VI. A NEW RACE OF HARE FROM THE PERSIAN FRONTIER OF MESOPOTAMIA.

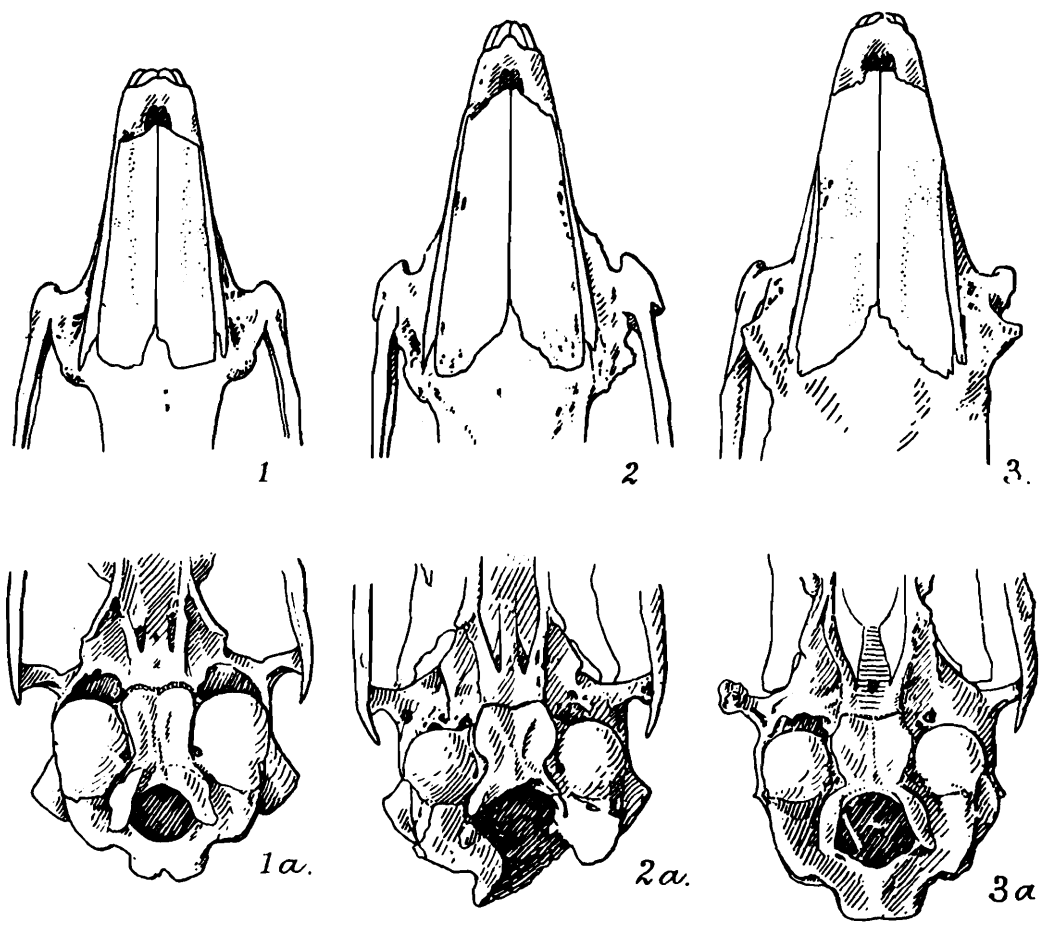
By H. C. Robinson, *C.M.Z.S.*

Lepus dayanus connori, subsp. nov.

Lepus craspedotis, Thomas (*nec* Blanford), *Proc. Zool. Soc.* 1905 (2), p. 527.

Co-types :—Adult male skin without skull and adult skull unsexed, between Ahwaz and Mohammerah, Karun R., Persia, collected on October 30th, 1917, by Lt.-Col. F. P. Connor, I.M.S. Ind. Mus. Nos. 10278 (skin) ; 10279 (skull).

A form belonging to the section *dayanus*[1] with long broad ears and soft pelage. Larger than *L. d. craspedotis* [2] from Baluchistan (type



Figs. 1, 1*a*.—Nasal bones and auditory bullae of *Lepus dayanus* Blanford, from Narra, Sind.

Figs. 2, 2*a*.—Same bones of type of *Lepus dayanus craspedotis*, Blanford, from Pishin, Persian Baluchistan.

Figs. 3, 3*a*.—Same bones of co-type of *Lepus dayanus connori*, nov., from Karun R., S. W. Persia.

---

[1] *Proc. Zool. Soc.* 1874, p. 633 ; type from Sukkur, Sind.

[2] Blanford, *Ann. Mag. Nat. Hist.* (4) XVI, p. 313 (1875) ; *id.*, *Zool. East. Persia*, II, p 80, pl. viii (1875) ; type from Pishin, S. Baluchistan, examined.

examined). Nasals decidedly broader than in *L. d. dayanus*, much produced posteriorly on their outer margins, not truncate as in *L. d. craspedotis*.

Colouration.—Upper surface very pale salmon-buff, the hairs of the back and upper flanks usually with short black tips. Base of the fur pale smoky-grey, lighter on the flanks, succeeded by a broad clearly defined band of black, most pronounced on the back, and then by a salmon-buff subterminal band and a short black tip, often absent. Chest and nape and anterior flanks pale isabelline-buff, the hind limbs more salmon-buff. Chin, inner surface of limbs and under surface of tail pure white. Upper surface of tail deep clear black.

Ears : external half of upper surface clad with fine salmon-buff hair, slightly intermixed with black, the proximal two-thirds of the upper edge fringed with coarse yellowish-buff hairs finely edged with black at the tips ; internal half of upper surface almost pure silvery-white with a large patch of black at the tip ; this patch edged with buff, the remainder with pure white. Ears internally thinly clad with buffy-white, deeper in tint towards the tips.

Measurements.—Hindfoot (dry) 120 mm. ; ear 110 mm.

Skull.—Larger than that of *L. d. craspedotis* or than an equally aged skull of *L. d. dayanus*. Palatal foramina longer and relatively narrower than in either of the allied forms ; nasals broad and parallel-sided, much produced posteriorly on their outer margins ; cranial region broad. Teeth as in *L. d. dayanus*. Bullae slightly smaller than in *L. d. dayanus*, very much smaller than in *L. d. craspedotis*.

Measurements of the typical skull : greatest length 87 (81·2)[1] ; basal length 67 (63·5) ; greatest length of nasals 39 (31) ; palatal foramina 23 (20) ; upper molar series (alveolar) 16 (14·5).

Remarks.—The affinities of this hare, so far as can be judged from descriptions and from the available specimens in the Indian Museum, are almost certainly with the Indian races, of which *L. dayanus* is the best known, rather than with Palaearctic forms. It does not seem in any way connected with forms from Arabia proper and from Muscat, which have been described by Hemprich and Ehrenburg and by Thomas.

---

[1] Measurements in parentheses are those of the type of *L. d. craspedotis*.

VII. FURTHER OBSERVATIONS ON *RANA TIGRINA*.

By G. A. BOULENGER, *LL.D., D.Sc., F.R.S., and*
N. ANNANDALE, *D.Sc., F.A.S.B.*

I. REMARKS ON *RANA TIGRINA* AND ITS VARIETIES.

By G. A. BOULENGER.

(*Published by permission of the Trustees of the British Museum.*)

Needless to say, I have been keenly interested in reading Dr. Annandale's attempt to solve the problem of the species, the races or varieties I should call them, that have been grouped together under the name of *Rana tigrina*.[1]

I cannot help thinking that with a more extensive material, Dr. Annandale would have reached somewhat different conclusions, and the object of these notes is to show on what points his definitions require emendation. I will first discuss the various 'species' under the names assigned to them by him, and in the same order, and then wind up with my own definition of *R. tigrina* and of the varieties into which it may be divided.

Rana tigrina, Daud.

There can be no doubt as to the application of this name in the restricted sense, and on this point we are in agreement. But I am surprised not to find any allusion to the two forms, strikingly different in their extremes, which are found in India and Ceylon. Dr. Annandale tells us that the inner metatarsal tubercle varies greatly in size and shape, a variation which, according to him, seems to be individual rather than racial, but he appears to me to be mistaken when he adds that this variation is not correlated with other differences and that it occurs at many or all points in the geographical range of the species. The two forms which I think should be distinguished are :—

(1) The typical *R. tigrina*, with smaller and blunter inner metatarsal tubercle (1⅔ to 3 times in length of inner toe, 7½ to 12½ times in length of tibia), 'habit rather slender than stout, but moderate rather than extreme in either direction,' and 'the tibia about half as long as head and body.'

(2) The much stouter, often more toad-like *R. crassa*, Jerdon (*fodiens*, Peters *nec* Jerdon, *ceylanica*, Peters) with very large, shovel-shaped inner metatarsal tubercle (1 to 1½ times in length of inner toe, 5 to 7 times in length of tibia), and the tibia 2⅐ to 2½ times in length of head and body. Further, when the hind limbs are folded at right angles to the body, the heels overlap in the former but do not in the latter ; the tibio-tarsal articulation reaches the eye or between the eye and the nostril in the former, the tympanum or the eye in the latter.

[1] *Mem. As. Soc. Bengal*, VI, p. 121 (1917).

The differences between these two forms are quite as great as between the typical *R. esculenta* and the var. *lessonae*, and, to judge from the rather scanty material at my disposal, there is not the same overlap.

As regards the distribution, although both forms appear to occur together in some localities (Benares, Malabar, Ceylon), it does not seem to be so generally, and I was assured some years ago by Dr. Henderson that the var. *crassa* is the only one found near Madras town, where its fossorial habits distinguish it so sharply from the true *R. tigrina* as to have raised doubts in his mind as to the propriety of uniting both under the same specific name.

From the following table of measurements it will be seen that the width of the head may considerably exceed its length in both the typical form and the variety. It has been stated that " when the foot is stretched out the margin of the web is slightly convex [1] between the fourth and fifth toes." If *R. crassa* is to be included in *R. tigrina*, this statement requires modification, as Peters in his description of *Hoplobatrachus ceylanicus* ascribes to it a rather deeply emarginate web, as is confirmed by a few of the specimens in the British Museum.

I have another correction to make to Dr. Annandale's definition of *R. tigrina*. The granular nature of the skin in some specimens may extend to the back of the head, as far as the eyes (Benares, Ceylon). Narrow, interrupted, but well defined glandular folds, 6 to 14 in number, are nearly always present on the back, and their number and regularity constitute a fairly good though not absolutely constant character for distinguishing the typical form and the var. *crassa* from the other varieties.

Some specimen of the var. *crassa* (Benares, Malabar) have large black spots on the gular region.

There is often a narrow light vertebral streak or fine line, which may be accompanied by another along the calf, as in the type figured by Daudin ; a broad vertebral band, as in the var. *cancrivora*, I have never seen.

Rana rugulosa, Annand. *nec* Wiegm.

Wiegmann's figures of *R. rugulosa* and *R. vittigera* are excellent and may be relied upon. They demonstrate that these two supposed species, founded on the coloration, are identical, even in a racial sense, and as both show a decidedly pointed snout, the tibia half the length of head and body, and the web between the toes strongly emarginate and not reaching beyond the penultimate phalanx, they answer the definition of *R. cancrivora* and not that of Annandale's *R. rugulosa*.

The name *R. burkilli*, Annand., should therefore be revived for the form, from Burma, Siam, and China, which differs from *R. tigrina*, *s. str.*, in the generally shorter hind limb, the length of the tibia being contained $2\frac{1}{5}$ to $2\frac{1}{2}$ times in that of head and body, the heels not or but slightly overlapping, and the tibio-tarsal articulation reaching the shoulder, the tympanum, or the posterior border of the eye. The fourth

[1] No doubt a lapsus for ' concave '.

Measurements in millimetres.

	R. tigrina, typica.													var. *crassa*.						
	Lahore.		Sikkim.	Nepal.		Benares.	Madras.	Malabar.		Ceylon.		Penang.(?)*		Benares.	Madras.		Malabar.	Ceylon.		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	♂	♀	♂	♂	♀	♀	♀	♀	♀	♀	♀	♀	♀	♀	♂	♀	♂	♂	♀	♀
From snout to vent	108	120	108	77	86	142	162	70	65	88	80	158	114	82	90	89	76	76	112	102
Head	38	38	36	26	29	46	51	24	22	30	29	50	38	28	31	29	23	26	36	33
Width of head	40	41	43	26	29	55	62	25	23	32	29	61	40	30	36	32	26	27	40	39
Snout	17	16	16	10	12	20	21	9	9	11	12	21	16	10	12	11	9	10	14	15
Eye	11	11	10	8	9	12	15	8	8	10	9	14	10	8	11	9	9	9	11	11
Interorbital width	4	4	4	3	3	5	6	3	3	3	3	6	5	4	3	3	2·5	2	4	4
Tympanum	8	8	9	6	6	11	11	6	5	6	6	11	8	6	6	6	5	5	8	8
Fore limb	54	57	53	37	40	75	80	37	33	47	41	75	53	39	49	42	36	39	57	60
1st finger	9	11	11	7	8	15	15	7	7	9	7	16	11	8	9	8	7	7	10	11
2nd ,,	7	9	9	6	6	12	12	5	5	7	6	12	9	6·5	7	6	5	5	8	8
3rd ,,	10	14	12	8	9	15	15	7	8	10	8	16	12	9	10	9	7	8	11	11
4th ,,	6	7	9	5	6	12	11	5	5	7	6	11	9	6·5	7	6	5	5	8	8
Hind limb	156	170	167	117	130	202	222	100	97	125	116	225	174	100	139	118	98	106	155	161
Tibia	51	54	58	38	43	71	74	31	30	43	38	75	60	35	42	35	31	32	48	48
Foot	50	52	55	36	42	67	68	32	30	45	38	71	55	38	44	41	32	32	50	50
3rd toe	27	27	27	17	20	33	33	15	15	22	17	34	27	15	23	21	13	16	27	27
4th ,,	39	43	41	28	33	50	49	24	24	37	29	54	43	25	34	31	24	25	38	40
5th ,,	27	28	27	18	23	35	35	17	17	25	19	35	28	17	26	23	16	17	29	29
1st ,,	12	13	13	9	10	17	17	7	7	9	8	17	14	7	9	7	6	7	9	10
Inner metat. tubercle	5	6	7	3	4·5	9	9	4	4	5	4	9	6	7	6	6	6	5	7	7

* This locality is doubtful, as in the case of other specimens, probably from India, described by Cantor as found in the Malay Peninsula.

toe is usually, but not constantly, shorter; sometimes the third toe reaches the distal subarticular tubercle of the fourth, sometimes it does not; there is no constant difference in the degree or emargination of the web, the large specimen from Toungoo, of which measurements are given in the following table, having the web as full and as feebly notched as in any Indian specimen I have seen. The inner metatarsal tubercle is blunt and its length is $2\frac{1}{2}$ to 4 times in that of the inner toe and $8\frac{2}{3}$ to 14 times in that of the tibia.

Although usually more rounded than in the typical form, the shape of the snout cannot be used for the distinction of this variety since it is more pointed and prominent in some specimens from China (Shanghai) than in others from India (Madras).

The folds on the back, if present, are short and in many cases they are more correctly described as elongate warts.

The absence of any trace of a light streak above the upper lip, which is marked with vertical dark bars, one or two of which may extend to the eye, distinguishes this form, but the presence of black spots or marblings on the lower parts is not constant; a specimen from Pegu is without any spots on the throat and belly, and others from Thayetmyo, Ayuthei, and Shanghai have the markings reduced to a streak in the middle of the throat. A light vertebral streak or band is absent in all the specimens examined by me.

