cases of overgrowth are known in wild birds.

Lower mandible upcurved. This is rare, apparently only occurring when the tip of the upper mandible is missing. The only certain cases seem to be a Starling in the British Museum (Natural History) (Fig. 5) and a Great Crested Grebe (*Podiceps cristatus*) seen on Queen Mary Reservoir, Middlesex (Bruce 1952); a record of a Rook quoted by Groebbels (1932) is probably of a similar kind. There is also one record of the whole bill being upcurved slightly, in a Snipe (*Gallinago gallinago*), no elongation being involved in this case (Bottomley 1957 and *in litt.*).

Upper mandible upcurved and/or lower mandible decurved. This can be one of the most spectacular types of deformity, as in the House Sparrow shown in Fig. 6 (Donark 1950) where the lower mandible was 31 mm. long, the upper one 44 mm. long and the tips of the mandibles 51 mm.

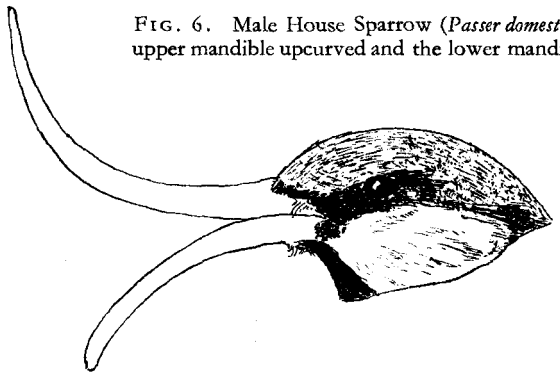

FIG. 6. Male House Sparrow (*Passer domesticus*) with the upper mandible upcurved and the lower mandible decurved

apart! Another House Sparrow (Petit 1926) had the upper mandible normal, whilst the lower one was decurved and reached a length of 40 mm. A third House Sparrow (Hantzach 1902) had the upper mandible upcurved and 31 mm. long, the lower being straight and only half as long; and a fourth (Piechocki 1952) had the upper mandible normal whilst the lower was downcurved and reached 30 mm. in length. Although most frequently recorded in the House Sparrow, this type of deformity does occur in other species. For instance, a Song Thrush (*Turdus philomelos*) in the City of Leicester Museum has a beak curving over in an almost complete loop, the tip being just above the nostrils and pointing forwards (T. A. Walden). Another record concerns a Starling whose upper mandible was curved back over its shoulder, so that when seen in flight it appeared to be carrying a short twig (*The Lincolnshire Chronicle,* November 1957).

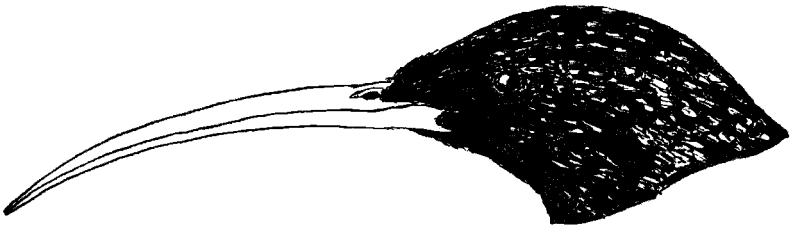

FIG. 7. Starling (*Sturnus vulgaris*) with the whole bill elongated and downcurved

Elongation. This, a fairly common deformity, is nearly always associated with a down-curving of the bill, and may therefore be described as "curlew-type". Typically, elongation affects both mandibles equally (e.g. Fig. 7 and plate 9b). Deformities of this sort are common in Starlings, a length of two and a half inches having twice been recorded (Dady 1951; and a specimen in the Royal Scottish Museum, quoted in *British Birds,* 44: 349). A remarkable case is that of a Californian Thrasher (*Toxostoma redivivum*) in which the lower mandible was 112 mm. long and decurved through about 150°, while the upper mandible had broken off at 69 mm. (Fox 1952). The normal length is 32-39.5 mm. and decurvature about 30° (Engels 1940). As might be expected, the tips of these elongated mandibles are very thin, and therefore become broken quite frequently. In the case of a Nuthatch (*Sitta europaea*) whose bill grew to about one and a half times the usual length, the extended part was sufficiently weak for the tips to break off, leaving a bill of normal size (M. Bryant). Occasionally the mandibles become laterally twisted to some extent. The degree of curvature varies considerably, as can be seen from a comparison of Figs. 3 and 7. A pronounced curvature might be expected in a parrot, but in fact it

also occurs elsewhere, as in the Californian Thrasher already mentioned and a House Sparrow recorded by Moltoni (1949); the latter had a bill which was 30 mm. in length and decurved through more than 90°. Engels (1940), who was studying bill curvature in thrashers in general, found that not only does the degree of arc become greater in longer bills—as would be expected—but the degree of curvature also becomes greater in the more distal part of the bill. This would account for Fox's Californian Thrasher, and perhaps for some of the other cases, but certainly not all of them.

