

bird. There is no evidence that *griseus* interbreeds with *marianæ*, and I think it should be give full specific rank. The breeding range of *griseus* extends along the South Carolina coast as far north as the mouth of the Santee River. A glance at the map of South Carolina, will show that there are no salt marshes of any extent from Georgetown to Southport, N. C., in which this wren could breed.

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## THE FEATHER TRACTS OF SWIFTS AND HUMMINGBIRDS.

BY HUBERT LYMAN CLARK.

*Plates II and III.*

SOME years ago I undertook to obtain material for a study of the arrangement of the feather tracts in the Swifts and Hummingbirds. Through the kindness of the authorities of the United States National Museum, the alcoholic material in that collection was placed at my disposal, and was carefully examined. Later on, some beautiful hummingbird material from Arizona came into my possession through the efforts of Mr. R. D. Lusk, and in 1897, Mr. C. B. Taylor of Kingston, Jamaica, presented me with some very valuable specimens of both swifts and hummingbirds. In April, 1901, a brief statement appeared in 'The Auk' concerning the conclusions to which the study of this material had led me, and a more extended reference to them appeared in 'Science' for January 17, 1902. The preparation of the entire report, however, was continually postponed in the hope of obtaining more specimens, and in July, 1905, through the kindness of Dr. Witmer Stone, some alcoholic hummingbirds from Brazil were loaned me by the Academy of Natural Sciences of Philadelphia. As there is little



probability at present of securing in this country further material of importance, I have decided to delay no longer the publication of this account of the work that has been done and the conclusions reached.

It is an interesting fact that the pterylography of no group of birds has received so much attention as has that of the swifts and hummingbirds. The classic work of Nitzsch ('40) deals quite fully with the matter, so far as his material and methods allowed. Shufeldt ('88) has given a very full account of the pteryloses of both swifts and hummingbirds, making use however of Nitzsch's figures, which are, unfortunately, very inaccurate. Lucas ('92) has described the pterylosis of the hummingbirds in Ridgway's paper on that group, giving figures of the dorsal and ventral aspects of *Florisuga mellivora*. Thompson (:01) has described in full, and figured well, the pterylosis of *Patagona gigas*, compared it with both *Caprimulgus* and *Collocalia*, and given a figure of the dorsal aspect of the latter. His conclusions were criticised by me in 'Science' (January 17, 1902) and Shufeldt published a counter criticism in 'The Condor' (March-April, 1902), to which a brief reply was made in the next issue of the same journal (May-June, 1902). Discussion centers around the question whether the swifts and hummingbirds have essentially distinct and unique pteryloses or not, and to this question we shall return when we have completed an examination of the evidence in the case. The pterylography of the swifts will be considered first, a brief general description of the cypseline pterylosis being followed by a short account of each genus examined. The account of the hummingbirds follows in the same way, after which the two groups are compared, and final conclusions stated.

In this connection I wish to thank Mr. Lusk, Mr. Taylor, Mr. Stone, and especially Mr. F. A. Lucas, for the help they have given me in securing the needed material, without which nothing could have been done, and to Mr. Stone and Dr. J. A. Allen, I am indebted for assistance in nomenclature.



## CYPSELI.

The general pterylosis of the swifts is very distinctive and remarkably uniform, so that the figures of *Chætura pelagica* (Plate II) will answer with slight changes for any of the other species. The tracts are all clearly defined and well feathered, while the apteria are uniformly naked. The forehead is quite thickly feathered, but with large crescent-shaped apteria over the eyes, while the crown and occiput are rather sparsely feathered, in longitudinal rows. The throat is fully feathered but there are apteria along the rami of the lower jaw. The upper cervical tract is very broad, and unites along the sides of the neck with the lower cervical tract, so that there are no lateral cervical apteria. Between the shoulders, it bifurcates to form the dorsal tract. On the anterior part of the neck, close to the head, is a large and very evident apterium, one of the most characteristic features of the pterylosis. It is a very curious fact that Shufeldt ('88 and :02) positively denies the existence of this apterium in the swifts, while Lucas ('92) states that "some of the swifts" possess it, and Thompson (:01) makes no reference to it in his description of *Collocalia*, though his figure shows an entire absence of feathers on the anterior dorsal part of the neck. A careful reëxamination of my material, figures and notes, leaves no doubt whatever of the existence of this apterium in every species of swift examined. I can only account for Shufeldt's statements by supposing that they are based on his examination of *Chætura pelagica* and *Aëronautes melanoleucus*: in *Chætura* this apterium is not very large, while in *Aëronautes* it is smaller than in any other swift. It is not inexplicable therefore that it was overlooked in these cases, but it is hard to see how it could have been overlooked in *Cypseloides*, which he also examined.—The dorsal tract is divided from the shoulders to the middle of the sacrum, by another long but narrow apterium, into two narrow bands of nearly uniform width, but it ends in a single narrow band at the base of the oil gland. The anterior portion of the space between the dorsal and humeral tracts is sometimes separated from the rest so as to form a small but quite distinct apterium on each side of the upper cervical tract. This is well shown in *Chæ-*