The size often exceeds 110 millimetres from snout to vent (Toungoo, Siam, Shanghai).

Measurements in millimetres.

var. *burkilli*.

	Toungoo.	Thayetmyo.	Mandalay.	Pegu.	Takhana, Siam.	Siam.		Ningpo.		Shanghai.		Formosa.			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	♀	♀	♀	♂	♂	♀	♀	♂	♀	♂	♀	♀	♀	♀	♀
From snout to vent	142	60	57	127	93	130	133	85	95	90	117	92	91	90	89
Head	47	20	19	39	30	41	44	28	32	27	37	28	28	29	29
Width of head	53	21	21	44	32	45	53	32	34	30	43	32	31	33	31
Snout	20	9	8	16	12	16	16	12	12	12	15	11	12	12	11
Eye	13	7	6	11	10	12	12	8	8	8	10	9	9	9	9
Interorbtal width	5	2·5	2·5	4	3	5	5	4	4	4	5	3	3	3	3
Tympanum	10	4	4	9	6	8	9	7	6	8	8	7	7	7	7
Fore limb	73	29	27	65	48	63	70	45	49	50	58	48	45	46	46
1st finger	15	6	6	13	9	12	13	10	9	11	12	9	9	9	10
2nd ,,	13	5	5	10	8	10	10	8	8	9	10	7	7	8	8
3rd ,,	15	7	6	14	10	14	14	10	10	11	13	10	10	10	10
4th ,,	12	4	4	10	7	9	10	7	8	9	9	7	7	7	7
Hind limb	180	80	72	159	128	178	192	120	140	138	160	116	123	125	125
Tibia	58	26	24	52	40	57	62	38	39	40	47	38	37	39	38
Foot	62	26	24	54	44	59	64	42	43	47	54	42	43	42	42
3rd toe	31	15	13	27	22	28	35	23	25	26	28	21	22	23	23
4th ,,	60	21	18	42	35	46	54	34	35	39	43	32	34	34	34
5th ,,	35	16	13	30	26	33	38	24	26	28	30	23	24	24	25
1st ,,	17	7	6	14	11	15	16	12	12	13	14	11	11	10	11
Inner metat. tubercle	6	3	2	6	3	4	6	3	3	4	5	4	3	4	4

This form is hardly to be distinguished from the African *R. occipitalis*, Gthr., the range of which extends from the Egyptian Soudan and Uganda to the Senegal and other parts of West Africa as far south as Angola. I am not sure I could always tell a Burmese frog from an African, and the tadpoles are identical. Although I have examined over forty specimens of *R. occipitalis*, I have never seen one with a light vertebral streak. It reaches a length of 130 millimetre from snout to vent.

Rana cancrivora, Gravenh.

I have a large material from the Indo-Malay Archipelago which shows that although the toes vary considerably in length, the web between them is always strongly emarginate ; in some specimens even the two last phalanges of the fourth toe are free from the web, and such may be described as having the toes three-fourths webbed. The length of the tibia is $1\frac{3}{4}$ to $2\frac{1}{4}$ times in the length of head and body, the heels strongly overlap, and the tibio-tarsal articulation reaches the eye or between the eye and the nostril ; the longer hind limb thus distinguishes the var. *cancrivora* from the var. *burkilli*. The inner metatarsal tubercle is blunt and its length is contained $2\frac{1}{2}$ to 3 times in that of the inner toe, $8\frac{1}{2}$ to 12 times in that of the tibia.

The shape of the head varies greatly ; it is often quite as long as broad, and it may even be slightly longer (Padas, N. Borneo) ; the snout may be broadly rounded or as pointed as in any specimen of *R. tigrina typica* ; when the snout is pointed, the nostril is as a rule equidistant from the eye and the tip of the snout.

The distance between the eye and the tympanum measures $\frac{1}{2}$ to $\frac{3}{4}$ the diameter of the latter ($\frac{2}{5}$ to $\frac{2}{3}$ in the typical form).

The vomerine teeth vary considerably and often differ from those of the typical form in being disposed in rather short oblique series, well separated from the anterior borders of the choanae ; but some specimens (Borneo, Java, Celebes) have longer and stronger series, which agree entirely with the usual description.

The longitudinal dermal folds, in the strict sense, are often absent on the body ; if present, they are reduced to 2 or 3 pairs.

The coloration is much as in the var. *burkilli*, but there may be, rather exceptionally, a light streak along the side of the body, as in the typical form (specimens from the Phillippines and Celebes) ; a light vertebral line or broad band is sometimes also present, but it is very rarely accompanied by a light line along the calf (specimens from the Philippines). This is a small form, not exceeding the length of 90 millimetres from snout to vent assigned to it by Dr. Annandale.

I will now give a definition of *Rana tigrina* and of the forms into which it may be divided.

Rana tigrina, Daud.

Vomerine teeth in strong or very strong oblique, straight or slightly curved series narrowly separated from each other, originating close to or at a short distance from the anterior border of the choanae and usually extending beyond the level of their posterior borders. Head as long as

Measurements in millimetres.

var. *cancrivora*.

	Jambu, Jalor.	Kedah.	Deli, Sumatra.	Java.				Sumbawa.	Sumba.			Ombay.		Timor.	Borneo.				Padas, N. Borneo.				Philippines.		Surigao, Philippines.		Laguna del Bay, Philippines.	Manado, Celebes.	Kema, Celebes.
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
	♂	♀	♂	♂	♂	♀	♀	♀	♂	♀	♀	♂	♂	♀	♂	♂	♂	♀	♂	♂	♀	♀	♀	♀	♀	♀	♀	♂	♂
From snout to vent.	49	82	60	88	77	88	75	65	56	67	59	57	57	73	86	81	78	86	59	54	57	57	66	61	75	72	72	82	68
Head	16	27	21	28	26	29	26	22	20	22	21	20	21	23	29	27	27	29	20	19	18	19	22	21	26	24	22	24	25
Width of head	18	30	21	32	27	30	27	22	20	22	22	21	22	27	31	27	27	29	19	21	18	20	23	21	27	26	25	26	25
Snout	7	11	8	11	11	12	11	9	7	9	8	7	7	9	11	11	11	12	8	7	8	8	9	8	10	10	9	10	10
Eye	6	8	7·5	8	8	8	8	8	7	8	7	7	7	8	8	8	8	8	7	6	7	7	8	7	8	9	8	8	8
Interorbital width.	2	3·5	3	4	3	3	3	3	2·5	3	2·5	2	2	3	3	3	3	3	2·5	2·5	2·5	2·5	2·5	2·5	3	3	2·5	3	3
Tympanum	3·5	6	4	6	6	6	6	4	4	4	4	4	4	4·5	6	6	7	6	4	4	4	4·5	5	5	6	6	5	6	5
Fore limb	30	46	36	47	40	47	42	32	31	35	32	33	34	39	47	45	43	47	36	34	34	34	37	32	42	39	36	45	41
1st finger	6	9	7	9	10	11	10	7	6	7	7	7	7	8	9	10	10	10	7	6	7	7	9	8	9	9	8	10	9
2nd ,,	5	8	6	8	7	8	8	6	5	6	6	6	5	7	6	8	7	7	5	5	5	5	7	7	7	8	7	8	7
3rd ,,	7	10	8	10	10	11	10	7	6·5	7	7	7	7	9	9	10	10	10	7	7	8	8	9	8	9	9	9	11	9
4th ,,	4	6	5·5	7	6	8	7	5	5	6	6	5	5	6	6	8	7	7	5	5	5	5	6	6	7	6	6	8	7
Hind limb	74	119	86	131	115	132	112	93	82	102	87	95	92	108	127	120	121	140	90	87	88	93	111	95	107	103	105	122	110
Tibia	23	38	27	42	37	42	36	29	26	33	29	30	30	35	41	39	38	43	28	27	28	29	36	31	34	32	35	37	35
Foot	25	41	32	45	40	45	39	29	26	35	30	31	30	36	43	43	43	47	30	29	30	33	36	31	36	35	35	41	38
3rd toe	14	20	17	22	19	23	20	14	13	17	14	15	15	18	21	20	20	23	15	14	15	18	19	17	18	17	17	20	20
4th ,,	19	33	25	37	32	37	31	23	19	27	24	24	25	26	36	36	35	38	22	22	23	25	29	26	30	29	29	33	33
5th ,,	14	23	18	27	22	27	21	16	14	19	17	16	17	18	24	24	25	25	16	16	16	18	21	18	23	22	20	25	23
1st ,,	6	10	8	11	9	11	10	7	6	8	7	7	7	9	9	11	10	12	7	7	7	8	9	7	9	9	8	10	10
Inner metat. tubercle.	2	4	3	4	4	4	4	3	2·5	3	2·5	3	2·5	3	4	4	4	4	2·5	3	3	3	3·5	3	4	3·5	3	4	4

broad or broader than long, rarely slightly longer than broad; snout rounded or pointed, projecting more or less beyond the mouth, longer than the eye in the adult; canthus rostralis obtuse; loreal region very oblique, more or less concave; nostril equidistant from the eye and the tip of the snout or nearer the latter; interorbital space much narrower than the upper eyelid; tympanum very distinct, $\frac{1}{2}$ to once the diameter of the eye, its distance from the latter $\frac{2}{5}$ to $\frac{3}{4}$ its diameter. Fingers obtusely pointed, first longer than second; subarticular tubercles rather small and feebly prominent. Hind limb variable in length, but tibio-tarsal articulation never reaching the tip of the snout; heels meeting or overlapping when the limbs are folded at right angles to the body; tibia $1\frac{3}{4}$ to $2\frac{1}{2}$ times in length from snout to vent, as long as, or shorter than the foot, usually shorter than the fore limb. Toes obtuse or somewhat swollen at the end, at least $\frac{3}{4}$ webbed, often webbed to the tips; subarticular tubercles rather small; a more or less developed dermal fold on the outer side of the fifth toe and usually a feeble one on the inner side of the first and of the tarsus, interrupted by the inner metatarsal tubercle, which may be small and blunt or large and sharp-edged; no outer metatarsal tubercle. Upper parts rarely nearly smooth, usually with large, more or less prominent warts forming longitudinal series on the back, or with more or less regular longitudinal glandular folds; usually a strong fold across the head, behind the eyes continued as a curved glandular fold from the eye to above the shoulder; lower parts smooth.

Male with a white or grey external vocal sac on each side of the throat, forming longitudinal folds; fore limb moderately thickened; a strong pad on the inner side of the first finger, covered, during the breeding season, with a greyish-brown velvet-like horny layer.

Nasal bones large, in contact with each other and with the fronto-parietals; ethmoid hidden or only a small portion uncovered; fronto-parietals narrow, feebly grooved along the median line, sometimes fused; zygomatic process of squamosal long. Coracoids more or less distinctly overlapping with their proximal extremities; clavicles strong and horizontal; omosternum and sternum with a moderately long bony style, the former forked at the base. Terminal phalanges obtusely pointed.

Tadpole with the tail attenuate to a fine point, about twice as long as the body. Circular lip entirely bordered with papillae; back entirely black, the upper mandible with a strong median cusp, the lower with two; horny teeth in 3 or 4 upper and 4 or 5 lower series, the outer upper long and uninterrupted, the outer lower short and uninterrupted, the outer but one lower long and uninterrupted.

A. Regular glandular folds, 6 to 14 in number, usually present on the back; toes webbed to the tips.
  Tibio-tarsal articulation reaching the eye or between the eye and the nostril; heels overlapping; tibia $1\frac{9}{10}$ to $2\frac{1}{5}$ times in length of head and body; metatarsal tubercle $\frac{1}{3}$ to $\frac{3}{5}$ length of inner toe — *Forma typica*
  Tibio-tarsal articulation reaching the tympanum or the eye; heels not overlapping; tibia $2\frac{1}{7}$ to $2\frac{1}{2}$ times in length of head and body; metatarsal tubercle $\frac{2}{3}$ to once length of inner toe — var. *crassa*, Jerd.

B. Glandular folds much broken up or absent; if long, fewer in number; inner metatarsal tubercle ¼ to ⅖ length of inner toe.

a. Toes webbed to the tips or at least to the base of the last phalanx of the fourth; tibia 2⅕ to 2½ times in length of head and body; heels not or but slightly overlapping.

Tibio-tarsal articulation reaching the eye or between the eye and the nostril . . . var. *occipitalis*, Gthr.

Tibio-tarsal articulation reaching the shoulder, the tympanum, or the posterior border of the eye var. *burkilli*, Annand.

b. Toes incompletely webbed, one or two phalanges of fourth free; tibia 1¾ to 2¼ times in length of head and body; heels strongly overlapping: tibio-tarsal articulation reaching the eye or between the eye and the nostril . . var. *cancrivora*, Gravh.

In uniting these different forms under one species, I am simply adhering to the standard adopted in the case of *R. esculenta*, in which we find the same amount of variation in the shape of the head, in the proportions of the hind limb, in the development of the inner metatarsal tubercle and, nearly though not quite, in the extent of the web between the toes; and as I have not the slightest doubt as to the justification of the course followed in dealing with that highly variable and widely distributed species, of which I have carefully studied a very large material, I feel satisfied that the conclusion adopted in the analogous case of *R. tigrina* serves best the purposes of exact systematics. It has always been my firm conviction that the multiplication of specific names on differences which break down when put to the test of a large material is not conducive to an advance in our knowledge, whilst the recognition of forms to which subordinate rank is assigned fulfils all requirements and leads to a truer appreciation of the state of things in Nature.

It is, however, with diffidence and provisionally that I include *R. cancrivora* among the varieties of *R. tigrina*.

I have not seen examples of van Kampen's *R. angustopalmata*, from Macassar, but if its tadpole is practically identical with that of *R. limnocharis*, as he states, may it not be a distinct species? As to the tadpoles described from Java, is a confusion with *R. limnocharis* absolutely out of question? Dr. van Kampen himself, when alluding to Flower's identification of Siamese tadpoles, regarded it as almost incredible that the Malay frog, so difficult to distinguish from the Burmo-Siamese, should differ to that extent in the larval condition. I therefore believe the question of the specific rank of *R. cancrivora* should remain open until Dr. van Kampen adduces further proof of the correctness of his identification of the Javan tadpoles.

I hope I may be pardoned for raising these doubts, in view of the fact that, even in so geographically remote a form as *R. occipitalis*, the very striking buccal characters of the tadpole of *R. tigrina* have remained unchanged.

If, however, it should be established beyond doubt that *R. cancrivora* passes through a larval stage so different from that of *R. tigrina*, I would then unhesitatingly endorse Dr. Annandale's conclusion as to the specific distinction.

II. FURTHER NOTES ON *RANA TIGRINA* AND ALLIED FORMS.

By N. ANNANDALE.

Rana tigrina is one of the commonest Indian frogs and is used for dissection in all the North Indian colleges in which practical zoology is taught. Its identity is therefore a matter of more than usual interest to naturalists in India. I have recently expressed the opinion [1] that the species should be divided into three forms, which I have treated as specifically distinct. I have, however, pointed out that one of these forms (*R. cancrivora*, Gravenhorst) stands on a somewhat different footing from the other two (*op. cit.*, p. 136). Dr. G. A. Boulenger has replied to my observations in a paper printed immediately before this one. He holds that not three but five forms must be recognized. In this I am in agreement with him, but he differs from me in regarding all these forms as varieties or races of a single species. I am glad that my remarks have at any rate called his vast experience to bear on the problem, but there are still certain points both general and particular in which I find myself unable to accept his decision.

