

A REVIEW OF THE HISTORY AND CLASSIFICATION OF THE FAMILY RENICOLIDAE DOLLFUS, 1939 (TREMATODA: DIGENEA)

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ABSTRACT

The family Renicolidae was established by Dollfus in 1939 for the trematodes parasitizing kidney tissues and ureters of birds. This family has been studied by several helminthologists and attempts have been made to present new taxonomic keys for the family. Prominent among the authors who have contributed to the family are: Dollfus (1939 and 1946); Nigrelli and Gandal (1958); Witenberg (1929); Rue (1957); Odening (1962); Riley and Owen (1972); Sudarikov and Staiko (1984); Wright (1954: 1956 and 1957); Stunkard (1958 and 1964) and others. Of the 56 known species of Renicolidae (Munyer *et al.*, 1990), two were described on the basis of cercariae only. The genus *Renicola* was created by Cohn in 1904. From India the only three species of *Renicola* which have been described so far are: *R.indicola* Odening, 1962 in *Pelecanus onocrotalus*; *R.indica* Mehra and Kharoo, 1974 in *Turdoides tericolor tericolor* and *R.melastigmai* Dhankumari, 2000 in *Aplocheilus melastigma* (Pisces). A brief review of the history and classification of the family and the genus is presented.

Key Words: *Renicolidae, Digenea, Trematode, Renicola, Cercariae, Turdoides Tericolor*

INTRODUCTION

Family Renicolidae Dollfus, 1939: Renicolid trematodes are digenes parasitizing tissues of kidneys and ureters of birds feeding on bivalves and fishes. Though with a large gravid uterus, these parasites have a reduced ventral sucker. The genus *Renicola* was created by Cohn in 1904 in which he included *Monostoma pingue* (Mehlis in Creplin, 1846) on the basis of the species having a distinct acetabulum and therefore, could no longer be regarded as monostome. On the basis of this fact and other observations made after restudying the original material of Mehlis from the kidneys of *Podiceps cristatus* in Germany, Cohn (1904) observed that these worms live in pairs in renal tubules and the acetabulum is so obscured by gravid uterus that it is often invisible in whole mounts. He also implied that adhesive organs of the digenes which live in closed cavities do not function actively and consequently fail to develop or sustain atrophy and thus become reduced in size.

Odhner (1914) included *Renicola* in his new family Troglotrematidae Odhner (1914) the parasites of which often occur in pairs and not in the intestine. Dollfus (1939) did not accept Odhner's view regarding inclusion of *Renicola* in Troglotrematidae because he considered this family as artificial and erected a new family Renicolidae in which he transferred the genus *Renicola* as type genus. Dollfus (1946) while revising the family Renicolidae presented a list of trematodes from the renal organs of birds and devised a key for identification of nine species already included under the genus *Renicola* based largely on the extent and location of vitellaria. "This feature is a conspicuous one and undoubtedly significant; it appears that the extension of uterus is also an important and distinguishing specific feature" (Stunkard *et al.*, 1958). In the same paper Dollfus accepted *Stamparia* Nezhlobinsky, 1926 as a second genus in the family based upon the difference between *Renicola* and *Stamparia* in the shape of testes. However Sudarikov (1951) and Leonov (1958) accepted it as a subgenus of *Renicola*. Caballero (1953) did not accept the generic status of *Stamparia* but instead synonymised it with *Renicola* which was also supported by Stunkard, Nigrelli and Gandal (1958), Wright (1956), Yamaguti (1958) and Odening (1962).

Till 1924 only three species of the genus *Renicola* were described: *R.pinguis* Mehlis (1846) Cohn, 1904 in Germany and *R.tertia* and *R.secunda* by Skrjabin (1924) from the white Pelican, *Pelecanus*

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onocrotalus and the Tern, *Sterna fluviatilis* respectively in Turkestan. These species were characterised by the shape of body, the relative length of intestinal caeca and extent and location of vitellaria. However, Skrjabin, because of meager material concluded that specific determination was uncertain. Witenberg (1929) described fourth species *Renicola glandoloba* in *Puffinus kuhli* in Sinai. He also expressed the opinion that previously reported species were incompletely described and so the new species should be determined with caution. Though Skrjabin (1927) had added one more species viz., *R. zarudni* but Odening (1962b) considered it as *nomen nudum* and thought it to be identical with *R. secunda* Skrjabin (1924). David (1933) described *R. lari* from *Larus argentatus* from France. Dollfus (1946) gave a detailed account of *R. lari*. Since then the number of species has multiplied.

