On the structure of the beak and its muscles in the crossbill (Loxia curvirostra) / by William Yarrell.

Anatomy of the Crossbill
&
British Fishes —

ART. LVII. *On the structure of the Beak and its muscles in the Crossbill,* (Loxia curvirostra.) *By* WILLIAM YARRELL, *Esq., F.L.S., &c.*

THE peculiar formation and direction of the parts of the beak in the Crossbill, its anomalous appearance, as well as the particular and powerful manner in which it is exercised, had long excited in me a desire to examine the structure of an organ so curious; and the kindness of a friend has lately supplied me with an opportunity.

To those who have not made the habits and economy of birds an object of investigation, it may be necessary to state that our two species of Crossbill are the only British birds that exhibit or seem to require any lateral motion of the mandibles, and it is the object of this paper to describe the bony structure and muscles by which this peculiar and powerful action is obtained.

It may be necessary to premise that Mr. Townson in his "Observations "in Natural History and Physiology," has devoted a chapter to the structure of the bill of the Crossbeak, some extracts from which will be introduced in this notice; but to show that I am not occupying the valuable pages of the Journal with a tale twice told, the first sentence I select is as follows. Speaking of the beak, he says, "I ought now to "give the anatomy of it, and I wish it were in my power; but on the "muscles, by which the motions I have spoken of are performed, I find "scarce any memorandums in my portfolio."

The beak of the Crossbill is altogther unique in its form; the mandibles do not lye upon each other with their lateral edges in opposition as in other birds, but curve to the right and left, and always in opposite directions to each other. In some specimens the upper mandible is turned to the right, the lower mandible curved to the left; in others, the position of the mandibles is reversed as to their direction. In the specimen I examined the upper mandible curved downwards and to the left, the under portion turned upwards and to the right, as the figures 1 and 2, plate xiv, will demonstrate. When holding the head of this bird in my fingers, I found I could bring the point of the under mandible in a line underneath and touching the point of the upper, but not beyond it towards the left side, while on its own side the point passed with ease to the distance of $\frac{3}{8}$ of an inch. The upper mandible has a limited degree of motion on the cranium, the superior maxillary and nasal bones being united to the frontal by flexible bony laminæ.

The form as well as the magnitude of the processes of some of the bones of the head are also peculiar to this bird.

The pterygoid processes of the palatine bones are considerably elongated downwards, as shewn at figure 3, letter *a*, to afford space for the insertion of large pterygoid muscles. The os omoideum on each side (figure 3, letter *b*,) is strongly articulated to the os quadratum, (figure 3,

letter c,) affording firm support to the moveable portion of the upper mandible. Letters *d. d.* figure 3, refer to the jugal bone, which, united to the superior maxillary bone in front, is firmly attached by its posterior extremity to the outer side of the os quadratum; when, therefore, the os quadratum is pulled upwards and forwards by its own peculiar muscles, to be hereafter mentioned, the jugal bone on each side by its pressure forwards elevates the upper mandible.

The inferior projecting process of the os quadratum, to which the lower jaw is articulated, in most other birds is somewhat linear from before backwards, and compressed at the sides, admitting vertical motion only upwards and downwards; the same processes in the Crossbill are spherical, as shewn at *c.* figure 3; the cavity in the lower jaw destined to receive this process is a hollow circular cup (figure 5, letter *a*); the union of these two portions therefore forms an articulation possessing the universal motion and flexibility of the mechanical ball and socket joint.

The lower jaw is of great strength, the sides or plates elevated, with prominent coronoid processes, (figure 5, *b. b.*,) to which, as well as to the whole outer side of the plates, the temporal muscle is attached, and in a head of this bird which had been divested of all the soft parts, I found on sliding the lower jaw laterally upon the upper as performed by the bird, that before the coronoid process is brought into contact with the pterygoid on its own side, the extreme points of the mandibles were separated laterally to the extent I have already mentioned of $\frac{3}{8}$ of an inch.

The temporal and pyramidal muscles on the right side of the head, that being the side to which the lower jaw inclined, were considerably larger than those on the left, as represented in figures 1, 2 and 4, letters *a.* and *b.*, and indicated by their bulk the great lateral power this bird is capable of exerting to be hereafter noticed. The unusually large size of the pterygoid muscles on each side was very conspicuous, (figure 2, letters *c. c.*,) the space for them being obtained by the great distance to which the articulated extremities of the lower jaw were removed, and the food of the bird being small seeds rendered a narrow pharynx sufficient for the purpose of swallowing.

The muscles depressing the lower mandible are three in number, only one of which, the great pyramidal, is visible, figures 1, 2 and 4, letter *b.*

This strong muscle covers two other small ones, the triangular and square muscles, so called from their particular shape. These three muscles, all of which have their origin on the occipital portion of the cranium, are inserted by strong tendons on the under and back part of each extremity of the lower jaw behind the centre of motion, and consequently by their simultaneous contraction raise the point to which they are attached, and depress the anterior part of the mandible. The lower portions of the ossa quadrata are pushed somewhat forwards by this compression, assisted by two small muscles not exhibited, but the situation of which may be explained by a reference to figure 3. One of these, a small flat muscle, arises from the septum of the orbits behind the small aperture observed in the septum, and passes downwards to be inserted upon the projecting styloid process of the os quadratum; the second is a small pyramidal shaped muscle arising also from the septum, anterior to the other muscle, and passing downwards and backwards is inserted upon the omoideum, both by their contraction pulling the os quadratum forwards and thus elevating the other mandible. The depressors of the lower jaw, and the elevators of the upper, therefore act together to separate the mandibles.

