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# STUDIES ON CAECA OF SOME INDIAN BIRDS

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## INTRODUCTION

Intestinal caeca in birds are single or paired 'diverticulae found at the junction of the small and large intestine' (Van Tyne and Berger, 1976). Beddard (1898) stated that caeca in birds are generally small or absent, but the variations do occur in the two families, namely, Coraciidae and Todidae. Baker (1922-1929) utilised the caeca as a defining character in the general classification of birds in ordinal level. Apart from Mitchell's (1901) elaborate work on avian caeca (cited by Stresemann, 1928) and also the report of Bhaduri and Biswas (1947) dealing with 52 species and subspecies of Indian birds, no other comprehensive account is available. As regards the correlation between the food and the structure of caeca, Stresemann (1928) reported that the shape of caeca is hardly influenced by the method of feeding. He stated, for example, that in Columbae, caeca are very small or altogether absent, while corn-eating pheasants have prominent caeca ; owls have long caeca, while other flesh-eating birds like Accipitres have small ones or none. He pointed out that all passerines with their varied diet have small caeca which have been completely transformed into lympho-epithelial organs. Moreover, in Anseres, a relationship between diet and caecal shape exists ; *Murgus* which is a fish-eater, possesses very short, functionless caeca, like other fish-eaters (e.g., Steganopodes), while in other Anseres long caeca, which are rich in follicles, do occur. In this context, it may be of interest to note that Bhaduri and Biswas (1947) made an attempt 'to correlate this structure with food habit of birds, but they

proved abortive in a general way, although in some groups there are elements of truth on this fact'.

Caeca may be classified in the following types :

(i) Functional : Very long caeca, the sum of caecal length being equal to that of the remaining part of the intestines (e.g., Galliformes).

(2) Functionless : Sometimes, one caecum being very reduced, resulting in an unequal pair (e.g., Accipitres, Upupidae).

(3) A short appendix of the intestine, the contents having no connection with the former (e.g., Passeres and *Columba*).

According to Mitchell (1901, cited by Stresemann, 1928), in primitive form caeca, where long and thin-walled, play a role in digestion. He pointed out that the two following forms have evolved from the former : (i) enlarged caeca which help in digestion ; besides they contain lymph follicles in their wall, and (ii) very small caeca or totally absent having no functional role. Welty (1963) mentioned that caeca absorb water and digested proteins along with the bacterial decomposition of crude fibrous foods. Recently, Van Tyne and Berger (1976) also pointed out that caeca might have important role in food digestion.

