Rec. zool. Surv. India, 69 : 295—303, 1976

DISTRIBUTION OF THE GENUS *CYCLOCOELUM* BRANDES, 1892 ON HOST ORDERS AND ITS BEARING ON THEIR INTER-RELATIONSHIPS

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(With 1 Table)

Digenetic trematodes are endoparasitic forms inhabiting in adult stages the vertebrates, and invertebrates and lower vertebrates in larval forms. The trematodes exhibit host-specificity of varying degrees. Host specificity is well marked in Monogenetic trematodes while in digenetic trematodes, it is more pronounced in larval condition. However, the fact that certain genera of these trematodes have not been recorded from some host orders inhabiting the same ecological niche as others harbouring these parasites suggests incipient host-specificity in adult trematodes also. To cite a concrete example, species of the genus *Cyclocoelum* Brandes, 1892, known to parasitise as adults, birds of the orders Anseriformes, Gruiformes, Charadriiformes etc. (*vide infra*), are not known from the Ciconiiformes which share the same habitat as the orders mentioned above (Table 1).

The intricate relationship between the host and its parasite has been utilized by parasitologists in the study of the phylogeny of hosts and their parasites, ancient migratory routes and palaeogeological land connections etc. An exhaustive review was published by Metcalf (1929) and the principle has been well taken advantage of by several entomologists in Phthiraptera (Hopkins, 1942, 1949, Clay, 1950 a,b, 1951, Eichler, 1949, Lakshminarayana, 1968, 1970 a,b,). In recent years Baer (1951), Cameron (1952, 1964), Manter (1955,1963, 1965), Sindermann (1937), Stunkard and Gandal (1965), Szidat (1961 a,b) have paid attention on zoogeography and phylogeny of the hosts on the basis of their trematode parasites.

A brief discussion on the distribution of the genus *Cyclocoelum* Brandes, 1892 on different avian host orders and its bearing on their inter-relationships are given here.

The genus *Cyclocoelum* Brandes, 1892 (Family Cyclocoelidae) has been thoroughly revised by Dubois (1959). In the course of

present work six species of this genus have been studied on five host species belonging to two orders.

The genus *Cyclocoelum* (*sensu* Dubois, op.cit.) contains three subgenera viz., *Cyclocoelum* (*sensu. str.*,) *Haematotrephus* and *Hyptiasmus*. The genus chiefly occurs on Phoenicopteriformes, Anseriformis, Galliformes, Charadriiformes, Podicipitiformes, Piciformes and Passeriformes. Attention has been paid here on the distribution of the genus on different groups of these host orders in the light of Dubois' revisionary work and present records. It is interesting to find that some of the conclusions arrived at agree with those drawn from other parasitological, palaeontological, evolutionary and taxonomic contribution on these host orders. The distribution of the known species on the different host orders is given in Table 1. Since Charadriiformes comprise most of the host groups, the following discussion is chiefly based on it.

Table 1.— Showing the distribution of the genus *Cyclocoelum* on bird-hosts.

Species of genus *Cyclocoelum*	Bird-host orders and families
1. *Cyclocoelum* (*Cyclocoelum*) *mutabile*	Jacanidae, Charadriidae (Charadriiformes), Rallidae (Gruiformes), Phasianidae (Galliformes)
2. *C.* (*C.*) *ovopunctatum*	Charadriiformes
3. *C.* (*C.*) *obscurum*	Charadriiformes, Rallidae, Passeriformes
4. *C.* (*C.*) *phasidi*	Galliformes
5. *C.* (*C.*) *erythropis*	Charadriiformes
6. *C.* (*C.*) *theophili*	*Phoenicopterus* (Phoenicopteriformes)
7. *C.* (*C.*) *vogeli*	Galliformes
8. *C.* (*Haematotrephus*) *gendrei*	Jacanidae (Charadriiformes)
9. *C.* (*H.*) *lanceolatum*	Recurvirostrinae, Charadriidae, Scolopacinae
10. *C.* (*H.*) *tringae*	Scolopacinae
11. *C.* (*H.*) *phaneropsolum*	Scolopacinae
12. *C.* (*H.*) *brazilianum*	Scolopacinae
13. *C.* (*H.*) *kossacki*	Scolopacinae, Recurvirostrinae
14. *C.* (*H.*) *jaenschi*	Podicepediformes
15. *C.* (*Hyptiasmus*) *arcuatum*	Anseriformes
16. *C.* (*Hy.*) *robustum*	Anseriformes
17. *C.* (*Hy.*) *magnum*	Anseriformes
18. *C.* (*Hy.*) *ocuieum*	Rallidae
19. *C.* (*Hy.*) *magnipoles*	Charadriiformes
20. *C.* (*Hy.*) *skrjabini*	*Grus*
21. *C.* (*Hy.*) *antigonis*	*Grus*
22. *C.* (*Hy.*) *ominosum*	*Grus*
23. *C.* (*Hy.*) *elongatum*	Passeriformes, Piciformes, Galliformes
24. *C.* (*Hy.*) *vagum*	Galliformes