*tura*. The femoral tracts though diffuse, are very evident, and are usually long, so that they extend backward almost or quite to the tail-coverts, while anteriorly they reach downward and forward, often to the sternals and along the sides to the posterior end of the humerals. The latter tracts are narrow or of moderate width, passing over the humerus either at its head or near the middle, and are clearly connected with the feathering on the patagia of the wings and even with the upper cervical tract. The large oil gland is almost surrounded by a small tract, chiefly made up of the upper tail-coverts.

The lower cervical tract is forked quite far forward on the neck, and each half passes into a broad sternal tract which continues without interruption, though becoming narrower, to the belly, where it ends rather abruptly. In many swifts just at the point where these pteryllæ leave the neck and pass on to the breast, an anteriorly divergent fork of the ventral apterium nearly severs them; this is most evident in *Chætura* and *Hemiprocne*. In some of the large swifts (*Hemiprocne*, *Cypseloides*) scattered feathers in the region of the furculum tend to unite the anterior ends of the 2 sternal tracts. There is nothing else peculiar or specially noteworthy in the ventral pterylosis, but the sternals are connected anteriorly over the shoulders with the humeral tracts and posteriorly, occasionally, with the femorals.

The characteristic and important features of this pterylosis may be summarized as follows: the presence of supraocular apteria, an upper cervical apterium, and a long and conspicuous spinal apterium, the absence of lateral cervical apteria, the large and diffuse femoral tracts, and the continuity and marked development of the lower cervical, sternal and ventral tracts. In addition to these features, the following points are noteworthy. Aftershafts are present on the contour feathers and are often very large. True down feathers are wanting and filoplumes are not notably abundant, though usually evident on the neck and the posterior part of the back. The oil gland never bears a terminal tuft of feathers. There are always 10 rectrices and 10 primaries. The alula consists of 2 or 3 feathers and in some cases there is also a distinct claw. The secondaries are usually 8 or 9 in number, and the wing quincubital, but in *Cypseloides*, *Hemiprocne* and *Macrop-*



*teryx* there are 10 or 11 secondaries and the wing is aquincubital. Except in *Macropteryx* and *Collocalia*, the skin on the hand is very dark, and this darkening extends in some cases not only along the forearm but nearly to the shoulder.

The above account of the cypseline pterylosis is based upon the examination of 15 swifts, representing 10 species and 8 genera. Nitzsch ('40) studied *Hemiprocne collaris* Temm., *H. acuta* (*Cyps. acutus* Pr. Max v. Neu Wied.) and *Cypselus apus*; Shufeldt ('88), *Chætura pelagica*, *Aëronautes melanoleucus*, and *Cypseloides niger*; and Thompson (:01), *Collocalia epodiopyga*; but so far as I know, the pterylosis has not been examined in any others of the Cypseli. The genera will now be considered in detail.

### Macropteryx.

It is especially noteworthy that the pterylosis of this interesting genus does not differ in any essential point from that of *Chætura*. The nuchal apterium is present but is quite small, as the upper cervical tract is comparatively long and narrow. The femoral tracts are notably strong posteriorly. The legs are feathered about to the tarsal joint. The skin on the hand is not dark. The 10 rectrices, 10 primaries, 11 secondaries, and 3 alula feathers are not peculiar, but the wing is aquincubital.

#### *Specimen examined.*

No.	Name.	Collection.	Condition.
1	<i>Macropteryx coronata</i> (Tickell).	U. S. Nat. Museum.	Alcoholic; fair.

### Collocalia.

The single specimen of this genus which I was able to examine was in poor condition, but the only points in which its pterylosis appeared to differ from that of *Chætura* is in the shape of the upper cervical tract, which is longer and narrower, and the nuchal apte-



rium, which is correspondingly narrow. The tarsus is feathered part way down in front. The skin on the hand is not specially dark. There are 10 rectrices, 10 primaries and 9 secondaries and the wing is quincubital. The alula consists of 2 feathers.

*Specimen examined.*

No.	Name.	Collection.	Condition.
1	<i>Collocalia</i> sp.?	U. S. Nat. Museum.	Alcoholic; poor.

