

ing plumage, and on the next or the following day another in the same plumage. Both specimens show conclusively that they are very young birds, each being in the undeveloped feather-stage peculiar to altricial birds just leaving the nest. As both specimens were taken in the same neighborhood, it is presumable that they were nest companions, although one is some days more developed than the other. I have shown them to Mr. J. A. Allen, who informs me that he knows of no instance of such immature birds migrating.

THE AFFINITIES OF CHÆTURA.

BY FREDERIC A. LUCAS.

FOR a long time the Swifts have been debarred from the society of passerine birds and made to associate with those contained in that avian waste basket, termed the order Picariæ. Of late, however, several ornithologists, notably Mr. Sharpe and Dr. Parker, have advanced a plea for their reinstatement in the order Passeres. Latest of these is Dr. Shufeldt who reaches the conclusion* that "the Swifts are essentially modified Swallows, and, as the family Cypselidæ, they belong, in the order Passeres, next to that group."

Notwithstanding the evident care of Dr. Shufeldt's work I must confess myself as unconvinced by the evidence he brings forward and will briefly review the case of *Chætura* as a plea for the continued separation of Swifts and Swallows and the retention of the first named family near the Hummingbirds. I am well aware of the risk I run in opposing my own slight knowledge of the subject to the results of Dr. Shufeldt's more extended studies, and it is with still greater diffidence that I venture to disagree with so distinguished a morphologist as Dr. Parker. Nevertheless, until still more evidence to the contrary is adduced, I will hold fast to Huxley's union of Hummingbirds and Swifts. As for the Caprimulgidæ, there are few, I think, who will object to their

* Contribution to the Comparative Osteology of the Trochilidæ, Caprimulgidæ, and Cypselidæ. Proc. Zool. Soc. London, Dec. 1 1885.

being placed in an order by themselves. They are a most attractive group of birds for study, and all that I have examined or seen figured offer good cranial generic characters, which is more than can be said for most birds. In the ensuing comparisons *Trochilus* may be construed as *T. colubris*, while *Chelidon* stands for *C. erythrogaster*, this bird having been chosen simply because its name is a little less formidable than that of most Swallows, and not from any peculiarity of its skeleton.

Before taking up the more salient structural characters, it may be well to say that, viewed in profile, the skull of *Chatura* is very suggestive of *Chordeiles*, while that of *Chelidon* unmistakably resembles that of a Flycatcher. The sphenoidal rostrum of *Chatura* is broad, the palatines are separated from one another, and the pterygoids are in close proximity to the basi-temporal region,* all characters wherein *Chatura* agrees with *Trochilus* and differs from *Chelidon*. This bird has the rostrum narrow, the palatines applied to each other posteriorly, and the pterygoids standing well out from the basi-temporal region, as in the higher Passerines. In *Chatura* the curiously expanded end of the vomer abuts on the maxillo-palatines, with which in young birds it is intimately connected. While this is wholly unlike the sharp-pointed, anteriorly free, vomer of *Trochilus*, and more nearly resembles the typically passerine vomer of *Chelidon*, yet the vomer of *Chelidon* is quite free from the maxillo-palatines, although it overlies them for its entire length. Now, among the Goatsuckers, *Chordeiles* has a slender, pointed vomer, which at first rests upon and later in life coalesces with the united maxillo-palatines, while in *Antrostomus*, and to a less extent in *Nyctidromus*, the vomer is broad and at its free extremity articulates with the maxillo-palatines. Assuredly there is an interesting suggestion of relationship between *Chatura* and the Goatsuckers, and a study of the embryology of the former bird would undoubtedly yield good results. The maxillo-palatines of *Antrostomus* terminate in recurved points which bear a certain resemblance to the slender, curved maxillo-palatines of *Chatura*. In *Chelidon* these bones are expanded at their free extremities, these expansions having the

*Perhaps I over estimate the importance of this last character, but it is a pronounced feature of many 'Picariæ,' notably of the Woodpeckers and Goatsuckers, less so of the Cuckoos.

same peculiar and characteristic shape in the six species of Swallows at my disposal.*

The maxillo-palatines of *Trochilus* are apparently not prolonged, but it would be unsafe to affirm too positively that such is the case before examining some large species, since, even if present, they would be filamentous in character.

