

XLI.—*On the Pterylosis of the Embryos and Nestlings of Centropus sinensis.* By R. SHELFORD, B.A. (Curator of the Sarawak Museum).

(Plate XIII.)

THE most remarkable feature in the young of *Centropus sinensis* is the clothing of long, white, thread-like structures, most strongly developed and most densely disposed on the dorsal surface of the head and body (Plate XIII.). Dissection and microscopical examination show these threads to be enormous prolongations of the horny sheaths which envelop the developing feathers, a narrow lumen extends from the base to the tip of each, whilst the base of each lumen, again, is occupied by a feather-papilla, situated below the skin. In order to avoid unnecessary circumlocution and repetition, I shall term these thread-like structures trichoptiles. The skin in young nestlings and ripe embryos is black, except between the rami of the mandibles and on the belly; the white trichoptiles stand out in striking contrast to this dark background, and give the young bird a sufficiently remarkable appearance.

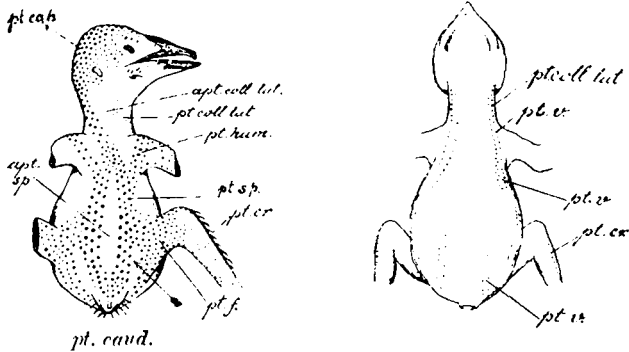
The horny sheaths of *all* the definitive feathers are not produced to form trichoptiles; whilst, on the other hand, certain areas occupied in the young nestling and embryo by trichoptiles are in later stages devoid of feathers. To describe the changes in shape and extent of the pteryke and apteria during the passage from the trichoptile-clad embryo to the adult is the purpose of the present paper.

Thanks to the generosity of Mr. Charles Hose, who has furnished me with several gradational examples, the material at my disposal can be divided, roughly speaking, into three stages, though the divisions are not very well marked.

A nearly ripe embryo with a total length of 92 mm. constitutes Stage 1 (Plate XIII. A); a young nestling with a total length of 112 mm. may be regarded as typical of Stage 2 (Plate XIII. B, and figs. 1 & 2, p. 655); and nestlings ranging from 125 mm. to 145 mm. fall into the third division,

Stage 3 (figs. 4 & 5, p. 661). I have also seen a very young embryo of this species, in which prominent feather-papillæ occurred in three definite regions :—A double tract from each side of the head immediately above the eye to the pygidium, and in the areas subsequently occupied by the *pt. humeralis* and *pt. femoralis* respectively. The foot of this embryo had not yet become zygodactylous.

Figs. 1, 2.



Nestling of *Centropus sinensis*, Stage 2.

Fig. 1.—Dorsal aspect, showing the form of the pterygæ and apteria. Compare the form of the pterygia spinalis with that of Stage 3, fig. 4.

Fig. 2.—Ventral aspect, to show the incomplete pterygia ventralis in the embryonic stage.

*Explanation of the lettering.*

- apt. coll. lat.* = apterion colli laterale.
- apt. sp.* = .. spinale.
- pt. cap.* = pterygia capitis.
- pt. coll. lat.* = .. colli lateralis.
- pt. hum.* = .. humeralis.
- pt. sp.* = .. spinalis.
- pt. cr.* = .. cruralis.
- pt. f.* = .. femoralis.
- pt. v.* = .. ventralis.
- = apterion between *pt. femoralis* and pterygia spinalis. See p. 657.

STAGE 1.—The trichoptiles are now at the highest point of their development. The longest, those on the head and back, measure 30 mm., or about one-third of the total length of

the embryo; being all directed backwards they constitute a regular flowing mane (Plate XIII. A), the exact boundaries of which are not easy to define. None of the actual definitive feathers have yet made their appearance, so that the following description applies strictly to the distribution of the trichoptiles.