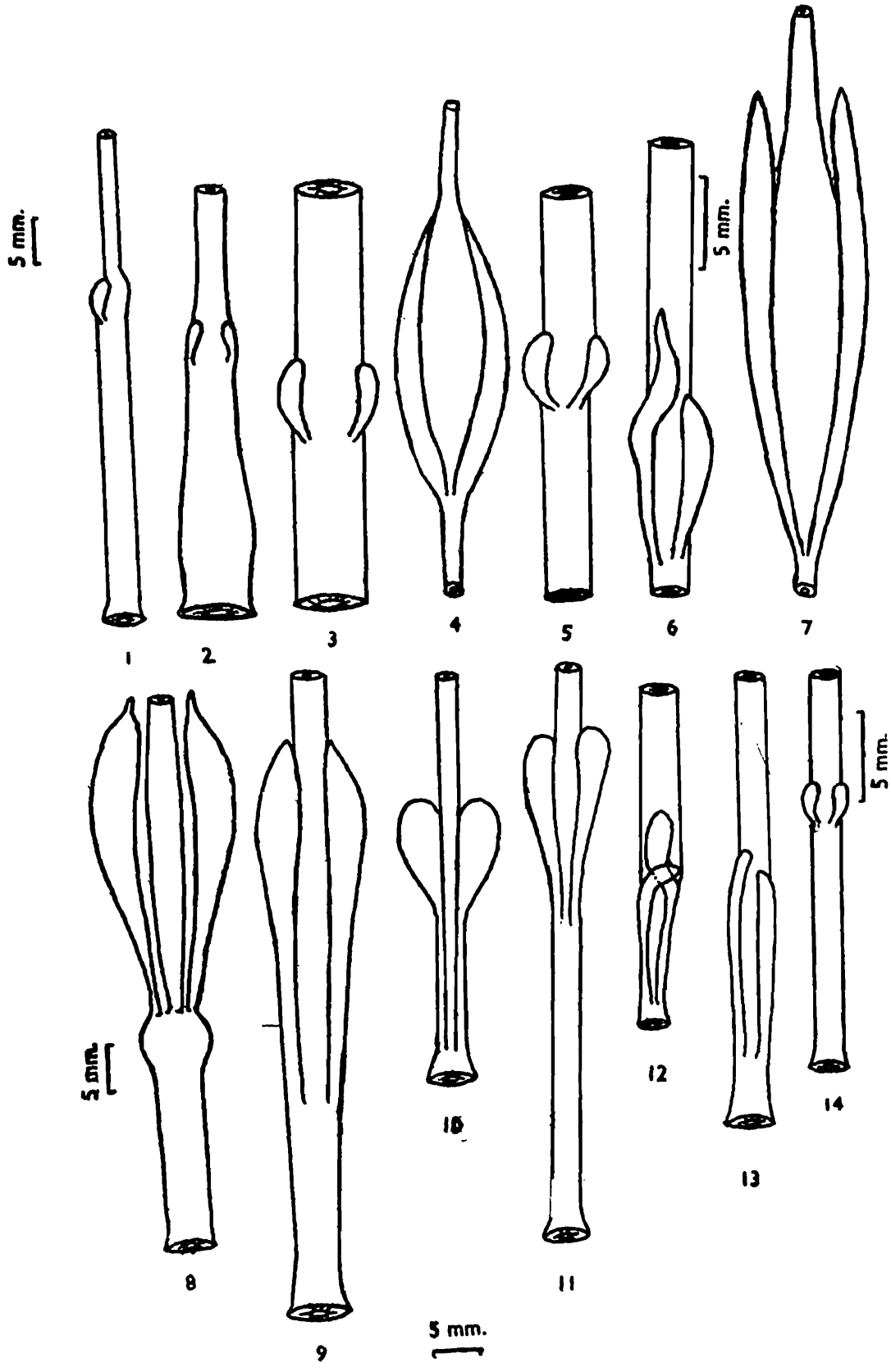
This paper deals with the intestinal caeca of birds from Bastar district, Madhya Pradesh, India, made by one of the authors (N.M.) during January-February, 1979. For systematic arrangement of the species in the Tables I and II, Ali and Ripley's (1968-1974) classification is adopted. The present authors studied 70 different species and subspecies belonging to 31 families in 12 orders, of which 41 species and subspecies boast caeca and the rest 29 species and subspecies are without them.

All the measurements are expressed in millimetres.

The study of food material was conducted by one of the author (N.M.) and corroborated from the compendium published by Ali and Ripley (1968-1974).

## OBSERVATION

The data on the intestinal caeca, their measurements (in milimetres), and location in relation to the cloacal opening and food habits are tabulated in Table I.




Figs. 1-14. Intestinal caeca in birds

TABLE I—The measurements (in millimetres) of caeca and their position in relation to the cloacal opening (R=right caecum ; L=left caecum)