In the first place he expresses the opinion that if I had had a larger collection before me I would probably have come to conclusions other than those I arrived at with only the specimens in the Indian Museum to examine. This may be true, but only with qualifications. If I had had both this and the British Museum collections before me at the same time I would certainly have recognized the Madras form as distinct, but I do not think from what he says that I would have had reason to alter my views as to either the geographical or, with the exception stated, the taxonomic limits of the three forms that I recognized. The correct names (specific or racial) of the forms discussed (as distinct from their identity) depend, in the absence of adequate original descriptions, not on the examination of a large number of specimens from different localities, but rather on geographical considerations and on the interpretation of published figures.

The question whether the forms under discussion should be called species or races depends on one's concept of these terms—a subject on which a difference of opinion is perhaps legitimate. I have called certain forms allied to *R. limnocharis* " races or sub-species," though Dr. Boulenger recognizes them as distinct species. My reason for this has been that the forms which I regard as mere races are to some extent isolated geographically and that a considerable proportion of the individuals representing each differ from the *forma typica* in relatively unimportant characters such as size and colour. On the other hand I call forms included under the specific name *Rana tigrina* by Dr. Boulenger " species," because they are not isolated geographically but occur over large areas together, and because I do not think that individuals intermediate in character ordinarily occur.

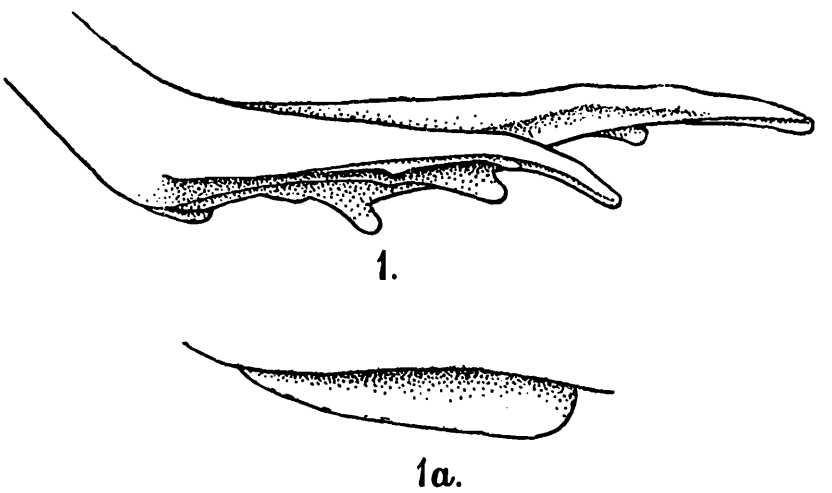
The following notes on the four forms that occur in the Indian Empire and the Malay Peninsula are based mainly on the examination of living

[1] *Mem. As. Soc. Bengal*, Vol. VI, part II, 1917.

or freshly preserved specimens examined since I have had the advantage of reading Dr. Boulenger's notes.

Rana tigrina, Daudin.

I have little to add to Dr. Boulenger's notes on this frog except in reference to its geographical distribution. I will, however, discuss the form and structure of its inner metatarsal tubercle in dealing with *Rana crassa*.



FIGS. 1, 1*a*.—Right foot of *Rana tigrina* from Calcutta, with metatarsal tubercle enlarged.

Geographical distribution.—I have made a careful examination of the specimens in the Indian Museum referred to in my original paper (*op. cit.*, pp. 125-126) and find no reason to change my opinion as to the great majority of them. The form certainly occurs not only in Northern India, but also at many places in the south of Peninsular India, as well as in Assam, Burma and Yunnan. Its range thus overlaps that of both *R. crassa* and *R. rugulosa*. Apparently it differs in habits from both these forms, being feebly or not at all possessed of powers of burrowing.

Rana rugulosa, Wiegmann.

The name of this species depends entirely on the interpretation of Wiegmann's figure. [1] I have great hesitation in differing from Dr. Boulenger on a point of interpretation, but cannot agree with him that the snout is represented as being pointed; indeed, Wiegmann says "Schnautze stumpf." Nor can I agree that the feet are meant to be webbed in exactly the same way as in the figure of *Rana vittigera* on the same plate. I have no doubt, therefore, that the types of my *Rana burkilli*, which are in very good condition, and also the series of specimens sent to me by Dr. Malcolm Smith from Siam are specifically identical with the specimen that Wiegmann selected to be figured as typical of his *R. rugulosa*.

---

[1] *Nov. Ac. Ac. Leop.*, XVII, pl. xxi, fig. 2 (1835).

Dr. Smith [1] has recently sent me three tadpoles, which agree well with Flower's figures.

Geographical distribution.—The species appears to be widely distributed in Burma, Siam and China. In Burma it is found commonly with *Rana tigrina, s. s.* and in Southern Siam with *R. cancrivora*, but apparently it does not penetrate far south into the Malay Peninsula.

According to Burkill [2] both this species and *R. tigrina* are eaten by the Burmese. At Prome the former is said to be distinguished from *R. tigrina* (which the Burmese call Hpa Zang under the name Hpa Boung-she. It is stated by them to differ also in habits, in which apparently it resembles *R. crassa*, although the inner metatarsal tubercle is usually small and resembles that of *R. tigrina* in structure. The tubercle is perhaps, however, somewhat more prominent than in the latter.

Rana crassa, Jerdon.

1854. *Rana crassa*, Jerdon, *Journ. As. Soc., Bengal*, XXII, p. 531.

Jerdon's original description of this species is very short and is not accompanied by a figure. The frog is, however, in my opinion quite distinct. The reason why I did not recognize it was that the only specimens I had examined were very old and all more or less distorted. Dr. J. R. Henderson has been kind enough to send me five living frogs from Madras. A comparison of these specimens with those already preserved in the Indian Museum has convinced me that there is much less variation within the limits of *Rana tigrina, s.s.* than I formerly thought to be the case.[3]

The most important difference to be recognized in preserved material lies not so much in the size as in the structure of the inner metatarsal tubercle, and this character is very liable to be obscured. In *R. crassa* the tubercle is usually larger than in *R. tigrina, s. s.*, but my original statement that its size is not correlated with other characters is literally correct so far as either form is concerned. In *R. tigrina*, however, it is a simple broad longitudinal ridge rounded on the inner surface and situated at some little distance behind the base of the fifth toe ; whereas in *R. crassa* it is much more prominent (at any rate in the living frog) and is distinctly concave on the inner surface, with a strong blunt carina running along its lower margin. It is also situated further forward

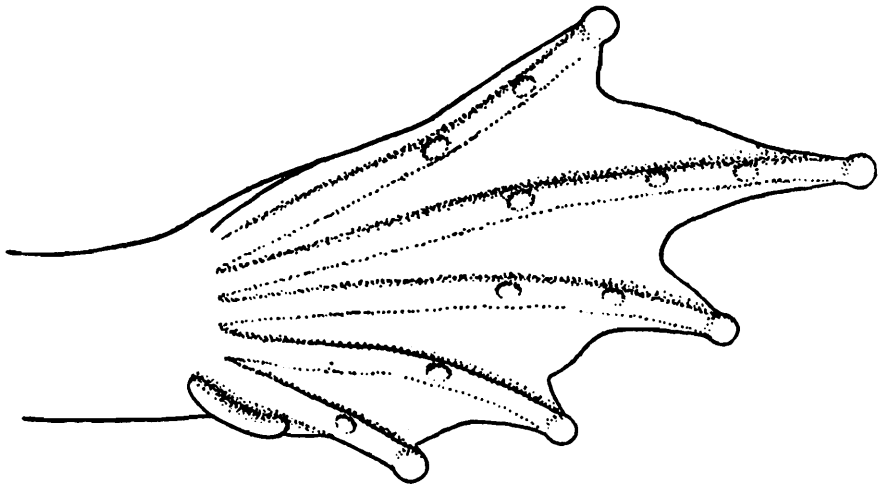
---

[1] Dr. Smith has just published further figures of the tadpole. See *Jorn. Nat. Hist. Soc., Siam* II, p. 263, pl. iv, figs. 2, 2*a*.

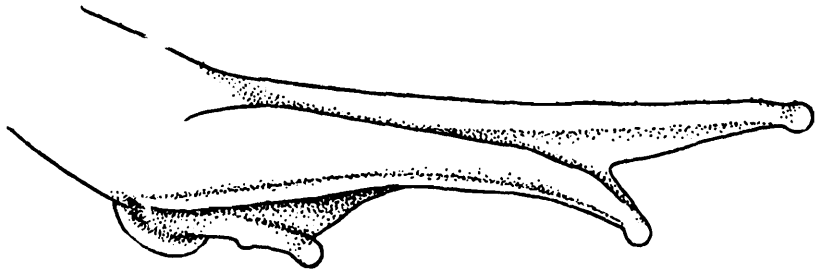
[2] *Agricult. Ledg.*, No. 2, pp. 13 and 15 (1911).

[3] Since Dr. Boulenger saw this note Dr. Henderson has sent me twelve further specimens of *R. crassa* well preserved in spirit. So far as the immediate neighbourhood of Madras is concerned they bear out the views expressed above. There is, however, one very important fact connected with them, *viz.*, that Dr. Henderson captured at the same time a single specimen to which he drew my attention and which I cannot distinguish from *R. rugulosa* from Burma. The occurrence of a single individual of this form, so far from its proper home, suggests the question, may not *R. rugulosa* (or *R. tigrina* var. *burkilli* as Dr. Boulenger calls it) have arisen as a mutation of *R. crassa* ? The fact that specimens of *R. crassa* itself have been found sporadically in Northern India, would further suggest that it also may have arisen as a mutation, from the typical *R. tigrina*. Further evidence is, however, necessary before attempting to answer this question. In any case it has no bearing on the taxonomic position of *R. cancrivora*.

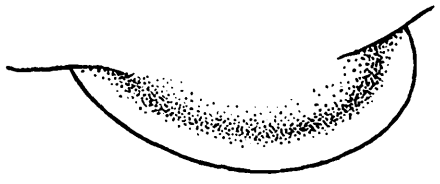
on the foot, almost parallel to the basal part of the toe, and has a much stiffer consistency, being strongly cornified in old frogs. When specimens are preserved in spirit, however, the tubercle is apt, owing to the shrinkage of the soft tissues of the foot, to collapse in such a way that its concave surface lies flat on the sole and is thus entirely concealed. This has occurred in all the old specimens that I have examined.



2.



2 a.



2 b.

Figs. 2, 2*a*, 2*b*.—Right foot of *Rana crassa* from Madras (× 2), with metatarsal tubercle further enlarged.

The colour of living specimens from Madras is similar to that of *R. tigrina*, but much duller, a dull brown being substituted for the greens and yellows, and with the exception that the throat is spotted with black. In general appearance the frog seems to be very like *R. rugulosa*, and Indian specimens that I referred to as being intermediate between that species and *R. tigrina* actually belong to *R. crassa*.

I have been able to examine only two tadpoles that can be assigned to this species. In one of them the hind legs are fairly well-developed, while in the other the toes are already differentiated. So far as it is

possible to make a definite statement on the basis of this material, they differ from those of the true *R. tigrina* in the following particulars :—

They are larger and of stouter build, with the abdomen more convex ; the dorsal surface is more densely pigmented and there is a pale band extending backwards in an oblique direction from the nostril to a pale space surrounding the eye. They very closely resemble those of *R. rugulosa*, except that the dorsal membrane of the tail is not so elevated and that the coloration of the dorsal and lateral surfaces of the head and body is less uniformly mottled.

Geographical distribution.—The following specimens in the collection of the Indian Museum must be transferred to this species :—

9025. Agra, United Provinces. Agra Mus. (Ex.).
12572. Chandbally, Orissa. C. H. Dreyer.
9074-5 : 9071. Ceylon. Dr. Kelaart.
9017 : 9057 : 9060. Colombo, Ceylon. Dr. J. Anderson.

Combining my records with those of Dr. Boulenger, we find, therefore, that *R. crassa* is by no means confined to South India, in some part of which it probably occurs together with *R. tigrina, s.s.*, and Ceylon, where it may occur alone. It is known from Agra and Benares in the United Provinces, from Orissa, from the town of Madras and from several other localities on both coasts of the Indian Peninsula, as well as from several localities in Ceylon.

The behaviour of the living specimens sent to me from Madras differed totally from that of individuals of *Rana tigrina, s. s.* The former when placed in a vivarium the bottom of which was covered with sand, burrowed immediately and concealed themselves below the surface. This I have never known *R. tigrina* to do. Moreover, they did not possess anything like the same power of leaping.

Rana cancrivora, Gravenhorst.

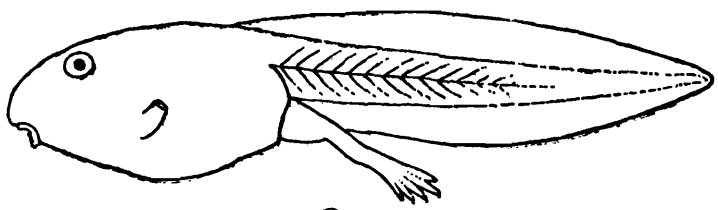
Dr. Boulenger's notes rather lead me to think that there may be in the Malay Archipelago several races or species closely allied to this form. Dr. Van Kampen's var. *angustopalmata*[1] may perhaps be distinct after all. My chief reason for including it in the synonymy of *R. cancrivora* was a letter from him in which he wrote as follows :—" My *angustopalmata* has a still somewhat shorter web than this *R. cancrivora*, but this difference does not occur in all specimens from Celebes, and as it is very difficult to describe it is perhaps better to drop the name."

It is important, therefore, that I should make it quite clear that my description was based almost entirely on specimens from Siam, one of which Dr. van Kampen had kindly compared with specimens from Java, the type locality of the species. I had also examined a series of old and sodden specimens from North Borneo, but had paid, in accordance with my usual rule, comparatively little attention to them.

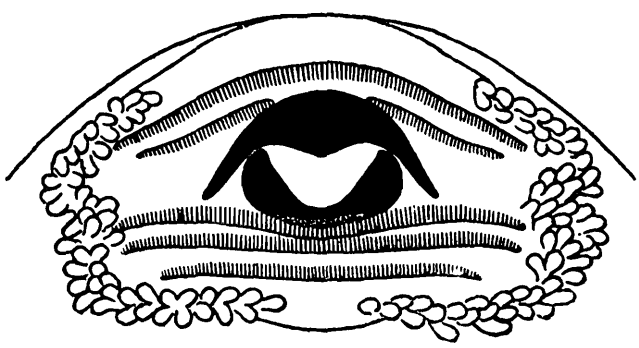
Doubt has been cast by Dr. Boulenger on the identification of the tadpole of this frog by Dr. van Kampen. *R. cancrivora* is a very common frog in the plains of Java, where *R. limnocharis* is, according to

[1] In Weber's *Zool. Ergebn. Neid. Ost.-Ind.*, IV, p. 388, pl. xvi, fig. 3c.

Barbour,[1] scarce. Dr. van Kampen paid great attention to the Batrachian larvae of the island when resident there for some years and it seems to me improbable that a tadpole so peculiar as that of the *R. tigrina* type, had it been at all common, would have escaped his notice. Moreover, Dr. Malcolm Smith of Bangkok has sent me tadpoles from Siam that



3.



3a.