*Pt. capitis* (fig. 1\*, p. 655, *pt. cap.*).—This is very well developed on the crown and back of the head, but is sparse on the sides; the skin below the ear, between the mandibular rami and between the eye and nostril is naked, a few delicate threads are to be seen surrounding the upper and posterior borders of the ear-opening and on the gonys of the mandible. The eyelashes have not yet made their appearance.

*Pt. spinalis* (fig. 1, *pt. sp.*) is confluent with the *pt. capitis*; at first it is single, but at about the level of the attachment of the humerus it bifurcates, the two branches again reunite in the lower lumbar region and run on to the pygidium, stopping short just in front of the oil-gland papilla. The apterium between these two spinal branches is very narrow, and might easily be overlooked had one no later stages at hand for comparison.

*Pt. humeralis* (fig. 1, *pt. hum.*) arises from the *pt. spinalis* just below the point where the bifurcation begins, and runs up to the point of the shoulder to fuse with the trichoptiles on the patagial membrane; its connection with the *pt. ventralis* is not yet established, nor does the ill-developed parapteron join it.

*Pt. femoralis* (fig. 1, *pt. f.*) is a triangular tract, the long trichoptiles converging from the back over the whole of the outside of the thigh to a point at the knee; anteriorly the base of this triangle is confluent with the *pt. spinalis* for a short distance, but it soon diverges and runs down as far as the anterior angle of the pygidium, leaving

\* The figure representing Stage 2 is introduced here for expediency, since the difference between it and Stage 1 is almost imperceptible (see p. 658).

between itself and the *pt. spinalis* an elongate narrow apterium (see arrow in fig. 1 p. 655). At the knee the *pt. femoralis* runs into the—

*Pt. cruralis* (fig. 2, *pt. cr.*), which is divisible into two portions, a narrow pre-axial and a broader post-axial, which again are confluent with each other in the lower third of the crus on its outer aspect.

*Pt. colli lateralis* (fig. 2, *pt. coll. lat.*) is at present well defined, though not recognizable in the adult or even in Stage 3; it branches off from the *pt. spinalis* at the junction of the head and neck, and runs obliquely on to the upper part of the breast, where it becomes confluent with the *pt. ventralis*. After its origin it is separated from the *pt. spinalis* by the *apt. colli laterale*, which runs down as far as the *pt. humeralis* (it is found also in the adult), and from its fellow of the opposite side by the naked skin of the throat. The trichoptiles of this and the following tract are very small.

*Pt. ventralis* (fig. 2, p. 655, *pt. v.*).—This is, as yet, merely rudimentary, and the rudiments are curiously disposed. As is well known, the *pt. ventralis* in the genus *Centropus*, after bifurcating, redivides again on each side into an inner and outer branch. In the embryo now under discussion, the posterior end only of the inner branch is seen running on each side from the lower part of the stomach to the anus, and the upper part of the outer branch extends from its junction with the *pt. colli lateralis* to the level of the knee-joint only.

The oil-gland is not tufted, and there is no *pt. aui*.

*Pt. caudæ* (fig. 1, *pt. caud.*).—The ten rectrices and their coverts are represented by short trichoptiles.

*Pt. alaris*.—Owing to the small size of the fore-limb and the disproportionately long trichoptiles, it is almost impossible to make out their relative positions (*cf.* description of this tract in a nestling of Stage 2).

With the exception of the pterylosis, there is not much in the external features of this embryo to call for special notice. The egg-tooth is small but prominent; the nostrils are

slit-like and open downwards; the foot is now zygodactylous, but the long spur-like claw of the hallux is not yet developed, the claws of all the toes being approximately equal. The papilla of the oil-gland is markedly elongate.