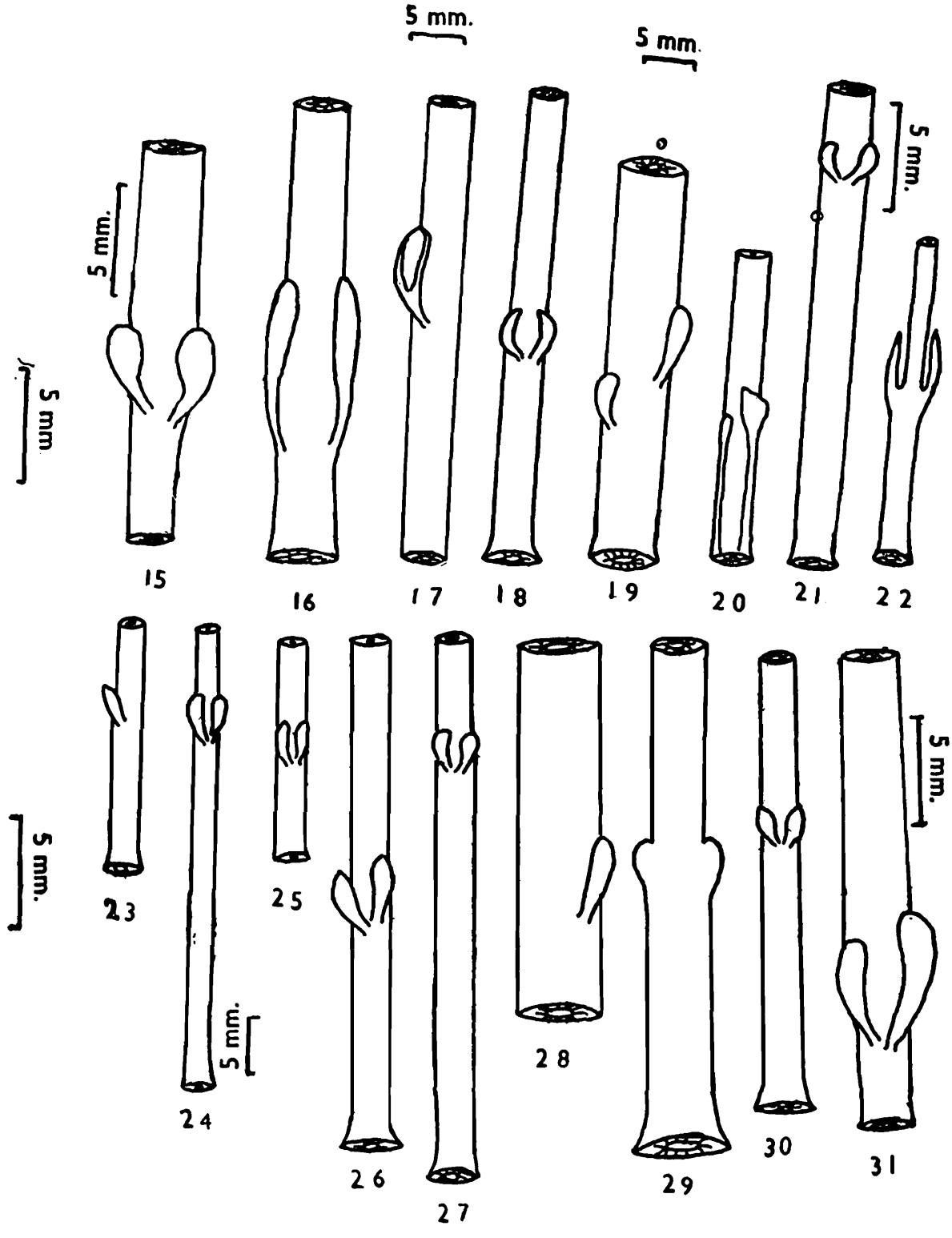
| Order | Family | Name | Fig. No. | Food habits | No. of specimens | Maximum Length | Maximum Width | Distance between cloacal opening and base of caeca |
|---|---|---|---|---|---|---|---|---|
| Ciconiiformes | Ardeidae | *Ardeola grayii grayii* (Sykes) | 1 | Fish, frog, crab, water beetles | 1 | R 4.50 | 2.00 | 31.50 |
| Falconiformes | Accipitridae | *Accipiter badius dussumieri* (Temminck) | 2 | Rats, mice, lizards, frogs and insects | 1 | 4.50 | 1.25 | 26.00 |
| Charadriiformes | Jacanidae | *Hydrophasianus chirurgus* (Scopoli) | 3 | Vegetable roots, aquatic insects and also molluscs | 1 | 9.00 | 2.25 | 16.50 |
| | Charadriidae | *Tringa ochropus* Linnaeus | 4 | Crustacea, molluscs, acquatic insects and worms | 1 | 30.00 | 2.75 | 9.50 |
| Columbiformes | Columbidae | *Treron phoenicoptera chlorigaster* (Blyth) | | Wild figs. and berries | 1 | — — — Absent — — — | | |
| | | *Ducula aenea sylvatica* (Tickell) | | Wild fruits, tender foliage (Majumdar, 1984) | 1 | — — — Absent — — — | | |
| | | *Streptopelia orientalis erythrocephala* (Bonaparte) | | Grains and seeds | 1 | — — — Absent — — — | | |
| | | *Streptopelia chinensis suratensis* (Gmelin) | 5 | Grains of jowar, pulses, weed seeds and oilseed (Majumdar, 1984) | 1 | 8.00 | 2.50 | 20.00 |

Table I (*Contd.*)

