SOME ANATOMICAL NOTES ON THE WRYBILL

By P. J. K. BURTON
British Museum (Natural History), Tring, Herts, U.K.

ABSTRACT

Head and neck anatomy in the Wrybill *(Anarhynchus frontalis)* are described from a spirit specimen and a skeleton. In most respects, the Wrybill closely resembles plovers of the genus *Charadrius.* Careful examination has failed to reveal any asymmetry other than that of the bill. Apart from the bill shape, and a gape situated unusually far forward, the main peculiarity of the Wrybill is a bony bridge between the two ventral bars of the upper jaw, mentioned by Lowe (1931). The significance of this structure in relation to bill asymmetry is discussed. An analysis of the stomach contents of the spirit specimen is given.

INTRODUCTION

The laterally curved bill of *Anarhynchus frontalis,* the Wrybill, is unique among birds. Despite this, there have been few studies made of this species, and only recently (Turbott 1970) has any convincing account been given as to the manner in which its bill is used. The anatomy of *Anarhynchus* has remained virtually unstudied, apart from a brief note in a review of the waders by Lowe (1931). This paper presents the findings of an investigation on the anatomy of the Wrybill's head and neck, made possible by Mr. E. G. Turbott's generous gift of a spirit specimen of this bird. This specimen has provided the necessary complement to a skeleton, already in the collections of the British Museum (Natural History). Details of the two specimens are as follows:

Spirit specimen, Reg. No. A/1971.21.1., Auckland, New Zealand, 1 April 1970.

Skeleton specimen, Reg. No. S/1961.11.2, No data. (Rothschild Bequest).

Observations and dissections were made using a stereoscopic dissecting microscope. Careful attention was paid to comparisons of left and right sides, in view of speculations (Bock 1958; Turbott 1970) that anatomical study might reveal further asymmetry linked with that of the bill.

BILL

Most descriptions of *Anarhynchus,* including the original one by Quoy and Gaimard (1830), mention the deflection of the bill tip to the right, and the sharp tip of the bill. Oliver (1955) noted the deflection as about 12°. Some additional details have been noted from the spirit specimen. This bill of this specimen is 33.5 mm long, measured from the junction of nasal and jugal bars. Relative to the

skull (24.0 mm from junction of nasal and jugal bars), this is unusually long for a plover. The portion which is bent to the right is approximately 11.5 mm long. The tomium of both upper and lower jaws is curved inward on the right side, so that the tips of the jaws appear almost cylindrical seen from this side. On the left, the tomia are more normal, but the upper overlaps the lower slightly in the proximal part of the deflected portion. The ventral surface of the upper jaw bears one median and a pair of lateral rows of backwardly directed papillae, starting about 15 mm from the tip of the jaw. These are similar to those of other plovers, and show no sign of asymmetry. An unusual feature, however, is the position of the angle of the gape, which lies about 2 mm anterior to the junction of nasal and jugal bars. In all other plovers (Charadriidae) and many sandpipers (Scolopacidae) examined in an earlier study by Burton (1969; and in press) the angle of the gape lies posterior to this junction. A position anterior to it is found mainly in waders with a highly rhynchokinetic upper jaw (i.e. those with a narrow bending zone situated far forward in the jaw), but as explained below, *Anarhynchus* does not fall into this category.

TONGUE

The tongue extends just into the bent portion of the bill, and is itself bent to the right for about 4.5 mm from the tip. The length of the tongue from anterior tip to the tips of the postero-lateral papillae is 21.6 mm. The ratio of tongue length to bill length (measured from junction of nasal and jugal bars) is 0.64, similar to that of most waders of comparable size.

SKULL

The note on the skull of *Anarhynchus* by Lowe (1931) draws attention to an unusual feature: " . . . its bill is pseudo-desmognathous in the sense that a bony bridge extends in front of the vomer from one palatine process of the premaxillae to the other. This is doubtless an adaptive modification correlated with its curious way of feeding." Lowe does not comment on the remainder of the skull.

The feature referred to by Lowe is shown in Fig. 1, with that of a normal wader for comparison. In the skeleton specimen (probably the one examined by Lowe), the bridge is in fact fused with the tip of the vomer and is 3.5 mm in length. Beyond this, the paired ventral bars of the upper jaw are free of the dorsal bar for a further 10 mm. The curve to the right starts at their point of fusion. The presence of a similar bridge, and fusion with the vomer, has been confirmed also in the spirit specimen.