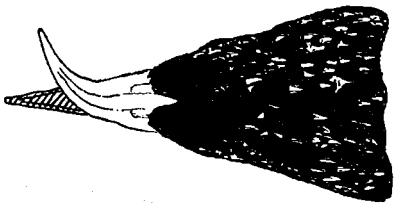

FIG. 8. Starling (*Sturnus vulgaris*) with the upper mandible curved to the right

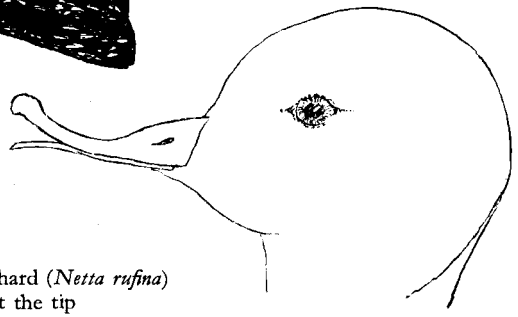

FIG. 9. Red-crested Pochard (*Netta rufina*) with the bill splayed out at the tip

Lateral curvature. Deformities of this kind are very unusual. Groebbels (1932) referred to a Rook in which the upper mandible was broken and the lower turned to the left; he also recorded a Swallow (*Hirundo rustica*) which had a bill turned to the right, and a South American parrot of the species *Amazona leucocephala* whose beak "turned outwards". The only other recorded examples are the Starling shown in Fig. 8, where the lower mandible appears normal, but the upper mandible is turned to the right (R. R. Lovegrove) and a Northern Red-breasted Sapsucker (*Sphyrapicus varius*) whose elongated upper mandible was curved "far over to the right" (Bowles 1908).

Locked bills. Three cases have been recorded (see *Field,* 1958): the tip of the upper mandible pierced the skin between the two rami of the lower mandible, probably as a result of an accident, such as crash-landing bill first on to a hard surface. The birds concerned were a Pheasant (*Phasianus colchicus*), a Partridge (*Perdix perdix*) and a Fantail Pigeon. A similar instance involving a Snow Bunting (*Plectrophenax nivalis*) took place on Fair Isle in October 1955 (I. J. Ferguson-Lees).

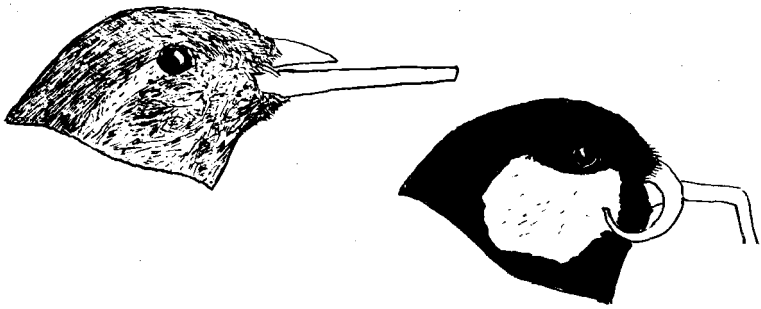

FIG. 10. Female House Sparrow (*Passer domesticus*) with the lower mandible elongated in the form of a trough, the tip being as wide as the base and open. Great Tit (*Parus major*) with the upper mandible decurved to pierce the cheek and the lower mandible elongated and twisted

Miscellaneous. A few examples will serve to show the range of other abnormalities which exist. The Red-crested Pochard (*Netta rufina*) illustrated in Fig. 9 had a bill which was normal at the base, but splayed out distally in such a way that it could not be closed (Viscount Chilston) (it is possible that this was a case of the upper mandible being upcurved). One Black-headed Grosbeak (*Pheucticus melanocephalus*) has been described as having a flange of rhamphotheca on the left side of the lower mandible, extending across the side of the upper mandible to such an extent that "the bird could only have fed from the right side, and must have been considerably handicapped" (Loye Miller, quoted by Fox 1952). In the House Sparrow shown in Fig. 10, the upper mandible was normal but the lower, instead of coming to a point, was in the form of a trough, which was just as wide at the tip as at the base, the tip being open; and it was 27 mm. long (von Madarász 1902). A Starling in the British Museum (Natural History) has a similar lower mandible which, although rather worn, is 46 mm. long; this bird's upper mandible is enlarged at the base and broken off short. Similarly, the lower mandible of the House Sparrow in Fig. 6 also appears to be trough-shaped, as well as decurved, and the same applies to Petit's House Sparrow mentioned on page 57. It seems possible, however, that each of these "troughs" was the result of the tip breaking off from a mandible which had been longer still. A most extraordinary deformity occurred in the Great Tit represented in Fig. 10, which was killed on 14th December 1891 at Zemplen in Hungary. The upper mandible curved down to such an extent that the tip pierced the bird's cheek, whilst the lower mandible stuck out forwards and was twisted "like a cow's horn" (von Madarász 1902).

MORPHOLOGY

In most cases, all that is recorded is the outward appearance of the

deformity, with no reference to the underlying structures. However, Fox (1952) stated that X-ray photographs of the deformities of a Scrub Jay (*Aphelocoma caerulescens*), a Red-breasted Sapsucker and a Californian Thrasher suggested that the bony portions of the bill were normal; and that the abnormal growth was limited to the dermatheca. He concluded from this that the abnormalities were due to damage of the rhamphotheca, but he presented no evidence as to how such damage might come about. There is, however, one case where a deformity may have been due to damage. An Oystercatcher (*Haematopus ostralegus*) recorded by Rutherford and Wagstaffe (1955) showed evidence of shot-gun wounds at the base of each mandible, which were both overgrown and had the tips crossed. It seems possible, but not conclusive, that this may have been due to the damage caused by the pellets.