To close the mandibles the temporal and pterygoid muscles elevate the lower jaw, assisted by the slender slips marked *d. d.* figure 2, which extending forwards to the superior maxillary bones, act in concert by bringing them down.

When the lateral motion is required, the great pyramidal muscle on the right side pulls the extremity of the lower jaw to which it is attached backwards, the pterygoid muscles of the left side at the same time powerfully assisting by carrying that side of the lower jaw inwards.

Having thus described the muscles of the mandibles in birds generally, and their peculiar mode of action in the Crossbill, I shall quote Mr. Townson's description of the manner in which they are made subservient to the use of the bird in feeding. "The great pine forests, such "as the Hartz in Germany, are the natural places of residence of the "Crossbeaks, and the seed of the cones of these trees their food, and "it is to pull out the seeds from between the squamæ, or scales of the "cones, that this structure is given them. Their mode of operation is "thus: they first fix themselves across the cone, then bring the points of "the maxillæ from their crossed or lateral position, to be immediately "over each other. In this reduced compass, they insinuate their beaks

" between the scales, and then opening them, not in the usual manner,
" but by drawing the inferior maxilla sideways, force open the scales
" or squamæ.

At this stage of the proceeding the aid of the tongue becomes necessary, and this organ is no less admirably adapted for the service required. The os hyoides or bone of the tongue has articulated to its anterior extremity an additional portion formed partly of bone with a horny covering, figures 6 and 7, letter *a*. In shape it is narrow, about $\frac{3}{8}$ of an inch in length, and extends forwards and downwards, the sides curved upwards, the distal extremity shaped like a scoop, somewhat pointed, and thin on both edges, the proximal extremity ending in two small processes elongated upwards and backwards above the articulation with the bone of the tongue, each process having inserted upon it a slender muscle, *b*. figures 6 and 7, extending backwards to the glottis and attached to the os hyoides, which muscles by their contraction extend and raise the scoop-like point. Underneath the articulation of this horny and grooved appendage is another small muscle, *c*. figure 7, which is attached at one extremity to the os hyoides, at the other to the moveable piece, and by its action, as an antagonist to the upper muscles, bends the point downwards and backwards; while, therefore, the points of the beak press the shell from the body of the cone, the tongue brought forward by its own muscle (genio-hyoideus) is enabled, by the additional muscles described, to direct and insert its cutting scoop underneath the seed, and the food thus dislodged is transferred to the mouth; and it will be seen by a reference to the first figure, that when the mandibles are separated laterally in this operation the bird has an uninterrupted view of the seed in the cavity, with the eye on that side to which the under mandible is curved.

" The degree of the lateral power of these birds," says Mr. Townson,
" is surprising, and they are fond of exercising it for mere amusement;
" they are therefore not a little mischievous.

" My pets would often come to my table, whilst I was writing, and
" carry off my pencils, little chip boxes in which I occasionally kept
" insects, and other similar objects, and tear them to pieces in a minute.
" Their mode of operation is by first pecking a little hole, in this they
" insert their bill, and then split or tear the object by the lateral force.
" When I treated them, as I often did, with almonds in their shells, they

" got at the kernel in the same manner ; first pecking a hole in the shell, " and then enlarging it by wrenching off pieces by the lateral power."

Notwithstanding M. Buffon's assertion to the contrary, they can pick up and eat the smallest seeds, and they shell or husk hemp and similar seeds like other birds; so well contrived and useful is this singular beak. My friend Mr. Morgan kept a pair of these birds for some time, and had opportunities for observing their curious habits. They were impatient under confinement, and restless, climbing over the wires of their cage by the use of their beak and claws like parrots. One of their principal occupations was twisting out the ends of the wires of their prison, which they accomplished with equal ease and dexterity. A short flat-headed nail that confined some strong net-work was a favorite object upon which they tried their strength; and the male, who was usually pioneer in every new exploit, succeeded, by long continued efforts, in drawing this nail out of the wood, though not without breaking off the point of his beak in the experiment. Their unceasing destruction of cages at length brought upon them sentence of banishment. During the period of their captivity a complete change took place in the colour of their plumage without the shedding of a single feather.

The remarks of Buffon on the beak of this bird, which he characterizes as " an error and defect of Nature, and a useless deformity," exhibit, to say the least of them, an erroneous and hasty conclusion, unworthy the spirit of the science he cultivated. During a series of observations on the habits and structure of British birds, I have never met with a more interesting or beautiful example of the adaptation of means to an end, than is to be found in the tongue, the beak and its muscles in the Crossbill.

Explanation of the Plate.

Fig. 1. Head of the Crossbill; side view. *a.* temporal muscle; *b.* great pyramidal muscle.

2. Head viewed from below. *b.* great pyramidal muscle; *c. c.* pterygoid muscles; *d. d.* graciles muscles.

3. Head viewed from the side; *a.* pterygoid process; *b.* os omoideum; *c.* os quadratum; *d. d.* os jugale.