Thompson (:01) has given a very detailed account of the pterylosis of the head and wing of *Collocalia* and a somewhat briefer description of that of the body. He has also figured the dorsal aspect of the plucked bird. So far as the head and wing are concerned, his figure and descriptions are very good, but it is necessary to take exception to his statements concerning the cervical and femoral tracts. He says that the dorsal tract "runs more than half way up the neck" but does not mention any connection with the pterylæ on the head, and his figure does not show any; either his specimen was peculiar and I must believe, abnormal, or else he has overlooked the real connection which exists. He also states that the "pectoral tracts are . . . separated from the feathering of the neck"; if that is correct, I must consider the specimen still more unique. The statement that there is "no well-defined femoral tract" is not so contradictory to his own figure and to what I have described above, as at first appears, for on page 324, he refers to a "lumbar" tract in *Collocalia*, which indicates that he there uses that term for what is, in this paper, called "femoral"; the word "lumbar" is not used elsewhere in his paper. It is greatly to be regretted that these discrepancies should occur between his paper and my observations. Further study of the pterylosis of this genus is very desirable.



**Chætura.**

(Plate II, Figs. 1-3.)

The general pterylosis is better shown by the figures given than by any amount of description. The humeral tracts are somewhat narrower than in some genera and less clearly connected with the femoral. The dorsal bands are unusually narrow, especially posteriorly. The legs are feathered to the tarsal joint. The skin on the hand is very dark, but not on the forearm. There are 10 rectrices, the first longest, the fifth shortest. Of the 10 primaries, the first is longest. There are 8 or 9 secondaries, but the first 6 are much longer than the others, and the ninth, when present is very small indeed. The wing is quincubital. The alula consists of 2 feathers.

*Specimens examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Chætura pelagica</i> (Linn.).	—	U. S. Nat. Mus.	Alcoholic; fair.
2	" "	—	" "	" "
3	" "	Amherst, Mass.	H. L. C.	" "
4	" "	Olivet, Mich.	" "	" very good.

**Hemiprocne.**

The general pterylosis is essentially the same as in *Chætura*. The ventral cervical apterium is very well defined, and is separated from the great ventral apterium by numerous feathers in the region of the furculum. The femoral tracts are very broad and extend backward to the upper tail-coverts, but their anterior prolongation on the sides is not specially noticeable. The legs are feathered to the tarsal joint. The skin of the hand is very dark, but that of the forearm is lighter. There are 10 rectrices, of which the outer ones are longest and the middle pair shortest. Of the 10 primaries, the tenth is the longest and the others are successively shorter to the first. There are 10 secondaries and the wing is aquincubital. The alula consists of 3 feathers and a distinct claw.



*Specimen examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Hemiprocne zonaris</i> (Linn.)	Jamaica.	U. S. Nat. Mus.	Alcoholic; very good

Nitzsch refers to the "lange, kräftige, dichtfiedrige" femorals, and to the width of the branches of the dorsal tract, "ziemlich breit" in *collaris*, "zweireihig fiedrig" or "einreihig" posteriorly in *acuta*. In both, he says, he found "sechszehn Schwingen," which is probably a mistake.

**Cypseloides.**

(Plate II, Figs. 4-5.)

The general pterylosis of this genus is not essentially different from that of *Chætura*, but the tracts are wider and more thickly feathered. The legs are feathered to the tarsal joint. The skin on the hand and forearm, and even on the upper arm, is very dark. There are 10 rectrices, 10 primaries, and 10 secondaries, and the wing is aquincubital. The alula consists of 3 feathers and a little claw.

*Specimen examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Cypseloides niger</i> (Gmel.).	Jamaica.	U. S. Nat. Mus.	Alcoholic; very good.

**Tachornis.**

In this genus, the nuchal apterium is small, but otherwise the pterylosis is remarkably like *Chætura*. The legs are sparsely feathered to the very base of the toes in front, but the tarsus is bare behind. The skin on the hand is almost black, and the darkened color extends nearly to the shoulder. There are 8 rectrices and



10 primaries; of the latter, the ninth is the longest, and even the eighth is longer than the tenth. There are 10 secondaries, the wing is quincubital, and the alula consists of 2 feathers.

*Specimens examined.*

No.	Name.	Collection.	Condition.
1	<i>Tachornis parva</i> (Licht.).	U. S. Nat. Museum.	Alcoholic; fair.
2	" "	" "	" good.

**Aëronautes.**

This genus is notable for the very small nuchal apterium but in other respects is very similar to *Chætura*. The legs are feathered in front to the base of the toes. The skin on the hand is very dark. There are 10 rectrices, and 10 primaries of which the ninth is longest. The wing is quincubital and has 9 secondaries and 3 feathers in the alula.