A few other points seem worthy of mention. In the old cock House Sparrow described by Hantzsch, and already mentioned here on page 57, "the condition of the beak near its base was bony, rather than horny, the colour there being lighter than towards the tip". Unfortunately he gave no further information, except that the feet were in poor condition. There are other records of unusual coloration: for example, a curlew-billed Starling had a broad blackish-brown band halfway down the otherwise normally coloured bill (Huyton 1953). In general, however, the bill coloration seems to be the same in abnormal as normal birds.

Little is known about regeneration of broken parts of the bill. Groebbels (1932) recorded an Eagle Owl (*Bubo bubo*) which broke off a bit of its upper mandible; this then regenerated, after which it was abnormally long. Groebbels also recorded that Bordage noted regrowth of broken edges of the bills of storks (*Ciconia*) and chickens (*Gallus*). This appears to be all the available information concerning regeneration. In many birds where the mandibles are broken, the damaged part heals off; this would seem to be a protective function. Mercier and Poisson (1927) noted that the tongues of domestic fowls became tougher when the beak was crossed. Stabler (1938) found a similar thing in a Chinese Ring-necked Pheasant which also had crossed mandibles. Presumably this is a result of the sharp edges of the mandible causing fibrous tissue to form in the tongue.

CAUSES

(*a*) *Genetic*

Despite the conspicuousness of some bill abnormalities, and the widespread belief that they are inherited, there is little evidence that this is so, although other dermal and epidermal abnormalities, such as albinism and comb formation, have received much attention from geneticists.

Hodges (1952) found that two out of four nestlings of an American Robin (*Turdus migratorius*) had crossed bills, whilst the other two nestlings and the parents were normal. An obvious explanation is the recombination, in two of the offspring, of recessive factors present in both parents. Mercier (1926) mated a female domestic fowl that had a crossed beak with a normal male. Thirty-four eggs were laid; three were infertile and five chicks died before hatching. Of the remainder, some were normal, but others showed a variety of defects, including crossed bills (three crossed at hatching and a fourth later), rickets, brittle feathers and dwarfism. The occurrence of four offspring with crossed beaks suggests that this anomaly was inherited.

However, cage birds often show bill abnormalities, which aviculturists are prone to correlate with nutritional deficiencies. Hutt (1949) in his account of the genetics of the domestic fowl that "only a small proportion of birds homozygous for hooked beak is visibly affected", and Landauer (1938) found it impossible to produce a true-bred cross-billed fowl, despite considerable inbreeding.

So even the case of the American Robins, quoted above, may not be as simple as at first might seem; and further data on this subject are clearly needed.

(*b*) *Accident*

If the bill of a bird is damaged, it may respond in various ways. Damage to the bone can be only locally repaired. However, if only the rhamphotheca is injured, regeneration may occur and this has been recorded occasionally.

Hutt (1949) believes that the commonest deformities of the domestic fowl, namely unilateral microphthalmia and anophthalmia, are probably accidental in origin. In microphthalmia the upper mandible is decurved and laterally displaced, the eye is reduced on the same side as the bill displacement and there are other defects. Anophthalmia is a more serious form of the same phenomenon. Both conditions are prenatal and most of the chicks never hatch. The occurrence of these deformities is increased by unfavourable incubation conditions (Landauer 1938).

Nestlings falling from the nest often land on their beaks and cause permanent damage which results in a displaced or deformed bill in the adult. This is of concern to breeders, but wild birds falling from the nest are unlikely to survive, of course. Accidental damage to the beaks of adult birds is probably rare, but it does occur. Examples are the Starlings shown in Figs. 4 and 5, where the tips of lower and upper mandibles respectively had been broken off. It is immediately obvious in both these cases that the opposite mandible has overgrown considerably and, as already mentioned, it appears that in most species each mandible owes its usual length to wear on the other. This

wear occurs largely in normal feeding activities. When the tip of the upper mandible is broken off in some way, there is no longer a wearing surface for the tip of the lower mandible, and it therefore lengthens unopposed; and vice versa. Similarly, the tips will continue to grow if they are slightly crossed, as appears to have happened in the Blue Tit in Fig. 2. This slight lateral displacement, which may be accidental (perhaps due to slight asymmetry of the jaw) is probably a purely mechanical effect, and different from the curving of the crossbill-type and the elongation of the curlew-type, both of which are suggested to be genetically caused.

In species where the tips of the mandibles do not normally oppose each other, e.g. many raptors, increase in length may be limited by wear and tear during feeding, since the beaks of birds of prey are inclined to overgrow in captivity unless they are given bones to pick (J. J. Yealland).

(*c*) *Disease*

Since the horny covering or rhamphotheca of the bill is produced by the underlying epithelial dermotheca, it is quite possible that diseases of the latter could lead to deformities of the former. However, there appear to be no records in which this has been shown.

Another and quite different cause of deformity might be due to parasites damaging the dermotheca. Appleby (1958), referring to Budgerigars (*Melopsittacus undulatus*), stated that *Cnemidocoptes pilae* (a mite) "may be responsible for damage to the developing beak in nestlings, resulting in later deformity". This view was supported by Keymer (1958), for the same species. There are no similar records for other species, but this may be due to lack of observation, and it could well be that such irregular growths as that of the Great Tit in Fig. 10 are due to this cause. The irregularity could be due to the parasite attacking the tissues for a relatively short period, causing uneven growth at this time. *C. pilae* has been recorded from the Hoopoe (*Upupa epops*) and the Alexandrian Parakeet (*Psittacula nipalensis*) as well as from the Budgerigar. However, it is the only mite which is known to attack the beak (G. O. Evans *per* P. N. Lawrence).

