On *Artyfechinostomum malayanum* (Leiper, 1911) Mendheim, 1943 (Trematoda: Echinostomatidae) with Synonymy of Allied Species and Genera

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**ABSTRACT:** The genus *Artyfechinostomum* Lane, 1915, with its type species *A. sufrartyfex* Lane, 1915, has been studied from naturally infected pigs and experimentally infected white rats. Six species so far described under this genus are: *A. malayanum* (Leiper, 1911) Mendheim, 1943, from man; *A. indicum* (Bhalerao, 1931) Mendheim, 1943, from *Uromastix hardwickii*; *A. mehra* Jain, 1960, from experimental rats; *A. paradoxuri* Baugh, 1962, from palm-civet; *A. varanum* Simha and Deshpande, 1964, from *Varanus bengalensis*; and *A. munshii* Deodhar et al., 1967, from dogs. On detailed comparison and in view of intergrading variations, all these six species have been synonymized with *A. malayanum* (regarded henceforth as type species). The three allied genera: *Reptiliotrema* Baschkirova, 1941; *Neoartyfechinostomum* Agarwal, 1963, and *Pseudoartyfechinostomum* Bhardwaj, 1963, have, on similar study, been held identical with *Artyfechinostomum*. Consequently, the species assigned to these genera, namely, *R. indicum* (Bhalerao, 1931) Baschkirova, 1941; *R. primata* Premvati, 1960; *R. tandani* Agarwal, 1963; *N. shubhrai* Agarwal, 1963; and *P. larueiformis* Bhardwaj, 1963, have been synonymized with *A. malayanum*. Generic characters of *Artyfechinostomum* have been emended. Host: reptiles and mammals.

The genus *Artyfechinostomum* Lane, 1915, with type species *A. sufrartyfex* Lane, 1915, seems to be prevalent in Southeast Asia. Its common occurrence in pigs of India and Malaya, together with its record from man, makes its study considerably important. Six other species so far described are: *A. malayanum* (Leiper, 1911) Mendheim, 1943, from man; *A. indicum* (Bhalerao, 1931) Mendheim, 1943, from *Uromastix hardwickii*; *A. mehra* Jain, 1960, from experimental rats; *A. paradoxuri* Baugh, 1962, from palm-civet (*Paradoxurus hermaphroditus*); *A. varanum* Simha and Deshpande, 1964, from *Varanus bengalensis*; and *A. munshii* Deodhar et al., 1967, from dogs. The present study has been planned to compare morphological variations in *A. sufrartyfex* as described by earlier workers with those studied by present authors, and to ascertain the validity of all species described so far under this genus.

Besides, the question of validity of three allied genera: *Reptiliotrema* Baschkirova 1941, with its three species—*R. indicum* (Bhalerao, 1931) Baschkirova, 1941; *R. primata* Premvati, 1960; *R. tandani* Agarwal, 1963; *Neoartyfechinostomum* Agarwal, 1963, with a single species *N. shubhrai* Agarwal, 1963; *Pseudoartyfechinostomum* Bhardwaj, 1963, with a single species, *P. larueiformis* Bhardwaj, 1963, has been examined.

These taxonomic units have mostly been erected on such morphological differences as: number and arrangement of collar spines; ratio of suckers; number of testicular lobes; posterior extent of cirrus sac with spinose or aspinose cirrus; presence or absence of seminal receptacle; anterior extent of vitellaria to anterior, middle, or posterior level of ventral sucker; size of eggs; and presence or absence of spines on excretory pore.

Metacercarial cysts, isolated from the infested renal tissue of *Rana cyanophlyctis*, were fed to albino rats. The following experiments have been conducted:

<table>
<thead>
<tr>
<th>No. of cysts fed</th>
<th>Date of infection</th>
<th>Date of egg detection in feces</th>
<th>Date of autopsy</th>
<th>No. of adult flukes recovered</th>
</tr>
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<tbody>
<tr>
<td>135</td>
<td>25.6.71</td>
<td>10.7.71</td>
<td>12.7.71</td>
<td>81</td>
</tr>
<tr>
<td>57</td>
<td>26.6.71</td>
<td>9.7.71</td>
<td>9.7.71</td>
<td>15</td>
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<tr>
<td>86</td>
<td>19.8.71</td>
<td>30.8.71</td>
<td>2.9.71</td>
<td>56</td>
</tr>
</tbody>
</table>

Adult flukes were also recovered from naturally infected pigs.