In neither specimen does the proximal portion of the bill show any sign of deflection to either side. There is no significant asymmetry in skull structure besides that of the bill; nor are there any other unusual features in the rest of the skull. Apart from the jaws, the

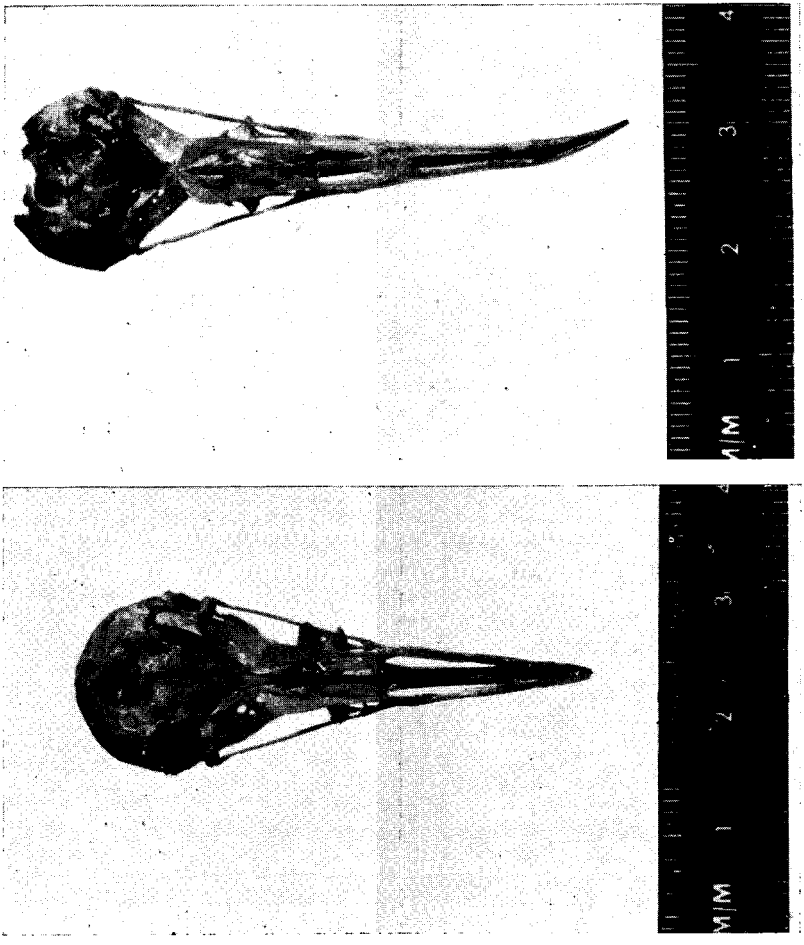

FIGURE 1 — Skulls of *Anarhynchus frontalis* (upper) and *Charadrius wilsonia* (lower) in ventral view with lower jaws removed.

skull is closely similar to that of most *Charadrius* species, if differences due to varying development of the supra-orbital glands are disregarded. The medial brace of the lower jaw (Bock 1960) is normally developed on each side.

KINESIS

Kinesis — the movement of the upper jaw and palate relative to the rest of the skull — is a property of most vertebrate skulls other than those of mammals, but reaches a high degree of refinement in birds. Two main types are generally distinguished. In prokinesis,

shown by the majority of birds, the upper jaw is hinged to the skull by a thin strip of flexible bone at its base; in rhynchokinesis (typical of waders), the upper jaw bends some way anterior to its junction with the skull. In all plovers so far investigated (except the Magelian Plover, *Pluvianellus socialis*) and in many sandpipers, the bending zone is a wide one, starting relatively close to the skull. In some highly modified types (e.g. snipes, stints, curlews), the bending zone is narrower, and situated far forward in the bill. Manipulation of the spirit specimen of *Anarhynchus* and skeleton specimen (previously softened in water) shows that the Wrybill is a typical plover, with a wide bending zone, centred around the midpoint of the bill. When manipulating the specimens, it was noticed that when the upper jaw is raised by exerting pressure at its tip, a slight twisting motion occurs, the left side rolling slightly downwards and inwards with respect to the right. This was more obvious in the spirit specimen, and may be accentuated by the presence of the rhamphotheca.

MUSCULATURE

Jaw and tongue muscles were dissected on both sides of the spirit specimen, without finding any indication of asymmetrical development. The entire neck musculature with the exception of M. longus colli was dissected without finding any asymmetry in the numbers or position of slips of attachment; nor was there any apparent difference in the bulk of any neck muscles between the two sides. The neck muscles attached to the skull have been compared throughout the Charadrii in a previous study (Burton 1969; and in press) and three of them show variation among waders in their sites of origin. In *Anarhynchus*, these origins are as follows: M. complexus from vertebrae 4, 5 and 6; M. splenius capitis from 2; and M. rectus capitis superior from vertebrae 1 to 5. This arrangement is found in many plovers as well as other waders. M. splenius capitis shows little indication of cruciform structure as described in several families of birds by Burton (1971).

SALIVARY GLANDS

The salivary glands resemble those of *Charadrius* species except that the right Gl. angularis oris is considerably enlarged, and consists of two lobes instead of the normal one.