Some cases occur in which the abnormality appears to be a superficial growth that is presumably due to some disease, and the bill is otherwise unaffected. Schauberg (1901) recorded a remarkable instance of a Curlew (*Numenius arquata*) with a swelling on its upper mandible; this swelling resembled a potato in shape and colour, and was sufficiently large to be seen with the naked eye at a considerable distance. The bird was later found dead, with an empty stomach.

(*d*) *Other causes*

Birds kept in captivity sometimes suffer bill deformities as a result of

incorrect feeding, lack of grit or related causes. These may be permanent or only temporary (e.g. Wilkinson 1953, Rankin 1953). However, the processes involved in such deformities are obscure; to quote Groebbels (1932), "Holmgren found that pigeons fed on fibrin and meat grew elongated and downward-curving bills. Brandes, who repeated the experiment, came to an entirely negative conclusion."

J. J. Yealland says that in the London Zoo few birds suffer deformities; those that do are principally parrots, but include some birds of prey and waders. Other species which may be affected in captivity include Choughs (*Pyrrhocorax pyrrhocorax*) (B. C. Turner) and various finches (Groebbels 1932). All these are birds whose beaks are, in the wild, subject to heavier wear than those of purely insectivorous species—on food, stones, sand or other abrading surfaces.

The effects of what has been called "industrial contamination" have been suggested as the cause of some deformities (Ash 1958). The birds concerned were a House Sparrow and several Partridges. Their bills were overgrown (three or four times the normal size) and badly mis-shapen. They were examined by Dr. J. M. Harrison who pointed out the presence of warty excrescences which, he said, might have been caused by a carcinogen. Except for the sparrow, the birds were otherwise in good condition, but all showed very dirty plumage. The deformed Partridges were found near a Yorkshire colliery, the sparrow at Gravesend.

BEHAVIOUR AND SURVIVAL

(*a*) *Behaviour apparently not affected*

I have received a total of 48 records in which the behaviour of a bird with an abnormal bill was observed, and in only eight was there no apparent alteration in habits. Seven of these eight (including five Starlings) referred to wild birds in which the abnormality took the form of elongation, although in one case (a Blue Tit) there was also some lateral displacement. The last bird, whose bill was not elongated, was a captive cock Budgerigar with the lower mandible knocked to one side; this did not prevent him from feeding himself successfully and his mate "quite well", however (F. C. Gower). In the case of the seven wild birds, it would probably be more accurate to say that no irregularities in behaviour were seen: on the whole it seems unlikely, for example, that a Starling with a curlew-type bill would be as successful at preening, or feeding its mate, as a normal one.

(*b*) *Behaviour definitely affected*

The forty cases of abnormal behaviour included nineteen Starling records and twenty-one of fifteen other species. In ten different species, ranging from Starling and Blackbird to Green Sandpiper (*Tringa ochropus*), and Chough to Great Tit, the head was turned on one

side to feed. For example, a Starling recorded by Dady (1951) in Regent's Park, London, with a decurved bill about two and a half inches long, turned its whole head on one side to pick up food at about the same distance from the base of the bill as it would have done if it had been normal. A Starling reported by B. C. Turner, with a very long decurved upper mandible and apparently normal lower mandible, used the long tip as a probe for testing potential food. Its head was then turned on one side, and it picked its food up at the tip of its lower mandible. Another Starling, reported by Warham (1951), had a sharply decurved upper mandible and a deformed or broken lower mandible, and it fed by a series of sideways scooping movements which, however, were not always successful. Warham noted that this bird seemed more quarrelsome when feeding than the other Starlings with which it associated. B. Coleman, on the other hand, observed that a Starling with a very long, thin bill would not feed whilst other Starlings were feeding—suggesting some fear of them.

Turning the head on one side to feed leads, after a time, to some abrasion. In the case of a Green Sandpiper (Amann 1950) where the upper mandible was 3 mm. shorter than the lower, one side of the bill was worn, showing that the head had been turned to that side when feeding. Two Starlings with elongated bills had the lores bare, presumably for a similar reason (P. A. Rayfield, Williamson 1951).

The Red-breasted Sapsucker (Bowles 1908) whose upper mandible was about two and a half times the normal length, and which fed by turning its head on one side, evidently had no difficulty in feeding and was fat and healthy. Similarly, a cock Great Tit with an elongated upper mandible learnt to tilt his head on one side to pick up food (Howard 1951). His mate at first hesitated to accept food, but soon learned to turn her head on one side too. The House Sparrow with the incredible bill shown in Fig. 6 survived for a year and a half—throughout which period the bill was growing—by scooping up grain with its head turned to one side and flat on the ground (Donark 1950). This was an artificial source of food, of course; it is doubtful whether the bird could have lived in the wild state with such a bill. A similar case concerned a Blackbird with elongated and crossed mandibles, which survived for three years on food given to poultry and came to judge their feeding time with considerable accuracy (W. S. Craster).

A remarkable change of behaviour occurred in a Hoopoe which was wounded by gunshot in the upper mandible. It was kept in a large cage, and procured its food by scratching with its feet. "When a worm turned up, it threw it with great skill with its lower mandible into the air, and then caught it in flight" (Count Emilio Ninni, quoted by Moltoni 1949).