Several workers have described but not named many species. Sokolova and Andronova (1937) have described *Renicola* sp. from *Phaleris psittacula* and *Melanita fusca*. Dollfus (1946) described a *Renicola* species from *Sterna cantiaca*. Wright (1954a) described three unnamed species of *Renicola* from *Larus dominicanus*, *Poecilonetta bahamensis* and *Sula leucogaster*. Again Wright (1954b) described four unnamed *Renicola* species from three bird hosts, *Threskiornis melanocephala*, *Pelecanus onocrotalus* and *Bulbulcus coromandus*. Ginetzinskaia (1952) reported *Renicola* species from *Fulica atra* while Bykhovskaia-Pavlovskiaia (1962) described three unnamed species from *Plegadis falcinellus*, *Galidris martima* and another from unnamed host from Russia. Though some of the species were also named by Odening (1962b) but Stunkard (1964) criticized it and said, "But mere naming, while it facilitates identification of particular specimens, adds nothing to the knowledge of the genus *Renicola*".

After Dollfus (1946) several helminthologists have attempted to devise new taxonomic keys for identification of Rencolidae which include Wright (1954; 1956 and 1957); Odening (1962); Rue (1957); Riley and Owen (1972); Sudarikov and Staiko (1984).

Wright (1956) further studied the genus *Renicola* and worked upon their life histories but confined his work only to British birds. While discussing the morphological criteria upon which the then reported species were described, he opined that a single host may acquire multiple infections of Rencolid species. He also criticized the earlier workers for not taking into account the differences occurring within a single species. He noted that, "host specificity in the sense of a group relationship does not apply in the genus." After discussing hosts, he concluded, "The only feature in common, then, between most of the host species recorded is their fish eating habit and for this reason the main search for *Renicola* was concentrated on fish eating sea birds."

While discussing the species of *Renicola*, Wright (1956) adds, "The characters most frequently used for the separation of the species are the linear distribution of vitelline glands, length of intestinal caeca, relative size and shape of gonads, size of suckers and the ratio between these sizes and egg size." After dismissing the criteria for the size and shape of gonads, he clarified that they are dependant upon the state of maturity of worms. Further, the position of testes with relation to each other and to ventral sucker will be shown to be variable. He accepted the size and size ratio of suckers as reasonable characters for separation of species provided all the specimens are fixed by the same technique because pressure alters the size slightly and has more effect on oral sucker than the ventral sucker, thus rendering the size ratio valueless. Though useful, but he considered the length of intestinal caeca as a character with limited application because in most cases there are only two alternatives-either to the approximate level of ventral sucker or to the posterior end of body. Whereas Dollfus (1946) based his key to the species of the genus *Renicola* upon the principal feature of linear distribution of vitelline glands, Wright (1956) considered it a useful criterion but admitted that these organs can be distorted by pressure. He further accepted the usefulness of the size of eggs in some cases but clarified that in many species the size-ranges overlap within a narrow field. Wright (1957) distinguished and arranged the Rencolid species in four groups:

1. The Pinguis group, with majority of the species in which the vitelline follicles are often large and coarse and disposed lateral to intestinal caeca, mostly on the dorsal side or ventral also.
2. The Mediovitellata group, represented by *R. mediovitellata* and *R. brantae* with dorsal vitelline follicles arranged in linear series between caeca.

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3. The Pelecani group, represented by a single species, *R. pelecani* with a spindle shaped body having a long oesophagus as compared to other known species at that time.
4. The Goliath group, also represented by a single species, *R. goliath* where vitelline follicles are arranged in groups throughout the mid region of the body ventral to caeca from the lateral margins, almost to the middle.

Though Wright (1954b) noted that the lateral branching system is difficult to observe in *Renicola* and appears to be suppressed in gravid adults, yet Riley and Owen (1972), despite the variability of excretory system, divided the Rencolid trematodes into four groups depending upon the form of excretory vesicle. Their observation was based upon only twelve species but only eight were named in which the excretory system had been described. The four groups according to Riley and Owen (1972) are:

Excretory vesicle 'Y' shaped, bifurcating at or just below the level of ventral sucker; arms terminating at or near the level of pharynx. It includes: *R. pinguis* (Mehlis, 1831) Cohn, 1904; *R. pelecani* Wright, 1954a; *R. lari* Timon-David, 1933 and *R. bretensis* Timon-David, 1952.