From the distribution point of view, the subgenus *Cyclocoelum* (*sensu. str.*) occurs chiefly on Phoenicopteriformes, Galliformes, Gruiformes, Charadriiformes, Passeriformes; the subgenus *Haematotrephus* on Podicipitiformes, Charadriiformes and subgenus *Hyptiasmus* occurs on Anseriformes, Galliformes, Gruiformes, Piciformes, Passeriformes and a single genus of Charadriiformes.

CHARADRIIFORMES

Mayr and Amadon (1951) included the families Jacanidae, Thinocoridae, Chionididae, Dromadidae, Burhinidae, Haematopodidae, Charadriidae (subfamily Charadriinae, Scolopacinae, Phalaropinae, Recurvirostrinae, Rostratulinae), Glareolidae, Laridae (subfamilies Sterocorariinae, Larinae, Sterninae, Rhynchopinae) and Alcidae under the order Charadriiformes. Recurvirostrinae has, however, been raised to family rank by Ripley (1961). Of these families Jacanidae, Charadriidae and Recurvirostridae are known to have been infected by these parasites.

Charadriidae : The family Charadriidae is divided into three subfamilies, namely Charadriinae, Scolopacinae and Phalaropinae (*vide* Ripley, 1961).

Lakshminarayana (1970b) has proposed what he calls "Hopkins' Principle" which enunciates that one correspondence between the lice of two hosts, whose hypothetical relationship is under examination means very little; two such correspondences establish a probability that it may be genuine; and that three correspondences come very close to certainity. This principle may also hold good for other groups of parasites. Using this principle it appears that Scolopacinae and Charadriinae are closely related because they share atleast four species of the same parasites. Clay (1962) on the basis of the distribution of mallophagan genus *Actornithophilus* states that :

> "all the genera of the Charadriidae form a related group with a gap between the Vanellinae *sensu* Peters and the Charadriinae ; and follows Bock's contention of the close relationship of the 'genera' comprising the Charadriinae on one side and the Vanellinae on the other, but differs in suggesting that *Vanellus* is somewhat distinct from the rest of the Vanellinae."

From the helminthological point of view it seems that the so called gap between *Vanellus* and the members of Scolopacinae is not much as compared to the other Charadriinae, in which *Vanellus* is also included. Among the members of the Scolopacinae, many genera share common parasitic fauna and it may be attributed either to the feeding habit and/or from a common descent. Peters (1934), Mayr and Amadon (1951) and Biswas (1953) consider Recurvirostrinae as a subfamily of Charadriidae while some authors like Ripley (op.cit.)

as a family. Three species of parasites are shared by the members of Recurvirostridae with Charadriinae and Scolopacinae. This shows that Recurvirostridae has closer relationship with Charadriidae. Even Clay (op.cit.) considers that species of the *Actornithophilus* parasitic on Recurvirostridae has similarities with those present on Charadriinae except *Ibidorhyncha* (Sf : Ibidorhynchinae, F. Recurvirostridae).

Jacanidae : Two species of the parasite, namely *Cyclocoelum* (*Cyclocoelum*) *mutabile* and *Cyclocoelum* (*Haematotrephus*) *gendrei** are known from Jacanidae. Of these the former is known extensively on Rallidae (Gruiformes) and two genera of Charadriidae (*Tringa*, Scolopacinae; *Vanellus*, Charadriinae) and *Gallus* (Galliformes). It is interesting to note that *Jacana*, the host of *C.* (*C.*) *mutabile*, shares the parasite with a number of genera of Rallidae, suggesting its relationship closer to Rallidae than Charadriiformes in which the family Jacanidae is normally placed. This fully endorses the evidences derived from the Mallophaga that Jacanidae is more closely related to Rallidae and perhaps the connecting family between the two host orders (Clay, 1950b; Lakshminarayana, 1970a). The single record of *C.* (*C.*) *mutabile* on *Gallus* may be accidental.