A cock Blackbird, believed to be ten years old (a considerable age for this species), suffered a broken upper mandible in an encounter

with a cat (J. Burton). This bird also fed by putting its head on one side and scooping up food provided for it in a garden. It drank by catching drops of water from leaves or drainpipes. Drinking is clearly a problem for many birds with bill deformities. Captive Choughs, in which the bill frequently becomes overgrown in such a manner that the tips cross, both feed and drink by turning their heads slightly to one side. In this case, however, the action is part of these birds' normal behaviour pattern, as apparently the head is also inclined sideways when drinking from very shallow water (B. C. Turner). A Starling with an elongated upper mandible drank similarly (K. G. Clark *per* I. D. Woodward). There are no other drinking records.

A case of a deformity in one bird leading to an alteration in the behaviour of another has already been mentioned (the Great Tit feeding its mate). A most remarkable case involving more than one bird relates to a male Black-headed Grosbeak which was collected in 1926 by Dr. Loye Miller (Fox 1952). It had a flange of rhamphotheca on the left side of the lower mandible extending across the side of the upper mandible, so that "the bird could only have fed from the right side, and must have been considerably handicapped". Nevertheless, it was apparently in good condition. Dr. Miller had seen one grosbeak feeding another and presumed that it was the male courtship-feeding the female; however, the deformed bird which he shot proved to be the male. Fox continues: "There was no doubt in his mind that a hen had been feeding the cock. It seems probable that the well-fed condition of the cock, and his recent obviously successful migration, had been made possible by the efforts of the hen. At least, as a result of the cock's handicapped condition and the attention shown to him by the female, the dependency of the cock on the hen for an extended period seems evident." This would be quite remarkable and it is unfortunate that its absolute veracity is in doubt.

The extraordinary thing about all these birds is that they survive at all. In addition to the cases already discussed, two more deserve attention. The first concerns a Pink-footed Goose (*Anser brachyrhynchus*) which had had half of its upper mandible shot away (G. Atkinson-Willes). The injury was obviously an old one, since the damaged part showed a considerable amount of new growth and the tooth at the tip of the lower mandible had become enlarged, presumably from lack of wear. How a grazing goose could survive with such an injury—and it was in good condition when shot—is indeed a problem. So is the case of the young Hawfinch (*Coccothraustes coccothraustes*) shown in plate 9a. This bird, whose partial lack of bill appeared to be congenital, was ringed near Basle, Switzerland, and shot 43 days later about 460 kilometres away in the south of France (Amann 1950). Its weight was normal and it had evidently migrated normally, although only for the proximal 2 mm. of the bill did the mandibles meet.

TABLE 3—WEIGHTS OF BIRDS WITH ABNORMAL BILLS

Those marked with an asterisk were apparently migrants and the "normal" weights for these species have been taken from Browne and Browne (1956) and Turček (1956), except in the case of the Hawfinch where the "normal" weight is the range of six others caught on the same day. Each of the other three "normal" weights is that given by the authority concerned. The Crested Lark had been refrigerated for several days beforehand and so may have been below its true weight. K. Williamson described his Blackbird as "abnormally low, even for a migrant" and his Meadow Pipit as "quite good for a migrant"

Species	Deformity	Weight (gm.)	"Normal" weight (gm.)
Bar-tailed Godwit (*Limosa lapponica*)	Rami of lower mandible unfused (Harrison 1947)	227	340
Crested Lark (*Galerida cristata*)	Bill elongated (Moltoni 1949)	36	40-45
Magpie (*Pica pica*)	Upper mandible elongated and decurved (B. C. Turner)	220	210
*Blackbird (*Turdus merula*)	Upper mandible 3.5 mm. short (K. Williamson)	83.27	80-96
*Blackcap (*Sylvia atricapilla*)	Upper mandible elongated and decurved (Ruttledge 1952)	19.81	17-20
*Meadow Pipit (*Anthus pratensis*)	Lower mandible 2 mm. short (K. Williamson)	18.2	19
*Hawfinch (*Coccothraustes coccothraustes*)	Bill congenitally underdeveloped (F. Amann)	50.2	48.59

Weight can be taken as some indication of general condition. Birds with abnormal bills have been weighed on several occasions and the results are set out in Table 3. It will be seen that only the Bar-tailed Godwit (*Limosa lapponica*) had a weight appreciably lower than normal, which is at first sight surprising and suggests that the birds were able to feed themselves quite well, despite their deformities. Nevertheless, it is evident that nearly all the birds mentioned in this section showed some plasticity in behaviour. A number of examples have already been given in which individuals learned to feed themselves by turning their heads on one side. Other aspects of behaviour are also affected: feeding the mate, drinking, and possibly reactions towards, or by, other members of the same species. Greater tameness has been recorded several times: this gives access to readily obtained food, but may be the result of near-starvation, just as birds become tamer in very cold weather. Feral Pigeons, of course, subsist to a very large extent on food provided, intentionally or otherwise, by man. Overgrowth of the upper mandible is particularly common in these birds, and probably associated with a short lower mandible (D. Goodwin). Changes in feeding habits, especially with regard to the type of food taken, are well known in birds (e.g. tits and milk bottles), and there is clearly an advantage towards survival for a bird with a deformed bill that can adapt its feeding methods.

The ease with which a bird can adjust its motor patterns of behaviour probably depends, amongst other things, on the speed of the onset of the deformity. Presumably it is more difficult for a bird to survive if the change is sudden (e.g. due to injury) rather than slow (e.g. due to overgrowth); but there are no data on this point, as yet. It would also be interesting to know whether the chances of survival are higher in juveniles than in adults.