Excretory vesicle 'Y' shaped, bifurcating well below the level of ventral sucker, with a prominent cross linkage at or just below ventral sucker; arms terminating at or near to the level of pharynx. It includes: *R. sloanei* Wright, 1954a; *Renicola* sp. from *Colymbus arcticus* Wright, 1956; *Renicola* sp. from *Fratercula arctica* Wright, 1956; *Renicola* sp. from *Puffinus puffinus* Wright, 1956 and *Renicola glacialis* Riley and Owen, 1972.

Excretory vesicle 'Y' shaped, bifurcating well below the level of ventral sucker, arms terminating at mid body region. It includes: *Renicola* sp. from *Plotus* (= *Mergulus alle*) Dollfus, 1946 and *R. glandoloba* Witenberg, 1929.

Excretory vesicle 'V' shaped, stem very short, arms long and terminating at the level of pharynx. It includes: *R. cruzi* Wright, 1954b.

Though Riley and Owen (1972) agree that "the use of excretory vesicle as a diagnostic character has the disadvantage that it is not usually visible in whole mount preparations, except in juvenile worms. Nevertheless, it is easily reconstructed from sectioned material". Commenting further they concluded that "this character in combination with certain other relevant parameters for example, relative length of digestive caeca and distribution of vitellaria, might constitute a more satisfactory key for identification of Rencolid trematodes."

However, Gibson (2008) considers this division impractical because excretory vesicle is very difficult to see in whole mounts and moreover, no subsequent workers have commented upon this observation.

Odening (1962) revised the family Rencolidae and accepted the validity of only thirty species in the genus *Renicola*. He also discussed the morphology of several unnamed species and named a few of them as new species. On the basis of the length of intestinal caeca; ratio of the sizes of oral sucker, pharynx and acetabulum; size of eggs and the taxonomy of hosts, he arranged the species in groups and sub-groups and split the genus *Renicola* and erected two new genera for the existing species: *Pseudrenicola* Odening, 1962 based on elliptical body shape; anterodorsal position of ovary rather than posterolateral to ventral sucker; extracaecal vitellaria with *P. nana* (Bychovskaja-Pavlovskaja, 1953) as type species and *Neorenicola* Odening, 1962 based on oblong to oval body presence of only one testes (fusion of two possibly) extracaecal vitellaria; parasites of Accipitriiformes with *N. monorchis* (Dollfus and Capron, 1958) as type species. Stunkard (1971) while commenting on Odening's classification says "the erection of new genera has doubtful validity." The two genera were accepted by Smogorzhevskaya (1976) and Shigin (1983) but not by Yamaguti (1971) and Sudarikov *et al.* (1986). Yamaguti accepted *Neorenicola* as a subgenus of *Renicola* but Groschaft (1982) synonymized it with *Nephromonorchia* Leonov, 1958 which was earlier not accepted by Yamaguti (1971) but recognized by Groschaft (1982). The latter genus was erected by Leonov (1958) as *incertae sedis* for *N. skrjabini* Leonov, 1958 obtained from gulls and Terns off the black sea coast of Ukraine. Alekseev *et al.* (1969) considered *Nephromonorchia* a synonym of *Renicola* which was also accepted by Sudarikov and Stenko, 1984; Sudarikov *et al.*, 1986 and Bartoli, 1989.

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Odening (1962), while commenting on the classification implied that “Systematics of the genus *Renicola* is quite difficult to ascertain since nothing is known accurately about the degree of specificity.” He further clarified that a revision of the family has to be made according to different criteria rather than the previous attempts to divide the genus into two subgenera, *Renicola* and *Stamparia*. He was of the opinion that the position of ovary behind ventral sucker, the number of testes and the nature and location of vitellarium are particularly important as also the length of oesophagus; position of caeca and oral sucker; location of ventral sucker; expansion of uterus; position of gonads and size of eggs. He therefore concluded that part of existing descriptions is incomplete because of the non visibility of such important organs like intestines, gonads, vitellaria and ventral sucker. While recognizing the four groups of Wright (1957) and Odening (1962) divided the genus *Renicola* into three subgenera:

Renicola: Included *Pinguis* and *Peleceni* groups. Vitellaria extracaecal; two separate testes placed laterally around the area of ventral sucker and overlapping gut-caeca ventrally or dorsally; ovary pyriform or spindle shaped; Apart from *R. (R.) pinguis* (Mehlis in Creplin, 1846) Cohn, 1903 as type species, he included 27 other species under this subgenus. Parasitic in several bird orders.

