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"Birds of a feather."

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[PART I.]

## On the Osteology of the Red Wattle-Bird (*Anthochæra carunculata*).

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D.C.

ON the 19th of October, 1912, I received, per favour of Mr. A. J. Campbell, R.A.O.U., an excellent and complete articulated skeleton, which I understand was prepared at the National Museum, Melbourne, of an adult specimen of the Red Wattle-Bird, known to science as *Anthochæra*\* *carunculata*, one of the *Meliphagidæ* of Australia. It was Mr. Campbell's wish that I prepare a brief, illustrated account of the osteology of this species as a contribution to *The Emu*, of which he is co-editor. This request was seconded, in a letter dated 8th June, 1912, by Mr. F. Erasmus Wilson, the hon. secretary of the Royal Australasian Ornithologists' Union, on behalf of the Council. Mr. Campbell's letter of transmittal was dated at Melbourne, 14th September, 1912.

At the time this skeleton came into my possession for description I had before me several hundred specimens of Pleistocene fossil birds from Oregon to work up—the task being well in hand—and I could not conveniently set it aside in order to undertake what my colleagues in the R.A.O.U. had favoured me with, and done me the honour to ask me to describe for the use of avian osteologists in Australia.

I was especially pleased to get a skeleton of *Anthochæra carunculata* to study, for I had already published descriptions of the skeletons of a very large number of the Passerine birds of the United States, with some of those of China, the Philippine Islands, and elsewhere, and expressed opinions with respect to their classification.† A few years ago I examined and compared skeletons of a number of the *Cærebidæ*, *Nectariniidæ*, *Meliphagidæ*,

\* So spelt in the new "Check-list," R.A.O.U., but formerly *Acanthochæra*.

† Shufeldt, R. W., "An Arrangement of the Families and Higher Groups of Birds," *Amer. Anat.*, vol. xxxviii., Nos. 455-456, Boston, Nov.-Dec., 1904, pp. 835-856.

Also, "Contributions to the Comparative Osteology of the Families of North American Passeres," *Jour. Morph.*, vol. iii., No. 1, Boston, June, 1889, pp. 81-114, Pls. V. and VI.

and *Certhiidae*, sent me for the purpose by Dr. F. E. Beddard, F.R.S., Prosector of the Zoological Society of London. These were subsequently described and published,\* and the material upon which the paper was based—some 13 skeletons in all—is before me at the present writing. Those of the *Meliphagidae* examined belonged to the genera *Acanthorhynchus*, *Prosthemadera*, *Entomyza*, and *Acanthogenys*.

In the collections of the United States National Museum at Washington there are numerous osteological specimens in the Division of Birds, which I have been permitted to use in writing this contribution. For this privilege I am indebted to the authorities of that institution, and especially to Dr. Charles W. Richmond, of the Bird Division. Among the specimens to which I refer there is a nearly complete skeleton of *Creadion carunculatus* (No. 18,289), as well as a sternum of *Anthochaera carunculata* (No. 9,344). There is quite a considerable collection of sterna of Australian Passerine birds of many species, and they are all interesting objects to study. Others which have proved of value by way of comparison are the following skulls and skeletons:—

- 1.—*Drepanis*, sp. ?, 4 skulls (see Sharpe's "Hand-list of Birds," vol. v., p. 129).
- 2.—*Vestiria coccinea* (skull No. 19,130; see Sharpe's "Hand-list of Birds," vol. v., p. 130).
- 3.—*Oreomyza bairdii* (skeleton 19,097; see Sharpe's "Hand-list of Birds," vol. v., p. 132).
- 4.—*Loxioides bailleui* (skeleton 19,098; see Sharpe's "Hand-list of Birds," vol. v., p. 136).
- 5.—*Cephalopterus pardaliger* (skeleton 19,688; Sharpe ?)
- 6.—*Himatione sanguinea* (skeleton 19,092; Sharpe's "Hand-list of Birds," vol. v., p. 131).
- 7.—*Himatione parva* (skeleton 19,136. Sharpe ?)
- 8.—*Acrulocercus braccatus* (skeleton 19,125; Sharpe's "Hand-list of Birds," p. 91).
- 9.—*Tropidorhynchus*, sp. ? (skull 18,410; Sharpe's "Hand-list of Birds," p. 92).
- 10.—*Creadion carunculatus* (skeleton 18,289; Sharpe's "Hand-list of Birds," vol. v., p. 544).

In Sharpe's "Hand-list of Birds" the genus *Anthochaera* is found on page 89 of vol. v., where two species are given—namely, the one here considered and *A. inauris*, of Tasmania.

The specimens which were kindly supplied me by Dr. Beddard, alluded to above, are in the subjoined list, with their Zoological Society numbers attached.

\* Schufeldt, R. W., "On the Comparative Osteology of the Passerine Bird *Arachnothera magna*," *Proc. Zool. Soc.*, Lond., Aug., 1909, pp 527-544, Pl. LXVIII.

No.	No.
289. <i>Cyanerpes cyanea</i> .	306. <i>Cæreba chloropyga</i> .
345. <i>Arachnothera longirostris</i> .	781. <i>Acanthorhynchus</i> , sp. ?
318.     " <i>magna</i> .	365. <i>Prothemadera novæ-zealandiæ</i> .
497. <i>Leptocoma grayi</i> .	702. <i>Entomyza cyanotis</i> .
340. <i>Cinnyris chalybeus</i> .	725. <i>Anthogenys ruficularis</i> .
426. <i>Diglossa baritula</i> .	712. <i>Climacteris scandens</i> .
500. <i>Anthreptes malaccensis</i> .	

In the excellent work by A. J. Campbell (2 vols., 8vo) on the "Nests and Eggs of Australian Birds," we find the following arrangement—that is, the *Nectariniidæ*, or Sun-Birds, containing the single species *Cinnyris frenata*, followed by the *Meliphagidæ*, or Honey-eaters, thus :—

FAMILIES.	SUB-FAMILIES.						
<i>Meliphagidæ</i> .. ..	<table> <tr> <td>{ <i>Zosteropinæ</i> .. ..</td><td>27 species</td></tr> <tr> <td>{ <i>Myzomelinæ</i> .. ..</td><td>27 "</td></tr> <tr> <td>{ <i>Meliphaginæ</i> .. ..</td><td>69 "</td></tr> </table>	{ <i>Zosteropinæ</i> .. ..	27 species	{ <i>Myzomelinæ</i> .. ..	27 "	{ <i>Meliphaginæ</i> .. ..	69 "
{ <i>Zosteropinæ</i> .. ..	27 species						
{ <i>Myzomelinæ</i> .. ..	27 "						
{ <i>Meliphaginæ</i> .. ..	69 "						
<i>Dicædiæ</i> . (Flower-peckers, with 10 species).							

Several species of *Anthochæra* are listed under the *Meliphagidæ*, some of which are differently classified by Sharpe in his "Hand-list"; as, for example, *Anthochæra ruficularis* is there listed as *Acanthogenys ruficularis*, and so on.