*Specimens examined.*

No.	Name.	Collection.	Condition.
1	<i>Aëronautes melanoleucus</i> (Baird)	U. S. Nat. Museum.	Alcoholic; good
2	" "	" "	" "

**Micropus.**

The humeral tracts in this genus are somewhat peculiar, for in *melba* they seem to have a small horizontal branch on the inner side extending in towards the dorsal, while in *æquatorialis* and *streubeli*, they pass very nearly over the head of the humerus and thus are nearer the dorsal tract than in *Chætura*. In *melba*, the nuchal apterium is short and wide, but in the others is long and narrow. The legs are feathered to the toes in front, in *æquatorialis* and *streubeli*, but only about half way down the tarsus in *melba*. The skin on the hand is very dark but not on the forearm. Of



the 10 rectrices the middle pair is shortest, the outer ones longest; in *streubeli*, however, there is a sexual difference, for the tail is only a very little forked in the female, while in the male the fork is deep and the feathers narrowed. Of the 10 primaries, either the ninth or tenth may be longest. The quincubital wing has 8 or 9 secondaries and the alula is made up of 2 or 3 feathers.

*Specimens examined.*

No.	Name.	Collection.	Condition.
1	<i>Micropus melba</i> (Linn.).	U. S. Nat. Museum.	Alcoholic; good.
2	" <i>æquatorialis</i> (Müll.).	"	" "
3	" <i>caffer streubeli</i> (Hartl.) ♂	"	" "
4	" " " ♀	"	" "

**Cypselus.**

Nitzsch describes and figures the pterylosis of *Cypselus apus*, but the arrangement of the feathers and tracts on the head and neck are certainly not as he shows it, unless we are to believe that this genus differs radically from all other known swifts. He says there are "achtzehn Schwingen," which is probably correct.

**TROCHILI.**

The hummingbirds are another group in which the pterylosis is remarkably uniform and quite distinctive, so that the figures given of *Trochilus alexandri* will answer with slight changes for any other species. The tracts are well defined and the apteria are perfectly bare. The head is not thickly or uniformly clothed but on the contrary the feathers tend to form longitudinal rows or narrow tracts with more or less definite apteria between. Thompson (:01) figures and describes admirably no less than 10 apteria on the head of *Patagona*, and other hummingbirds show the same general arrangement. Of these apteria, the most important are those to which he gives the names *frontal* and *supraocular*, both



being characteristic of the Trochili. The upper cervical tract is completely united on each side of the neck with the lower cervical for a considerable distance, so that there is a distinct lateral cervical tract for some little distance on the side of the neck, which ultimately divides to form the real cervicals. The conspicuous and characteristic nuchal apterium occupies the upper surface of the greater part of the neck. The humeral tracts are well defined, rather short, pass over the upper end of the humerus, and at their posterior end are usually very slightly connected by 2 or 3 feathers with the dorsal tract. The latter is very broad, covering most of the back, but contains a long and conspicuous spinal apterium. Posteriorly it unites more or less completely with the femoral tracts, though the latter are usually quite easily distinguished, as the feathers composing them are larger and stouter than those which connect them with the dorsal. The lower cervical tract is divided as far forward as the angle of the mouth, into two branches, which for a part of their length are united with the upper cervical, as already described. Each half passes backward, over the sides of the breast, as the sternal tract, which is wide and well developed; they terminate so abruptly just posterior to the margin of the sternum that there are practically no ventral tracts. Anteriorly the sternal tracts are connected over the shoulders with the feathering on the upper side of the wings and thus with the humerals.

The characteristic and important features of this pterylosis may be summarized as follows: the presence of frontal and supra-ocular apteria, a very large and conspicuous nuchal apterium, and a long and conspicuous spinal apterium, the absence of lateral cervical apteria, the small femorals noticeably connected with the dorsal, the well-marked sternals and practical absence of ventrals. In addition to these features, the following points are worthy of note. Aftershafts are present on the contour feathers though very weak. True down feathers are wanting and filoplumes are not notably abundant except on the neck and to a lesser extent on the back. The oil gland never bears a terminal tuft of feathers. There are always 10 rectrices and 10 primaries; of the latter, the tenth is the longest, the others successively shorter. The alula is usually wanting, though a single feather is sometimes present



indicating its position. The secondaries are usually 6, but not uncommonly 7, in number, and the wing seems to be generally aquincubital, though in several cases examined it was clearly quincubital. In one instance one wing had 6 secondaries and was clearly aquincubital as in *Patagona*, while the other wing had 7 secondaries and was as certainly quincubital. Apparently this point in wing structure is no longer of significance in the hummingbirds. The skin on the hand is often very dark, and this color extends more or less markedly onto the forearm.

This account of the trochiline pterylosis is based on the careful examination of 31 hummingbirds, representing 17 species and 15 genera, and on Thompson's (: 01) very valuable study of *Patagona gigas*, Nitzsch's ('40) figure and description of *Chrysolampis moschitus*, Shufeldt's ('88) account of *Selasphorus platycercus*, and Lucas's ('92) figure and brief description of *Florisuga mellivora*. So far as I know, no other hummingbirds have ever been examined pterylographically. The various genera will now be considered in detail.