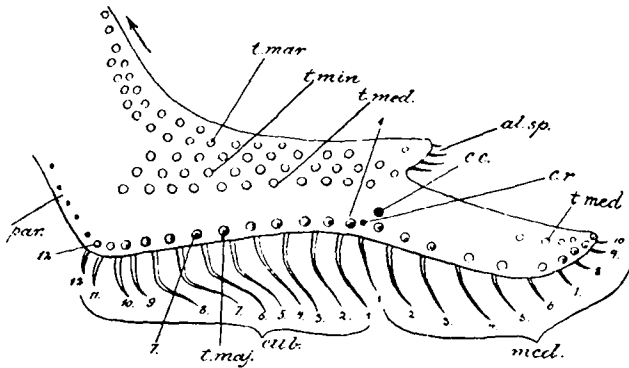
STAGE 2 (fig. 1, p. 655).—There are no very striking differences between the young nestling of this stage and the embryo just described, save in the matter of size. None of the actual definitive feathers have even yet appeared, but though the longest trichoptiles have increased in length from 30 mm. to 40 mm., there is no increase in their numbers, with the result that the body of the nestling appears less densely clothed than formerly. Furthermore, owing to the rubbing of the nestling against the sides of the nest, its fellows and other external objects, the trichoptiles stand out at all sorts of angles to the body, giving it a very dishevelled appearance (Plate XIII. B).

To my description of the pteryllæ and apteria of the embryo I have little to add. Some minute tips have appeared along the lower border of the eye, but otherwise the *pt. capitis* is unchanged, and the same may be said of the *pt. spinalis*, *pt. humeralis*\*, *pt. femoralis*, and *pt. cruralis*. The *pt. colli lateralis* is as distinct as before, whilst the trichoptiles of the *pt. ventralis* have not increased in extent. There have, however, now appeared on the throat and on each side of the upper part of the breast numerous papillæ arranged in distinct chevrons; protruding from some of these papillæ may be seen the minute tips of the future feathers.

*Pt. alaris* (fig. 3, p. 659).—As the fore-limb has now considerably increased in size, it is now possible to make out quite clearly the different members of this tract and their relations one to the other; and as the trichoptiles are no more numerous than in Stage 1, this description will apply equally to this stage and to that.

\* The gap between the *pt. humeralis* and *pt. femoralis* is somewhat greater than in Stage 1, but this is owing to increase in the size of the body.

Fig. 3.



Dorsal aspect of the right wing of the nestling *Centropus sinensis*, Stage 2, to show the positions of the developing coverts and remiges. The wing is eutaxic.

*Explanation of the lettering.*

- t. mar.* = tectrices marginales.
- t. min.* = „ minores.
- t. med.* = „ mediae.
- t. maj.* = „ majores.
- al. sp.* = ala spuria.
- c. c.* = carpal covert.
- c. r.* = „ remex.
- par.* = parapteron.
- cub.* = cubitals or secondaries.
- mc. d.* = metacarpo-digitals or primaries.
- 1. 2. 3-10 = „ „
- 1. 2. 3-12 = cubitals 1-12.
- 7 = 7th major covert.

The following somewhat tabular statement will, when taken in conjunction with the diagram, best represent the arrangement of the tract :—

OUTER ASPECT.

*Manus.*

- Primaries. 10. The 4th to the 7th are the largest.
- Tect. majores. 10.
- Tect. mediae. 4 only—viz., the 3rd to the 6th of the series.  
These are not present in Stage 1.
- Tect. minores. { As yet unrepresented.
- Tect. marginales. {

*Carpal reme.c & covert* are present: the former is very much smaller than the latter, which is not readily distinguishable from the tect. majores of the cubitus.

*Cubitus.*

Cubitals.	12.	Decreasing in size from before backwards, Nos. 11 and 12 being quite minute.
Tectrices majores.		Proximally continuous with the parapteron.
Tect. medie.	11+1	which belongs to the ala spuria: that is, the series commences by just one member in front of the tect. majores, and terminates by just one member short of it, and there is a broad gap between the two series.
Tect. minores.	10+2	which belong to the ala spuria. I can distinguish only one row.
Tect. marginales.		Distally one row, which is short and composed of 9 units only, behind the 3rd unit the second row begins: this is composed of 12 units: behind its 4th unit the third row begins and runs along the anterior border of the patagium to join the pt. humeralis.
<i>Ala spuria</i> . . . . .	4	trichoptiles, in addition to those already alluded to as constituting the distal members of the t. medie and t. minores.

## INNER ASPECT.

<i>Manus</i> . . . . .		A few minute points, the forerunners of the t. minores inf.
<i>Cubitus</i> . . . . .		Nothing as yet has made its appearance.