Sharpe gives but two species of *Anthochæra*—namely, *A. carunculata* and *A. inauris* (p. 89).

*Anthochæra mellivora* (Campbell) is *Anellobia chrysoptera* of Sharpe's "List," and *Anthochæra lunulata* (Campbell) is *Anellobia lunulata* in the same work.

In any event, it will be appreciated, after reviewing the foregoing material at my command, that a very fair *comparative* study of the skeleton of *Anthochæra carunculata* can be made through its use, and to this I shall now proceed without further delay.

*The Skull* (Plate I., fig. 1, and Plate III., fig. 16).—With respect to its general *facies*, the skull, including the lower mandible, of this Red Wattle-Bird possesses all the characteristics of that part of the skeleton in any of the ordinary *Passeres* of a more or less similar size. On its upper surface the cranial portion is smooth, and the vault of the brain-case semi-globular. The superior margins of the orbits are sharp and somewhat elevated above the depressed frontal region standing between them. Anteriorly, over the cranio-facial part, the aforesaid depression is best marked, while beyond it the upper surface of the somewhat broad mandible slopes gently away. Beyond this again, the culmen between the very large, subelliptical narial apertures is notably narrow; the rest of the mandible is slightly decurved, and terminates rather acutely at its apex.

When thus viewed from above, the skull of *Creadion carunculatus* very much resembles *A. carunculata*, as will be observed by comparing figs. 15 and 16 of Plate III., where it will be noted that *Creadion* simply has the fore part of the skull narrower than in

*Anthochæra*, the general characters being identical. These species are in different families and placed far apart by Sharpe, the former being arrayed with the *Eulabetidæ*, and having between this last and the *Meliphagidæ* no less different and distinct families than the *Icteridæ*, *Tanagridæ*, *Fringillidæ*, and others.

However, on lateral and basal views, the skull in *Creadion* differs considerably from the corresponding features in the skull of the Red Wattle-Bird.

Skulls that more or less closely agree with the skull of *Anthochæra carunculata* are those of *Entomyza cyanotis* and *Prosthemadera novæ-zealandiæ*, both of which species belong to the *Meliphagidæ*, and complete skeletons of both are before me at this writing.

In most particulars the skull of *Entomyza cyanotis* is more like that of *Anthochæra carunculata* than any other Meliphagidine skull I have at hand, with the exception of *Acanthogenys ruficularis*, which, although a smaller species of this family, has a skull that closely agrees with the skull of *Anthochæra*. In fact, Gadow arrayed both the genera *Acanthogenys* and *Anellobia* with *Anthochæra*, and he doubtless had examined their osteology ("Catalogue Birds Brit. Mus.," ix., p. 262, 1884).

Turning to the lateral aspect of the skull in our subject, we are to note how largely the aural aperture is closed over posteriorly by the flat shield of bone furnished chiefly by the exoccipital. In not a few *Passeres* this flap is far more bulging and produced further forward, causing the auricular opening to face directly to the front, as in *Arachnothera longirostris* and other forms among the *Nectariniidæ*.

In *Anthochæra* the post-frontal and squamosal processes at the side of the cranium are of about an equal length and prominence, the latter being situated mesiad to the former, while the valley between them is deep oval in contour and conspicuously defined. Such forms as *Hemignathus procerus* and its near allies have these apophyses practically aborted (fig. 18, Plate IV.), while in *Vestiaria coccinea* only the squamosal one is developed, and it is lamelliform in type, with the flat surface facing forwards and upwards.

*Anthochæra carunculata* has a large orbit with great joining vacuities in the anterior wall of the brain-case and the inter-orbital septum (Plate I., fig. 1). This feature is less marked in some other Meliphagidine birds, though not so very much so.

The basi-sphenoidal rostrum is straight, being directed about equally forwards and upwards, having its lower margin rounded and its upper cultrate.

A *pars plana* in front of either orbital cavity is a very large bone, and, apart from the circumscribed foramen above it, completely divides the latter from the rhinal chamber in front of it. It fuses completely with the lachrymal anteriorly, and with it extensively spreads out over the delicate and very slender zygomatic bar below, without actually coming in contact therewith, while in front it presents a deep concavity with projecting

margins. Posteriorly, it has a curvature or concavity adapted to the general form of the orbit, of which it forms the entire anterior wall.

Turning to the skull of a small species of *Acanthorhynchus* at hand, it is to be observed that in it the *pars plana* are also very large and concavo-convex in contour, simulating what we find in many species of *Trochilidæ*, in which family, as a rule, they are immense in proportion to the size of the rest of the skull, as in *Archilochus alexandri*. Antero-posteriorly they are considerably deeper in *Prothemadera novæ-zealandiæ* than they are in *A. carunculata*.

All the species of this section of the *Meliphagidæ* have a large nasal bone, which is concave mesiad and convex externally.

The osseous tomia of the superior mandible are sharp, and in *A. carunculata* slightly produced below the roof of the palate.

*Creadion carunculatus* has the most of the morphology of the structures here being described very different; in fact, the skull of this species comes much nearer some of the congeners and representatives of the *Icteridæ*, and its consideration has only been introduced here with the view of exhibiting how it and its near affines depart from the *Meliphagidine* types with respect to this part of its osteology. Still, the departures here are not as great as those presented by these parts of the skull in *Cinnyris chalybea*, a species belonging to a large genus of the *Nectariniidæ*, and considered to be much nearer related to the *Meliphagidine* Red Wattle-Bird than is any member of the family to which *Creadion carunculatus* belongs. Indeed, we find in *Cinnyris chalybea* the big *pars plana*, the hair-like *quadrato-jugal* bar, and the still finer nasal bone, together with some of the associated osseous structures of the face in this bird, very much as they are found in any of the typical Humming-Birds of the *Trochilidæ*. Particularly does this apply to the marvellously attenuated nasal bone, so different from what we meet with in this respect among the ordinary *Passeres*.

With respect to the skulls of such species as *Oreomystes bairdii* and *Himatione parva* of the family *Drepanididæ*, it may be said that they approach, in all their general characters, nearer to many of the North American Warblers (*Mniotiltidæ*) than to any of the *Meliphagidæ* as a whole, or to *Anthochaera carunculata* in particular. Little or nothing would be gained by comparing such forms with our subject here, and we therefore pass them by. Even *Himatione sanguinea*, with its longer and more curved beak, falls in the same category, though it may be a bit—a very slight bit—nearer than the two first-mentioned species. Birds of the genus *Himatione*, and especially *H. sanguinea*, possess the most extraordinary palatine bones, the postero-external angles being drawn out into long hair-like processes, while the rest of the bone, on either side, is but slightly stouter, rendering the entire structure one of extreme delicacy.