Whilst the number of deformed birds which survive is remarkable, inevitably there are many which do not. A minority of those recorded have been described as thin and weak, with the feathers in poor condition. D. Goodwin noticed that Feral Pigeons with badly overgrown beaks were characterised by drooping wings (the primaries actually dragging on the ground), uplifted tail and thrown-back head. Nevertheless, of the 60 or so records of Starlings with abnormal bills, excluding those "collected", there is only one in which the bird died and that was nearly two years after it was first seen (P. W. D. Waite). On the other hand, of five Oystercatchers with elongated bills (which in three cases were also crossed and curved), all but one were found dead (J. B. Bottomley, Miss A. M. Mackintosh, W. T. C. Rankin 1953 and *in litt.*, and Rutherford and Wagstaffe 1955); in two cases this followed a cold spell. The only other record of death in a wild bird concerns a melanistic Blue Tit with curved and elongated mandibles, which was found drowned in a shallow bowl "from which a normal healthy bird would have had no difficulty in escaping" (Sage 1956). There is also circumstantial evidence in the case of the Great Tit shown in Fig. 2 that it did not survive the winter (P. P. G. Bateson).

Four birds actually appeared to gain some advantage from their deformities. A. D. Townsend watched a Great Tit with an elongated and crossed upper mandible (the tip of the lower being broken) and found that it could not only feed normally on fat, but also seemed to extract nuts from their shells faster than a normal bird, although it had some difficulty in picking them up afterwards. W. P. White made similar observations on another Great Tit, which also appeared to gain advantage in threat displays at a Chaffinch (*Fringilla coelebs*). The Red-breasted Sapsucker observed by Bowles (1908) used its long upper mandible rather like a nut pick, digging insects to the surface with it, and then picking them up by turning its head to one side. A hen Indian Silverbill (*Euodice malabarica*) belonging to A. H. Hayes had the mandibles slightly overgrown and crossed; it had difficulty in cracking seeds, but found the sharp points useful in squabbles with other females!

Although a number of birds have had their deformities "manicured" with nail-clippers and scissors, there is, regrettably, only one record which throws any light on subsequent behaviour. This concerns a Feral Pigeon which, although free-living, had been hand-fed from the

nestling stage to an age of 19 months (W. Shipp and K. N. Brockhouse). Its upper mandible was strongly decurved and there is no doubt that the bird owed its survival to being hand-fed. However, its beak was eventually trimmed to normal length and it was then kept in a cage for several days, during which time it learned to feed itself for the first time in its life. It was finally released, and was still alive four months later.

(c) Parasites

Preening cannot be performed so effectively by a bird whose bill is abnormal, particularly when, as in most cases, the tips of the mandibles are not closely opposed. A number of records refer to the poor condition of the plumage, but by no means all. For instance, J. H. Lawton has described a Starling whose mandibles were considerably elongated and decurved, the upper being about one and a half centimetres longer than the lower. Observation on one occasion showed that the bird had difficulty in reaching all of its upper breast and nape and the side of its neck. The projection was of some use in reaching the ends of the wings and tail, however, and the bird was always well preened despite its handicap.

Removal of parasites also requires a normal bill with the tips approximating closely, so that it is to be expected that birds with deformed bills would have more parasites (see Ash 1960). It is interesting in this connection to compare the normal infestation rate of the Crossbill with that of other finches. Although the sample is rather small, the figures given in Table 4 can be taken as a general indication that the Crossbill is more highly infested than the other two species and this is probably because its bill is less effective in the removal of ectoparasites.

Kartman (1949) found that domestic fowls which had been debeaked* were significantly more infested with lice than normal birds, and it seems likely that this holds good for all species which actively remove ectoparasites, except perhaps those which take dust baths (when some may be removed). The Starling certainly uses its beak for delousing, as was shown by the presence of lice in the stomach contents of Starlings analysed by Fox (1940). Of three hundred Starlings examined by Boyd (1951), there was only one with a deformed bill and that was heavily parasitised with Mallophaga.

There are very few other records relating to wild birds, but this is probably a reflection of the small number of people who look for parasites. Rothschild and Clay (1952) examined a Robin with most of its upper mandible missing and it was "infested with 127 specimens of *Ricinus rubeculae*, the numbers of which rarely exceed 15 on any

*Tip of the upper mandible cut off, to prevent the birds from severely pecking each other. Food is easily scooped up, with the lower mandible used as a shovel.

TABLE 4—LICE INFESTATIONS IN CERTAIN FINCHES

This is drawn up from information kindly supplied by Miss T. Clay. All percentages and averages are rounded to the nearest whole number

Species	Number deloused	Birds definitely infested No.	%	Numbers of Mallophaga Total	Average
Crossbill (*Loxia curvirostra*)	40	39	97	556	14
Bullfinch (*Pyrrhula pyrrhula*)	47	28	60	184	4
Chaffinch (*Fringilla coelebs*)	159	51	32	365	2

normal bird". Ash (1960) recorded a Willow Warbler (*Phylloscopus trochilus*) with a crossed mandible and a House Sparrow with a lower mandible over two centimetres long, both heavily infested with Mallophaga. On the other hand, D. Summers-Smith has reported that a Robin with a crossed bill was not heavily infested.