The egg-tooth is still prominent; the eyes are not yet opened. The foot now more nearly approximates in appearance to that of the adult; the second digit is the shortest, the third the longest, and the claw on the hallux is now seen to be a trifle longer and less curved than those on the other toes. The tarso-metatarsus is covered with transverse scutes, those on the dorsal surface being the larger and more distinct; each digit is dorsally covered with one row of transverse scutes, which laterally pass more or less abruptly into the reticulated surface of the planta.

STAGE 3 (Pl. XIII. C, and figs. 4, 5, p. 661).—A nestling with a total length of 145 mm. is taken as typical of this

stage; it will at once be seen that the changes in appearance that have occurred are both striking and important. In the first place, the horny sheaths of some of the definitive feathers carrying at their extremities the trichoptiles have broken through to the exterior in certain well-marked areas: in the second place, the *pt. ventralis* is now almost completely

Figs. 4, 5.

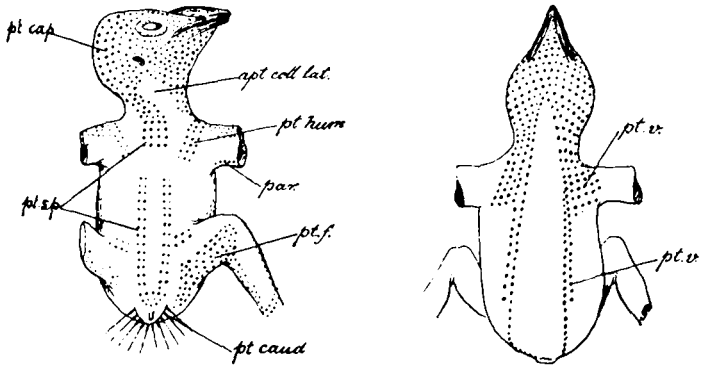


Fig. 4.—Dorsal aspect of Stage 3, showing the changes in the form of the pterylae. Compare with fig. 1.

Fig. 5.—Ventral aspect of Stage 3. The pteryla ventralis has now completed its growth. Compare with fig. 2, p. 655.

*Explanation of the lettering.*

- apt. coll. lat.* = apterion colli laterale.
- par.* = parapteron.
- pt. cap.* = pteryla capitis.
- pt. caud.* = „ caudalis.
- pt. hum.* = „ humeralis.
- pt. sp.* = „ spinalis.
- pt. f.* = „ femoralis.
- pt. v.* = „ ventralis.

plotted out by feather-sheaths which, however, do not bear trichoptiles at their extremities; and, thirdly, the areas previously occupied by trichoptiles are still so occupied, except where they have been encroached on by the newly appeared feather-sheaths. The reason and significance of these changes will be explained later, meanwhile it is neces-



sary to describe in some detail the distribution of the actual feather-sheaths: those on the dorsal surface are transversely banded with rufous and black, in a manner suggestive of the colouring of the plumage of the young first-year *Centropus*; those on the ventral surface are whitish yellow, and much less far advanced in their development.

*Distribution of the Feather-sheaths.*

*Pt. capitis* (fig. 4, p. 661, *pt. cap.*).—This is now a perfectly continuous tract covering the whole of the head, including the skin between the mandibular rami, between eye and nostril, and between ear-opening and the gonys of the jaw, areas which in Stage 2 were naked save for a very few delicate threads; the sheaths on the back of the head are the longest, the trichoptiles have disappeared almost entirely, being strictly limited to the sheaths on the crown and back of the head, and even these are much abraded; as already shown, they never were present between the mandibular rami; and it would, perhaps, be more reasonable to consider the feathers of this region as belonging to the *pt. ventralis*. It is to be noted that the upper eyelid bears a row of very short eyelashes (still enclosed in their sheaths), but these are not present on the lower lid, though a row of similar sheaths runs just below it.

*Pt. spinalis* (fig. 4, *pt. sp.*).—Runs from the *pt. capitis* as a single tract to the level of the junction of coracoid and scapula; it then abruptly ceases (fig. 4) to appear again at a lower level as a double tract, the two halves of which re-unite at a short distance above the pygidium and run down as far as the oil-gland papilla. The hiatus between the upper and lower portions of this pterygia is filled by trichoptiles so arranged that it is possible to see that the break in this feather-tract began in front of the point of bifurcation of the original trichoptilar tract. All the feather-sheaths bear trichoptiles.