FIGS. 3, 3a.—Tadpole of *R. cancrivora* from Siam (×2), with mouth-disk further enlarged.

conform, with minor differences, to the *R. limnocharis* type, and which he identifies as those of *R. cancrivora*. About them he writes :—

> " The specimens that I sent you last week are I think without doubt *cancrivora*. My men brought in a large number from the mouth of the Chumpon River (P. Siam), where the frog was common, and with young ones just leaving the water from which I have made the diagnosis. They differ from van Kampen's description only in the 3rd or lowest tooth row of the lower lip. In *cancrivora* this is nearly or quite as long as the row above, whilst in *limnocharis* it is only half the length. Koh Lah specimens confirm this, but I will get some living tadpoles and confirm the frog." [2]

The chief differences between these tadpoles and the larvae of *R. limnocharis* are that (1) the dorsal membrane of the tail is much less sinuate in outline ; (2) the tail is shorter and less pointed, and (3) the

---

[1] *Memoirs of the Museum of Comparative Zoology at Harvard College*, Vol. XLIV, No. 1, p. 65.

[2] Dr. Smith has recently (October 10th, 1917) sent me the following additional note :—" There is other evidence, however, by which I am quite sure that *R. rugulosa* and *R. cancrivora* are distinct. Their breeding calls are entirely different. That of the former is a deep " wrnk, wrnk, wrnk (WRNK) " of the latter a loud bleat, something like the noise produced by a goat. I have kept them both and am sure on this point." I understand that Dr. Boulenger now accepts *R. cancrivora* as distinct. Dr. Smith (*Journ. Nat. Hist. Soc., Siam* II, 264) has just published a note on the tadpole.

dorsal coloration is darker and more uniform. The mouth-disk and its armature are closely similar except that the lowest tooth-row on the lower lip is broader and the teeth larger, and that the fringe of papillae is interrupted on the middle below.

Geographical distribution.—The only point precisely ascertained as to the general range of this species is that it occurs in South Siam, including the provinces of Singgora and Patani in the Malay Peninsula, as well as in Java. It is apparently synonymous with *R. schlueteri*, Werner, from North Borneo, but there is a possibility that the var. *angustopalmata* of van Kampen from Celebes may be distinct, if it is not synonymous with *R. vittigera*, Wiegmann, from the Philippines.

III. POST-SCRIPTUM.

By G. A. Boulenger.

Dr. Annandale having most courteously communicated to me his reply to the suggestions contained in the first paper, I will add a few words rather than make any alteration to my original draft.

As I say in the last paragraph, my opinion on the rank to be assigned to *R. cancrivora* stands or falls on the question of the tadpole, and as Dr. Annandale appears to have proved his case, I have no further reason to disagree with him, except from the theoretical point of view.

The old conception of the frog in its development climbing up its own genealogical tree must be abandoned. As I pointed out twenty years ago,[1] " larval forms such as the tadpoles are outside the cycle of recapitulation, the ontogeny being broken by the intercalation of the larval phasis. The horny beak, the circular lip with its horny armature, the spiraculum, the enclosure of the fore limbs in diverticula of the branchial chambers, and such special adaptations as the ventral disc or sucker of certain mountain forms, clearly point to tadpoles having had a developmental history of their own. We need, therefore, not be surprised at occasionally finding, within the same genus, very different types of tadpoles, or even a total suppression of the larval stages, as is actually the case in the large and widely distributed genus *Rana*." That adaptational gyrinal polymorphism occurs has been pointed out by Camerano,[2] and I have myself drawn attention to a very remarkable dimorphism, apparently non-adaptive, in *Pelodytes punctatus*.[3]

Our progress in the knowledge of the metamorphoses of Batrachians has most decidedly invalidated the prediction of my late chief Dr. Günther who, in his Preface to my Catalogue of 1882, expressed the opinion that probably the next step in perfecting the system of classification would be marked by a consideration of the larval stages.

I conclude, from the close agreement of *R. cancrivora* with the other forms grouped under *R. tigrina*, that the differentiation of the tadpole has arisen independently from that of the adult, the cuspidate beak and other buccal features of the *R. tigrina* tadpole being, of course, as

[1] *Tailless Batrachians of Europe*, p. 110.
[2] *Atti. Acc. Torin.*, XXVI, 1890, p. 72.
[3] *Proc. Zool. Soc.*, 1891, p. 617, pl. xlvii, figs. 1, 2.

Dr. Annandale admits, deviations from the more normal pattern preserved in *R. cancrivora* ; and therefore I do not think that the case in question points to forms originally distinct having converged to resemble each other in the adult condition. My opinion is supported by various examples, drawn from other types of animals, which Giard (1891-1892) has grouped together under the term poecilogony, the list of which is constantly being increased.

I am glad my remarks have led Dr. Annandale to procure further material of the Bull-frog which occurs commonly in India and Ceylon ; I only regret he has not had more before expressing a decided opinion on the two forms the distinction of which I have pointed out. These he now regards as valid species, a divergence of view which may appear to some to be merely a matter of opinion. I wish, however, to observe that I feel sure a larger series would have convinced him that intermediate specimens fill up the gap between the extremes shown by his text-figures. To mention only one example, the specimen from Ceylon of which measurements are given in column 10 of my table under *R. tigrina typica* has the metatarsal tubercle in an exactly intermediate condition as regards shape and size.

I have only seen a few living specimens of the Indian frogs, but in dealing with the European *R. esculenta* I have carefully studied enormous numbers, many caught by myself, and I may appeal to experience thus gained, as the distinction between the typical *R. esculenta* and the var. *lessonae* is a perfect parallel to the case of *R. tigrina* and *R. crassa.* The difference between the two extremes, in the proportions of the hind limbs and in the size and *shape* of the metatarsal tubercle is the same, as may be realized from the following measurements (*a*, length from snout to vent ; *b*, length of tibia ; *c*, inner toe, measured from the metatarsal tubercle ; *d*, length of metatarsal tubercle ; *e*, perpendicular diameter of the tubercle) :—

	a.	*b.*	*c.*	*d.*	*e.*
R. esculenta typica, Nice ...	74	37	10	4	1
R. esculenta var. *lessonae*, Norfolk	72	29	8	6	2·5

I add the same measurements of a *R. crassa*, from the Madras Presidency, presented under that name to the British Museum by Dr. Jerdon, which show the inner metatarsal tubercle to be even smaller, in proportion, than that in the *R. esculenta* var. *lessonae*, from Norfolk :—

R. tigrina var. *crassa*	90	42	9	6	2·5

Now it is perfectly well known that there is so complete a gradation between the two extremes indicated by the above measurements that not even the extremists in species multiplication, of which we have a few among European herpetologists, have ventured to separate the form *lessonae* as a species. I have not the least doubt that if a large number of specimens could be obtained, from Ceylon for instance, and carefully measured, the distinction between *R. tigrina* and *R. crassa* would present the same difficulties and fully justify the course I have followed, and prove that, as in the European frogs, geographical non-isolation cannot be appealed to as a safe criterion in deciding what warrants specific rank.

I have one more remark to make, and that is on Wiegmann's figure of *R. rugulosa.* I have re-examined this figure, and, with all deference to Dr. Annandale's opinion, I can only repeat my statement that I regard the snout as pointed, as much so as in Dr. Annandale's figures of *R. tigrina,*[1] and the web between the toes incomplete and deeply notched.[2] It must be borne in mind that the types of *R. rugulosa* and *R. vittigera* have been compared by no less an authority than the late Professor Peters, and pronounced by him to be specifically identical (*Mon. Berl. Ac.* 1863, p. 78).

---

[1] Dr. Annandale mentioned as one of the characters of his *R. rugulosa* the less pointed snout as compared to *R. tigrina,* and that is why I draw attention to the shape of the snout in Wiegmann's figure. I therefore request a comparison of the latter with the heads figured on Plate V of the *Mem. As. Soc. Beng.*, Vol. VI.

[2] I have not said that the feet " are meant to be webbed in exactly the same way as in the figure of *R. vittigera* on the same plate," and I know how greatly the extent of the web varies in *R. cancrivora* (see my remarks under that heading). I was alluding to Dr. Annandale's definition on p. 122 of his paper, where *R. rugulosa* is stated to have the feet almost fully webbed and the web very little emarginate.

VIII. THE LYMPH GLANDS IN THE GENUS *PHERETIMA* WITH A NOTE ON THE COELOMIC ORGAN OF BEDDARD.

By GOBIND SINGH THAPAR, *M.Sc., Professor of Biology, Islamia College, Peshawar. (From the Zoological Laboratory, Government College, Lahore.)*

(Plate VI.)

In the common Indian species of earthworms of the genus *Pheretima* there occur on either side of the dorsal vessel throughout the intestinal region a series of segmentally arranged whitish structures which constitute a prominent feature in the ordinary dissection of the animal. Since this genus is usually taken as a type for study in the Colleges of Northern India, and since but little has been published on these organs, I determined, at the suggestion of my Professor, Lieutenant-Colonel J. Stephenson, to investigate them in the three common species of *Pheretima* which occur in Lahore, *P. posthuma* (L. Vaill.), *P. heterochaeta* (Mchlsn.), and *P. hawayana* (Rosa). My grateful acknowledgments are due to Colonel Stephenson for the help and suggestions which I received from him in the course of my work.

Beddard, whose monograph sums up what was known on the Oligochaeta prior to 1895, speaks of these structures along with certain others in other worms as " Coelomic Organs of problematic nature " ; " in certain Perichaetidae there are a series of minute paired whitish bodies lying one on either side of the dorsal vessel in the middle region of the body, and springing from the septa (in *P. indica*), or from the dorsal vessel itself (*P. dyeri*). These bodies are quite solid, consisting of a mass of cells surrounding a few muscular fibres." *P. indica* is probably the species now known as *Pheretima heterochaeta*, and *P. dyeri* a synonym for *P. rodericensis*.

G. Schneider published (*Zeit. f. wiss. Zool.*, LXI, 1896) a paper entitled " Ueber phagocytäre Organe und Chloragogenzellen der Oligochäten " (I have not seen his preliminary account, published in Russian with a German abstract in *C. R. Soc. Natural. Pétersbourg* of the previous year). He also investigated *P. indica* and *P. dyeri*, and in addition *P. barbadensis* (a subspecies of *P. hawayana*). According to Schneider the dorsal vessel, at the place of origin of the glands in each segment, lies in a sheath, which is a funnel-shaped forwardly directed diverticulum of the septum ; the glands arise from this sheath. The sheath is deficient at a small opening on each side, and from the margins of this opening muscular fibres branch out into the gland ; the adjoining segments communicate with each other through this opening. The muscular fibres form the frame-work of the gland, which is not a solid mass, as Beddard states, but a tree-like branching structure, whose twigs in older examples lie so close that the whole gives the impression of a lobed

cell-mass penetrated by numerous canals and lacunae. The cells are thickened peritoneal epithelium ; their nuclei are similar to those of the peritoneal cells on the one hand, and those of the leucocytes on the other ; the outer cells of the gland form rounded projections into the peritoneal cavity. Foreign bodies and parasites are found in the glands, and also setae covered with a thick layer of leucocytes ; in addition to the leucocytes, which make up the bulk of the cells of the glands, there are also large clear cells, with small deeply staining and apparently shrivelled nucleus ; these are sometimes full of small round refractile granules, and mostly occur in small aggregates surrounded by leucocytes ; they are probably dead chloragogen cells. Fresh chloragogen cells are also present in the glands. The author obviously considers the gland-cells to be merely heaped around the supposed opening in the septum. He also describes similar organs in certain Lumbricidae, and performed a number of interesting physiological experiments in order to ascertain the function of the glands ; he comes to the conclusion that they are phagocytic organs.

Schneider introduced the name " lymph-glands " for these structures, which is quite appropriate.

Lloyd (*An Introduction to Biology for Students in India*, 1910) after describing the naked-eye characters of the organs, says " The function of these glands is unknown ; they consist of a mass of nucleated cells, which may be blood cells, or phagocytes in a state of development." He calls them " blood glands," an unsuitable term, which had better be dropped, especially as there are definite blood glands in some species of *Pheretima* (Lloyd's " oesophageal glands ").

METHODS.

The technique employed was the following :—The dissections made in order to describe the form and situation of the glands were made under the binocular dissecting microscope. The worms for sectioning were kept for a week and fed during this time on damp blotting paper renewed daily ; they were then narcotized, and fixed in 10 per cent. formalin for 24 hours, then washed and passed through graded alcohols ; some were cut into pieces and fixed in warm sublimate and acetic for an hour, then washed several times in distilled water and passed through graded alcohols.

The sections were first overstained with Delafield's haematoxylin and then differentiated in acidulated water (five drops HCl to 100 cc. distilled water ; I used acidulated water in preference to acid alcohol because in the latter case there is no graduated and regular transference of the sections from a watery to an alcoholic medium). After passing through graded alcohols up to 90 per cent. the sections were counter-stained in alcoholic eosin (1 per cent. eosin in 90 per cent. alcohol for one minute), then dehydrated and cleared in the usual way.

I also used Dobell's iron-haematein method (*Arch. Protistenkunde*, XXXIV, 1914). Films of the coelomic fluid, which I examined in the course of my work, were fixed in either sublimate or absolute alcohol, and stained in a similar manner to the sections.

THE GLANDS AS SEEN IN DISSECTION.

Pheretima hawayana.—The lymph glands are a double series of whitish bodies, situated on either side of the dorsal vessel, lobulated, segmentally arranged, beginning in segm. xxvi. In the anterior portion of their extent they occupy the posterior third of each segment, and extend from the dorsal vessel outwards about half way towards the lateral margin of the intestine. As we pass backwards they enlarge, until in the middle region they cover the greater part of the intestine in each segment (fig. 1). Still further back they diminish again, and ultimately they totally disappear in the last two or three segments. Each consists of a large number of very closely set small lobules.

The septa are pouched forwards where they cross the dorsal vessel so that the dorsal vessel is here enclosed in a tube-like sheath, the cavity of which is part of the cavity of the segment behind the septum. It is to the walls of this pouch that the glands are connected.

On some of the glands a number of small white bodies are to be seen, which on examination are found to be the cysts of the spores of a Gregarine,—probably of the *Monocystis* found in the seminal vesicles.

Pheretima heterochaeta.—The glands begin in segm. xvii. In the anterior part of their extent they appear attached by a short stalk; behind, the glands enlarge and a stalk is not to be distinguished; at the hinder end the glands of a pair meet and fuse over the dorsal vessel and below it, so that the vessel is enclosed by the glands. The glands are of simpler form than in *P. hawayana*,—not lobulated in the same way; though towards the hinder end a number of lobes, with a digitate arrangement, may be present (fig. 2).

Pheretima posthuma.—The glands begin, as in *P. hawayana*, in segm. xxvi; the lobulation and variations in size correspond to what was found in that species; some of the glands also show the spore cysts of Gregarines.

HISTOLOGY OF THE GLANDS.

A detailed description need only be given for one species; for this purpose I choose *P. hawayana.*

The lobules of the gland surround a central cavity, and this cavity opens into the cavity of the sheath round the dorsal vessel at this region; the interior of the gland is therefore morphologically in connection with the cavity of the segment behind that in which the gland itself lies. Fig. 3, actually drawn from *P. posthuma*, will illustrate this relation.

The boundary of the gland consists of an extremely fine membrane, in which nuclei appear at intervals as flattened swellings; these ovoid nuclei contain a deeply staining granule ("pseudonucleolus"), as well as fine irregularly distributed chromatin particles; the protoplasm surrounding the nucleus appears to be fibrillar in structure, and is continued into the membrane which forms the boundary of the gland.