| Order | Family | Name | Fig. No. | Food habits | No. of specimens | Maximum Length | Maximum Width | Distance between cloacal opening and base of caeca |
|---|---|---|---|---|---|---|---|---|
| Psittaciformes | Psittacidae | *Psittacula eupatria nipalensis* (Hodgson) | | Wild fruits, vegetables and foliage (Majumdar, 1984) | 1 | — — — | Absent | — — — |
| | | *Psittacula krameri borealis* (Neumann) | | Fruits, cereal and seeds | 1 | — — — | Absent | — — — |
| | | *Psittacula cyanocephala cyanocephala* (Linnaeus) | | Fruits, grain and wild figs. | 1 | — — — | Absent | — — — |
| Cuculiformes | Cuculidae | *Cuculus varius varius* Vahl | 6 | Insects of various kinds and wild figs. | 1 | L 8.75<br>R 13.75 | 1.50 | 1.25 |
| | | *Rhopodytes tristis tristis* (Lesson) | 7 | Insects, lizards and frogs | 1 | 50.50 | 3.50 | 3.50 |
| Strigiformes | Strigidae | *Glaucidium radiatum radiatum* (Tickell) | 8 | Large insects, rats and mice | 1 | 34.00 | 4.50 | 25.00 |
| | | *Ninox scutulata lugubris* (Tickell) | 9 | Large insects, frogs and also lizards | 1 | 39.00 | 4.50 | 22.00 |
| Caprimulgiformes | Caprimulgidae | *Caprimulgus asiaticus asiaticus* Latham | 10 | Insects of various kinds | 1 | 27.00 | 4.25 | 2.50 |
| | | *Caprimulgus affinis monticola* Franklin | 11 | Insects in general | 1 | 21.00 | 3.50 | 33.00 |
| Apodiformes | Apodidae | *Hemiprocne longipennis coronata* (Tickell) | | Flying insects | 2 | — — — | Absent | — — — |

Table I (*Contd.*)

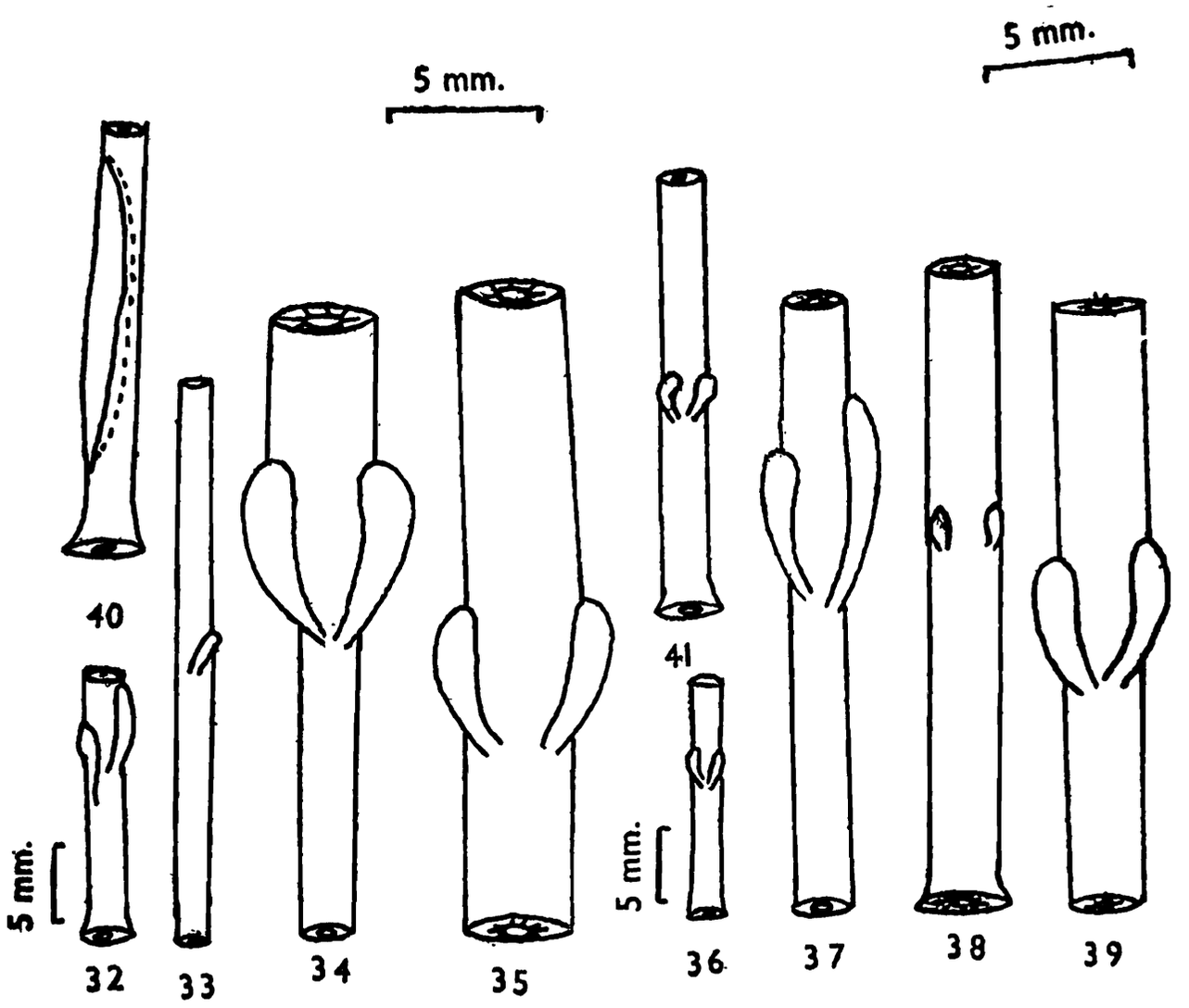
| Order | Family | Name | Fig. No. | Food habits | No. of specimens | Maximum Length | Maximum Width | Distance between cloacal opening and base of caeca |
|---|---|---|---|---|---|---|---|---|
| Coraciiformes | Alcedinidae | *Halcyon smyrensis fusca* (Boddaert) | | Fish and aquatic insects | 2 | — — — Absent — — — | | |
| | Meropidae | *Merops leschenaulti leschenaulti* Vieillot | 12 | Winged insects | 1 | L 21.00 | 1.75 | 2.00 |
| | | | | | | R 19.00 | 2.75 | |
| | | *Merops orientalis orientalis* Latham | 13 | Winged insects | 1 | L 20.00 | 1.75 | |
| | | | | | | R 22.50 | 1.00 | 6.00 |
| Piciformes | Capitonidae | *Megalaima zeylanica caniceps* (Franklin) | | Wild figs, berries, insects and nectar | 1 | — — — Absent — — — | | |
| | | *Megalaima haemacephala indica* (Latham) | | Wild figs, berries and insects | 1 | — — — Absent — — — | | |
| | Picidae | *Micropternus brachyurus phaioceps* Blyth | | Insects, nectar and fruits | 1 | — — — Absent — — — | | |
| | | *Picus myrmecophoneus* Stresemann | | Insects and nectar | 1 | — — — Absent — — — | | |
| | | *Dinopium benghalense benghalense* (Linnaeus) | | Fruits, insects and nectar | 1 | — — — Absent — — — | | |
| | | *Picoides mahrattensis mahrattensis* (Latham) | | Fruits and insects | 1 | — — — Absent — — — | | |
| | | *Picoides nanus hardwickii* (Jerdon) | | Fruit, insects and necter | 1 | — — — Absent — — — | | |
| | | *Chrysocolaptes lucidus quttacristatus* (Tickell) | | Insects and nectar | 1 | — — — Absent — — — | | |