Recurvirostriidae : Two genera of this family, namely *Recurvirostra* and *Himantopus* are known to have trematode infestation. Restricting to the parasites of the genus *Cyclocoelum*, *C.* (*C.*) *obscurum* occurs on the former and *Cyclocoelum* (*Haematotrephus*) *kossacki* and *Cyclocoelum* (*Hyptiasmus*) *magniproles* on the latter. *Cyclocoelum* (*Cyclocoelum*) *obscurum* is very common on Scolopacinae as also *Cyclocoelum* (*Haematotrephus*) *kossacki* and this clearly suggests the probable relationship of *Himantopus* with Scolopacinae, though the latter has its own distinct parasite species also, supporting contention of Mayr and Amadon (1951) contrary to Ripley (1961).

GRUIFORMES

The following families are included under Gruiformes by Mayr and Amadon (1951) : Cariamidae, Psaphiidae, Gruidae, Aramidae, Eurypygidae, Heliornithidae, Rhynochetidae, Otididae, Rallidae, Mesoenatidae and Turnicidae.

Lowe (1931) considers that amongst Gruiformes the Gruidae is more closely related to Charadriiformes than Rallidae and hence suggested the division into Rallimorphae and Telmatomorphae.

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*While describing *C.* (*H.*) *gendrei*, Dubois (1959) mispelt the host genus *Actophilornis* as *Arctophilornis*.

Clay (1950b) and Lakshminarayana (1970a) also agree with Lowe's opinion but with the addition of Jacanidae, (Clay, 1951), Jacanidae and Eurypygidae (Lakshminarayana, 1970a, b). So far only Rallidae and Gruidae have been reported as the hosts of the genus *Cyclocoelum*. Chandler (1916) states that :

> "In general it seems best to consider the Gruidae, Aramidae and Rallidae as off-shots from a primitive stem leading to the Charadriiformes, while the Otididae, Phosphiidae and possibly Aramidae, are more probably early off-shots from the stem leading to the Columbae and Galli."

The distribution of *Cyclocoelum* among Gruidae, Rallidae, Charadriiformes and also Galliformes in a way supports Chandler's contention.

Rallidae : *Cyclocoelum* (*Cyclocoelum*) *mutabile* on *Fulica*, *Gallinula* and *Porphyrula* ; *C.* (*C.*) *obscurum* on *Fulica* and *Cyclocoelum* (*Hyptiasmus*) *oculeum* on *Fulica*, *Porzana* and *Gallinula* are the known parasite records. None of these parasite species are shared by Gruidae though they occur on other Charadriidae. It indicates the distinctness of Gruidae from Rallidae and corroborates the evidences arrived at on the basis of Mallophaga studies (*vide supra*). *C.* (*C.*) *mutabile* has also been reported on Galliformes and *C.* (*C.*) *obscurum* on Muscicapidae (Passeriformes). Members of the same generic complex of Mallophaga are also known from these two host orders (Clay, 1950b, 1953; Carriker, 1944, 1966; Lakshminarayana, 1968, 1970a,b). Carriker (1966) is of the opinion that the mallophagan genus *Furnaricola* (a member of *Rallicola-complex*) on Passeriformes should be separated into a distinct genus. Lakshminarayana (1970a) considers the similarity of *Rallicola* and *Furnaricola* may be either parallel evolution or secondary infestation and establishment.

Gruidae : Three species viz., *Cyclocoelum* (*Hyptiasmus*) *ominosum*, *C.* (*Hy.*) *skrjabini* and *C.* (*Hy.*) *antigonis* are known from *Grus*. Up till now these species are not known on any other host orders, although the subgenus *Hyptiasmus* is known mainly on Anseriformes, Rallidae, Charadriiformes, Piciformes, Passeriformes and Galliformes. The mallophaga of Gruidae are more closely related to Charadriiformes than to those of Rallidae (Clay, 1950b; Lakshminarayana, 1970a).