Besides this bounding membrane, the interior of the gland is traversed by a reticulum, sometimes comparatively sparse, of the same character,—much flattened cells joined end to end,—and continuous with the limiting membrane, or capsule, as it may be called. In the centre of the gland this reticulum is almost or quite absent, so that there

is there an uninterrupted space, containing more or fewer of the cells to be described ; this space, as has been mentioned above, opens into the cavity of the sheath round the dorsal vessel.

From the margins of this opening, *i.e.*, from what may be called the mouth of the gland, a number of muscular fibres take origin, as has been described by Schneider ; these pass into the gland, and then branch and radiate ; they are perfectly distinct from the reticulum.

Within the gland are contained numerous cells, of irregular shape, with rounded nucleus containing a pseudonucleolus ; their processes may resemble pseudopodia, and the nucleus may be excentric. These are leucocytes, and as their characters are well known, they need not be further described.

These cells are more compactly aggregated at the periphery of the gland, where they form fairly solid masses corresponding to the lobulations seen on the surface ; each such lobule is surrounded by a corresponding outward bulging of the enveloping membrane or capsule. The cells are also contained in the meshes of the reticulum of the gland, but are here more loosely aggregated ; in the centre of the gland towards the opening into the sheath of the dorsal vessel they are still more scattered.

The cells are to be looked on as proliferated from the inner surface of the capsule within the peripheral lobulations ; thence they travel into the central part of the gland, and ultimately they reach the general body-cavity through the sheath around the dorsal vessel, which, as already explained, communicates with the cavity of the next posterior segment.

From what has been said, it will be seen that I regard the capsule as peritoneal in origin ; it is indeed, as fig. 3 shows, continuous with the septum, and may be looked on as in fact an irregular sac-like forward bulging of the septum, which has become extremely thin by the loss of all muscular elements,—which has been indeed reduced to a thin sheet of peritoneal cells only. No doubt this sheet is morphologically double, and results from the coalescence of the two layers of peritoneum covering the two faces of the septum, but its double character is not to be made out in the actual specimens.

I differ, therefore, from both Beddard and Schneider in the conception of the essential nature of these organs ; neither author seems to have recognised the capsule, or bulging of the septum within which the cells are contained. Beddard's idea is that the organ is a mass of cells surrounding a few muscular fibres ; while Schneider speaks of a definite opening in the sheath of the dorsal vessel, through which the cavity of one segment communicates with that of the next adjacent, and the gland is a tree-like branching structure originating from the margins of the opening.

I must guard myself from saying that the capsule is to be made out as a complete investment over the whole periphery of the gland in every section ; it seldom is so, in this species at any rate. At places the cells of the gland are closely adherent, so that the capsule does not stand off as a separate structure, and frequently the capsule is absolutely continuous with the cells. This of course necessarily follows from the

fact that the cells are budded off from the inner surface of the capsule. It is possible also that some cells are budded from the outer surface of the membrane ; or the cells which may be seen there may perhaps be leucocytes of the coelomic fluid which have become temporarily adherent.

In *Pheretima heterochaeta* the lobulation of the glands is less marked than in *P. hawayana*, and the outline of the glands in sections is comparatively smooth ; there is consequently not the same massing together of the newly formed and forming cells within the lobules, and the texture of the gland seems on the whole to be looser ; the capsule is as a rule more easily traced, and its connection with the reticulum within the gland is easily made out.

In *P. posthuma* the lobulation is similar to that of *P. hawayana*, and the relation of the capsule to the cells also is as described for that species.

OTHER CONTENTS OF THE GLANDS.

That the main mass of the cells of the glands are leucocytes with a phagocytic function has been established by the experiments of Schneider.

In addition I have seen the cells described by Schneider as containing small round refractile granules ; the cells may be partially or even entirely filled by the granules. Chloragogen cells are also to be seen, and may be met with in various stages of degeneration. Cysts and pseudonavicellae of *Monocystis*, which may be surrounded by an almost epithelial arrangement of leucocytes, are present. Setae and fragments of setae, similarly surrounded by leucocytes, are also found.

THE COELOMIC FLUID IN *PHERETIMA*.

I add a few notes on the coelomic fluid in this genus.

The fluid is of a yellowish colour, which varies according to the nature of its cellular contents. Its consistency also varies ; it is thick and gelatinous in specimens coming from a dry locality, thinner in those from places where there is abundant moisture. As is well known, it is coagulable by alcohol.

Its cellular constituents are of four chief kinds :—

(1) Leucocytes, granular and colourless, of various sizes ; the nucleus is usually spherical, and excentrically placed ; the chromatin is distributed as irregular granules, while in the middle of the nucleus is a larger aggregate, which may be called the pseudonucleolus. In normal salt solution these cells are seen to be actively putting out pseudopodia, fine filiform processes extending in various directions, which may anastomose with similar pseudopodia of other cells and lead to the production of plasmodia. The cells may sometimes become pear-shaped, with a fine filiform process which gives the appearance of a flagellated Protozoon till the movements are observed.

(2) Minute colourless nongranular cells, mostly spherical, but sometimes becoming elongated and pointed at the ends ; they are numerous, and may also form plasmodia. In stained preparations the clear protoplasm readily takes up the eosin stain ; the nucleus when present is

excentric, spherical, and contains a pseudonucleolus; there is a large clear vacuole in the middle of each.

(3) The cells described in the account of the lymphatic glands as containing a number of refractile granules or globules are also seen.

(4) Yellow cells,—the chloragogen cells,—in various stages of degeneration are found.

In addition, numerous rod-like bacteria are present; and also the sporozoite stage in the development of *Monocystis*.

THE COELOMIC ORGAN OF BEDDARD AND FEDARB.

Beddard and Fedarb have described ("On a new Coelomic Organ in an Earthworm," *Proc. Zool. Soc.*, 1902), in specimens of *Pheretima posthuma* sent from Calcutta by Mr. F. Finn when Deputy Superintendent of the Indian Museum, a number of pouches or tunnels on the inner surface of the body-wall. These, which were visible in the ordinary dissection of the worms, were found in a number of specimens,—it is not stated that they were absent in any. Their direction is transverse on the lateral and ventro-lateral body-wall; they occur on both sides, from segment xxii to the hinder end of the animal, being largest from about segment xl for about twenty segments onwards. Extending outwards and upwards from near the ventral nerve cord, they present the appearance of tunnels open at both ends, considerably constricted in the middle of their extent; or the two halves may be quite separate, *i.e.*, the constriction may be complete, resulting in the formation of two pouches on each side, those on the same side having their mouths facing in opposite directions, their narrow closed ends close together. The roof of the tunnels or pouches is thin and membranous,—merely an extension of the peritoneum. The structures are not equally marked in all specimens; but, as stated above, they are not said to have been absent in any of the specimens examined.

In a large number of dissections of *P. posthuma* I was unable to see these organs, even with the binocular dissecting microscope. I also prepared several series of sections for the same purpose, but the results were here also negative, except in one case, in a few segments taken from a little in front of the middle of the body. Here the tunnel was present, as described by the authors; while reaching to not very far from the ventral nerve cord below, they terminated above a little dorsal to the lateral line of the body.

The organs are therefore not found in all specimens of the species; in some localities, as at Lahore, they appear to be of rare occurrence.

A point not noticed by the previous authors is the modification of certain cells of the roof of the tunnel. A section across the tunnel,—such as is obtained in a longitudinal vertical series where it passes through the lowest part of the tunnel on the ventral body-wall,—shows the floor to be flat, and the roof a semicircular arch, just as in an ordinary railway tunnel (fig. 4). The floor is carpeted by ordinary peritoneal cells, clear and squarish; the sides of the arching roof consists of flattened cells joined at their edges, as in the case of the capsule of the lymph glands, previously described. The vertex of the roof is peculiar; it consists of cells which are much elongated vertically, joined together

at their bases, and projecting downwards into the tunnel, with their free ends, which are narrower than the bases, separate from each other, and so giving a ragged appearance to the lower side of the roof; the length of these downwardly projecting cells may be more than one-third of the height of the tunnel; they have a fibrillated structure, the fibrils running in the direction of the long axis of the cells.

In the tunnels numerous leucocytes are seen, and many nephridia, as mentioned by Beddard and Fedarb. I have no suggestions to offer as to the function of these organs.

EXPLANATION OF PLATE VI.

FIG. 1.—Dissection in the middle region of *Pheretima hawayana ; b. w.*, body-wall ; *c*, spore cysts of *Monocystis ; d. v.*, dorsal vessel ; *int.*, intestine ; *l.g.*, lymph gland.

„ 2.—Dissection in the posterior region of *Pheretima heterochaeta ;* letters as before.

„ 3.—Horizontal longitudinal section through a lymph gland of *Pheretima posthuma*, showing relations to the septum and dorsal vessel ; only a few cells are shown in the interior of the gland, and the reticulum and branching muscular fibres are omitted ; *a*, a leucocyte ; *ac.*, one of the peripheral lobules of the gland ; *d. v.*, the dorsal vessel ; *m*, encapsuling membrane of the gland ; *peri.*, peritoneum ; *sep.*, septum ; *v*, valve in dorsal vessel.

„ 4.—Vertical longitudinal section passing through the lower end of Beddard and Fedarb's organ ; *c*, leucocyte ; *c.m.*, circular muscular layer ; *c.p.*, coelomic organ ; *cu.*, cuticle ; *ep.*, epithelium ; *l.m.*, longitudinal muscular layer ; *neph.*, nephridium ; *peri.*, peritoneum. The epithelium is shown as a thick black line only.

Figs. 3 and 4 are semidiagrammatic.

IX. NOTES FROM THE BENGAL FISHERIES LABORATORY

No. 4. CESTODE PARASITES OF HILSA, *HILSA ILISHA* (HAM. BUCH.).

By T. SOUTHWELL, *A.R.C.Sc. (Lond.), F.Z.S., Director of Fisheries, Bengal and Bihar and Orissa ; Honorary Assistant, Indian Museum, Calcutta, and* BAINI PRASHAD, *M.Sc., Superintendent of Fisheries.*

(Plates IV, V.)

CONTENTS.

I. THE ANATOMY AND LIFE-HISTORY OF *RHYNCHOBOTHRIUS ILISHA*, N. SP., FROM THE INTESTINE OF *CARCHARINUS GANGETICUS* (MÜLL. and HENLE).[1]

DURING September and October, 1917 observations were made by us in the Pusser river, district Khulna, on the habits of Hilsa, *Hilsa ilisha* (Ham. Buch.). This anadromous fish ascends the Bengal rivers, during the rains, for the purpose of breeding. Two methods of catching the fish are practised by the Bengal fishermen :—

(1) Small canoes drift down stream, broadside on, trailing behind them a *shangla jal*. This is a small purse-like net which can be manipulated easily by one man. The moment a Hilsa is caught, the mouth of the net is closed, the net is hauled aboard, the fish removed, and the net cast over again. By this method it is very rare for more than one fish to be caught at a time.

(2) A large gill-net, often measuring 300 feet in length, is shot by one, or between two, boats, and allowed to drift downstream for perhaps two miles or so. It is then hauled. The catch varies between two or three fishes and two hundred.

In both cases, the boats return to the starting point, picking their way close to the bank of the river, aided by the wind, which fills a big sail of fantastic shape and colour. In both the above methods of fishing the entry of a fish into the net is most easily detected. Whilst working with the gill-net, we frequently noticed that fish entered the net, but somehow escaped. On hauling the net it was in every case found to be torn. The fishermen assured us that the damage had been

[1] *Carcharius gangeticus* (Müll. and Henle) in Day's Fishes in the "*Fauna of British India.*"

done by a shark, and that sharks frequently attacked and ate Hilsa from the large net. A few days later we were fortunate in catching a shark in one of the small *shangla jals*. It proved to be a specimen of *Carcharinus gangeticus* (Müll. and Henle), which measured a little over 6 feet. The stomach contained a Hilsa, partly digested, and also a portion of the net. On examining, carefully, the partly digested Hilsa, it was found that the flesh of this fish contained numbers of club-shaped Cestode cysts, which, as a result of the partial digestion of the fish, were actively emerging from the flesh into the stomach of the shark. These cysts, which occurred in the muscles, had not been noticed previously. The large intestine of the shark contained numbers of adult Cestodes, but the spiral valve was clean. These parasites were found, ultimately, to be of two species, *viz.*, (1) *Discocephalum pileatum*, Linton. The only species of the genus was recorded by Linton from the spiral valve of the dusky shark *Carcharius obscurus* ? Woods Hole, Mass., July 19th, 1886 ; it has not been recorded since. (2) *Rhynchobothrius ilisha*, n. sp., which forms the subject of this paper. All the cysts seen emerging from the partly digested Hilsa were found to contain larvae of *Rhynchobothrius ilisha*. No cysts were obtained which contained larval forms of *Discocephalum pileatum*, Linton. De, in his report on the "Fisheries of Eastern Bengal and Assam," Shillong, 1910, mentions that sharks and saw-fishes follow the Hilsa up the rivers of Eastern Bengal and Assam. This is certainly true of *Carcharinus gangeticus*.

Systematic position.

Family Tetrarhynchidae.
Sub-tribe Trypanorhyncha, Diesing.
Sub-family Phyllorhynchinae, Van Beneden.
Sub-family I. Dibothriorhynchinae.
Family Dibothriorhynchidae, Diesing.
Genus *Rhynchobothrius*, Rudolphi.
(*Tetrarhynchus* of authors.)

Generic characters :—Body taeniform. Neck tubular. Head continuous with neck, with two opposite bothria, parallel or converging at the apices, lateral or marginal, entire or undivided, or, either bilocular with a longitudinal partition, or bilobed or divided. Proboscides four, terminal, filiform, armed, retractile in the neck, for the most part longer than the head. Genital apertures marginal, female lateral, or male and female marginal approximate.[1]

Rhynchobothrius ilisha, n. sp.

(Plate iv, figs. 1—7.)

Bothria two, lateral, entire, rounded, external face hollowed to form a sucking disc ; widely separated posteriorly, and approximated anteriorly. Neck shorter than the head, flat. Proboscides filiform and armed with four kinds of hooks, arranged in oblique circles, the larger

[1] After Linton (2).

hooks being distributed principally on the outer surface. Anterior segments shallow and numerous. Last segment much longer than head. Total number of segments about 232. Genital apertures irregularly alternate, and situated about the posterior third of the proglottid. Length of worm 11·5 cms. Posterior segments separating in two's and three's.

Habitat.—The large intestine of *Carcharinus gangeticus* (Müll. and Henle). Khulna, district Khulna, Bengal, 21st October 1917 Eleven adult specimens, several young forms just emerged from the cyst, and three cystic forms. No. Z.E.V $\frac{7248}{7}$ in the collection of the Indian Museum.

Observations were made on the adult living worms and also on the free proglottides, in fresh water. Later on, these were preserved in corrosive acetic solution. Specimens were mounted stained whole with borax carmine, and also unstained. Sections were not found necessary as the anatomy could easily be determined from the mounted specimens. The head is large compared with the size of the worm and measures 4·2 mm. in length. The breadth of the anterior extremity is 2·6 mm., and of the posterior extremity 1·4 mm. Length of bothridia 1·8 mm. Length of proboscides 2·1 mm. Length of proboscis sacs 1·6 mm.

The bothridia (B) are paired, approximated anteriorly and widely separated posteriorly (plate iv, fig. 2). They are round in shape, having entire margins, and sucker-like external surfaces. The proboscides (P) are four in number; the armed portion is very short, with an equal length unarmed and very long tubes connecting them to the proboscis sacs (P. S). The hooks (plate iv, fig. 2 *a*—*e*) are of four types arranged in oblique rings, the larger ones being disposed along the outer margins. As usual, the hooks towards the base of the proboscides are much smaller than the rest.