Figs. 15-31. Intestinal Caeca in birds.

Table I (*Contd.*)

| Order | Family | Name | Fig. No. | Food habits | No. of specimens | Maximum Length | Maximum Width | Distance between cloacal opening and base of caeca |
|---|---|---|---|---|---|---|---|---|
| Passeriformes | Alaudidae | *Mirafra assamica affinis* Blyth | 14 | Wild seeds and insects | 1 | 2.25 | 0.75 | 12.75 |
| | | *Eremopterix grisea* (Scopoli) | 15 | Grass and weed seeds and insects | 1 | L 4.50<br>R 4.25 | 1.50 | 5.00 |
| | Hirundinidae | *Hirundo daurica nipalensis* Hodgson | | Flying insects | 1 | — — Absent — — | | |
| | Laniidae | *Lanius cristatus cristatus* Linnaeus | 16 | Insects mice and lizard | 1 | 7.75 | 1.00 | 47.05 |
| | Oriolidae | *Oriolus xanthornus maderaspatanus* Franklin | 17 | Fruits, insects, and nectar | 1 | R 14.50 | 2.50 | 20.00 |
| | Dicruridae | *Dicrurus adsimilis macrocercus* Vieillot | 18 | Insects | 1 | 4.75 | 1.00 | 17.00 |
| | | *Dicrurns caerulescens caerulescens* (Linnaeus) | | Insects and nectar | 1 | — — Absent — — | | |
| | Sturnidae | *Sturnus malabaricus malabaricus* (Gmelin) | 19 | Wild fruits, insects, and nectar | 1 | L 7.50<br>R 5.00 | 2.00<br>1.50 | L 15.00<br>R 11.00 |
| | | *Sturnus contra contra* Linnaeus | | Insects, frogs and fruits | 1 | — — Absent — — | | |
| | Campephagidae | *Tephrodornis pondicerianus pondicerianus* (Gmelin) | 20 | Insects and spider | 1 | L 15.00<br>R 13.00 | 2.00<br>1.00 | Nil |




Figs. 32-41. Intestinal Caeca in birds.