The total number of parasites present may sometimes be very high. Worth (1940) found that a Slate-coloured Junco (*Junco hyemalis*) which had the distal part of its upper mandible missing was heavily infested with Mallophaga, whereas other birds trapped in the same locality at the same time had few parasites. Worth estimated that the Junco may have had over 5,000 parasites; but even this was exceeded by a Socotra Cormorant (*Phalacrocorax nigrogularis*) which had the tip of its upper mandible broken off and which had no less than 6,785 Mallophaga. The average for six others of the same species was 43 (Miss T. Clay).

SUMMARY AND CONCLUSIONS

(1) Abnormalities in birds' bills have been studied as the result of an enquiry combined with a survey of published records. Brief reference is made to the structure of normal bills.

(2) The limited available information on incidence suggests that the number of wild birds affected is well under ½%. Different types of abnormality are described and illustrated; the range is considerable.

(3) Possible causes are discussed. It is suggested that many instances are genetic, but there is no conclusive evidence for this and the way in which control is exercised must be complex. Other causes include injury and disease. In cage birds at least, incorrect feeding or lack of wear may be important.

(4) The behaviour of most birds is affected to a certain extent, and sometimes it may be quite different from the normal, particularly in feeding.

(5) Some birds with bill abnormalities suffer a high incidence of ectoparasitism, probably because of their inability to remove the parasites.

ACKNOWLEDGEMENTS

I particularly wish to express my grateful thanks to Dr. R. A. Hinde for his help and suggestions at all stages, and especially for reading

and commenting on the first manuscript. P. P. G. Bateson kindly prepared Figs. 2-12 inclusive and Robert Gillmor drew Fig. 1 from J. Z. Young's *The Life of Vertebrates*.

The information in this paper is largely derived as a result of requests published in *The Avicultural Magazine, Bird Study, British Birds* and *Cage Birds,* and my thanks are also due to the editors of these journals. Individual records quoted are acknowledged in the text; in addition, I am indebted to A. L. Attwater (per G. N. Slyfield), G. J. Bayliss, G. A. Bowden, W. S. Carnaby, Miss T. Clay, W. S. Craster, A. Dobbs, C. Elliott, F. P. Errington, H. W. Hancock, E. E. Jackson, T. Keeler, J. W. Phillips, M. Schwarz, K. Senior, J. Stafford, R. E. Starkey, I. F. Stewart, F. Thomas, G. B. Thompson and D. Webster.

I am also grateful to Dr. J. S. Ash, Miss T. Clay, D. Goodwin, Dr. J. G. Harrison, I. F. Keymer, R. Spencer, Sir A. Landsborough Thomson, T. A. Walden, K. Williamson and J. J. Yealland for unpublished information; to E. R. C. Dartington, D. Goodwin, K. W. Keyes and F. J. Thomson for help with translation; and to I. N. Wilkinson for help with the section on genetic causes.

REFERENCES

AMANN, F. (1950): "Körperliche Abnormitäten bei Vögeln". *Orn. Beob.,* 47: 7-9.

APPLEBY, E. C. (1958): B.S.A.V.A. First Annual Congress, 25-30.

ASH, J. S. (1958): "Partridges apparently affected by industrial contamination". *Brit. Birds,* 51: 241-242.

——— (1960): "A study of the Mallophaga of birds with particular reference to their ecology". *Ibis,* 102: 93-110.

BATESON, P. P. G. (1957): "Err Kjöttmeis med uvarlig nebb". *Fauna* (Oslo), 10: 35-36.

BOTTOMLEY, J. B. (1957): "Snipe with abnormal bill". *Brit. Birds,* 50-75.

BOWLES, J. H. (1908): *Condor,* 10: 129-30.

BOYD, E. M. (1951): *J. Parasit.,* 37: 56-84.

BROWNE, K. and E. (1956): "An analysis of the weights of birds trapped on Skokholm". *Brit. Birds,* 49: 241-257.

BRUCE, A. J. (1952): In "Birds with abnormal bills". *Brit. Birds,* 45: 402.

DADY, W. H. (1951): "Abnormal bill of Starling". *Brit. Birds,* 44: 60.

DONARK, T. (1950): "House Sparrow *Passer d. domesticus* (L.) with very abnormal bill". *Dansk. Orn. Foren. Tidsskr.,* 44: 16-19.

ENGELS, W. L. (1940): "Structural adaptations in thrashers (Mimidae: genus *Toxostoma*) with comments on inter-specific relationships". *Univ. Calif. Publ. (Zool.),* 42: 341-400.

"FIELD" (1958): Anonymous article and two letters, all relating to locked bills in birds (Pheasant, Partridge and Fantail Pigeon). Issues dated 1 Feb., 13 Feb., 6 Mar.

FOX, —. (1940): *Fleas of Eastern United States.* Iowa State College.

FOX, W. (1952): "Behavioral and evolutionary significance of the abnormal growth of beaks of birds". *Condor,* 54: 160-162.

GROEBBELS, F. (1932): *Der Vogel.* Berlin. Vol. 1, pp. 418-420.

HANTZSCH, B. (1902): Schnabelmissbildung". *Orn. Monat.,* 10: 5-6.

HICKS, L. E. (1934): "Individual and sexual variations in the European Starling". *Bird Banding,* 5: 103-118.

HINDE, R. A. (1959): "Behaviour and speciation in birds and lower vertebrates". *Biol. Rev.,* 34: 85-128.