### **Campylopterus.**

Reference is made to this genus only because Lucas ('92) states that the skin of the hand is "colored black" as in the swifts and some other hummers.

### **Florisuga.**

The single specimen examined showed no peculiarities, except that there were apparently only 9 primaries, doubtless accidental or an abnormal condition. The skin on the hand is black.

#### *Specimen examined.*

No.	Name.	Collection.	Condition.
1	<i>Florisuga mellivora</i> (Linn.)	U. S. Nat. Museum.	Alcoholic; very poor.

The figure and description of this genus given by Lucas ('92) are fairly good, though I find no tendency in the sternal tracts to



connect with each other near the furculum, either in *Florisuga* or any other hummer, as indicated in Lucas's figure. Moreover the head and wing are too closely feathered, and the humeral tracts are not well enough defined. Incidentally, I wish to dissent strongly from Lucas's statements as to the reasons for the existence of the various apteria.

### Patagona.

The pterylosis of this genus, so admirably figured and described by Thompson (:01), deserves special mention because of the presence of 7 secondaries in the aquincubital wing, and of a "lateral tract" just outside of the sternal tract. This small tract occurs in no other genus of Trochili, so far as I know, but a similar tract occurs in *Todus*, according to Nitzsch's figure. It would be interesting to know if the tract has any special significance in *Patagona* or is composed of feathers in any way peculiar, or different from those which make up the sternals.

### Argyrtria.

There is nothing exceptional or worthy of note in this genus, except that the formula for the length of the rectrices is 3-2-4-1-5.

### *Specimen examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Argyrtria brevirostris</i> (Less.).	Brazil.	Phil. Acad. Nat. Sci.	Alcoholic; fair.

### Eucephala.

The general pterylosis is like that of *Trochilus alexandri*. There are 6 secondaries in the right wing, with 7 major coverts, and the wing is clearly aquincubital, but in the left wing there are 7 well developed secondaries, of nearly equal size, and only 7 major coverts, the wing being perfectly quincubital. The tail is slightly



forked, the middle pair of rectrices being shortest and the outer pair longest. The legs are feathered just over the tarsal joint.

*Specimen examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Eucephala cæruleo-larvata</i> (Gould).	Brazil.	Phil. Acad. Nat. Sci.	Alcoholic; poor.

**Thalurania.**

There is nothing to be said of this genus to distinguish its pterylography from other hummingbirds. The tail is deeply forked, the outer feathers being much the longest.

*Specimen examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Thalurania</i> sp.?	Brazil.	Phil. Acad. Nat. Sci.	Alcoholic; good.

**Lampornis.**

In this genus, the secondaries are 6 or 7, but the wing is clearly aquincubital. The skin on the hand, and even on the forearm, is very dark. In the specimens examined the rectrices were 2-1-3-4-5 in one, and 4-5-3-2-1 in the other.

*Specimens examined.*

No.	Name.	Locality.	Collection.	Condition.
1 2	<i>Lampornis violicauda</i> (Bodd.).	Brazil.	Phil. Acad. Nat. Sci.	Alcoholic; good. " very poor.



**Chrysolampis.**

In his account of *Trochilus moschitus* Nitzsch ('40) refers to the small aftershaft, the absence of down, the broad, rhombic form of the dorsal tract, the long and rather broad spinal apterium, the slight development of the femoral tracts, the nuchal apterium, and the large oil gland. The figure given (Plate III, fig. 19) was probably prepared from a skin and is seriously defective in its representation of the tracts and spaces on the head, neck, and posterior part of the back.

**Leucochloris.**

There is nothing specially noteworthy about this genus, except that in both specimens the right wing had 7 secondaries and the left 6, but all four wings were clearly aquincubital. In one specimen the formula for the rectrices is 1-2-3-4-5 and in the other it is 3-2-1-4-5.

*Specimens examined.*

No.	Name.	Locality.	Collection.	Condition.
1 2	<i>Leucochloris albicollis</i> (Vieill.).	Brazil.	Phil. Acad. Nat. Sci.	Alcoholic; good.

**Eugenes.**

The pterylosis of this genus is exactly like *Cæligena*. There are 6 or 7 secondaries and the formula for the rectrices is 5-4-3-2-1 in the male and 4-3-2-1-5 in the female.

*Specimens examined.*

No.	Name.	Sex.	Locality.	Collection.	Condition.
1 2	<i>Eugenes fulgens</i> (Swains.).	♂ ♀	Arizona.	H. L. C.	Alcoholic; very good.



Cœligena.

In this genus the head is more sparsely feathered than in *Patagona*, with the lines of feathers very clear, the occipital apterium is very distinct, the frontal apterium is very long, and the humeral tract is clearly connected with the dorsal. The secondaries are 6 or 7, the wing is aquincubital, and the formula for the rectrices is 4-3-2-5-1.