Anatirenicola Odening, 1962: to contain the *Mediovitellata* group. Vitellaria intercaecal, dorsal, almost in two rows, parasites of Anseriforms. Apart from *R. (A.) mediovitellata* Bychovskaya-pavlovskaya (1950) as type species, added three other species.

Wrightrenicola Odening, 1962: to contain the *Goliath* group. Vitellarium ventral to caeca, often wide in intercaecal region; parasitic in Ardeiforms. Apart from *R. (w.) goliath* Wright, 1957 as type species added only one species - *R. (w.) fischeri* n.sp.

These subgenera were not accepted by Yamaguti (1971) who considered such variations in vitelline distribution as specific differences. The main diagnostic features with which the family *Renicolidae* Dollfus, 1939 was identified by Odening (1962) is:

Diagnosis

Body more or less spindle shaped or oval, usually convex on ventral side, dorsal side flat or concave, cuticle covered with scales. Oral sucker sub-terminal; Ventral sucker post equatorial, mostly underdeveloped. Prepharynx absent; pharynx present. Oesophagus present or absent. Intestine usually horseshoe shaped, caeca reaching centre of body. Testes two (fused into a single in *Neorenicola*), slightly behind median line, close together with ventral sucker or a little anterior or behind but always behind region of ovary, irregular, smooth edged or lobed. Vasa efferentia combine to form vas deferens to merge into a small laterally placed vesicula seminalis. A short ejaculatory canal emerging from vesicula seminalis is surrounded by prostatic cells in genital atrium. Cirrus absent. Ovary lies in front of testes, mostly on right side, more or less irregular in shape, rarely smooth and rarely symmetrical. Complex vitellarian follicles small and scattered, extracaecal tendency on ventral side or dorsally overlap intestinal caeca. Shell gland median, submedian or lateral. Receptaculum seminis present near shell gland. Laurer's canal missing. Uterus in ascending loop descends with large bulges in almost the entire body. Eggs numerous. Excretory canal 'Y' shaped.

Earlier Rue (1957) had proposed the super family *Renicoloidea* Dollfus, 1939 and suborder *Renicolata* Rue, 1957 and order *Renicolida* Rue, 1957 based on the epithelial excretory vesicle of the cercariae. However, Odening (1971) while accepting the super family, placed it under the suborder *Plagiorchiata* Rue, 1957. Yamaguti (1958) recognized this group only at the subfamilial level which he named as *Renicolinae* (Yamaguti, 1958) included under *Troglotrematidae* Braun, 1915. Subsequently in 1971 he opined that judging from adult morphology and scarce knowledge of the life history Rue, 1957 had gone too far, included the family within the superfamily *Troglotrematoidea* Odhner, 1914. While Smogorzhevskaya (1976) accepted Rue's suborder *Renicolata* but Sudarikov *et al.*, (1986) elevated it to a full ordinal level as *Renicolida* Rue, 1957. However, Schell accepted its validity at superfamily level as *Renicoloidea*.

Of the 56 known species of *Renicolidae* (Munyer *et al.*, 1990), two were described on the basis of cercariae only (Martin, 1971). Sudarikov and Stenko (1984) accepted the validity of only two genera-

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Renicola (Cohn, 1904) and *Nephromonorch*a (Leonov, 1960) which was also supported by Munyer *et al.* (1990). The latter genus was accepted on the basis of its testicular fusion. Munyer *et al.* (1990) consider Renicolidids as a small group with little variation in adults but with two different types of cercariae-one large pigmented, with excretory bladder of adult form- the *Rhodomitopa* type and the other in Cable's (1965) words "a rather prosaic *Xiphidocercaria*", small and with simple 'Y' shaped bladder.

The Superfamily Microphalloidea Ward, 1901 was established by Morozov (1955). Takach, Littlewood, Olson, Kinsella and Swiderski in 2003 outlined a wide variety of components in this group. They studied Phylogenetic relationships of 32 species belonging to 18 genera and 4 families of Microphalloidea by partial sequence of nuclear 1sr DNA analysed by Bayesian inference and maximum parsimony. During the recent molecular findings (Takach *et al.*, 2000a; 2001b; 2003; Cribb *et al.*, 2001b; Olson *et al.*, 2003 and Bray, 2008), the composition of families considered members of this group comprise of a paraphyletic group of 'Lecithodendrid-like' taxa. The study of these molecular findings have validated that the families Microphallidae Ward, 1901, Eucotyliidae Cohn, 1904, Faustulidae Poche, 1926, Lecithodendriidae Luhe, 1901, Pachypsolidae Yamaguti, 1958, Pleurogenidae Looss, 1899, Prosthogonimidae Luhe, 1909, Renicolidae Dollfus, 1939 and Zoogonidae Odhner, 1902 form a monophylum now known as Microphalloidea (Bray, 2008). Consequently this leads us to infer that Renicolidids are Microphalloids as per the sequence of events involved in their evolution.