HODGES, J. (1952): "Two nestling Robins with abnormal beaks". *Condor*, 54: 359.
HOWARD, L. (1951): "Abnormal bill of Great Tit". *Brit. Birds*, 44: 350.
HUTT, F. B. (1949): *Genetics of the Fowl*. New York. pp. 42-45.
HUYTON, E. (1953): In "Birds with abnormal bills". *Brit. Birds*, 46: 254.
KARTMAN, L. (1949): "Preliminary observations on the relation of nutrition to pediculosis of rats and chickens". *J. Parasit.*, 35: 367-374.
KEYMER, I. F. (1958): "The diagnosis and treatment of common Psittacine diseases". *Modern Veterinary Practice*, 39 (21): 22-30.
KOENIG, L. (1951): "Beiträge zu einem Aktionssystem des Bienenfressers". *Zeits. f. Tierpsychol.*, 8: 169-210.
LACK, D. (1947): *Darwin's Finches*. Cambridge.
LANDAUER, W. (1938): "Notes of cross-beak in fowl". *J. Genet.*, 37: 51-68.
LUDWIG, W. (1932): *Das Rechts-Links-Problem im Tierreich*. Berlin.
MADARÁSZ, J. VON (1902): "Über schnabelmissbildung". *Orn. Monat.*, 10: 36-37.
MERCIER, L. (1926): "Dystrophies observées dans la descendance d'une Poule à bec-croisé (avec presentation de pièces et photographies)". *Bull. Soc. Linn. Normandie*, (7) 9: 70-71.
MERCIER, L., and POISSON, R. (1924): "Les Bec-Croisés (*Loxia*) du Musée d'Histoire Naturelle de Caen". *Bull. Soc. Linn. Normandie*, (7) 7: 29-31.
———— ———— (1927): "Adaptation de la langue chez les Poules à bec-croisés". *Bull. Biol. Fr. Belg.* (Paris), 61: 326-331.
MOLTONI, E. (1949): "Alaudidi ed altri uccelli a becco anomale presi in Italia". *Riv. Ital. Orn.*, 19: 145-166.
———— (1950): "Ulteriori notizie su uccelli a becco anomale". *Riv. Ital. Orn.*, 20: 99-105.
NEVIN, W. S. (1962): "Rook with unusual bill deformity". *Brit. Birds*, 55: 46 and plate 8b.
PETIT, L. (1926): "Un Moineau phénomène". *Bull. Soc. Zool. Fr.*, 51: 486-488.
PIECHOCKI, R. (1952): "Anomalie della guaina cornea della marscella inferiore della Passera europea (*Passer domesticus*)". *Riv. Ital. Orn.*, 22: 45-48.
RANKIN, W. T. C. (1953). In "Birds with abnormal bills". *Brit. Birds*, 46: 254.
RAWLES, M. E. (1960): "The integumentary system". Chap. VI (pp. 189-240) in Marshall, A. J., *Biology and Comparative Physiology of Birds*. New York and London.
ROTHSCHILD, M., and CLAY, T. (1952): *Fleas, Flukes and Cuckoos*. London. p. 126.
RUTHERFORD, G., and WAGSTAFFE, R. (1955): "Oystercatcher—*Haematopus ostralegus* L. with malformed bill". *North-Western Nat.*, 26: 130.
RZEHAK, —., quoted by DUCRST, U. (1909): In' 'Pathologische Difformation als Gattungs-, Art- und Rassenbildender. Faktor I. Mechanische, anatomische und experimentelle Studien über die Morphologie des Schädels von Angehöugen der Gattung *Loxia*". *Mitt. Naturf. Ges. Bern.*, 281-303.
SAGE, B. L. (1956): "On some examples of melanism in the Genus *Parus* Linnaeus". *Bull. B.O.U.*, 76: 130-132.
SCHAUBERG, BARON R. VON (1901): "Über eine monströse schnabelbildung". *Orn. Monat.*, 9: 18-19.
SNOW, D. W. (1954): "The habitats of Eurasian tits (*Parus* spp.)". *Ibis*, 96: 565-585.
SPALDING, D. A. (1873): "Instinct with original observations on young animals". *Macmillan's Mag.*, 27: 282-293 (reprinted *B. J. Anim. Behav.*, 2: 2-11).
STABLER, R. M. (1938): "A facial anomaly in a Pheasant". *Auk*, 55: 658-660.
THORPE, W. H. (1956a): "Records of the development of original and unusual feeding methods by wild Passerine birds". *Brit. Birds*, 49: 389-95.
———— (1956b): *Learning and Instinct in Animals*. London.
TURČEK, F. J. (1956): "On the bird population of the spruce forest community in Slovakia". *Ibis*, 98: 24-33.

VAN TYNE, J. and BERGER, A. J. (1959): *Fundamentals of Ornithology.* New York.
WARHAM, J. (1951): In "Abnormal bill of Starling". *Brit. Birds,* 44: 349.
WILKINSON, A. D. (1953): In "Birds with abnormal bills". *Brit. Birds,* 46: 254.
WILLIAMSON, K. (1951): In "Abnormal bill of Starling". *Brit. Birds,* 44: 349.
WITHERBY, H. F. *et al.* (1941): *The Handbook of British Birds.* London. Vol. 5.
WORTH, C. B. (1940): *Bird Banding,* 11: 23-24.
YOUNG, J. Z. (1950): *The Life of Vertebrates.* Oxford.