*Specimens examined.*

No.	Name.	Sex.	Locality.	Collection.	Condition.
1 2	<i>Cœligena clementiæ</i> (Less.).	♂ ♀	Arizona.	H. L. C.	Alcoholic; very good.

Trochilus.

(Plate III, Figs. 1-3.)

The pterylosis of this genus is clearly shown in the figures given, and is an excellent example of the trochiline condition. The feet are feathered to the tarsal joint. There are 6 secondaries and the wing is aquincubital.

*Specimens examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Trochilus alexandri</i> Bourc. & Muls.	—	U. S. Nat. Mus.	Alcoholic; good.
2	" "	—	" "	" "
3	" "	Arizona.	H. L. C.	" very good.
4	" "	"	"	"

Calypte.

The pterylosis of this genus shows no peculiarities whatever, nor is there anything noteworthy in the details, concerning the primaries, secondaries, alula and rectrices.



*Specimen examined.*

No.	Name.	Collection.	Condition.
1	<i>Calypte anna</i> (Less.).	U. S. Nat. Museum.	Alcoholic; fair.

**Selasphorus.**

In this genus, the femoral tracts are extended further backwards and downwards than in most hummingbirds, so that there is a slight connection between them and the group of under tail coverts. The legs are feathered to the tarsal joint. There are 6 secondaries, and the wing is probably normally aquincubital. Of the 10 rectrices, the first is longest and fifth shortest in the male, while in the female of *platycercus* the formula is 2-3-1-4-5.

*Specimens examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Selasphorus rufus</i> (Gmel.).	—	U. S. Nat. Mus.	Alcoholic; good.
2	" "	—	"	" "
3	" "	—	"	" "
4	" <i>platycercus</i> (Swains.).	Arizona.	H. L. C.	" very good.
5	" "	"	"	"

**Mellisuga.**

(Plate III, Fig. 4.)

Although no adults were examined, there is no indication in the nestlings that the pterylosis differs from that of *Trochilus*. Even in the embryos, the characteristic features of the pterylosis are evident. In the nestlings, the feathering of the head shows some peculiarities, which are illustrated in the figure given.



*Specimens examined.*

No.	Name.	Age.	Locality.	Collection.	Condition.
1	<i>Mellisuga minima</i> (Linn.).	Embryo.	Jamaica.	H. L. C.	Alcoholic; good.
2	" "	"	"	"	"
3	" "	Nestling.	"	"	" very good.
4	" "	"	"	"	"

**Orthorhynchus.**

There is nothing specially noteworthy with reference to this genus, for even in details it agrees with *Trochilus*. Of the 10 rectrices, the first is longest, the fifth shortest.

*Specimens examined.*

No.	Name.	Collection.	Condition.
1	<i>Orthorhynchus exilis</i> (Gmel.).	U. S. Nat. Museum.	Alcoholic; good.
2	" "	"	" "
3	" "	"	" "

**Stephanoxys.**

The long plume on the head is located in the group of feathers between the frontal and occipital apteria and its "pit" is very conspicuous in the plucked bird. There is nothing specially peculiar in the general pterylosis, but one wing is apparently quincubital. The tail formula is 2-1-3-4-5. The feet are feathered just over the tarsal joint, and the skin on the hand along the upper anterior edge, and even on the forearm is very dark.

*Specimen examined.*

No.	Name.	Locality.	Collection.	Condition.
1	<i>Stephanoxys delalandii</i> (Vieill.):	Brazil.	Phil. Acad. Nat. Sci.	Alcoholic; good.



**Genus unknown.**

An unidentified hummingbird (No. 23493 U. S. Nat. Mus.) shows a pterylosis exactly like the others, and is mentioned here simply to complete the list of those examined.

**COMPARISON OF THE TWO GROUPS.**

Before entering on a detailed comparison of the two groups which we have been examining, it will set some of the facts more clearly before us if we arrange them in tabular form.

	Cypseli.	Trochili.
No. of primaries	10	10
The three longest	10-9-8	10-9-8
No. of feathers in alula	2-3	0-1
Aftershaft	Present	Present
Condition of oil-gland	Bare	Bare
True down	Wanting	Wanting
Condition of wing	Either aquincubital or quincubital.	Usually aquincubital.
No. of secondaries	8-11	6-7
No. of rectrices	10	10
Frontal apterium	Wanting	Present
Occipital "	Indistinct	"
Supraocular "	Present	"
Nuchal "	"	"
Spinal "	"	"
Lateral-cervical "	Wanting	Wanting
Femoral tracts	Large, separate from dorsal	Small, connected with dorsal
Skin of hand	Usually very dark	Often very dark

It will readily be seen from the table and the foregoing accounts of the two groups that the points of difference between swifts and hummingbirds are comparatively few, and the important matter to determine is whether these differences are trivial or not. These points are the presence of frontal and occipital apteria in Trochili, their virtual lack of an alula, their small number of secondaries, their very broad, diamond-shaped dorsal tract and its practical union with the femorals, and their almost complete lack of ventral tracts. Let us consider these points under the three following heads, (1) pterylosis of head and neck; (2) pterylosis of wings; (3) pterylosis of trunk and legs.