Already I have remarked, in another connection, that “so

entirely different is the skull in such a species as *Prosthemadera novæ-zealandiæ* of New Zealand—a bird placed among the *Meliphagidæ*—that a separate description would be required to give an account of it. Here the *nasals* are very broad antero-posteriorly, and each is pierced by a central foramen—an unusual character. Then the *pars planæ* are very thick from before backwards, and a longitudinal groove marks the external aspect of each.

“In not a few particulars *Acanthogenys ruficularis* of Australia is a *Meliphagidine* species with a skull not at all unlike what we find in the species of *Acanthorhynchus*, and these forms are more or less nearly related. *Acanthogenys* has the broad *nasals*, each pierced by the small central foramen, and there are several other points in the two skulls of more or less close agreement. But such representatives of the *Meliphagidæ* have no special relationship with the *Cærebidæ*, and even less with the typical *Nectariniidæ*. Judging from the skulls alone, it is not difficult to recognize the more or less close relationship existing among the species I have before me of the genera *Entomyza*, *Acanthogenys*, and *Prosthemadera*, all of which present characters in this part of the skeleton quite different from anything we find in *Arachnothera*, and surely offer no skull-characters at all approaching any of the *Trochilidæ*.”\*

Turning our attention next to the *basis cranii* of *Anthochæra carunculata*, we are to note that all the characters it presents are essentially those pertaining to this part of the Passerine skull. The large *foramen magnum* is of a subcordate outline, with rounded posterior apex and nearly transverse, straight base situated anteriorly. Hemispherical in form, the *occipital condyle* is of extremely minute proportions, unnotched and sessile. Somewhat elevated in character, smooth, and of considerable extent, the *basi-temporal area* presents the usual fossæ, at the bases of which we note the foramina for certain vessels and nerves passing to and from the brain-case.

\* Schufeldt, R. W., “On the Comparative Osteology of the Passerine Bird *Arachnothera magna*, *Proc. Zool. Soc.*, Lond., 1909 (Aug., 1909), pp. 527–544, Pl. LXVII. The two paragraphs quoted are found upon page 533 of this paper. When this contribution appeared there was considerable elation in many quarters over the fact that I had found all the representatives of the *Nectariniidæ* and *Meliphagidæ* to be completely Passerine in the matter of their osteology, and in no way especially related to the Humming-Birds (*Trochilidæ*). Indeed, so exultant were some of our avian morphologists, and nearly all of our systematic ornithologists, over this announcement, and the candid and emphatic manner in which it was set forth, that the circumstance was quite lost sight of by them, that, although there was but little in the skeleton of any of the birds belonging to the *Nectariniidæ* and *Meliphagidæ* which at all suggested an affinity between those two families and the *Trochilidæ*, this circumstance in no way detracted from the truth of my previous demonstrations, published in many places in Europe and America, that the skeleton of a typical Swift (*Cypseli*) and a Humming-Bird (*Trochili*) were, in their corresponding characters, apart from their “unnotched sterna” and “long hands,” essentially utterly different, and it still remains for the avian taxonomer to decide what such wide differences in skeletal structure as exists between these two groups of birds, the *Cypseli* and *Trochili*, really indicates.

*Quadrates* and *pterygoids* are of the usual Passerine type, though it may be said that the distal extremities of the latter are but very slightly expanded.

Either *palatine* is a shell-like formation, articulating somewhat extensively beneath the sphenoidal rostrum with the fellow of the opposite side, while the posterior angle of either bone is produced as a long spicula-form process, and the narrow prepalatine is extended forward to make the usual articulations with the bones of the roof of the mouth. Mesially, there is a considerable interval between the prepalatines, and in this interval the posteriorly bifurcated and anteriorly truncated *vomer* is visible.

The floor of either orbit, and all the central portion of the roof of the mouth, are entirely deficient in bone, and this condition obtains in the case of all the *Meliphagidæ*, owing to the extreme slenderness of the palatines, pterygoids, zygomas, the lateral processes of the premaxillary and small maxillo-palatines.

In the larger representatives of the *Meliphagidæ*, if not in all, the lateral masses, composed on either side of the ethmoidal element, the lachrymal and *pars plana*, form one of the largest and altogether the most conspicuous part of the mid-region of the skull, and through the various articulations of this mass—or masses—the stability of the cranio-facial region of the skull is practically insured and maintained. This is the case in many Passerine birds.

Posteriorly, the *occipital area* is distinctly circumscribed by a low, linear curved line, convex superiorly, and carried down laterally upon either side to the external auditory meatus. In the middle line here there is always present a conspicuous and smoothly rounded *supra-occipital prominence*, though not quite as well marked a one as in *Nectariniidæ* and *Trochilidæ*. Through the middle of this the aforesaid line always passes. No foramina occur upon either side of it, and a similar prominence is present in the various species of birds named in the foregoing pages of this paper.

*Anthochaera carunculata*, in common with other Meliphagidine species, possesses the usual V-shaped lower mandible, which is slightly decurved from about its middle to the apex (fig. 1, Plate I.)

The upper and lower borders of the rami are smooth and rounded, while distally the considerable symphysis present is concave above and correspondingly convex below. A large elliptical *ramal vacuity* is always present in either ramus of the jaw in all the typical *Meliphagidæ*, and the sutural boundaries of the several bones in its neighbourhood are entirely absorbed. The articular end of this mandible is truncated posteriorly, concaved above for the quadrate, and correspondingly convex below, with the usual various apophyses short and blunt.

In such species as *Prosthemadera novæ-zealandiæ* the hinder part of either ramus is markedly weakened through the presence of the unusually large ramal vacuity on either side, the upper and

lower boundaries being thus reduced to extremely slender rodlets of bone, which in any case would require but little to fracture.

There may be a minute *articular sesamoid* present at the quadrate-mandibular articulation on either side, and a free, ossified *siphonium* leading into the aural cavity, posterior and above either quadrate, such as we find in many other birds.

Such *Meliphagidæ* as the species here being considered, and representatives of the genera *Entomyza*, *Prosthemadera*, and others, have the *hyoidean apparatus* constructed upon a similar plan, and this requires a more careful description than I have accorded it in previous papers of mine on the subject.

We find that the *thyro-hyals* do not curve up over the skull behind, as they do in some of the *Nectariniidæ*, as I have elsewhere pointed out.

In *Anthochaera carunculata* and its near allies the *glosso-hyal* is of some size (fig. 3, Plate I.), rather elongate, V-shaped, concaved above, convex below, and with its postero-external angles somewhat produced. Anteriorly it is slightly bifurcated, and only semi-ossified. Mesially, from beneath this *glosso-hyal* there extends far forwards a long, slender bundle of bony bristles, which, for their anterior third or more, minutely re-divide so as to form a stiff little distal free brush, which the bird employs in feeding itself, after the fashion of its well-known, peculiar habit.

This arrangement is equally well developed in other *Meliphagidine* genera, as stated in a former paragraph.

The *basi-hyal* is rather short, laterally compressed, and is extended posteriorly in the middle line by a semi-ossified, flattish *uro-hyal*.