The neck is short, measuring only 2·2 mm. It is flattened and not cylindrical. The anterior proglottides are shallow and numerous. The posterior proglottides are much longer than broad, measuring 5·1 mm. by 1·3 mm. The total number of proglottides is about 232. The male genital organs appear first. The female organs are to be seen only in the last few proglottides. Of the male organs, the testes are first visible about the middle of the worm. The genital aperture is situated about the posterior third of the proglottis, and the male aperture is immediately in front of that of the female.

Male organs (plate iv, fig. 4).—These consist of a large number of testes (T) occupying the greater part of the mature proglottid. They first appear laterally. From each of these is given off a minute tubule; these unite later to form the vas deferens (V D). This is a thick coiled tube originating a little in front of the ovaries and opening directly into the cirrus sac (C). The vesicula seminalis (V S) is a bag-like structure which opens close to the junction of the vas deferens and the cirrus sac. The penis is fairly long and lies coiled up in the spacious cirrus sac. We could not distinguish any armature.

Female organs (plate iv, fig. 4).—The ovaries (Ov) are paired and lie one on each side of the centre line, posteriorly. From each is

given off, anteriorly, a very small oviduct (O.d). The two oviducts unite in the middle-line and receive, at the point of junction, the duct of the shell-gland (S. G). This organ lies between the ovaries, in the centre line. The uterus (Ut) originates, anteriorly, from the point of union of the two oviducts. It runs forward in the middle-line as a blind diverticulum, practically to the anterior termination of the proglottid, narrowing as it goes. The vagina (V) also originates close to the mouth of the uterus and is continued as a narrow coiled tube to near its opening. It then widens to form a barrel-shaped receptaculum seminalis (R.S).

Water-vascular system (plate iv, fig. 3).—This consists of a single pair of wide tubes (W T), situated one on each side, internal to the excretory vessel and nerve. These two tubes communicate with each other by a wide transverse vessel situated at the posterior margin of each segment. In the head, the two tubes break up into a series of fine vessels distributed throughout the substance of the head.

Excretory system (plate iv, fig. 3).—This consists of a pair of very fine tubes (E. D) situated, one on each side, between the water-vascular vessel and the nerve. In the proglottides, they do not unite, but in the head they are united by a single transverse vessel.

Nervous system (plate iv, fig. 3).—In each proglottid this consists of a single fine nerve (N) on each side, external to the water-vascular and excretory duct. No attempt was made to follow the distribution of the nervous system in the head.

The larva.—We have already referred to the fact that numbers of tadpole-like cysts were found in the lateral muscles of the partly digested Hilsa. Previous to this record no cysts had been noticed in the flesh of Hilsa, although some time ago larval forms of *Syndesmobothrium filicolle*, Linton, were recorded by one of us from the mesenteries of this fish (5 & 6). The *Rhynchobothrius* cysts were, as noted, tadpole-shaped (plate iv, fig. 5). They consisted of a club-like head, and a long tail-like structure which was capable of considerable movement, and appeared to us to serve the purpose of mooring the larva in the intestine of the shark, during the digestive processes.

The head, in one specimen, measured 4·8 mm. by 3·6 mm. The tail tapers to a point and measured 51·8 mm. in length. On opening out the " head," the larva (Y) was seen to be a massive structure occupying the greater part of the head and lying in a coiled position (plate iv, fig. 6). The tips of the four proboscides were just everted, and the spines could be clearly seen. Many young worms (plate iv, fig. 7) were also obtained from the lumen of the intestine. These had not had time to attach themselves to the intestine of the host.

Life-history.—The Cestodes usually complete their life-histories in two separate hosts, the larval form occurring in an animal which is devoured wholly, or in part, by the final host of the worm. In a great number of cases the larval forms of adult worms have not been recorded. In fewer instances larval forms have been described, but the adult worm developing therefrom is not known. The circumstances under which we are able to follow the life-history of this worm are undoubtedly unique. In the present instance, the larval form of *Rhyn-*

chobothrius ilisha occurs in the lateral muscles of Hilsa. This fish is eaten by the shark *Carcharinus gangeticus*, and practically all stages between the cystic form and the adult worms are to be found in the intestine of the shark in question.

Three points arise for consideration :—

(1) We have already called attention to the fact that the tail of the tadpole-like cyst is mobile. It appeared to us on examining the living material, *in situ*, that the movements of the tail were directed toward retaining the cyst in the lumen of the shark's intestine, until the larva had had time to emerge and attach itself to the wall of the gut.

(2) We have no information as to the exact manner in which the Hilsa become infected. The eggs of the adult worm are obviously shed into the water. Most probably they are swallowed accidentally by the Hilsa, in which case the larva would be liberated and carried to the muscles, *viâ* the lymph or the blood stream. It is further possible that the larvae hatch out in water, and, attaching themselves to the Hilsa, bore their way to the lateral muscles ; but as we know nothing regarding the structure of the larva, we can only hazard a guess as to the initial mode of infection of the Hilsa.

(3) It will be clear that parasites occurring in the intestines of fish are removed with the entrails of the fish, before the fish is cooked and eaten. But when these parasites occur in the flesh, their removal is impossible.

Rhynchobothrius ilisha, n. sp., is the first example of an Indian Cestode whose life-history has actually been worked out. It is true that in the cosmopolitan forms of tapeworms, such as *Taenia solium*, *Taenia serrata*, etc., the life-history is well known. In India, owing to the occurrence of these species in precisely similar hosts, the same life-history has been inferred ; but so far as we are aware no experimental work of this kind has been attempted.

Shipley and Hornell (4) described two species of tapeworms from *Carcharias gangeticus* (now *Carcharinus gangeticus*) obtained in Dutch Bay, Ceylon (salt water), 3rd January 1905, *viz.*, *Tertrarhynchus perideraeus* and *Tetrarhynchus gangeticus*. Our species is totally dissimilar to the former and differs in the following particulars from *Tetrarhynchus gangeticus* :—

1. Our worms are 17 times longer.
2. A distinct neck is present.
3. The arrangement of the proboscis tubes is quite different.
4. The hooks are different.

As nothing has been stated by the authors regarding the anatomy of their species we have no means of carrying the comparison further. Our species is quite different from other species of this genus.

Four species of Cestoda have now been recorded from this shark, *viz.*, *Tetrarhynchus perideraeus*, *Rhynchobothrius ilisha*, *Tetrarhynchus gangeticus*, and *Discocephalum pileatum*.

Classification.—As a result of some years' observations on the Tetrarhynchidae we are of opinion that this family requires revision, particularly with reference to the anatomy of the reproductive organs. Fortunately, we have a fairly extensive and representative collection

and we are hoping, at no distant date, to be able to determine, in detail, the exact relationships of the various genera included in this family.

The anatomy of the reproductive organs in our species is quite unlike that given by Linton (2) for the various species of Rhynchobothridae recorded by him. On the other hand, it resembles very closely the figure of an immature proglottid of *Tetrarhynchus erinaceus*, Ben., figured by Johnstone (1). It differs only in the absence of vitellaria and a few minor details.

Literature cited—

(1) Johnstone, J.—*Tetrarhynchus erinaceus*, Van Beneden. *Parasitology*, Vol. IV, No. 4, Cambridge, 1912.

(2) Linton, E.—Notes on Entozoa of marine fishes of New England, with descriptions of several new species. *United States Fish Commissioners' Report*, 1887

(3) Regan, C. T.—A revision of the Clupeoid Fishes of the genera *Pomolobus*, *Brevoortia*, and *Dorosoma* and their allies. *Ann. Mag. Nat. Hist.*, Vol. XIX, No. 112, April, 1917

(4) Shipley and Hornell.—Cestode and Nematode parasites from the marine fishes of Ceylon. *Ceylon Pearl Oyster Report*, Vol. V, Royal Society, London, 1906.

(5) Southwell, T.—On some Indian Cestoda. Part I. *Rec. Ind. Mus.*, Vol. IX, Part V, December, 1913.

(6) Southwell, T.—Notes from the Bengal Fisheries Laboratory. Parasites from Fish. *Rec. Ind. Mus.*, Vol. IX, Part V, 1913.

II. A NOTE ON THE CYSTS OF *SYNDESMOBOTHRIUM FILICOLLE*, LINTON, PARASITIC IN THE LATERAL MUSCLES OF HILSA.

Specimens of Hilsa purchased from the Calcutta market during October, 1917 were found, on careful examination, to contain cysts of *Syndesmobothrium filicolle*, Linton, in their flesh (lateral muscles).

Southwell (3) recorded specimens of this cyst from the mesenteries of Hilsa in 1913. This parasite is, of course, distinct from the cysts of *Rhynchobothrius ilisha*, Southwell and Prashad, described in the first part of this paper.

The cysts, when removed from the muscles, showed a considerable amount of movement and remained alive in normal salt solution for a few hours. Both the head and tail of the tadpole-shaped cysts (plate iv, fig. 8) were mobile. The head, in addition, showed contractile movements, owing to which its shape exhibited great variation in form.

The cysts measured about 64 mm. in length, the head being 5·7 mm. long by 3·1 mm. broad, whilst the tail varied in length from 58 mm. to 60 mm. The tail was an elongated tapering structure. The cysts were of a milky-white colour, the head being formed of stout fibrous tissue, whilst the tail portion consists of a thin membrane enclosing an albuminous fluid.

On one of these cysts being dissected out it was seen that the head portion contained a second cyst (Y), almost cylindrical in shape, transparent, and 3 mm. in length.

This second cyst, on being opened, was found to contain the worm (plate iv, fig. 9), which showed four fully developed bothridia and four proboscides, with a neck and an undifferentiated part posteriorly, which terminated in a vesicle.

The parasites were not very numerous in the specimens of Hilsa which we examined.

Literature cited—

(1) Linton, E.—Notes on Entozoa of marine fishes. *Report U. S. Fish Comm. for* 1887. Washington, 1891.

(2) Southwell, T.—*Ceylon Marine Biological Reports*, Part VI. Colombo, 1912.

(3) Southwell, T.—On some Indian Cestoda, Part I. *Rec. Ind. Mus.*, Vol. IX, Part V, 1913.

III. A DESCRIPTION OF A CESTODE PARASITE OF DOUBTFUL SYSTEMATIC POSITION, FROM THE MESENTERY AND LIVER OF HILSA.

I. INTRODUCTION.

In the following paper we propose describing a parasite which, though of small size, appears to be of very great systematic importance, and which further reproduces itself in a manner not before known amongst the Cestoda.

The parasites were found first at Khulna in the mesentery of Hilsa. The mesentery (*m*), binding up the various coils of the intestine, was infected so very heavily as to appear something like a massive liver-like organ in which the various coils of the intestine appeared merely as tubes embedded therein. The infection had further spread to the liver [L (i)] which, in most specimens examined, was also heavily infected, though only in part (plate v, fig. 1).

Since the initial observations were made, the parasites have been found to be widespread. They were found in Hilsa examined by us from Goalundo, Sahebgunj, Kalna, and Calcutta. The infection is of such a heavy nature that, although more than a hundred specimens have been examined, not a single one was found which was not similarly infected. Continuous observations on living and preserved material were made at Khulna and Kalna and in the Fisheries Laboratory in the Indian Museum, over a considerable length of time. It has thus

been possible not only to make exact observations on the parasite, but also to refer to all the literature found necessary. The adult parasites, as found in the mesentery, lie in elongated cysts of a creamy-yellow colour. The cysts measure 2·5 to 3 mm. in length. The younger stages are found scattered in the mesentery, the cyst not having been secreted at this stage.

II. TECHNIQUE.

Living worms are dissected out of the cyst in normal salt solution, under a binocular microscope, and are examined alive on a slide with the highest powers available. They are best preserved for whole mounts in an alcoholic solution of Schaudinn's corrosive acetic solution. The salt solution containing these dissected out worms on the slide is first drained off and a few drops of the fixative added to cover them. After about half an hour the fixative is drained off and the usual method of staining and mounting adopted. We found that Heidenhain's iron haematoxylin gave the best results. Serial sections of the worms were cut with a Minot's rotatory microtome and stained with Heidenhain's iron haematoxylin.

III. THE ANATOMY AND DEVELOPMENT OF THE ADULT WORM.

(1) *The Cyst* (plate v, fig. 2).—The worm occurs, as we have already remarked, in an elongated cyst which varies from 2·5 to 3 mm. in length. Its width is usually ·4 to ·5 mm. The cyst is cylindrical and rounded at both ends. It is made up of strong fibrous tissue. On opening out the cyst it is found to consist of a single adult worm, with a few young worms which have been produced pathenogenetically in a manner to be described later on. The worm is attached to the internal wall of one of the rounded ends of the cyst by four suckers, which occur at the anterior end of the worm. The anterior extremity of the cyst, which is the same as that of the animal, can easily be distinguished under a lens, or the binocular microscope, owing to a reddish-orange pigment shining through the cyst at this end. It may be stated here that the cyst is in no way secreted by the parasite, but is formed by the tissues of the host itself undergoing a change. Besides the worm, the cyst contains a large number of fat globules and fat cells, which appear to serve as food for the parent worm.

(2) *The adult worm* (plate v, fig. 3).—The adult worm is a leaf-like animal resembling a small liver-fluke. It measures 2·4 mm. long and ·38 mm. broad. These measurements refer only to the fully grown animals found in the cyst. It is of a milky-white colour, with two more or less triangular patches of orange-red pigment (P.C.) situated near the anterior end, just posterior to the suckers, one on either side. The worm, on examination under a microscope, is seen to consist of an anterior and a posterior extremity. Anteriorly there is a median rostellum-like structure (R), devoid of any armature. Immediately posterior to it are four typical suckers (plate v, fig. 4), arranged symmetrically round the base of the rostellum. These are circular, having deep concavities, with thick raised, entire, margins. The usual three

kinds of muscles can be distinguished as forming the structures in question. The posterior extremity of the worm is rounded. No opening whatsoever is to be seen at this extremity. The outer cuticle is somewhat thickened.

(3) *Internal structure of the worm.*—On examining the worm with the high power it is seen to consist of a homogeneous substance in which no differentiation into separate organs is to be observed. In fact, the structure is of a most primitive character. All that can be distinguished besides the egg-cells (E) and the coloured corpuscles, in both living and stained specimens and in sections, is a tube, slightly coiled, which runs round the worm, close to, and parallel with, the margin of the leaf-shaped worm. Anteriorly, near the suckers, the two ends curve inwards for a short distance towards the centre of the worm. This is the excretory tube (E.t.), and from it are given off a large number of minute tubules which end in typical flame cells. The flame can, with an oil-immersion lens, be seen moving in these cells, in the living worm. The whole of the homogeneous substance referred to above is filled up with enormous numbers of minute egg-cells. Besides the eggs, *morulae* [(E (i)] and other higher stages in the development of the young were also present in the intima.

The orange-red coloured corpuscles (P. C.) are arranged in two triangular patches, one on each side, immediately behind the suckers. Each of these patches is formed of a large number of nearly rounded corpuscles measuring 23-25 μ in diameter. We are unable to say anything regarding the function of these corpuscles. When the worms die, or are preserved, the pigment disappears.