*Pterylosis of the Head and Neck.*—In all birds, the distribution of the feathers on the head seems to be more liable to variation than on any other part of the body; among the Caprimulgi, for example, we find that the different genera exhibit quite a notable diversity in the pterylosis of the head. When we consider therefore how the whole head of the hummingbird has been altered for its peculiar feeding habits, and how the plumage of the head has been modified in connection with the development of the gorgeous metallic colors, we should expect a characteristic pterylosis. When on the other hand, we consider how nearly in the opposite direction the modification of the swift's head has been, and that there is no development of a peculiar head plumage, it is not strange that there are some differences in the arrangement of the feathers of the head and neck between hummingbirds and swifts. That these differences are due to the modification of the trochiline head in connection with feeding habits is certainly suggested, if not demonstrated, by the pterylosis of the nestling hummingbird. A comparison of figure 4, plate III, with figure 3, plate II, certainly suggests a real resemblance between the two. The long, narrow frontal apterium shown by all adult hummingbirds, is almost wanting in the nestling, as it is in swifts, while the sparse feathering of the occipital region is quite as evident in *Chætura* as in *Mellisuga*. On the other hand, the nestling shows clearly the supraocular and nuchal apteria, and the absence of lateral cervical apteria which are such characteristic features of both swifts and hummers. It is a natural conclusion therefore, that the fundamental plan of the pterylosis of head and neck was originally similar, if not identical, in the Cypseli and Trochili.

*Pterylosis of the Wings.*—The general arrangement of the remiges and coverts of the wing is quite similar in the two groups under consideration, and such differences as occur are closely associated with the size of the bird. Thus we know that, as a rule, the smaller the bird, the fewer will be the secondaries, lesser coverts and alula feathers, and this is well shown by the swifts and hummingbirds. As regards the quincubital or aquincubital condition of the wing there is no constant difference between the two groups, for, as already shown, individual hummingbirds show variability on this point, and neither condition is characteristic



of the swifts, as a whole. A comparison of figures 4 and 5 of plate II, with the wings of *Chætura* and *Trochilus*, will emphasize how really intermediate between the two swifts, in this point, the hummingbird is. There is no essential difference in the humeral tracts, though those of the swifts are more obviously connected with the dorsal and femoral tracts, than are those of the Trochili.

*Pterylosis of the Body.*— In the form of the dorsal tract swifts and hummingbirds differ. In the latter it broadens on the middle of the back, extending downward to the sides, and then narrowing again to a point at the oil gland; were it not for its obvious connection with the femoral tracts on each side, it would thus be an almost perfect diamond in shape. In the swifts, on the contrary, the tract does not extend downward on the sides nor does it directly connect with the femorals; its shape therefore is that of an elongated ellipse. In each case, however, there is the well-marked spinal apterium, a very important point of resemblance. In the swifts, the femoral tracts are well developed, extend forward on the sides to the posterior part of the humerals, and backwards to connect with the upper tail-coverts. In the hummingbirds, however, the femorals are weak and only extend towards the dorsal with which they connect. It is evident therefore, that in the swifts the dorsal tract has become quite sharply defined, and the femorals extended to form a part of the covering for the sides, while in the hummingbirds the dorsal tract remains more extensive, has not become separated from the femorals, and provides all the covering for the sides. Thus the dorsal pterylosis of the swifts indicates a greater specialization than that of the hummingbirds, possibly associated with their extraordinary power of flight. The ventral pterylosis of the Cypseli is essentially identical with that of the Trochili, for the apparent absence of ventral tracts in the latter is a difference of degree, not of kind, while the separation of a lower cervical apterium from the ventral, in some swifts, is also an unimportant character, present in only a few species.