Either *cerato-branchial* is a long, nearly straight, very slender osseous rod, while the flattened *epi-branchials* are very short, and present but very slight curvature. The lengths of the latter vary somewhat in the different species of the *Meliphagidæ*.

The *sclerotal platelets* of the eye present nothing worthy of a special description, as they in no way differ from those structures in ordinary Passerine birds of this size among the assemblage as a whole (fig. 2, Plate I.)

Sharpe retained the genus *Acanthorhynchus* (Gould) in the family *Meliphagidæ* (*loc. cit.*, vol. v., p. 71). It will be seen in the list of material given above that I have at hand a small unidentified species of this genus (rough skeleton No. 718), it having been sent me, as pointed out, by Dr. F. E. Beddard. Of this specimen I said, on page 536 (footnote) of my paper on *Arachnothera magna*, cited above:—"Without going into details, and judging from the skeleton alone, I would remark that the Australian genus of birds named *Acanthorhynchus*, which have been referred to the *Meliphagidæ*, possess skeletal characters which, in the main, agree better with the corresponding ones in *Arachnothera* than with any of the same characters as seen in the short-billed *Meliphagidæ*." After a careful comparison of the aforesaid skeleton of *Acanthorhynchus* with additional material, the fact is

made clearer than ever that this bird at least belongs among the *Nectariniidæ*, the entire structure of its skull and tongue pointing unmistakably to this conclusion. The only question that can be raised is that the skeleton at hand was accidentally misidentified by the one who labelled it at the Zoological Society of London prior to transmitting it to me, and the skeleton is of some small Nectarine species instead of a Meliphagidine one. Such slips have happened to the best of naturalists.

#### REMAINDER OF THE AXIAL SKELETON.

A consideration of this part of the osteology of *Anthochæra carunculata* need not detain us long, and, indeed, this may likewise be said of the skeletology of the limbs of our subject. The reason for this lies in the fact that in my above-cited paper on the osteology of *Arachnothera magna* quite a complete account is presented of the osteology of these parts of the skeleton in such Meliphagidine species as *Entomyza cyanotis* and *Prosthemadera novæ-zealandiæ*, and the characters there presented on the part of any of the bones to be compared agree, in the main, with the corresponding ones as we find them in *Anthochæra carunculata*.

This last-named species agrees with *Prosthemadera* and *Entomyza* in possessing 19 vertebræ between the skull and the pelvis, and of these vertebræ 14 are cervicals and 5 are true dorsals. An extremely minute pair of very rudimentary free ribs are attached to the 13th cervical vertebra, while the pair articulating with the 14th are well developed, and possess small epipleural appendages. These are shown as the leading pair in fig. 4 of Plate I. of the present paper. From that illustration it will be observed that the last pair of ribs are *pelvic ribs*; they lack unciform processes, and their hæmapophyses do not reach the sternum.

All this part of the skeleton in the Red Wattle-Bird is essentially Passerine, and agrees, in the main, with any ordinary Passerine bird, quite irrespective of its habitat.

While *Anthochæra* agrees with *Entomyza* and *Prosthemadera* in having six free vertebræ and a *pygostyle* in the skeleton of its tail, these are far better developed than they are in *Entomyza cyanotis*, and still better than they are in *Prosthemadera novæ-hollandiæ*, in which last-named species they are very considerably reduced in size as compared with those in the tail of the Red Wattle-Bird, and yet the two birds are about of a size.

The *pelvis* of the three species here being compared likewise closely agree in all of their essential characters, and this composite bone is quite typically Passerine in its structure and morphology in these particular species of the *Meliphagidæ*. It may be noted, however, that the *pelvis* of *Anthochæra carunculata* is actually as well as relatively larger than it is in *P. novæ-zealandiæ* and *E. cyanotis*, and, in adult individuals, may at once be distinguished by the double row of five—or five pairs—of intervertebral foramina existing in the post-acetabular region between the

transverse processes of the co-ossified uro-sacral vertebræ. These are either entirely absent or else extremely minute in the representatives of the other two genera. They occur again, however, in the pelvis of *Acanthogenys ruficularis*, another short-billed Meliphagidine.

A glance at fig. 5 of Plate I. of the present paper is sufficient to convince the avian osteologist that not only the bones of the shoulder-girdle, but the sternum as well, are all typically Passerine in their morphology and arrangement with respect to articulations.

Apart from the matter of variation in size, and a few insignificant details in character, all this part of the skeleton in *Anthochaera carunculata* essentially agrees with *Entomyza* and *Prosthemadera* as represented by the two foregoing species of these genera.

Sternum, scapulæ, coracoids, and os furculæ are all as distinctly Passerine as they are in an average Thrush. It is interesting to note, however, that in one particular the sternum of *Anthochaera carunculata* agrees better with that bone in *Prosthemadera novæ-zealandiæ* than it does with *Entomyza cyanotis*. This agreement consists in a relatively longer manubrial process and a convex border for the lower moiety of the anterior part of the sternal carina, instead of a concave one, as it is in *Entomyza cyanotis*.

This lengthening of the manubrium sterni is also present in *Anellobia lunulata* of Western Australia\* and in other species.

In *Meliphaga phrygia* the hypocleidium of the os furcula is remarkably long, agreeing in this particular with the Red Wattle-Bird (fig. 5, Plate I.) This is also the case, however, in other Australian *Passeres* having no special relationships with the Meliphagidæ, as in *Sphecotheres* among the Oriolidæ, in which the sternum and shoulder-girdle very closely agree with *Anthochaera*.†

So far as the Meliphagidæ and some of the allied families are concerned, I present a very complete account of the comparative

\* There sometimes seems to be an individual variation in the matter of this character, as the manubrium is somewhat shorter in the sternum of a female *Anthochaera carunculata*, collected on the 5th of May, 1865, by E. P. Palmer, (?) at Dobroyde, and numbered 9,394 in the collection of the U.S. National Museum. (I fail to find this locality on any of the standard maps.)

† In the species formerly known as *Grallina australis*, which occurs on Clarence River, New South Wales, the sternum is remarkable for having large elliptical foramina, one on either side, in its xiphoidal extremity, instead of "notches," as is the rule throughout the *Passeres*. There are three of these sterna in the Collections of the U.S. National Museum (Nos. 9,396, ♂, 9,278, ♀, and 9,279, ♀), but this character occurs only in the sternum of the male.

Coues states in the "Century Dictionary," under *Grallina*:—"A genus of oscine Passerine birds, variously located in the ornithological system, lately placed in a family called *Prionopidæ*. The Pied Grallina (*G. picata*) inhabits Australia. It is entirely black and white, and 11 inches long. A second species, *G. bruijni*, is found in the Arfak Mountains of New Guinea; also called *Tanypus* and *Grallipes*" (p. 2,594). The only birds known to me, to which the specific name *bruijni* has been applied, belong to the *Paradiseidæ*. It would be very interesting to examine the entire skeleton of a species exhibiting the above described character in the sterna of the two sexes. I believe this condition may occasionally be found to occur in *Ptiloris paradisea*, of which species I have five sterna before me (No. 9,366, Coll. U.S. Nat. Mus., ♂, right side). The osteology of the *Paradiseidæ* stands in need of comparative description.

osteology of the *sternum* and *shoulder-girdle* in my above-cited *Proc. Zool. Soc.* paper on *Arachnothera magna*, rendering it entirely unnecessary to reproduce such descriptions here, especially as the matter of space is to be taken into consideration.