Sudarikov and Stenko, 1984 provided a key to 52 Renicolid species except five in *Renicola*. While attempting to split the genus, Nezlubinsky, 1926 raised the genus *Stamparia* (Nezlubinsky, 1926) obtained from Pelicans in Macedonia and compared with *Renicola*. Though provisionally accepted by Dollfus (1946) but he was not convinced by the diagnostic characters (testes symmetrical and entire versus asymmetrical and irregular in shape). Sudarikov (1951) considered it a subgenus of *Renicola* but Yamaguti (1958) synonymized it with *Renicola* which, however, was also accepted subsequently by several workers.

Gibson (2008) while studying the family Renicolidae accepted the validity of *Renicola* and recognized *Nephromonorch*a also but "with some degree of hesitance". While examining the species of the genus *Renicola*, Gibson (2008) pointed out that "The differences that have been used in the past are of questionable phylogenic significance in taxa where the material is often in poor condition and where the features are distorted or obscured by the uterus". Though not completely satisfied with the divisions of *Renicola*, he opined that for reassessment of morphological variations, Renicolid group needs a thorough study by using molecular techniques. The main diagnostic features which Gibson (2008) selected and recorded for the family are:

Family Renicolidae Dollfus, 1939

Body rounded to oval, subpyriform or claviform, often attenuated posteriorly. Tegument spined. Oral sucker present. Small ventral sucker in middle third of body. Prepharynx absent, pharynx small. Oesophagus short or absent. Caeca extend upto middle of body length or close to posterior end. Testes usually two, close or contiguous, occasionally fused into small mass, irregularly lobate, symmetrical to oblique, nearer to ventral sucker in or close to middle third of body. Cirrus sac absent. Seminal vesicle saccular in forebody. Pars prostatica and ductus ejaculatorious short or indistinct. Genital atrium small. Median genital pore anterior to ventral sucker. Ovary irregularly lobate, submedian, anterior to one of the two testis or anterolateral to one testis, usually anterolateral to ventral sucker, occasionally posterolateral. Seminal receptacle small. Winding uterine coils fill most of the body anterior to testes but absent at extremities. Vitellaria follicular, placed laterally in clusters in middle or posterior third of body. Eggs small and numerous. Excretory vesicle 'Y' or 'V' shaped. Excretory pore terminal. Type - genus *Renicola* Cohn, 1904. The key to genera and their diagnostic features accepted by him are:

1. *Renicola* Cohn, 1904..... Testes two, symmetrical to tandem, contiguous, may overlap. Ovary lobed or not. Vitellaria few to extensive, placed laterally in middle third of body. (Syns.- *Stamparia* Nezlubinski, 1926; *Anatirenicola* Odening, 1962 (Subgenus); *Pseudrenicola* Odening,

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1962; *Wrightrenicola* Odening, 1962 (Subgenus). Type species: *R. pinguis* (Mehlis in Creplin, 1846) Cohn, 1904.

2. *Nephromonorch* Leonov, 1958 Testes fused to form single mass. Ovary lobed. Vitellaria comprising of a few follicles restricted to middle third of body. (Syn.-*Neorenicola* Odening, 1962).

Type species: *N. skrjabini* Leonov, 1958.

Out of the 56 species of the Rencolidae described and accepted worldwide (Munyer *et al.*, 1990), the only three species which have been described and recorded in the genus *Renicola* from India are: *R. indicola* Odening, 1962 in *Pelecanus onocrotalus* collected from Berlin Zoo; *R. indica* Mehra and Kharoo, 1974 in *Turdoides tericolor tericolor* from Allahabad (U.P.); *R. melastigmai* Dhankumari, 2000 in *Aplocheilus melastigma* from Andhra Pradesh. Odening, 1962 has also described one unnamed *Renicola* sp. from a freshly imported *Pelecanus philippensis* from India.

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