I will touch but briefly on the vertebral column and ribs, as both time and space are wanting for a careful analysis of the characters contained therein. The following table shows the number of vertebræ and ribs in *Trochilus*, *Chætura*, and *Chelidon*, the two *Limosa* being added to show of how little value is the mere number of vertebræ. *L. rufa* is quoted from Eyton, and while his term 'sacral' includes some presacrals and some caudals, neither the total number of vertebræ nor the proportion of true dorsals and cervicals is thereby affected.

	<i>Trochilus.</i>	<i>Chætura.</i>	<i>Chelidon.</i>	<i>Limosa</i> <i>fedoa.</i>	<i>Limosa</i> <i>rufa.</i>
Cervicals.....	13	14	13	15	12
Presacrals.....	8	7	8	11	7
Sacrals.....	4	3	3	4	15
Caudals, including pygostyle....	9	12	12	12	6
Total	34	36	36	42	40
Cervical ribs	1	2	1	2	1
True ribs.....	8	7	6	8	7

The term sacral is here applied to the *true* sacrals as defined by Huxley and Parker.

According to the above table, *T. colubris* possesses one more vertebra than does *T. alexandri*, while the arrangement of ribs is also different. At first sight the last, free rib seems to be without a corresponding vertebra, but careful examination shows that the last apparent presacral vertebra is really composed of two. Very fortunately there was one specimen of *Trochilus* among my material in which the vertebræ could be clearly counted. Very significant is the fact that the last rib of *Chætura*, like that of *Trochilus*, is imperfect, only the lower moiety with its attached sternal rib being present. A similar condition is found in the Loons, but not that I am aware of in any passerine bird. *Cypselus* is the same as *Chætura* and I venture the prediction that careful dissection will reveal this rib in *Panyptila*.

*In Dr. Shufeldt's figures of *Panyptila* and *Tachycineta* the maxillo-palatines are imperfect.

The free caudals of *Trochilus* and *Chætura* agree in having long, slender, recurved transverse processes, in which particular they resemble the Goatsuckers, and contrast with the Swallows, whose short transverse processes are like those of other Passeres.

A character of great importance is found in the manner in which the ribs join the sternum. In *Trochilus* and *Chætura* they articulate with the *body* of the sternum, while in *Chelidon*, as in all Passeres I have examined, the ribs are attached only to the costal process. In this particular, as in many others, the Goatsuckers more nearly resemble the passerine birds than does *Chætura*. To say nothing of the great depth of keel* possessed by both *Trochilus* and *Chætura*, their sterna agree in having small costal processes and un-notched, rounded posterior borders. In *Chætura*, as Dr. Shufeldt has noticed in *Panyptila*, there are numerous vacuities in the body of the sternum and the upper part of the keel. This is but an exaggeration of the structure found in *Trochilus*, whose sternum is honey-combed by irregular depressions which in many places lack but little of completely perforating the walls of the sternum.

The manubrium is entirely wanting in *Trochilus* and very small in *Chætura*.

In all these particulars *Chætura* and *Trochilus* contrast strongly with *Chelidon*, which has the large Y-shaped manubrium, prominent costal processes, and deeply bi-notched sternum so characteristic of the Passerines.† The sterna of *Chordeiles* and

* Speaking of *Panyptila*, Dr. Shufeldt says (p. 907) "the keel to the sternum is not so deep in comparison with the remainder of the bone as we often find it among Passeres, and in this particular it is not to be mentioned with the extraordinary carinal development of *Trochilus*."

Dr. Shufeldt's eye has certainly deceived him here, for a pair of dividers applied to his figures shows that the proportion of length to depth is very nearly the same in both. As to the matter of carinal development among the Passeres, I must confess myself unable to name one which at all equals *Chætura* or *Panyptila*. At the same time it must be borne in mind that these proportions do not show the true state of the case, since *Trochilus* and *Chætura* have sterna not only unusually deep but unusually long. The relation of depth to length is much greater in the sternum of *Chordeiles* than in *Trochilus*, but the breast bone of *Chordeiles* is a short one. In *Chætura* and *Campylopterus* the proportion of length to depth is identical.

† Among birds the characters afforded by the sternum are so important that I must confess myself a little surprised that Dr. Shufeldt should so readily reject them (see p. 914), when only two pages before he lays stress on the development of the phalanges. The notched or un-notched condition of the xiphoid border is in no way due to physiological adaptation, while the modifications of the phalanges are very largely so caused. Some of the parrots fly well, some very poorly, none at all compare with *Trochilus* or *Chætura*. And yet all (*vide* Huxley) have the sternum un-notched.