*Pt. humeralis* (fig. 4, *pt. hum.*).—This is much reduced in size, and has lost its connection with the *pt. spinalis*

(fig. 1), except by means of the still persistent trichoptiles, but originates at a point about midway between the mid-dorsal line and the articulation of the humerus, from here it runs up to and over the point of the shoulder to fuse with the pt. ventralis; it is also continuous with the tectrices marginales but not with the parapteron. The sheaths, which are long and still provided with trichoptiles, are arranged in three rows deep. The distance between this tract and the following is much greater than formerly.

*Pt. femoralis* (fig. 4, *pt. f.*).—A glance at the diagram will show the peculiar nature of the tract at this stage: it is plainly divisible into two portions, a pre-axial and a post-axial; the former is rather indistinct, arising from the pt. spinalis it runs obliquely upwards for a very short distance; the latter is not connected with the spinal tract, its base-line is of considerable length, the lower extremity sweeping down past the pygidium and not far separated from the lower extremity of the inner branch of the pt. ventralis; from this base-line the feather-sheaths rapidly converge and run over the outside of the thigh, mostly on its post-axial half. The greater extent of this tract in younger stages is shown by the trichoptiles.

*Pt. cruralis* has not altered in shape or size, though its pre-axial portion has lost its connection with the pt. femoralis owing to the reduction of that tract.

*Pt. ventralis* (fig. 5, p. 661, *pt. v.*).—This is now well developed and dense. Commencing as a continuous tract between the mandibular rami (*cf. ante*), it divides at the junction of the head and neck into two broad main stems; these run down the sides of the neck and chest for some distance, when each stem re-divides into two branches—an outer, short branch\*, so short, in fact, that it hardly appears to be a branch at all; and an inner, narrow branch, which runs down almost to the level of the anus, diverging slightly from its fellow on the opposite side. The

\* This branch is said to be very short in *Rhinococcyx*.

feathers, at first, are in two rows, but shortly thin out to one row only. From this description it will be seen that this tract has now approximated quite closely to the adult condition, a further extension of the outer branch being all that is needed to make them identical. As a result of the great development of the feathers on the throat and neck, it is now no longer possible to distinguish a *pteryla colli lateralis*: the *apterium* between that former tract and the *pt. spinalis* is still apparent, and in fact persists even in the adult, but each half of the tract has now, so to speak, joined hands across the formerly unclothed gap of the throat and become confluent with and indistinguishable from the *pt. ventralis*. The meagre trichoptiles which in Stages 1 and 2 marked the *pt. colli lateralis* and (incompletely) the *pt. ventralis* have now totally disappeared.

*Pt. caudæ* (fig. 4, p. 661, *pt. caud.*).—The sheaths of the ten rectrices and their coverts are now prominent: all bear trichoptiles.

*Pt. alaris*.—All the feather-sheaths have now pushed through the skin, and in a few cases some of the feathers have just begun to break through their sheaths; the few trichoptiles that persist are much worn. The arrangement of the tract differs so slightly from that described under Stage 2, that I have but few remarks to add.

*Outer aspect*.—On the manus there are now five tectrices *mediæ* and five tectrices *minores*, and one row of tectrices *marginales* along the pre-axial edge.

The carpal remex is still much smaller than its covert.

No new feathers have appeared on the cubitus; the gap between the tectrices *majores* and tectrices *mediæ* is as apparent as ever; the parapteron is now continuous with the former series. There is a bare triangular space on the patagial membrane.

The *ala spuria* has four feathers with their coverts, continuous, as before, with the covert series of the cubitus.

*Inner aspect.*—There are two rows of tectrices marginales on the manus, one row on the cubitus. There is no hypopteron.

The nestling now appears to be remarkably short-necked; *i. e.*, the neck has not grown in length in proportion to the increase in size of the head and trunk. The egg-tooth has disappeared and the foot is now exactly like that of the adult, the spur-like claw of the hallux being very noticeable.