#### THE APPENDICULAR SKELETON : THE PECTORAL LIMB.

Such *sesamoids* as the *os humero-scapulare* at either shoulder-joint, and the *patellæ* at the knees, completely ossify in all *Passeres* as a rule ; and, as it is the case of many of the birds mentioned above, it is fair to presume that these elements are also performed in bone in the Red Wattle-Bird, though they have all been lost in the skeleton now at hand (figs. 6 and 7, Plate I.)

As is the case with nearly the entire skeleton of *Anthochaera carunculata*, the humerus is a completely pneumatic bone, and has an extreme length of 3.5 cms. The shaft is smooth, sub-cylindrical in form, and nearly straight, exhibiting but little of the usual sigmoidal curvature seen in the humeri of many species of birds. Thoroughly surrounded by a conspicuous and thickened margin, the pneumatic fossa is both large and deep, exhibiting several foramina at its base.

The radial crest is short, straight, and not lofty, ending abruptly on the shaft, nearly opposite where the ulnar tuberosity terminates on the other side.

At the distal end of the shaft we meet with all the features present there in the humerus of any Passerine bird, they being unusually large and prominently produced—in fact, distinctly more so than they are in *Prothemadera* or *Entomyza*. We invariably meet with a small *sesamoid* at the elbow in all of these birds.

Structurally, the skeleton of the arm in *Anthochaera* comes much nearer *Prothemadera* than *Entomyza*—that is, in the form and proportionate lengths of the bones composing it.

So well are the bones of the *antibrachium*, *carpus*, and *manus* shown in fig. 6 of Plate I. that any special description of them would seem to be almost superfluous.

None of the *phalanges* ever supports “claws,” while especial attention is invited to the prominent and much individualized olecranon process of the *ulna* ; to the peculiar little tubercle for the guidance of special tendons on the upper side of the distal extremity of the bone ; and to the deep tendinal groove passing down the entire length of the index metacarpal on its anterior aspect. This is for the passage of the tendon of the *flexor digitorum profundus* muscle, and occurs in other species.\*

#### THE PELVIC LIMB (fig. 7, Plate I.)

This limb seems to be non-pneumatic in all the species mentioned in the present paper, such being the rule throughout the *Passeres* generally.

*Femur* has an extreme length, in *Anthochaera carunculata*,

\* Shufeldt, R. W., “The Myology of the Raven,” p. 140, fig. 39.

*Prosthemadera novæ-zealandiæ*, and *Entomyza*, of 3 centimetres, the characters of the bone being very similar in all three of these genera. The summit, including the head and trochanter, is flat; the shaft is straight and cylindrical, and the condyles of considerable size proportionately. These last are sharp in front in *Anthochaera*, but not so in the other species named, while in all the groove for the head of the fibula on the posterior aspect of the external condyle behind is invariably well marked. It would be difficult to distinguish the femur of *P. novæ-hollandiæ* from that of *E. cyanotis*, while the form of the condyles *anteriorly* in *Anthochaera carunculata* is characteristic as well as diagnostic in so far as these birds go.

The *tibio-tarsus* has an extreme length of 5.4 cms. in *A. carunculata*, 5.3 cms. in *E. cyanotis*, and 5.9 cms. in *P. novæ-zealandiæ*. In all it is straight, and presents the typical Passerine characters. We note that the *fibula* is feebly developed, and in *P. novæ-zealandiæ* does not extend below the fibular ridge on the side of the tibio-tarsal shaft.

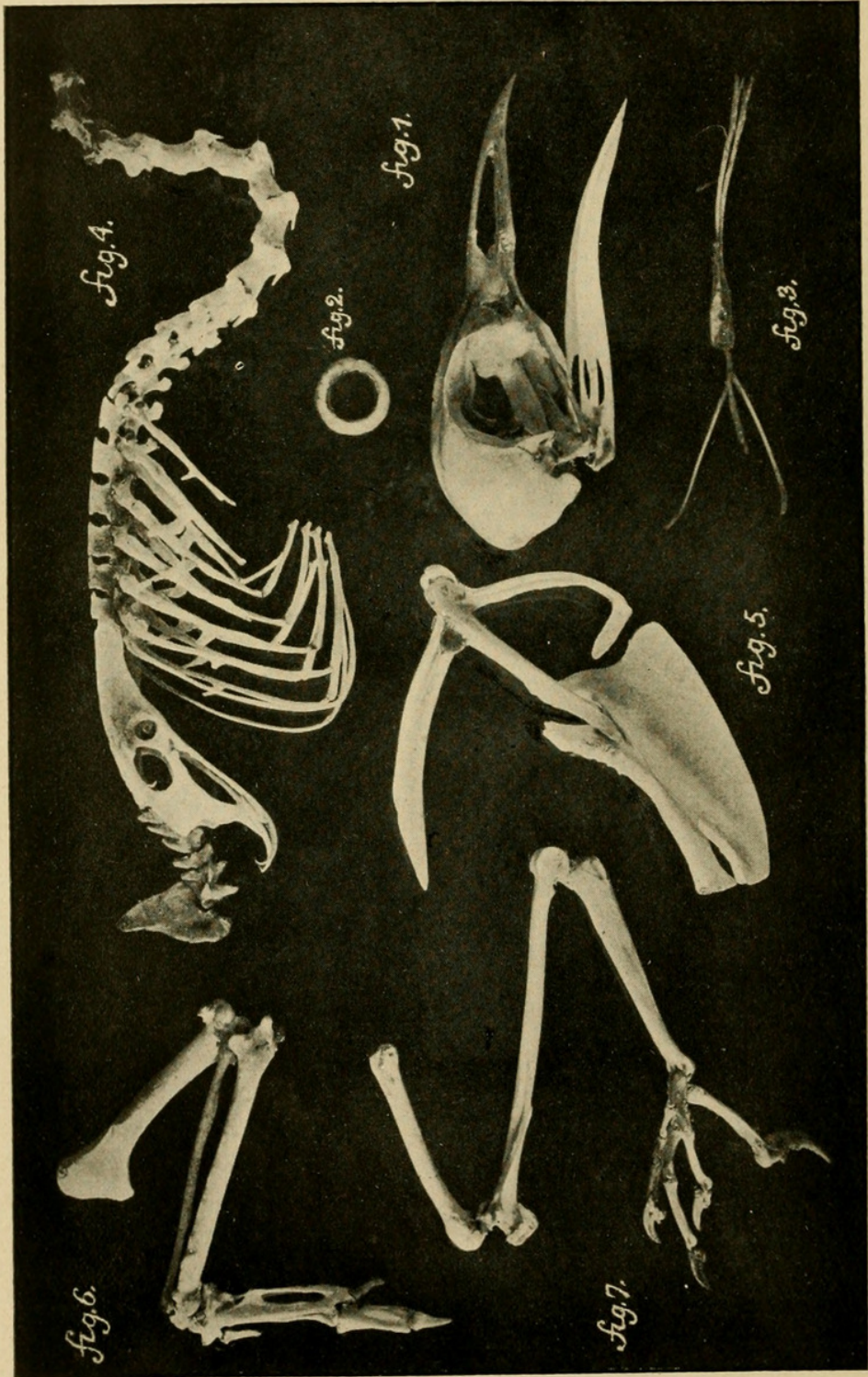
Of all the bones of the pelvic limb, in the case of the Red Wattle-Bird, the *tarso-metatarsus* is most diagnostic. Indeed, it is peculiar in its morphology, and may be recognized on sight and distinguished at once from the bone in the case of any of the other tarso-metatarsi of Meliphagidines at hand. This is due to the formation of the entire shaft, which, upon its outer aspect, is flat and smooth, being as broad proximally as the shaft and outer surface of the hypotarsus combined, completely shutting the latter out of sight on this view. From this point it gradually narrows down as it proceeds distally till it comes to be the width of the external trochlea, upon the outer side of which it merges. For the proximal moiety, or rather more, this is but a thin plate; and, as the inner border of the shaft is somewhat raised posteriorly, and the hypotarsus is but a small cube in form, the *posterior* aspect of the shaft, from the latter down to the free metatarsal, has the appearance of being deeply excavated, which excavation gradually shallows as we proceed distally.