Trogon resemble each other closely and are intermediate in form between those just described. In these birds the manubrium is absent, the costal processes large, and the xiphoid border marked with two rounded excavations.

The coracoids of both *Chætura* and *Trochilus* are short and stout, and in both birds these bones, instead of resting in the usual coracoid groove, articulate with a raised oval facet, forming a shallow ball and socket joint. While there is as wide a difference between the coracoids of *Chætura* and *Trochilus* as Dr. Shufeldt points out between *Trochilus* and *Panyptila*, this discrepancy is almost entirely due to the unusual development of the inner edge of the bone in *Trochilus*. This is so great as to make the distal end of the coracoid as wide as the proximal, while the prolongation of the clavicular process and its fusion with the scapular process forms a tendinal *foramen*. There is nothing of this in *Chætura*, but there *is* a good sized foramen corresponding to the lower foramen of *Trochilus*, and the coracoid as a whole is entirely different from the long, slender, imperforate bone we find in *Chelidon* and other typical Passeres. Here, again, *Chordeiles* stands intermediate between *Chætura* and *Chelidon*, the coracoid being moderately stout, but long and imperforate. The furculum of *Trochilus* is widely U-shaped, has an almost rudimentary hypocleidium, is devoid of an anterior process at its articulation with the coracoid, and is so short as to reach but half way to the anterior angle of the sternal keel.*

The furculum of *Chætura* agrees with that of *Trochilus* in all respects save width, and even here it greatly exceeds the corresponding bone of *Chelidon*. The furculum of *Chelidon*, moreover, reaches from coracoid to angle of sternum, has clavicular ends anteriorly expanded, and a large backwardly directed hypocleidium.

The point of the scapula has a downward droop in *Trochilus* that is wanting in that of *Chætura*, but in the nestling of this latter bird the cartilaginous supra-scapula is bent downward at an angle even greater than in *Trochilus*. The curious shape of the humerus in *Trochilus* and *Chætura* is due to the total sup-

* This shortness is not only *apparent* but *real*, and is not due to the depth of keel. Owing to the shortness of the coracoids the furculum of *Chelidon* will reach from scapula to angle of keel in *Chætura*, and that of *Virco* will do the same for *Campylopterus*.

pression of the shaft, the elongation of the distal head, and the exaggeration of all ridges.* The shortness of the humerus in *Trochilus* is remarkable, but in this particular it is equalled by *Chætura*, while the strange development of the radial ridge in this latter bird is, so far as I am aware, peculiar to the Swifts. The humerus of *Chelidon* is merely that of any typical Passerine a little shortened. *Os humero-scapulare* is present in *Chelidon*, but I have been unable to find it either in *Chætura* or *Trochilus*. This, however, does not signify much, for this little bone is found in such a distant relative of the Passeres as *Sticatornis*. *Trochilus* has two anconeal sesamoids; *Chætura*, *Chelidon*, and many Passerines have but one.†

The curious, straight antebrachium of *Chætura* is apparently another peculiarity of the Swifts, and bears no resemblance whatever to the forearm of either *Trochilus*, *Chelidon*, or *Chordeiles*. The radius and ulna of *Trochilus* are strongly bowed outward from one another, an arrangement which probably has some direct relation to the rapidity with which the wing is moved, for the same thing occurs in *Tinamus*, and to a less degree in the Gallinæ, and these birds are noted for their rapid wing beats. The principal bone of the carpus, the ulnare, is very similar in both *Trochilus* and *Chætura*, its inner side being prolonged into a process which overlaps, or underlies the metacarpus. The ulnare of *Chordeiles* resembles that of *Chætura*, but the ulnare of *Chelidon* has the roughly trihedral shape customary among the Passeres. The second metacarpal of *Chætura* is round, as in *Trochilus* and *Chordeiles*, and is very different from the broad, flat metacarpal of *Chelidon*, *Ampelis*, and other passerine birds. Its length in comparison with the ulna is the same in *Chætura* and *Trochilus*.

The first phalanx of the second digit is proportionally much

* A word in regard to variation. Apparently the smaller the bird the more exaggerated the characters of its bones. Thus little *Scelasphorus* with its narrow wings has in proportion to its size a more widely forked furculum, a stouter and more rugose humerus, and deeper sternal keel than its larger relative *Campylopterus*.