(4) *Egg-cells.*—The egg-cells (plate v, fig. 5) are elliptical, measuring 17 μ by 12 μ. The structures of the egg-cells is the same as that of a typical ovum with little yolk, and they probably originate in the same way as the parthenogenetic egg-cells in the sporocysts (and other larval stages) of the Trematodes. Some of these egg-cells were seen to be in different stages of development (plate v, fig. 6). They develop in the body of the parent to form young worms identical in structure and appearance with the parent. These will be fully described later on. Under ordinary circumstances the anterior extremity, or rostellum, of the adult worm shows no opening, but, when the development of the parthenogenetic young worms is complete, it is seen that the young worms have gradually worked their way to the anterior extremity of the adult. They now escape through a temporary aperture which is formed in the middle of the rostellum, anteriorly. In plate v, fig. 7 one such young worm is shown in the act of escaping. We were fortunate in being able to observe two such cases, on different occasions, in living animals under microscopic observation. After the parent form has produced numbers of such young, the cyst breaks up and the young escape into the mesentery of the host. The parent form now dies and many empty cysts can always be seen in the mesentery of the host.

(5) *The young worms* (plate v, fig. 8).—These vary in size from ·3 mm. to ·35 mm. in length by ·1 to ·12 mm. in breadth. They, like the adult worm, possess four suckers, a rostellum, imperfectly developed excretory tube, and a few eggs, but are devoid of pigment.

IV SYSTEMATIC POSITION OF THE WORM.

It will be clear from the preceding description that the parasite presents many unique characters. Our first impressions were that the parasite was a Trematode, but subsequent investigation showed that this was not the case. The entire absence of an alimentary canal, and the presence and arrangement of the four suckers, suggested the probability of the parasite being a Cestode, and it was only after careful examination that we concluded, definitely, that the animal belonged to the Cestoda.

Benham (1) defines the characters of the Cestoidea and the Trematoda as follows :—

(1) *Cestoidea.*—Platyhelminths in which an internal parasitic *habit has led to the disappearance of the alimentary canal from every stage in the life-history.*[1] The ciliated covering, as well as definite organs of sense, are likewise absent in the adult. The epidermis, which has sunk into the parenchyma, secretes a thick cuticle as in the Trematoda. In the parenchyma, certain lime-secreting cells are developed in greater or less number. Organs of fixation are developed in a characteristic, but varied form, at one extremity of the worm.

(2) *Trematoda.*—Parasitic Platyhelmia which retain the mouth and alimentary tract of the ancestor, but in which the epidermis not only loses its cilia during embryogeny but is apparently absent in the adult as a distinct continuous cellular layer, having sunk into the mesoblastic tissue after secreting a thick, stratified, chitinous cuticle. Further, in relation to their parasitic habits, suckers are developed at, or near, the posterior end on the ventral surface and also in the region of the mouth.

In considering the classification of the worm just described, three points are to be considered, *viz.* :—

(1) Is the animal a Trematode or a Cestode ?
(2) Is it a larval form or an adult ?
(3) If an adult, then is it a primitive or a degenerate form ?

(1) Is the animal a Trematode or a Cestode ?

The entire absence of all traces of an alimentary tract, the disposition of the suckers, and the absence of ventral posterior suckers are definite Cestode characters which, in our opinion, show that the worm is not a Trematode. The absence of an alimentary canal alone is considered by Luhé, and other leading helminthologists, to be the chief distinguishing character between Cestodes and Trematodes, although in some stages of the life-history of a few Trematodes, owing to degeneration, all traces of an alimentary canal disappear. We were unable to establish, by experiment, the actual presence of calcareous bodies, although under the microscope, typical calcareous bodies appeared to be present. The occurrence of orange-red corpuscles is an incidental character which it shares in common with many adult Tetrarhynchids, but we are not aware of any record of such coloured bodies being found in the Trematodes. Although the parasite seems to us to be undoubtedly a Cestode, we are aware that it differs very widely from

[1] The italics are ours.

any larval or adult Cestode hitherto described. These differences, as we shall see, are so great and so fundamental as to merit very careful consideration before coming to a conclusion.

(2) Is the parasite a larval or an adult form ?

Assuming it to be a larval form the following facts have to be considered :—

(*a*) The parasite exhibits, in common with the larval liver-flukes, the peculiar method of parthenogenetic development, but we know of no case among the Trematodes in which such active larval stages are passed in a vertebrate host. Further, nowhere does this type of parthenogenetic development take place within a cyst. Besides this, as the parasite in question has absolutely no trace of a digestive tract, we have no hesitation in concluding that it is not a Trematode larva.

Turning now to the Cestoda we find that the reproductive process is absolutely unique, whether the parasite be an adult or a larval form. It is unlike any Cestode larva we are acquainted with in being parasitic, absorbing food, reproducing itself, and in the progeny reinfecting the same host. Further, a combination of such adult structural characters as suckers, reproductive organs of whatever kind, and the excretory duct, is not to be seen in any larval Cestode. We are aware of the conditions existing in various species of the genus *Piestocystis* (3). We have seen Villot's account (6) of this form, as well as Hill's description of his species of *Piestocystis hoplocephali* and *Piestocystis lialis* (4). Although our form bears a superficial resemblance to *Piestocystis lialis* with the head evaginated, in having an unarmed rostellum and four suckers, yet our species, though encysted, has the rostellum and suckers always everted as in adult tape-worms ; this is so even in the young individuals of our species. Moreover, the excretory system in *Piestocystis lialis* and other species is open posteriorly, while in the parasite in question it is closed in all stages of its life-history. Also in *Piestocystis lialis* the buds are produced directly by a proliferation of the internal wall of the cyst. This is a typical larval condition, but in this worm which certainly appears to be an adult, the young are developed by a typical method of parthenogenesis (Lipospermia) in the body of the worm and not form the wall of the cyst.

For the above reasons we have to conclude that the parasite is an adult cestode, though the following facts might be urged against this assumption, *viz.*, (*a*) Absence of sexual genital organs, both male and female ; (*b*) the encysted condition of the adult parasite ; but the young parasites, as has been mentioned before, find their way out of the parent cyst, after they have grown to a fair size. They then lie in the mesentery for some time before themselves becoming encysted and repeating the same life-history ; (*c*) the entire absence of the nervous and water-vascular systems. The absence of these characters, however, in no way interferes with the acceptance of the form as a Cestode parasite, which is highly degenerate—a condition which perhaps is to be correlated with a changed life-history, completed in one host only, as appears to be the case with the form in question. This is further borne out by the extensive infection of the host which results in a very large progeny.

(3) If an adult, then is it a primitive or a degenerate form ?

We cannot consider the parasite to be a simple primitive form because of its structure, particularly the structure and disposition of the suckers, the excretory vessel, the specialised cyst, and the parthenogenetic method of reproduction.

Systematic position:—Owing to the degenerate nature, and the peculiar reproductive phase of the parasite in question, there is very great difficulty in assigning it to its true position amongst the Cestoda, but the presence of four unarmed suckers, as well as an unarmed rostellum, would suggest affinities with the Taeneoidea (Cyclophyllidea). For this peculiar worm we propose the name *Ilisha parthenogenetica*, n. g., n. sp.

The generic characters would be as follows :—

Small parasitic leaf-like worms occurring in cylindrical cysts. Anteriorly there is a rostellum and four suckers, which latter are arranged symmetrically round the base of the rostellum. All these are unarmed. Sexual organs and genital pores absent. Parthenogenetic development. The young are quite like the adult and find their way out of the parent, and later on repeat the same life-history.

Of doubtful affinity.

Habitat.—The mesentery and liver of *Hilsa ilisha* (Ham. Buch.) from various places in Bengal ; September and October, 1917.

A very large number of specimens. No. Z.E.V $\frac{7249}{7}$ in the collection of the Indian Museum.

Literature cited—

(1) Benham, W B.—Platyhelmia, Mesozoa and Nemertini, in Lankester's Zoology, Part IV London, 1901.

(2) Braun, M.—Cestoda in Bronn's *Klassen and Ordnungen des Their-Reichs*. Leipzig, 1879-1893.

(3) Diesing, K. M.—*Systema Helminthum*, Vol. I. Vienna, 1850.

(4) Hill, T. P.—A contribution to a further knowledge of the cystic Cestodes. *Proc. Linn. Soc. N. S. W., Sydney*, 1894.

(5) Lühe, M.—*Susswasserfauna Deutschlands*. II. Parasitische Plattwurmër. II. Cestodes. Jena, 1910.

(6) Villot, F. C. A.—Memoire sür les Cestique des Ténias. *Ann. des Sci. Nat.* (*Zool.*), VI. Paris, 1882.

X. NOTES ON SOME HARES IN THE INDIAN MUSEUM WITH DESCRIPTIONS OF TWO NEW FORMS.

By C. Boden Kloss, *F.Z.S.*

I owe to the authorities of the Indian Museum the opportunity of examining a number of the hares in their collection and while studying the material lent me have put together the following notes. Unfortunately many of the skins are old and deteriorated and in some instances the skulls are very imperfect so that many features are obscured : but on the other hand little detailed information seems to have been published about the hares of the Indian Empire and many of the older descriptions are very sketchy according to modern ideas.

Though I think but little weight can be attached to the form of the cement groove, or enamel folding, of the upper incisors except for broad distinctions I have described and figured all the examples in the present series. Forsyth-Major states :—" Specimens of the same species may vary slightly owing partly to individual variation. But the shape of the enamel fold varies equally at different stages in the age of the animal ; species whose incisors show the most complicated pattern in the adult have as yet no trace of this in very young animals ; and *vice versâ* in very old specimens complication tends to disappear again." (*Trans. Linn. Soc. Zoology*, 2nd Ser., VII, p. 466 ; 1899.)

The examination of a sufficient series from one place (which is required in order to show what the degree of variation is) still remains to be made, but judging from a set in my possession of *Lepus siamensis*, Bonhote, obtained from localities in North, Central, Eastern and South-Western Siam,—even after making allowance for age—species or races seem to have an incisor groove only definable within wide limits : *L. siamensis*, for instance, possesses a furcate groove but the number and shape of the branches are very variable.

As regards hares of the Indian Empire those with some form of triangular groove only occur just within northern limits and the branched-grooved group includes the majority of its forms ; for though in one or two of those examined the groove is squarish, in them the branches have probably aborted. The present series does not show any gradation or connection between the furcate and triangular forms of groove and these two patterns seem of value for grouping purposes.

It has seemed most convenient to deal with the material geographically beginning with the north-western races. Two new forms are described.

Lepus yarkandensis.

Günther, *Ann. Mag. Nat. Hist.* (4), XVI, p. 229 (1875).

No. 3782. Sub-adult skull from Katti-ilik, Fyzabad, Eastern Turkestan (F. Stoliczka coll.). Upper incisors with the grooves triangular

in section and well filled with cement (fig. 1): very like those of "*Lepus yarkandensis*?" from Koko Nor figured by Forsyth-Major (*Trans. Linn. Soc., Zool.*, 2nd Ser., Vol. VII, p. 468, fig. vii; 1899); and another specimen from Eastern Turkestan figured by Lyon (*Smithsonian Miscellaneous Collections*, Vol. XLV, p. 351, fig. 8; 1904).

Lepus craspedotis.

Blanford, *Eastern Persia*, II, p. 80, pl. viii.

No. 1322a. Nearly adult female (skin and skull) from Pishin, Baluchistan (W. T. Blanford coll.). Type of *L. craspedotis*.

Pelage very soft, apparently greyish-buff speckled with blackish, the rump greyest; a pale area about the eye; nape fulvous. Forelimbs brighter and more ochraceous than the body; hind-feet whitish or buffy white above, ochraceous below. Tail clear black above, ungrizzled. Underparts white except the foreneck which is fulvous; lower abdomen clad with long hair. Ears apparently very large with a long fringe of hair along their upper edge. Groove in upper incisors in shape a rather acute isosceles triangle about half filled with cement (fig. 2).

The skulls of this animal and of *L. yarkandensis* (No. 3782 *antea*) differ from all the following in the relative narrowness of their palatal bridges and in the large size of their bullae, those of *L. yarkandensis* being very big indeed, round and dilated; of *L. craspedotis* rather longer though not so broad but with even larger external auditory meatus: *craspedotis* has also rather larger palatal foramina and the anterior "foot" of the zygomatic arch is hardly expanded at all, while in *yarkandensis* the foot is smaller than in any of the following specimens.

Both have the nasals truncate posteriorly, those of *craspedotis* being quite square-ended, also its post-orbital processes are much larger, broader, and almost touch the frontals behind—often they probably do as there are distinctly rough-tipped projections on the latter bones which seem to indicate complete contact: in both species the processes are relatively larger than in any of the following.

Lepus dayanus.

Blanford, *Proc. Zool. Soc.*, 1874, p. 663.

No. 1293b. Adult skin and skull from Nara-Nai Hills, west of Sehwan on the Indus, Sind (W. T. Blanford coll.).

Pelage harsher than *craspedotis* but not so harsh as in the following species: apparently agreeing with the description of the types of *dayanus* which came from Sukkur on the Indus, about 100 miles N. N. E. of Sehwan. Hairs of upper side of tail with dark bases almost concealed by fulvous tips.

The specimen is apparently a female as the lower abdomen is clad with very long hair.

Upper incisors with cement-grooves completely filled and almost square in section but the posterior border and the sides slightly concave and the corners rounded (fig. 3), less elongate than those of the cotype

figured by Forsyth-Major (*l. c. s.*, fig. xviii) and not so forked posteriorly.

The skull has considerably smaller bullae but larger palatal foramina than *yarkandensis* and *craspedotis*, with the palatal bridge a trifle broader: the inter-orbital width is greater; there is a well-developed anterior foot to the zygomata; the nasals are rounded posteriorly towards their outer sides and the post-orbital processes are joined to the frontals behind.

Lepus cutchensis, sp. nov.

No. 9827. *Type.*—Nearly adult male (skin and skull) from Bhuj, Kutch, collected on 17th August 1911 by the Bombay Natural History Society's Mammal Survey. Original No. 401.

Characters.—Pelage very like that of *L. dayanus* from Sehwan but perhaps a little harsher; tail darker and less grizzled: bullae smaller. Skull like that of *ruficaudatus* in the broad sense, but pelage duller and tail dark.

Colour.—Upper parts a grizzle of pale buffy and dark brown, the former predominating, but distinctly greyish above the base of the tail. Limbs and top of muzzle ochraceous-buff, the hind feet rather paler above. Sides of muzzle and area about the eyes whitish; nape and foreneck nearly avellaneous-buff, not blackened. Throat, underside of body and tail and inner sides of thighs white. Hair beneath the digits of all limbs tawny. Ears finely grizzled buff and brown and edged with buff, the lower edge paler; the tips blackish posteriorly; the bases whitish below. Tail bone-brown above, slightly grizzled with ochraceous-buff.

Skull and Teeth.—Skull very like that of *ruficaudatus* (s. g.), having smaller bullae than *dayanus*, as small or smaller than *ruficaudatus*: palatal bridge broader but palatal foramina narrower than in *dayanus*, zygomatic feet equally developed; nasals similarly rounded posteriorly; inter-orbital breadth less; post-orbital processes considerably smaller and short, showing no sign of posterior contact with the frontals.

The grooves of the incisors, though of the same bifurcate pattern as in the cotype of *dayanus* figured by Forsyth-Major (*l. c. s.*, fig. xviii), have the branches longer and more distinct and more divergent; they are completely filled with cement (fig. 4).

Measurements.—Collector's external measurements:—Head and body, 415; tail, 80; hind foot, 101; ear, 93. For other measurements see table, p. 96.

Lepus ruficaudatus.