#### CONCLUSIONS.

In bringing to a close this account of the pterylography of swifts and hummingbirds, it is worth while to consider two general ques-



tions, still open to discussion, which may be stated as follows: Is the pterylosis of a swift sufficiently similar to that of a hummingbird to give support to the view that they have a common ancestry? If so, is that of the Caprimulgi sufficiently similar to warrant the belief that they also have the same ancestry? There are some other interesting questions which arise in connection with these, particularly as to whether the swifts and swallows have anything in common and as to what birds are most nearly allied to the groups considered in this paper. But lack of sufficient reliable evidence forbids any attempt to touch on such questions. Let us turn to those first stated: 1. *Is the pterylosis of a swift sufficiently similar to that of a hummingbird to give support to the view that they have a common ancestry?*

In the judgment of the writer, YES. What may properly be called the fundamental plan of the pterylosis is essentially the same. That is to say, each group has apparently sprung from an ancestor in which the head was fairly uniformly, though sparsely feathered except for an apterium over the eye; the neck had the upper and lower cervical tracts united anteriorly, so that there was no lateral cervical apterium; there was a conspicuous nuchal apterium; the back was well covered by a broad dorsal tract containing an elongated spinal apterium; but not fully distinct from the femoral tracts or even from the humerals; the lower cervical tract was deeply forked and continuous with the conspicuous sternal tracts; and the latter were separate from each other, and extended on to the belly as short, wide, ventral tracts. As regards the dorsal tract, it seems to me probable that this ancestral form was a bird in which the humeral, dorsal, and femoral tracts were more or less connected, and the two latter at least not sharply defined, somewhat as Nitzsch figures the dorsal surface of *Colius*; this condition was followed by such a pterylosis as Nitzsch shows for *Cuculus*, in which the spinal apterium has appeared; from this arrangement the dorsal tract of the hummingbird would arise with little change, while the cypseline condition would follow further condensation of the dorsal tract, accompanied by development of the femorals. In addition to this agreement in fundamental plan, the swifts and hummingbirds have so many details, of more or less importance, in common, we may say further of their ancestral form that it had 10 primaries with the 3 outermost



longest, and 10 rectrices; probably 9 secondaries, an alula of 3 feathers, an aftershaft on the contour feathers, no down feathers, filoplumes rather few and mainly confined to the neck and back, the feet feathered to the tarsal joint, the oil gland without a terminal tuft of feathers, and the skin on the hand dark colored. Whether the wing was originally aquincubital or not is open to question but judging from the wings of the hummingbirds examined, the evidence would seem to favor the view that the quincubital condition of most of the swifts is a specialized condition, and the ancestral form was probably aquincubital.

In the subsequent development of the Cypseli and Trochili, the pterylosis of the head and neck became more specialized in the latter group, while that of the back has been more modified in the swifts; with the wings, specialization has occurred in both groups, perhaps to a greater extent in Trochili, which have lost the alula, and 2 or 3 secondaries, and are apparently approaching the quincubital condition. Shufeldt ('88) in attempting to show the absence of relationship between swifts and hummingbirds lays much stress on the difference in the number of secondaries, the form of the dorsal tract, the absence of supraocular and nuchal apteria in swifts and the absence of femoral tracts and of black skin on the hand in hummingbirds. As has been\* repeatedly shown in the previous pages, his position is clearly based on insufficient or unreliable evidence; the number of secondaries is almost wholly a matter of size, the form of the dorsal tract is a real difference but not inexplicable, the supraocular and nuchal apteria are *not* absent in swifts, and the femoral tracts and black skin on the hand are *not* wanting in hummingbirds.

2. *Is the pterylosis of the Caprimulgi sufficiently similar to that of swifts or hummingbirds to give support to the view that they have a common ancestry with either?*

In the judgment of the writer, NO. Although the linear arrangement of the feathers on the head of the *Caprimulgi* (see Clark, '94) seems at first somewhat similar to that in *Patagona* (see Thompson, : 01) the more the pteryloses of the two groups are compared, the more evident it seems that there is no indication of a common fundamental plan in the two. The upper cervical tract in the *Caprimulgi* is quite narrow with no trace of a nuchal apterium,



and is more or less separate from the dorsal tract; the lower cervical is also narrow and not divided so far up on the throat as even in the swifts. Lateral cervical apteria are very evident. The dorsal tract of the Caprimulgi is clearly derived from an ancestral form in which the anterior and posterior portions were not equally well developed; moreover the spinal apterium is not long and narrow, but short and wide, with sharp lateral angles. Probably the caprimulagine form is derived from such a condition as is shown in Nitzsch's figure of *Falco brachypterus*, rather than from a form like that of *Cuculus*. The humeral tracts in Cypseli and Trochili are near the dorsal and there are some feathers connecting them therewith, but in Caprimulgi the humerals are narrow and distinct, at some distance from the dorsal. The form and position of the femoral tracts is clearly different in the Caprimulgi from those in the Cypseli and Trochili, and the marked contraction of the sternal tracts to form the ventrals is a minor characteristic of the Caprimulgi. Some of the details in which the Cypseli and Trochili agree are not the same in the Caprimulgi, as for example, the black skin on the hand and the last three primaries being the longest; the development of the alula and the presence of 12 or more secondaries in Caprimulgi may also be mentioned, though no weight should be attached to such differences taken by themselves.

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