The hypotarsus is four times pierced for the passage of tendons, the anterior pair of foramina being the larger, and the posterior ones very small. The distal end of the bone bearing the three trochlea is greatly bent posteriorly—a bending which is still more evident in the case of the tarso-metatarsus of *P. novæ-zealandiæ*.

*P. novæ-hollandiæ* has the outer side of the shaft of its *tarso-metatarsus* formed like *Anthochaera carunculata*, but to a very less degree, while it is entirely absent in the case of *Entomyza cyanotis*, the bone in the latter species being much as we find it throughout all medium-sized Passerine birds.

In *A. carunculata* it has an extreme length of 3.4 cms.; in *E. cyanotis*, 3.5 cms.; and in *P. novæ-zealandiæ*, 3.85 cms. In all these species the first metatarsal (free) is of considerable size as compared with many other birds of similar sizes.





FROM A PHOTO. BY R. W. SHUFELDT.

*Pes* is normally constituted osteologically, being Passerine in every particular. The joints of the outer toe are delicate and small, while the claw of *hallux* is a big one, being equal, and more, in size to any two of the other claws of the foot combined.

#### CONCLUSIONS.

Judging from such material as I have at hand, and without having had the opportunity to study the osteology of some 40 other genera of the *Meliphagidæ*, it is clear, from what has been brought out in this paper, that, in so far as the skeleton is concerned, *Anthochæra carunculata* comes nearer to *Prothemadera novæ-zealandiæ* than it does to *Entomyza cyanotis*, thus confirming the *linear arrangement* for these genera of Sharpe in his "Hand-list" (vol. v., p. xiv.), where he places *Manorhina* and *Myzantha* between *Anthochæra* and *Prothemadera* on the one hand and *Anellobia*, *Acanthogenys*, *Myza*, *Leptomyza*, *Acrulocercus*, and *Chætoptila* between *Anthochæra* and *Entomyza* upon the other.

Osteologically, *Anthochæra carunculata* may be at once distinguished from the other two or three Meliphagidines with which it has here been compared by some of the characters of its pelvis; by the relatively much larger size of the bones composing the skeleton of its tail; by the sharp anterior ridges of the femoral condyles; and, with great certainty, by the morphology of its tarso-metatarsi, together with the relative lengths of the bones of the pelvic limb.

In the plates accompanying this paper (Plates II.-IV.) are presented the skeletons of other Passerine birds of Australia more or less related to the Red Wattle-Bird—some remotely, others nearer—which will be of marked value in the way of comparison, and of assistance to the avian osteologist of the future, when the study of the skeletons in other genera is taken up.

#### EXPLANATION OF PLATES.

(All the figures in these plates are reproductions of photographs made direct from the specimens by the author. Adult. Natural size.)

##### PLATE I.

- Fig. 1.—Skull of *Anthochæra carunculata*, seen upon right lateral aspect. Mandible articulated, but left ramus somewhat elevated, owing to the loss of its articular extremity.
- Fig. 2.—Circlet of sclerotal plates of an eye, viewed upon their outer aspect.
- Fig. 3.—Hyoidean arches, with the extended pair of cartilaginous rods which bear at their distal ends the "brush" of the tongue.
- Fig. 4.—Right lateral view of the trunk skeleton, with shoulder-girdle and sternum removed. (See fig. 5.)
- Fig. 5.—Shoulder-girdle and sternum, seen upon right lateral view. Left scapula, clavicle, and upper border of sternum of the left side can be seen in part, owing to the fact that the view is not absolutely direct.
- Fig. 6.—Skeleton of the left pectoral limb. Palmar side. For the most part the bones are normally articulated, but the humerus sublaxed.
- Fig. 7.—Left pelvic limb; bones *in situ*, but sublaxed. The patella is performed in bone, and the fibula is notably short.