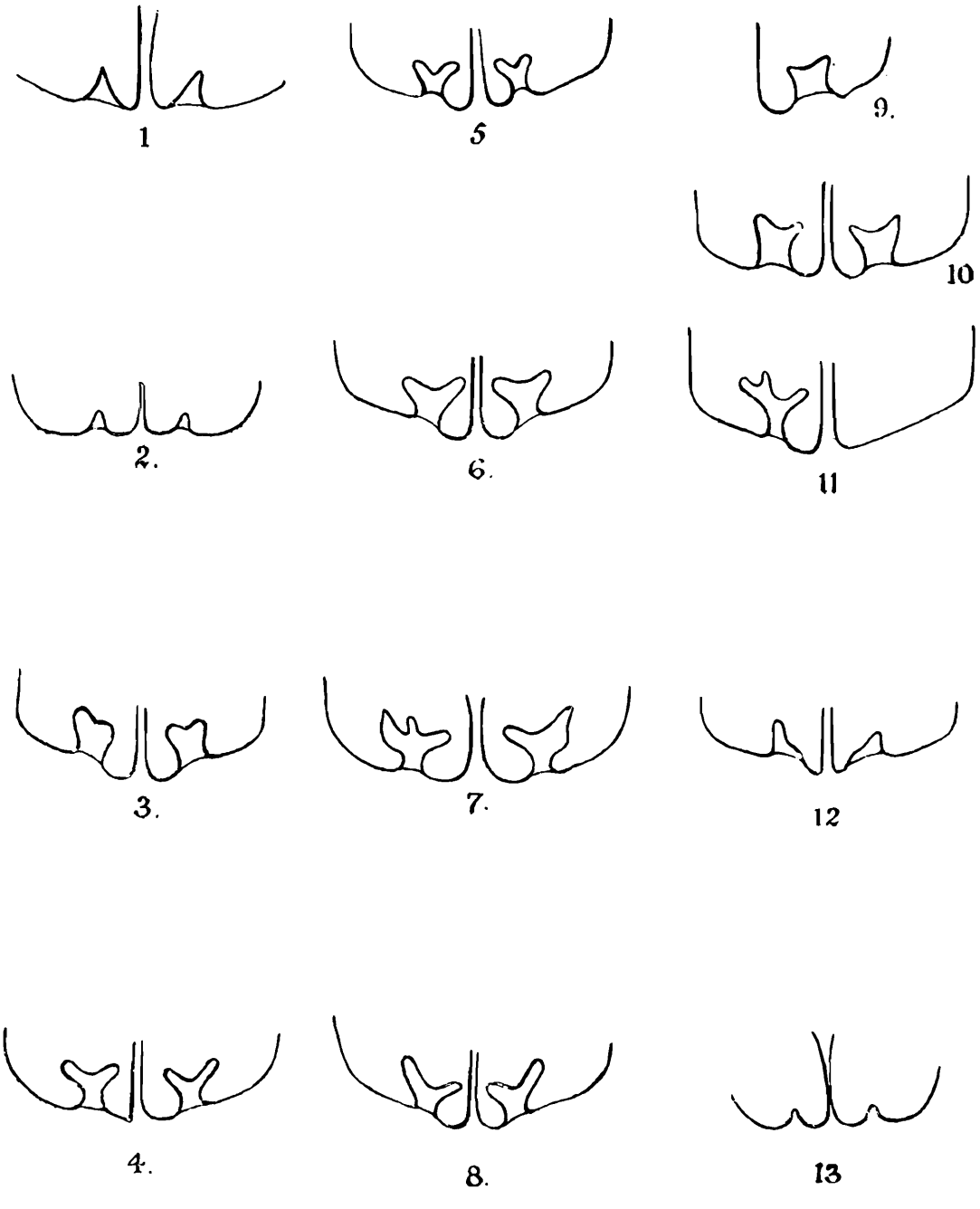
Geoffroy, *Dict. Class. Hist. Nat.*, IX, p. 381 (1826).
Lepus macrotus, Hodgson, *Journ. Asiat. Soc. Bengal*, IX, p. 1183 (1840) (Gangetic Plains and sub-Himalayas).

No. 10172. Adult skin and imperfect skull from Thankot, Nepal (J. Scully coll.).

Apparently a brightly coloured animal, ochraceous and black above, the lower portions of the limbs ochraceous to ochraceous-tawny throughout; the upper surface of the tail ochraceous, some of the

hairs tipped with black but all without dark bases. A pale patch in front of and about the eye. Ears apparently rather small.

The incisor grooves are of the same general form as No. 9827 (*L. cutchensis*); the principal difference being that the posterior edge is



Anterior end of upper Leporine incisors from below.
(Enlarged : not to scale.)

Fig. 1 *Lepus yarkandensis.*
„ 2. „ *craspedotis.* Type.
„ 3. „ *dayanus*
„ 4 „ *cutchensis.* Type.
Figs. 5-10. *Lepus ruficandatus.*
Fig. 11. „ *peguensis.* Type.
„ 12. „ *sadiya* Type.
„ 13. „ *sinensis*

sharply angular instead of regularly curved : the inner side of the tooth projects forward considerably so that the groove appears to be not fully filled with cement (fig. 5) : the molars are small.

Nasals short, irregularly rounded posteriorly, inter-orbital breadth small, palatal bridge of medium width.

The skull, though fully adult,[1] indicates an animal so much smaller than the last and following that, if typical, it might be regarded as subspecifically distinct in which case Hodgson's name *aryabertensis* would apply (*Calcutta Journal of Natural History*, IV, p. 293—Nepal).

No. 10327a. Old mounted male from Agra District much faded and worn.

Tail ochraceous above throughout.

Upper incisors large, the groove bifurcating fairly regularly, the posterior edge concave, branches of medium length, stem moderately broad (fig. 6).

No. 7244. Adult skin and skull from Gaya District, Bihar (F. Field coll.).

Colour less bright than the Nepal specimen, back and sides approaching buff; a considerable amount of whitish on the sides of the head; both sides of the hind feet also pale. Hairs of the upper side of tail ochraceous distally, dark brown basally.

Skull large, nasals somewhat rounded posteriorly, post-orbital processes of medium size and not touching the frontals behind: palatal foramina large and palate bridge broad, anterior feet of zygomata very large (12·5 mm. long).

Incisor grooves showing greater development than the last: the stem is narrower in proportion to the spread of the branches of which the right incisor exhibits two and the left three, the extra branch being median and small (fig. 7).

No. 10174b. Skin from Manbhum, Bengal (R. C. Beavan coll.).

In every way as brightly coloured as the Nepal specimen with the hairs of the upper side of the tail ochraceous throughout except for some dark tips. The hair below the digits is dark tawny, in marked contrast to the ochraceous limbs; but this feature is probably fortuitous.

No. 10328a. Skin from Manbhum, Bengal (R. C. Beavan coll.). As the last except that the hair beneath the digits is not dark.

No. 7317. Portion of skin with perfect skull from Calcutta.

The fragmentary skin indicates an animal nearly as bright as the Manbhum individuals.

Skull with nasals pointed posteriorly, and rather small post-orbital processes not approaching the frontals. Palatal bridge narrow with a posterior median spine, mesopterygoid space broad, bullae like the last but more globose; molars small.

Incisor grooves bifurcating with well developed branches completely filled with cement (fig. 8): Very like those of a specimen from the Jumna River figured by Lyon (*l. c. s.*, fig. 10) but branches more elongate.

Lepus ruficaudatus seems to be a species in which the incisor grooves are normally bifurcate but also develop three and four branches as in the animals from the Punjab and Rajputana figured by Forsyth-Major (*l. c. s.*, figs. xxiii and xxiv): for Punjab material the name *kurgosa* has apparently been proposed by Gray.

---

[1] Specimens are here regarded as fully adult when the frontal suture is largely obliterated: otherwise they are called nearly adult or sub-adult.

No. 10004. Adult skin and imperfect skull from Satpara, Puri District, Orissa (S. W Kemp coll.).

Colour not markedly differing from the Gaya example (No. 7244) with muzzle and top of head ochraceous but the sides of the head and hind feet less white. Hairs of upper side of tail ochraceous distally, greyish-brown basally.

Skull large with the nasals broadly rounded posteriorly, palatal bridge narrower than in No. 7244.

The groove of the right incisor (left missing) well filled with cement, of simple form almost square in section, the posterior angles projecting very slightly (fig. 9).

No. 10173. Nearly adult skin and imperfect skull from the Naga Hills, Assam (A. W Chennel coll.).

Colour like the last but a little less bright. A ring round the eye buffy instead of whitish : hairs of upper side of tail without dark bases.

A smaller skull than the last with the nasals narrower posteriorly, frontals much narrower and narrower palatal bridge.

Incisor grooves of essentially the same type but their posterior angles sharper and more projecting (fig. 10).

The difference between this individual and the last does not appear to be great and the incisor grooves are similar. If the latter were typical Tytler's name *tytleri* (*Ann. Mag. Nat. Hist.* (2), XIV, p. 176; 1854) based on material from Dacca, an intermediate locality, might possibly apply. But the presence of the above recorded specimen No. 7317 from Calcutta (fig. 8), also an intermediate locality, renders such a course impossible until more is known of the hares ranging from the Bengal Coast to Assam. It is of course highly probable that the Calcutta specimen was obtained in the Bazaar and came from up-country.

Lepus peguensis.

Blyth, *Journ. Asiatic Soc. Bengal*, XXIV, p. 471 (1855).

No. 435a. Mounted skin and imperfect skull (scarcely fully adult) from Upper Pegu (Sir A. Phayre coll.). Type of *L. peguensis*.[1]

The skin has suffered much from exposure but exhibits clearly the white upper surfaces of the hind metapodials and small pale patches on the forefeet ; and also the pure dark upper surface of the tail (now altered to " seal brown ").

Nasals pointed posteriorly, frontals broad, post-orbital processes not touching behind ; palatal foramina broad, palate bridge medium.

Groove of left incisor (right damaged) very similar to those figured by Forsyth-Major (*l. c. s.*, fig. xx), consisting essentially of a two-branched groove with the outer branch bifurcating and the stem fairly narrow : well filled with cement (fig. 11).

---

[1] The first example of *L. peguensis* seen by Blyth and recorded as identical with *sinensis* Gray (Journ. Asiat. Soc. Bengal, XXI, 1852, p. 359) was a hare from Arakan : it was evidently not made the type of the species for its ears had been destroyed whereas in the present specimen they are perfect, and there is no black on the underside of the paws as was stated to be the case with the first animal.

Lepus sadiya, sp. nov.

Lepus sp., Robinson, *Rec. Ind. Mus.*, VIII, p. 90 (1913).

No. 9165. *Type.*—Adult skin and skull from Kobo about 15 miles west of Sadiya, N.-E. Assam. Collected during the course of the Abor Expedition by Mr. S. W Kemp.

Characters.—Pelage somewhat as in *L. peguensis* Blyth, with metapodials of hind feet whitish, but colour generally paler and duller, and tail suffused with ochraceous. Grooves of incisors roughly triangular.

Colour.—Upper parts mingled buff and black, top of face tinged with ochraceous, sides of head rather paler buff, some white on the sides of muzzle and areas round eyes, sides of body buffy-white with a few black tips to the hairs. Nape ochraceous-tawny slightly grizzled with black. Fore-limbs ochraceous-buff; forefeet dull buff above with a few white hairs above the claws, below greyish-buff; hind feet white above with some buff hairs over the digits, below and at sides greyish-buff. Tail above superficially ochraceous but the hairs with dark brown bases ("seal brown") most visible near the tip: throat, under parts of body, back of fore-limbs, front and inner aspect of hind-limbs and under-surface of tail white, gradually blending on the under-body with the colour of the sides. Extremity of chin grey; fore-neck like the fore-limbs, the hairs faintly tipped with black. Ears finely grizzled blackish and buff, the former in excess; the edges fringed with buff except the tip externally which is brownish-black.

Skull and Teeth.—Skull rather smaller than the type of *peguensis*, the posterior termination of the nasals rounded; frontals narrower and post-orbital processes larger, not, however, touching the skull behind. Palatal foramina relatively narrower, palate bridge broader with a pronounced posterior spine, mesopterygoid space very narrow; anterior feet of zygomata moderate; bullae about as in *ruficaudatus* (they are missing in the type of *peguensis*).

Incisor grooves triangular (thus approximating towards *sinensis*, Gray) but well filled with cement and the inner borders slightly sinuate; inner side of incisor very narrow and projecting considerably (fig. 12).

Measurements.—See table, p. 96.

Remarks.—I have no skins of *Lepus sinensis* or other Chinese hares to compare this animal with, but judging from descriptions it is quite distinct. While the shape of the incisor groove shows that it is allied to the northern animals the white hind-feet connect it with *peguensis*.

Lepus sinensis.

Gray, *Ill. Ind. Zool.*, II, pl. xx (1834).

No. 436c. Imperfect skull of young adult from Amoy, South China.

Skull small, rostrum slender, nasals obliquely truncate, frontals broad, post-orbital constriction narrow; palatal bridge relatively broad and mesopterygoid space wide.

Incisor grooves triangular much as figured by Forsyth-Major (*l. c. s.*, fig. vii) but with less cement therein, the groove being practically empty except at the extreme apex (fig. 13).

No.	Name.	Hind-foot. s. w.*	Skull.										
			Greatest length.	Basilar length.†	Diastema.†	Upper molar row (alveoli).	Palatal bridge, least breadth.	Mesopterygoid space, least breadth.	Diagonal length of nasals.	Anterior frontal constriction.	Posterior frontal constriction.	Zygomatic breadth.	
3782	*Lepus yarkandensis*, Gthr.	..	78·0	61·0	22·0	14·0	5·2	7·2	39·3	16·0	14·0	37·0	Sub-ad.
1322*a*	„ *craspedotis*, Blanf. Type	106	80·0	64·2	23·0	15·0	5·0	7·0	31·0	15·5	11·0	39·0	Sub-ad.
1293*b*	„ *dayanus*, Blanf.	95	84·0	66·0	24·8	15·1	5·8	6·8	36·6	16·0	12·2	36·6	Ad.
9827	„ *cutchensis*, mihi. Type	101	86·2	66·5	23·0	16·1	7·0	6 6	38·8	15·5	12·1	38·2	Sub-ad.
10171	„ *ruficaudatus*, Geoffr.	90	..	60·0	22·8	14·0	6·2	6·1	..	16·0	12·1	38·2	Ad.
7244	„ „ „	101	92·0	73·0	28·0	17·0	8·0	7·5	44·0	19·3	13·8	41·5	Sub-ad.
7317	„ „ „	..	88·8	68·0	26·0	15·7	5·0	8·1	40·0	17·2	12·0	40·8	Ad.
10004	„ „ „	..	..	69·5	27·1	16·0	6·7	7·4	40·2	19·0	..	± 39·5	Ad.
10173	„ „ „	103	..	..	24·5	15·0	5·5	5·8	..	15·7	13·7	39·0	Sub-ad.
435*a*	„ *peguensis*, Blyth Type	100	89·0	..	27·0	16·3	7·0	6·7	42·5	17·5	14·8	..	Sub-ad.
9165	„ *sadiya*, mihi. Type	88	83·0	65·0	24·0	16·4	7·1	4·9	40·5	15·3	12·0	37·7	Ad.
436*c*	„ *sinensis*, Gray	..	..	..	22·1	16·0	6·2	6·7	39·2	17·2	11·8	37·7	Sub-ad.

* From dried skin.
† From back of large incisor.