† The majority of passerine birds dissected by me have an anconeal sesamoid, one on the ulnar side of the carpus, and one on the anterior edge of the wing at the base of the first phalanx of the second digit. I am inclined to believe that these sesamoids are seldom if ever lacking in Passeres except when lost in preparation, as may readily happen.

shorter in *Chætura* than in *Trochilus*. In shape it is intermediate between *Trochilus* and *Chordeiles*, *Trochilus* being intermediate between *Chordeiles* and *Chelidon*. The first phalanx of the third digit of *Trochilus*, although long and slender, does not begin to equal in these respects the corresponding phalanx of *Aptenodytes*, and is approximated even by *Chordeiles*, so that mere length can hardly be adjudged a good distinctive character. In the manner in which the second and third digits articulate with the metacarpus *Trochilus*, *Chætura* and *Chordeiles* agree very well among themselves, showing little of the 'breaking joints' found in *Chelidon* and other Passerines. In the proportional length of the outer phalanx of the second digit *Chætura* falls a little short of *Trochilus*, although vastly exceeding *Chelidon*.

The most remarkable feature in the pelvis of *Trochilus* is the great length of the slender, incurved pubes, which almost touch one another. This is also the case with *Chætura*, although to a much less degree. In *Chelidon*, on the contrary, the pubes are of but moderate length and but slightly incurved, so that they are very far removed from one another at their extremities, as in the higher Passerines. *Chordeiles*, in this as in other particulars, lies between *Chelidon* and *Chætura*.

A slighter character is found in the varying development of the ilio-neural grooves. These are practically obsolete in *Trochilus* and nearly so in *Chætura*, shallow in *Chordeiles*, and deeply excavated in *Chelidon*, *Ampelis*, *Merula*, and others. The region immediately over the true sacrals is strongly tumose in both *Trochilus* and *Chætura*, but not at all in *Chelidon*, or even *Chordeiles*.

Passing by the femora, which present few salient characters, we find that *Trochilus* and *Chætura* have the *cnemial* ridges of the tibia but poorly defined, while in *Chelidon* they stand forth as boldly as in *Merula*, *Chordeiles* again holding a median position. In *Trochilus* the fibula is one-fourth the length of the tibia, in *Chætura* less than one third, in *Chelidon* over one-half.

Both *Trochilus* and *Chætura* have a deep groove on the front of the 'tarsus,' at the lower end of which is a comparatively large foramen. Not only *Chelidon* but *Chordeiles* also has the shallow tarsal groove and minute perforation of the higher Passerines. *Trochilus* is peculiar in having a deep notch or emargination on the inner side of the 'tarsus' near its proximal extremity.

Trochilus, *Chætura*, and *Chelidon* all agree in having the penultimate phalanges of the foot much the longest of the series, *Chætura* standing first in the list. In this respect the three disagree with *Chordeiles*, in which the phalanges are inclined to be sub-equal. Finally, both *Trochilus* and *Chætura* have the three anterior digits of the foot somewhat equal in length, while *Chelidon* has the middle digit much longer than the others, and *Chordeiles* exaggerates the condition existing in *Chelidon*.

In thus reviewing the affinities of *Chætura*, I am fully aware that my comparisons have not been so extended as could be wished, but to have done the subject justice would have required an amount of time and material that unfortunately do not lie at my disposal. As Dr. Parker well says, "the structures of the skull and face govern the entire body," yet where these are divided in their allegiance it is surely allowable to fall back on other characters. Now, if I have read the skull of *Chætura* aright, it has affinities not only with the Passeres but with the Hummingbirds and Goatsuckers.*

Such being the case the remaining portions of the skeleton would seem unmistakably to point to the relationship of *Chætura* with *Trochilus*, while between these birds and the Passeres stand the Goatsuckers.

I am indebted to my friend, Mr. L. M. McCormick, for his kindness in supplying me with the specimens of *Trochilus*, *Chætura*, and Swallows on which this article has been mainly based, and to the National Museum for the use of the other material.

[Since this paper has been in the printer's hands Mr. J. W. Scollick has furnished me with a specimen of *Cotile riparia*, thus enabling me to examine all the North American Swallows. Dr. W. K. Parker has most kindly sent me *Cypselus apus*, and although I have not as yet had time to fully prepare the skeleton and compare it carefully with *Chætura* yet it promises to show no marked differences from that bird except, of course, in the numbering of the phalanges.]

* In order to be free from preconceived ideas Dr. Parker's matchless treatise on the Skull of Ægithognathous Birds was not consulted until this paper was finished. It is now a source of great satisfaction to me to find that in this, as in other places, I have followed in the footsteps of so trustworthy a guide.