DISCUSSION

It is clear from this investigation that the asymmetry of the bill in *Anarhynchus* has not led to any significant asymmetrical development in other features of head or neck anatomy.* In this respect it differs from the only other birds showing striking asymmetry of the bill, Crossbills (*Loxia* spp.) and the Hawaiian Honeycreeper *Loxops*

* Unless the condition of the right Gl. angularis oris in the spirit specimen is an example; more probably this is an individual peculiarity of this specimen.

coccinea, all of which exhibit marked asymmetry in the jaw musculature (Tordoff 1954, *Loxia;* Bock 1970, *Loxops coccinea*). However, these birds have the tips of lower and upper jaws twisted opposite ways, and exert lateral forces as a normal part of feeding. The Wrybill, as shown by Turbott's account, opens and closes its bill in an essentially normal manner, except that the head is frequently turned sideways, to bring the left side of the bill tip into contact with the substrate — a convenient position for grasping surface food items. Neck muscle asymmetry was perhaps more to have been expected in *Anarhynchus,* but has not been discovered. It may be noted that oystercatchers (*Haematopus* spp.) which also lay the head to the left when feeding show distinct asymmetry of the skull at the base of the bill (Stresemann 1929; Webster 1941) but in this case the bill is used to make forceful attacks on molluscs while in this position.

Nevertheless, the absence of asymmetry in the skull of *Anarhynchus* is somewhat surprising. Possibly it has been avoided partly by the device of a bony bridge connecting the mobile ventral bars of the upper jaw which transmit the movement of the quadrate and palate to the upper jaw tip. This bridge has two obvious properties. First, it must provide increased support against upwardly directed forces in a limited region of the bill; secondly, it must limit the movement of right and left ventral bars with respect to one another. The first of these seems of no obvious value; the ducts of the nasal glands would derive extra protection from the presence of the bridge, but there appears to be no reason why they should need it. The second property, the effect of the bridge on the two ventral bars, is probably of much more importance.

The deflected portion of the bill includes only the region in which dorsal and ventral bars of the upper jaw are fused. If it started behind this point, the left and right ventral bars would have to travel different distances, and follow a curved path during kinesis — an impossibly complex arrangement. Nevertheless, some unequal movement of the left and right ventral bars is possible if lateral movement of the bill tip occurs as a result of external forces; this can be shown by manipulating the two specimens. Such lateral forces may arise occasionally by pressure against the substrate while the left side of the bill is applied to the ground in the feeding action described by Turbott. The slight twisting movement seen when the bill tip is lifted by finger pressure is also indicative of unequal movement of the two ventral bars. Closer study and analysis may further clarify the mechanical consequences of the bent bill tip; nevertheless, it seems reasonable to suppose that the bony bridge has arisen as a result of stress between the two ventral bars, and has the effect of eliminating differential movement between them. It would be interesting to know the ontogeny of this structure; possibly it is in the form of a strong ligament in young birds which ossifies later; it is likely that such a condition preceded it in evolution.

It would also be of much interest to know more of the ontogeny of the bill deflection, but since this appears before hatching (Oliver 1955) it seems unlikely that it will ever be studied. The curious form of the tomia in the deflected portion of the bill is presumably an expression of its mode of development. It is worth noting that the tomium is of nearly normal structure on the left. This is the side which Turbott notes is normally used for prey capture, whether by sweeping the mud surface with head laid on one side, or by more conventional movements.

The anterior position of the gape in highly rhynchokinetic waders probably stems from an overall reduction in the extent of jaw opening, as a result of the enhanced mobility of the bill tip. The occurrence of this feature in the moderately rhynchokinetic *Anarhynchus* may also indicate a general decrease in the extent of jaw opening, but this case connected with its habit of feeding with the side of the bill against the substrate.

Unusual bill modifications are sometimes linked with a specialised and restricted diet — e.g. pine seeds taken by Crossbills, or snails by Openbill Storks (*Anastomus* spp.). However, there is nothing in the literature to suggest such specialisation in the Wrybill, although references to its diet are few. There is nothing surprising about the stomach contents of the spirit specimen which were as follows:

1 Staphylinid beetle, 4.0 mm long.

2 Dipteran larvae, 3.2 and 4.3 mm long.

3 jaws of polychaete worms, probably *Nereis*, respectively 1.2, 1.5 and 2.0 mm long; also a partly digested fragment of polychaete body, 4.0 mm long.

4 small stones, respectively 1.8, 2.3, 2.8 and 3.2 mm long.

Several fragments of plant matter, including some fine grass.

Similar items appear in the stomachs of many shore feeding plovers.

It must therefore remain for future investigators to place the bill form and feeding methods of the Wrybill in full ecological perspective. It is to be hoped that Turbott's paper and this one may stimulate further field studies on this interesting species.

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Dr. P. J. K. Burton,
Sub-department of Ornithology, British Museum (Natural History), Tring, Herts, U.K.