Table I (*Contd.*)

| Order | Family | Name | Fig. No. | Food habits | No. of specimens | | Maximum Length | Maximum Width | Distance between cloacal opening and base of caeca |
|---|---|---|---|---|---|---|---|---|---|
| Passeriformes | | *Coracina melanoptera sykesi* (Strickland) | 21 | Insects and fruits | 1 | L | 2.00 | 0.87 | 17.00 |
| | | | | | 1 | R | 1.87 | 0.62 | |
| | | *Pericrocotus flammeus semiruber* Whistler & Kinnear | 22 | Insects | 1 | | 3.00 | 0.37 | 7.50 |
| | | *Pericrocotus cinnamomeus cinnamomeus* (Linnaeus) | 23 | Insects | 1 | R | 4.00 | 1.25 | 12.25 |
| | Irenidae | *Aegithina tiphia humei* Baker | 24 | Insects | 1 | L | 2.00 | 0.50 | 15.50 |
| | | | | | 1 | R | 2.37 | 0.62 | |
| | | *Chloropsis cochinchinensis jerdoni* (Blyth) | 25 | Insects and nectar | 1 | | 3.50 | 0.75 | 7.50 |
| | Pycnonotidae | *Pycnonotus melanicterus flaviventris* (Tickell) | | Fruits and insects | 1 | | — — Absent — — | | |
| | | *Pycnonotus cafer humayuni* Deignan | 26 | Fruits and nectar | 1 | | 6.00 | 2.00 | 16.50 |
| | Muscicapidae | *Pellorneum ruficeps ruficeps* Swainson | 27 | Insects | 1 | | 1.52 | 0.62 | 18.00 |
| | | *Macronous gularis rubricapilla* (Tickell) | 28 | Insects | 1 | L | 3.75 | 1.00 | 3.50 |
| | | *Chrysomma sinense sinense* Gmelin | 29 | Insects | 1 | | 2.50 | 0.50 | 11.00 |
| | | *Turdoides striatus orientalis* (Jerdon) | 30 | Insects and worms | 1 | | 3.50 | 1.50 | 23.50 |

Table I (*Contd.*)

| Order | Family | Name | Fig. No. | Food habits | No. of Specimens | Maximum Length | Maximum Width | Distance between cloacal opening and base of caeca |
|---|---|---|---|---|---|---|---|---|
| | | *Alcippe poioicephala brucei* Hume | 31 | Insects and nectar | 1 | L 6.25<br>R 5.00 | 1.50<br>1.25 | 3.00 |
| | | *Mucicapa tickelliae tickelliae* (Blyth) | 32 | Insect | 1 | 5.50 | 1.25 | 8.00 |
| | | *Muscicapa thalassina thalassina* Swainson | | Insect | 1 | ——Absent—— | | |
| | | *Orthotomus sutorius guzuratus* (Latham) | 33 | Insect and nectar | 1 | L 1.50 | 0.50 | 9.00 |
| | | *Acrocephalus dumetorum* Blyth | | Insects | 1 | ——Absent—— | | |
| | | *Copsychus saularis saulabris* (Linnaeus) | 34 | Insects and nectar | 2 | 6.75 | 1.50 | 9.75 |
| | | *Copsychus malabaricus indicus* (Baker) | 35 | Insects | 1 | 5.00 | 1.25 | 6.25 |
| | | *Saxicoloides fulicata intermedia* Whistler and Kinnear | 36 | Insects | 1 | 2.75 | 0.37 | 4.25 |
| | | *Monticola cinclorynchus* (Vigors) | | Insects and nectar | 1 | ——Absent—— | | |
| | | *Zoothera citrina cyanotus* (Jardine and Selby) | 37 | Insects and fruits | 1 | L 7.25<br>R 5.25 | 1.00 | 10.00 |
| | Paridae | *Parus major stupae* Koelz | | Insects | 1 | ——Absent—— | | |
| | Sittidae | *Sitta frontalis frontalis* Swainson | | Insects | 1 | ——Absent—— | | |