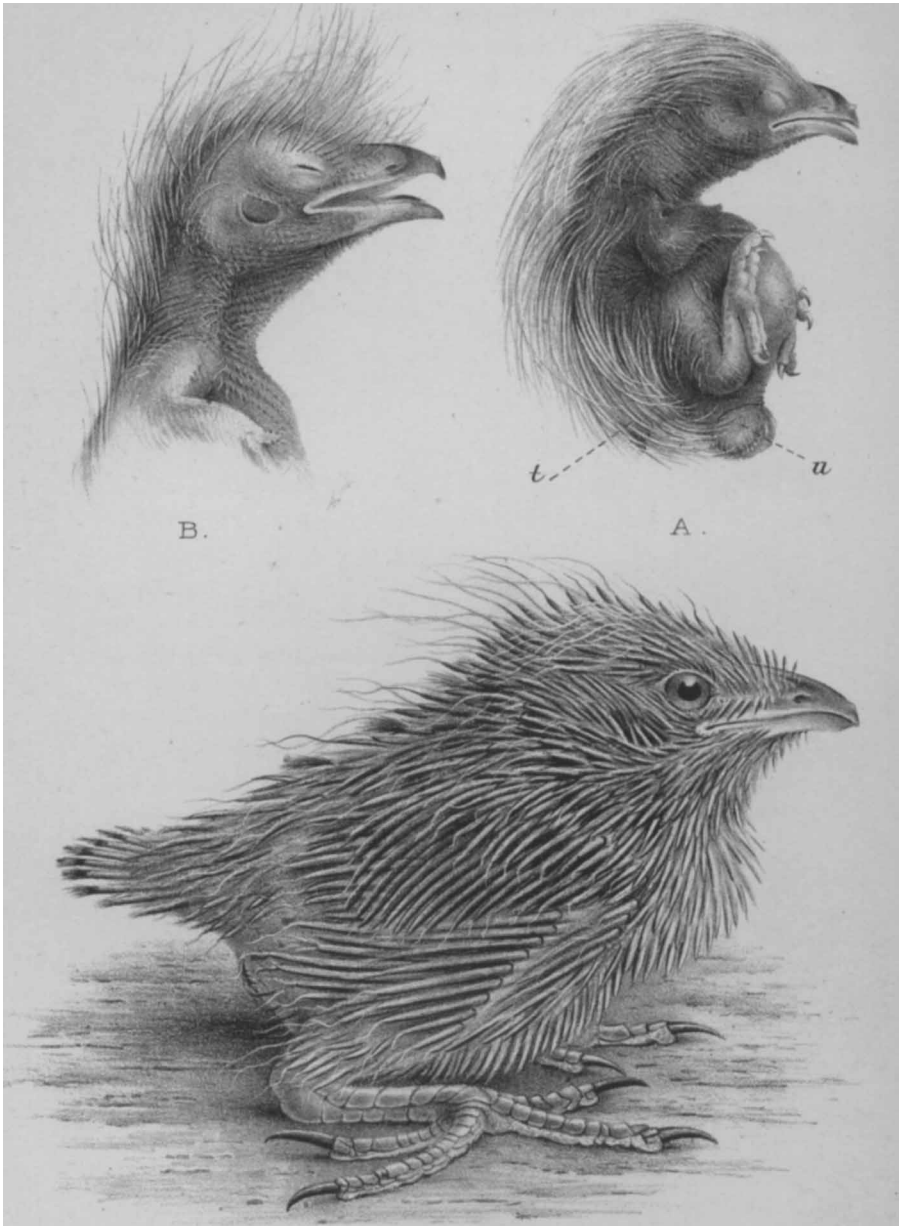
Comparison with smaller examples of the same stage reveal but few differences: these are:—the greater length of the trichoptiles; the absence of feather-sheaths at the angle of the jaw (as in Stage 2); the weaker development of the *pt. ventralis*, the point of bifurcation of its two main streams commencing much higher up, and thus affording an illustration of the method by which the *pt. colli laterales* of Stage 2 become confluent with the *pt. ventralis*; and, finally, the exact correspondence of the arrangement of the wing-feathers with the arrangement of the trichoptiles in Stage 2, fig. 3, p. 659.