ANSERIFORMES

The following trematodes are recorded from Anseriformes : *Cyclocoelum* (*Hyptiasmus*) *arcuatum* on *Anser*, *Bucephala*, *Clangula*, *Melanitta*, *Somateria*, *Aythya*, *Anas*, *Mergus*; *Cyclocoelum* (*Hyptiasmus*) *robustum* on *Aythya*, *Anser* and *Cyclocoelum* (*Hyptiasmus*) *magnum* on *Chenopis*. The occurrence of the same species of parasite on members of different host subfamilies within the order indicates that possibly these species have not yet attained host specificity and

the commonness of infection may be due to similar habits and habitat of the host genera.

PHOENICOPTERIFORMES

Cyclocoelum (*Cyclocoelum*) *theophili* is the only species reported on *Phoenicopterus*. The position of this host order is problematical. Many authors include this as a suborder under Ciconiiformes (Peters, 1931) and family (Ripley, 1961; Wetmore, 1951), others treat it as a separate order (*vide* Mayr and Amadon, 1951). The members of this order show characters of both Ciconiiformes and Anseriformes. It is generally argued that this similarity may be due to convergence. However, Hopkins (1942) and Clay (1950b, 1962) suggested Anseriformes affinities on the basis of the distribution of Mallophagan evidence. It is curious that the genus *Cyclocoelum* also occurs in Anseriformes and none of the Ciconiiform hosts have so far been reported.

GALLIFORMES

Five species viz., *Cyclocoelum* (*Cyclocoelum*) *mutabile* on *Gallus*; *Cyclocoelum* (*Cyclocoelum*) *phasidi* on *Guttera*; *Cyclocoelum* (*Cyclocoelum*) *vogeli* on *Francolinus; Cyclocoelum* (*Hyptiasmus*) *elongatum* on *Gallus; Cyclocoelum* (*Hyptiasmus*) *vagum* on *Chrysolophus* and *Syrmaticus* are known parasites in this host order. Of these *C* (*C.*) *mutabile* chiefly occurs on Rallidae, Jacanidae, Charadriidae; *C.* (*Hy.*) *elongatum* chiefly on Piciformes and Passeriformes. Isolated members of the same generic complex of mallophaga are known on Galliformes, Gruiformes and Passeriformes (*vide* Clay, 1950b; Lakshminarayana, 1970a) although the occurrence of *Furnaricola* (a member of *Rallicola-complex*) on Passeriformes may be due to parallel evolution.

PODICIPITIFORMES

Cyclocoelum (*Haematotrephus*) *jaenschi* is known on *Poliocephalus* and *Podiceps*. Members of the subgenus *Haematotrephus* are also known from Charadriiformes. It is interesting to find similar mallophagan genera on this order, Gruiformes and Charadriiformes (Clay, 1950; Eichler, 1952; Lakshminarayan, 1970a). Chandler (1916) states that :

> "In the structure of the breast feathers and down, loons come much nearer the Sphenisciformes than do grebes, and they are also more similar to the Procellariformes. The grebes appears to represent a separate offshoot of the group, and have a condition of breast feathers which is different from that of any other birds except some of the Alcidae."

Lakshminarayana (1970a) attributed the occurrence of the same parasitic genera of mallophaga as secondary infestation due to similar feather structure between the former and some of the members of the Charadriiformes. In the present case also it may be likely that due to similar habitat a member of the subgenus parasitised a member of the host order in the by-gone days and has undergone sufficient degree of distinction.

PICIFORMES

Only one species, *Cyclocoelum* (*Hyptiasmus*) *elongatum* is known from *Megalaima*. It is not possible to draw any conclusion from this stray record.

PASSERIFORMES

Cyclocoelum (*Cyclocoelum*) *obscurum* in *Zoothera* (Muscicapidae); *Cyclocoelum* (*Hyptiasmus*) *elongatum* on *Cyanopica*, *Cissa*, *Pica*, *Dumetella* (Corvidae) are known in this order. The former is well known on many members of Charadriiformes and Rallidae, while the latter is known on a single genus each of Galliformes and Piciformes. It is not possible to assess the nature of infestation due to varied feeding habits of this host order.

SUMMARY

The distribution of the genus *Cyclocoelum* Brandes, 1892 in bird host orders has been discussed. The inter-relationships of the bird host orders have been discussed on the basis of the distribution of parasites.

ACKNOWLEDGEMENTS

The authors are thankful to Drs. B. Biswas, K. K. Tiwari and K. V. Lakshminarayana, Zoological Survey of India, Calcutta, for their help in the preparation of this paper. Thanks are also due to the Director, Zoological Survey of India for facilities.

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