## PLATE II.

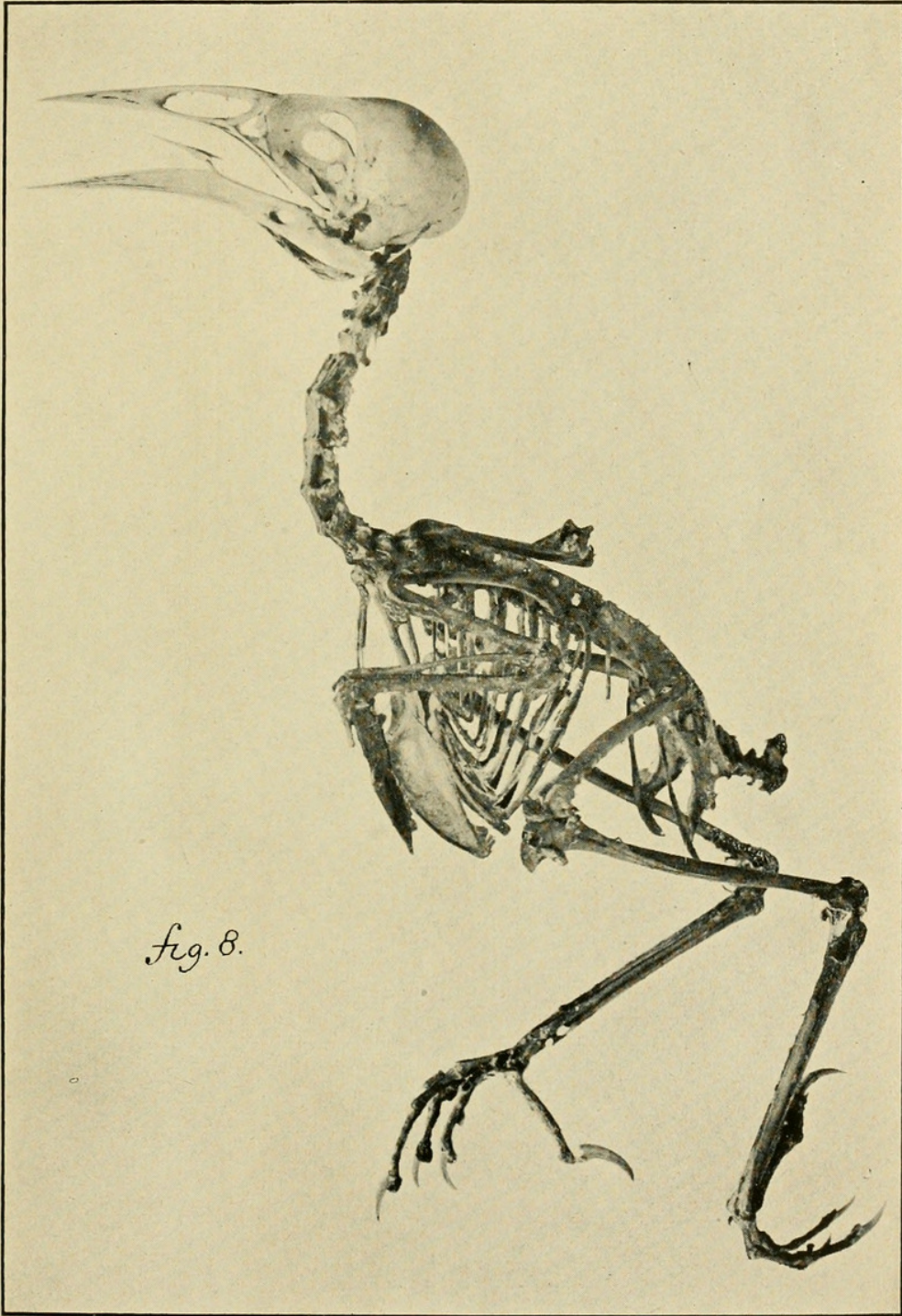
- Fig. 8.—Left lateral view of the skeleton of *Creadion carunculatus*, adult, natural size. (Coll. U.S. Nat. Mus., No. 18,289, where it is incorrectly catalogued as "*Anthochaera carunculata*," Taranga Islands.) In this specimen the skull has been perfectly cleaned up, but the balance of the skeleton, as will be observed, is more or less in the rough. It shows, however, many of the characters well, and the proportionate size, as compared with *Anthochaera carunculata*, it being about one-third less. (See Sharpe's "Hand-list of Birds," vol. v., p. 544.)

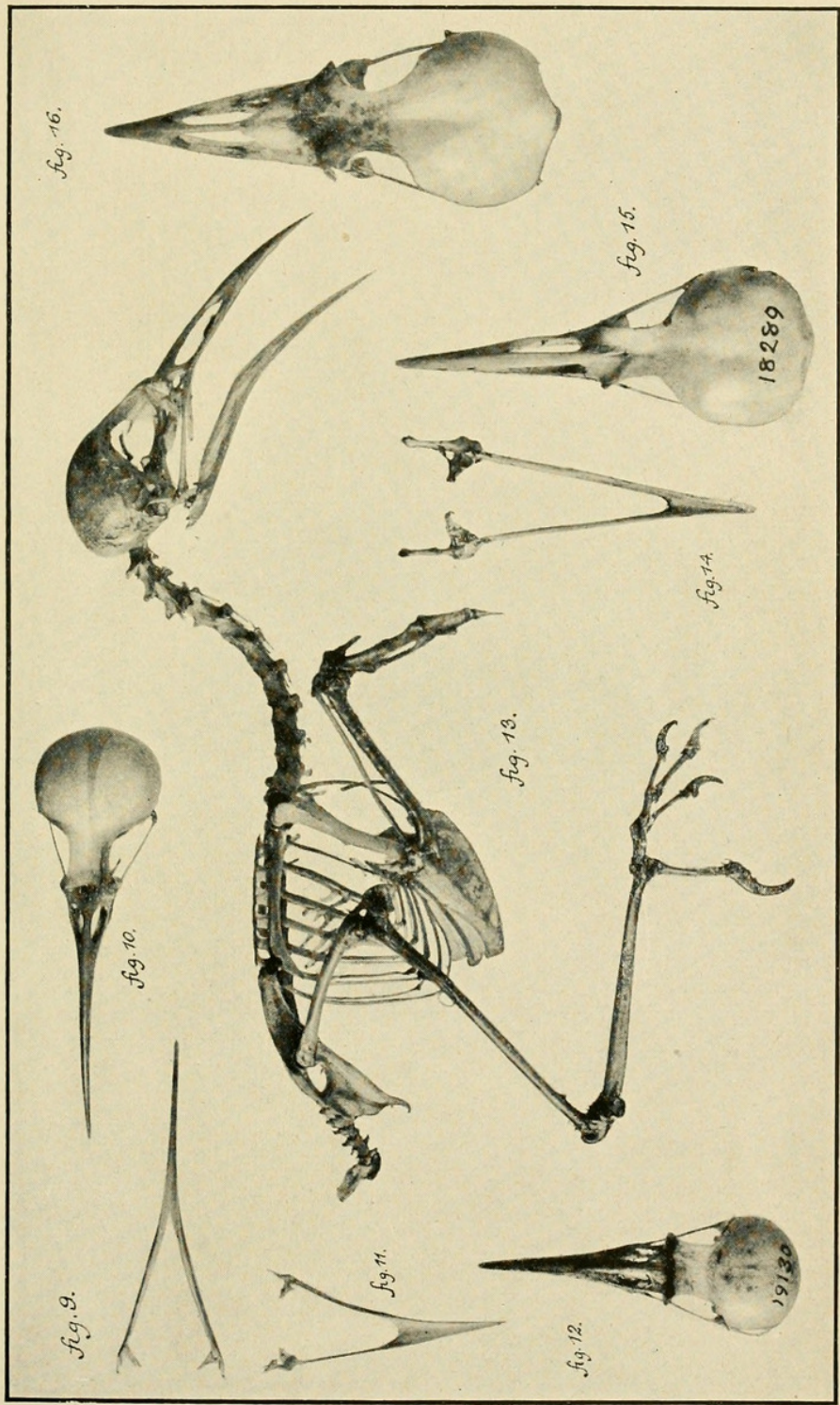
## PLATE III.