Table I (*Contd.*)

| Order | Family | Name | Fig. No. | Food habits | No. of Specimens | Maximum Length | Maximum Width | Distance between cloacal opening and base of caeca |
|---|---|---|---|---|---|---|---|---|
| | Zosteropidae | *Zosterops palpebrosa palpebrosa* (Temminck) | 38 | Insects, fruits and nectar | 1 | 1.50 | 0.62 | 11.50 |
| | Motacillidae | *Anthus novaesee landiae rufulus* Vieillot | | Insects and larvae | | — — Absent — — | | |
| | Dicaeidae | *Dicaeum agile agile* (Tickell) | | Insects and wild fruits | 1 | — — Absent — — | | |
| | | *Dicaeum erythrorhynchos erythrorhynchos* (Latham) | 39 | Insects, wild fruits and nectar | 1 | L 5.25<br>R 4.75 | 1.25<br>1.50 | 7.00 |
| | Ploceidae | *Petronia xanthocollis xanthocollis* (Burton) | 40 | Seeds, pulses and insects | | R 22.50 | 5.50 | 5.00 |
| | | *Lonchura punctulata punctulata* (Linnaeus) | 41 | Seeds, pulses cereals and fruits | 1 | 1·50 | 0.62 | 4.25 |
| | | *Lonchura malacca malacca* (Linnaeus) | | Seeds, pulses and cereals | 1 | — — Absent — — | | |
| | Fringillidae | *Carpodacus erythrinus roseatus* (Blyth) | | Insects, seeds and cereals | 1 | — — Absent — — | | |

## DISCUSSION

Beddard (1898), and Van Tyne and Berger (1976) put much importance on the presence or absence and also the degree of development of intestinal caeca in birds, which according to them, can be adopted as a basis for avian taxonomy. Welty (1963) pointed out that the caeca are larger in primitive birds. In grouse, which is primitive from taxonomical viewpoint, caeca have undergone remarkable enlargement, and their combined length totals the length of the entrire intestine. These enlarged caeca might have an important role in the physiology of digestion of the vegetable food matter. Gadow (1896) reported its absence or rudimentary state of devolopment in parrots, some pigeons, kingfishers and woodpeckers. Bhaduri and Biswas (1947) also reported the absence of caecum in Picidae, Capitonidae, Psittacidae and Alcedinidae. They reported its absence in two species of green pigeons, and its occurrence in rock pigeon. Among doves, they noticed its presence in four species and its absence in the emerald dove. Marcus's (1864) finding also corroborates Gadow's.

The present investigators dissected only a few specimens in most of the cases, sometimes only single specimen, on the basis of which this paper is prepared. They did not find any trace of caecum in Psittacidae, Capitonidae, Picidae, Hirundinidae, Alcedinidae, Paridae Sittidae, Motacillidae, Fringillidae and the green pigeons and imperial pigeon. In addition to this finding, the present authors would like to add that in another species of dove (*Streptopelia orientalis erythrocephala*), the caecum is conspicuously absent.

Van Tyne and Berger (1976) mention the presence of unpaired caecum in herons. The present investigators also noticed a single caecum in the Pond Heron (*Ardeola g. grayii*). In addition, we observed a single caecum on the right side in *Oriolus xanthornus maderaspatanas*, *Pericrocotus c. cinnamomeus* and *Petronia x. xanthocollis*, whereas in *Macronous gularis rubricapilla* and *Orthotomus sutorius guzuratus* only the left one is present. In *Chrysomma s. sinense* the

caeca slightly bulge out as rudimentary structures (Fig.29). In *Petronia x. xanthocollis* the unpaired caecum over lies the intestine in close apposition (Fig. 40). Excepting *Ardeola g. grayii* which feeds on frog, fish, crab and also on aquatic insects, the other six species mainly feed on a mixed diet of insect and fruit.

Pronounced asymmetry in the location of the caeca was reported by Bhaduri and Biswas (1947) in three species, namely, *Dendrocitta v. vagabunda* (Latham), *Milvus migrans govinda* Sykes and *Oenopopelia* (=*Streptopelia*) *tranquebarica* (Herman). The authors also have noticed similar asymmetry in *Sturnus m. malabaricus*. Bhaduri and Biswas (1947) noticed asymmetry in length of the two caeca in a few cases, namely, *Turdoides somervillei terricolor* (Blyth) (=*T striatus striatus* (Dumont), *Centropus s. sinensis* (Stephen), *Otus bakkamoena marathae* Ticehurst, *Athene brama indica* (Franklin) and *Querquedula* (=*Anas*) *queruedula* (Linnaeus) which they illustrated (p. 646) clearly. But they did not provide the measurements of individual caecum (pp. 647-649). In 11 species the authors observed this asymmetry and carefully measured both the caeca in individual cases as will be evident from the Table I as well as from the figs (Figs. 6, 12, 13, 15, 19, 20, 21, 24, 31, 37 and 39).