In order completely to understand the changes which take place during the growth of the nestling of an early stage to the nestling of Stage 3, it is necessary again to emphasize the fact that a trichoptile is merely an enormously prolonged feather-sheath, enclosing at its base, beneath the skin, a feather-papilla; as the feather-papilla grows, that part of the trichoptile which ensheathes it must perforce grow too, but the elongated part which, comparatively early in embryonic life, broke through the skin need not, and in fact does not, grow, except in the matter of length, and that only to a small extent, owing to its outwardly pushing base; finally, the actual feather-sheath makes its appearance, pushing before it its trichoptilar appendage, which has now become abraded to a considerable extent. In certain areas these feather-sheaths appear contemporaneously, but in others the feather-papillæ have not advanced so far in development, and the sheaths do not push through to the exterior till some time after the young bird has left the nest; further, these feathers are invariably degenerate semiplumes; not-

withstanding their late appearance and degenerate character, the trichoptiles appertaining to them appear at the same time as, and are quite indistinguishable from, the others. The arrangement of the trichoptiles is then prophetic of the adult pterylosis, at least so far as the dorsal surface is concerned, and a combination of the diagrams of the dorsal view of the nestling of Stage 2, and of the ventral view of Stage 3, fig. 5, will represent nearly exactly the adult pterylosis. The almost total absence of trichoptiles from the ventral surface I would explain thus:—The embryo lies in the egg in a strongly curved position, the dorsal side being the convex surface, the ventral side the concave; further, the curve is so circumscribed that almost every part of the ventral surface is in close contact with another part, and it is difficult to see where room could be found for a dense mane of trichoptiles such as is found on the dorsal surface, hence must occur a retardation in the outward growth of these structures along the area later occupied by the *pt. ventralis*. But when the young bird hatches out, it lies or moves about in the nest on its chest and stomach, subjecting these parts to a considerable amount of friction; and as I have already shown that the dorsal trichoptiles become much worn though subjected to much less friction, it is perhaps not unfair to conclude that ventral trichoptiles will not be developed to any extent if they are liable to be worn away on or soon after their first appearance. Still, this is the merest speculation, since I am unable even to hazard an opinion as to the function of the trichoptiles: the nestling is certainly not rendered inconspicuous by them, and as, moreover, it is concealed in a deep nest, invariably built in dense undergrowth, it is presumably independent of such protective devices; and still more unlikely is it, that the young of so highly specialized a group of birds as the Cuckoos should retain the primitive body-clothing, and this quite apart from the fact that both the distribution and structure of these trichoptiles point the way to deductions of an opposite nature.

The pterylosis of the adult *Centropus sinensis* differs in one or two details from that of *C. celebensis* as described by





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EMBRYO AND NESTLINGS OF  
CENTROPUS SINENSIS.

Beddard\*. In *C. celebensis* the ventral tract divides much lower down the neck, the pt. capitis is more sparse, the apt. colli lat. is (judging by the figure) more circumscribed, and, most important of all, the pt. spinalis is completely interrupted save for a few scattered feathers at the level of the junction of the coracoid and scapula, thus approximating to the arrangement of the tract in the Stage 3 nestling of *C. sinensis*. It is impossible to regard the complete spinal tract as anything but the more primitive: this condition of the tract is exhibited by the trichoptile-clad embryo and nestling (Stage 2) of *C. sinensis*, whilst the adult is intermediate between them and the insular and more modified species *C. celebensis*; it would be interesting to see what place in this series would be taken by the young of the latter species.

EXPLANATION OF PLATE XIII.

Embryo and Nestling of *Centropus sinensis*.

- A. Embryo from right side, showing the mane-like trichoptiles described on pp. 656-656.
- B. Head and neck of a nestling showing the appearance of the trichoptiles after hatching, p. 666.
- C. Nestling in which the definitive feathers are making their appearance: to show the relations of these with, and their proportions to, the trichoptile.

*u* = umbilicus.

*t* = tail.

XLII.—*On some Additional Species of Parrots of the Genus Pyrrhura.* By T. SALVADORI.

(Plate XIV.)

THE genus *Pyrrhura*, as treated in volume xx. of the 'Catalogue of Birds,' contains 19 species, besides a doubtful one, *Pyrrhura chiripepé* (Vieill.), mentioned in the appendix. At the present moment, nearly nine years after the publication

\* "On the Structural Characters and Classification of Cuckoos," P. Z. S. 1885, p. 168.