- (All the figures in this plate are natural size and reproduced from the author's photographs of the specimens.)
- Fig. 9.—Lower mandible of *Hemignathus procerus*, viewed from above; adult. (Coll. U.S. Nat. Mus., No. 19,094). The mandibles in this species are markedly, though gradually, curved downward for their entire lengths. The skull is shown in fig. 10 of this plate. (See Sharpe's "Hand-list of Birds," vol. v., pp. 134, 135.)
- Fig. 10.—Superior view of the skull of *Hemignathus procerus*, of which the mandible is shown in fig. 9 of this plate.
- Fig. 11.—Lower mandible of *Vestiaria coccinea*, adult. Seen on superior aspect. (Coll. U.S. Nat. Mus., No. 19,130). The bill is powerfully curved downward in this species. The skull is shown in fig. 12 of this plate, and is from the same specimen.
- Fig. 12.—Superior view of the skull of *Vestiaria coccinea*, of which the mandible is shown in fig. 11 of this plate.
- Fig. 13.—Right lateral view of the skeleton of *Acrulocercus braccatus*, adult. (Coll. U.S. Nat. Mus., No. 19,125.) Limbs of the left side and the hyoidean arches removed; right clavicle broken and somewhat displaced; otherwise quite perfect. (See Sharpe's "Hand-list of Birds," vol. v., p. 91.)
- Fig. 14.—Superior view of lower mandible of *Creadion carunculatus*. (No. 18,289, Coll. U.S. Nat. Mus.) From the skeleton shown in fig. 8, Plate II., of the present paper (which see).
- Fig. 15.—Superior view of the skull of *Creadion carunculatus*. (No. 18,289, Coll. U.S. Nat. Mus.) From the skeleton shown in fig. 9, Plate II., of the present paper (which see).
- Fig. 16.—Superior view of the skull of *Anthochaera carunculata*; mandible removed; adult. Same skull as shown in fig. 1, Plate I. of the present paper (which see).

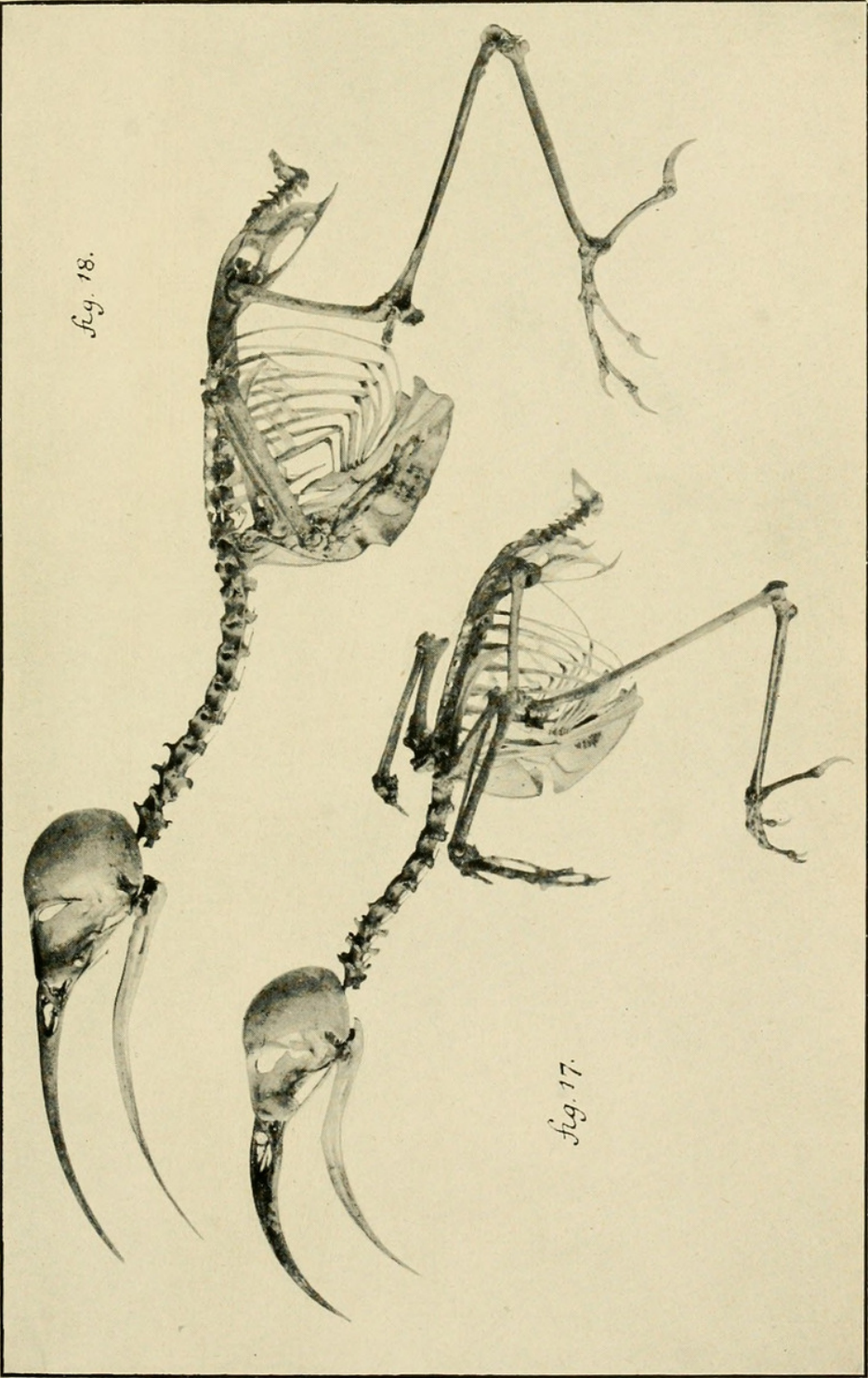
## PLATE IV.

- (The two figures in this plate are about one-seventh above natural size, and reproduced from photographs made direct from the specimens by the author.)
- Fig. 17.—Left lateral view of the skeleton of a specimen of *Vestiaria coccinea*. (Coll. U.S. Nat. Mus., No. 19,130.) See figs. 11 and 12, Plate III., of the present paper, where other views of the skull and mandible of this individual are presented. Right pelvic limb removed. Manus of right side broken off. Hyoidean arches removed, as well as the osseous portions of the larynx, trachea, &c. Ultimate vertebral rib of right side somewhat displaced.
- Fig. 18.—Left lateral view of the skeleton of a specimen of *Hemignathus procerus*. (Coll. U.S. Nat. Mus., No. 19,094.) See figs. 9 and 10 of Plate III. of this paper, where other views of the skull and mandible of this individual are presented. Right pelvic limb removed, also the hyoidean apparatus and the various ossifications of the air-passages. Otherwise this skeleton is remarkably perfect and well shown.





FROM A PHOTO. BY R. W. SHUFELDT.



FROM A PHOTO. BY R. W. SHUFELDT.



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