Bhaduri and Biswas (1947) reported that 'the origins of caeca measured from the cloacal openings are very varied in different families'. They also stated that 'some families like Dicruridae, Cuculidae etc., show close approximation of measurements'. On the basis of their findings, Bhaduri and Biswas (1947) speculated that 'these ought to indicate some close relationship in the members of the families', but they also cautioned that a large amount of data from each species should be collected. The present investigators find in Cuculidae and Dicruridae a marked difference in the relative distance. However, in two species *cuculus varius* and *Rhopodytes tristis* under the family Cuculidae ( Figs. 6 and 7 ), the origin is very similar in relation to cloacal opening. This indicates that caecal characters might be considered useful for classification of species belonging to the same family.

Welty (1963) shows that the length of intestine might be deciding factor as to whether caecum will be absent or rudimentary or enlarged. This may perhaps be correlated to the intestinal length, that is short and broad or long and small in diameter. In this paper, the Table II shows the relative length and breadth of intestine of some species which are worth mentioning in context of Welty's (1963) observation.

TABLE II

The measurements (in millimetres) of intestine and their average breadth. **Long and narrow ; ++ short and broad.

| Name of Species | Fig. | Total length of Intestine | Average breadth of Intestine |
|---|---|---|---|
| *Ardeola g grayii* (Sykes)** | 1 | 860 | 3.0 |
| *Sturnus malabaricus malabaricus* (Gmelin)++ | 19 | 245 | 6.0 |
| *Tephrodornis pondicerianus pondicerianus* (Gmelin)++ | 20 | 140 | 3.0 |
| *Pericrocotus cinnamomeus cinnamomeus* (Linnaeus)++ | 23 | 125 | 2.5 |
| *Aegithina tiphia humei* Baker** | 24 | 130 | 1.0 |
| *Chloropsis cochinchinensis jerdoni* (Blyth)** | 25 | 160 | 2.5 |
| *Pycnonotus cafer humayuni* Deignan++ | 26 | 190 | 3.0 |
| *Pellorneum ruficeps ruficeps* Swainson** | 27 | 190 | 1.75 |
| *Copsychus saularis saularis* (Linnaeus)++ | 34 | 185 | 4.0 |
| *Copsychus malabaricus indicus* (Baker)++ | 35 | 190 | 4.0 |
| *Dicaeum erythrorhynchos erythrorhynchos* (Latham)++ | 39 | 90 | 3.25 |
| *Muscicapa tickelliae tickelliae* (Blyth)++ | 32 | 150 | 2.5 |
| *Orthotomus sutorius guzuratus* (Latham)** | 33 | 150 | 1.0 |
| *Saxicoloides fulicata intermedia* Whistler and Kinnear++ | 36 | 130 | 2.25 |
| *Zoothera citrina cyanotus* (Jerdine and Selby)** | 37 | 230 | 2.0 |
| *Zosterops palpebrosa palpebrosa* (Temminck)++ | 38 | 118 | 2.25 |

This finding indicates that there exists a general trend of enlargement of the caecum where the intestine is short but broad, in contrast to where the intestine is long and narrow.

According to Wallace (1971), paired caeca are usually rudimentary, but well developed in gallinaceous birds, anatids and the ostrich. The authors noticed that in Charadriidae, Cuculidae, Strigidae, Caprimulgidae, Meropidae and Ploceidae the paired caeca are enlarged.

Regarding the structural similarity of caeca in allied genera under the same family, no literature is available. In strigidae, the allied genera namely *Glaucidium* and *Ninox* (Figs. 8 and 9), very close resemblance in shape and size of caeca exists, and also their place of origin is similar. Moreover, in the genus *Caprimulgus*, in two different species *Caprimulgus affinis monticola* and *C. asiaticus asiaticus* (Figs. 10 and 11), the structural similarity is markedly noticeable, although in the larger species (*C. a. monticola*) because of the lengthening of the large intestine the point of origin has shifted further forward, whereas in the smaller species (*C. a. asiaticus*) the origin is nearer the cloacal opening.

Our observation implied that the length of intestine in relation to its breadth might be a deciding factor as to whether the caecum will be large or rudimentary. In those particular species in which the intestine is long and narrow, the caecum is small. In contrast, where the intestine is markedly short and broad, the caecum becomes enlarged, as is evident from the Table II (16 instances are given).

Why the caecum is absent in some species is difficult to interpret. The present investigators look forward to persue this line in future.

At this stage, nothing can be commented on the significance of enlargement of the caecum, as both intra-familial (Strigidae) and inter-familial (Caprimulgidae) convergence exist. Instances of intra-familial divergence are also very marked in the families of Campephagidae and Ploceidae ; and in Muscicapidae all grades of variation is noticeable.

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