Encysted and ex cysted metacercarial stages and adults were studied alive and from stained and unstained permanent mounts. Spines were also studied after treatment with 1% KOH solution. Serial sections of adults were stained with Hematoxylin and Eosin. All measurements, unless otherwise stated, are recorded in microns.
Artyfechinostomum surfrartyfex
Lane, 1915
(Plate I. Figs. 1, 2, 3, 4a, b, c; Plate II. Figs. 5a–g)

Lane (1915) described this species for the first time from an Assamese girl. Later, Bhalerao (1931b), Rai and Ahluwalia (1958), and Ahluwalia (1962) studied it from pigs; Srivastava (1964) from honey-badger; Matta and Pande (1966) from rats and piglets (experimental); Dubey et al. (1969) from cat and dog; Mohandas (1971) from white rats (experimental); Nath (1972) from lizard (experimental); and Agrawal and Pande (1972) from piglets (experimental). Present authors studied it from naturally infected pigs and from white rats infected experimentally with metacercarial cysts isolated from kidney of Rana cyanophlyctis.

Description of this species, as given by the above various workers, is summarized as follows.

Measurements: Length 4.2–18.0 mm; width 1.2–6.0 mm; oral sucker 130–390 × 130–510; ventral sucker 495–1.53 mg × 448–1.8 mm; ratio of suckers 1:2.5 to 1:4; pharynx 108–450 × 120–405; anterior testis 490–2.10 mm × 530–3.21 mm; posterior testis 540–2.97 mm × 430–2.49 mm; ovary 160–800 × 120–800; eggs 56–165 × 49–90.

Collar spines: 37–39 arranged in zigzag manner (Lane, 1915); 39–42 in dorsally unbroken single row (Bhalerao, 1931b); 43 in two alternate rows (Rai and Ahluwalia, 1958; Ahluwalia, 1962; Matta and Pande, 1966; Nath, 1972 and Agrawal and Pande, 1973); 43–44 (Srivastava, 1964). Lie Kian Joe (1963) observed in Echinostoma malayanum Leiper, 1911 (synonym: A. surfrartyfex) 43 or 45 collar spines arranged in alternating dorsal rows, two lateral groups showing sometimes alternate arrangement, and two groups with five alternating corner spines each. According to Mohandas (1971), collar spines 43 in adult and 43–45 in cercariae, arranged in the pattern: 5 + 11 + 11 + 11 + 5 or 5 + 11 + 13 + 11 + 5. During present studies, the number of collar spines was mostly 41–43, except in one specimen it was 45; spines arranged uninterruptedly with 17 dorsals in two alternating series, 14 or 16 laterals, and 10 corner spines in two groups of five each. A narrow isthmus bridging ventral gap on reniform head collar, confirms the findings of Rai and Ahluwalia (1958), Ahluwalia (1962) and Lie Kian Joe (1963).

Testes deeply lobed by all, although number of lobes vary. During present study, extent of lobulation varies with degree of maturity of worm and with host (Plate II. Figs. 5a–g). All workers reported posterior extent of cirrus sac beyond ventral sucker, though its posterior limit varies slightly. Cirrus spiny by all except Bhalerao (1931b) and Mohandas (1971).

Seminal receptacle reported to be absent by all except Faust (1930) and Craig and Faust (1943). Present authors agree with Lie Kian Joe (1965) and Mohandas (1971) in the presence of a uterine seminal receptacle. Vitellaria extend anteriorly to caudal half of cirrus sac (Lane); to middle of posterior border of ventral sucker (Bhalerao); to region of ventral sucker (Craig and Faust); middle of ventral sucker (Rai and Ahluwalia; Ahluwalia, and Srivastava); and from middle to posterior border of ventral sucker, according to present authors. In size, eggs show slight variations— those recovered from experimentally infected rats being slightly smaller than those from pigs.

Spines on excretory pore not observed by previous workers. Present study reveals sub-terminal excretory pore with a crown of prominent lanceolate, eversible spines in proximal and distal groups (Plate I. Figs. 4a, b, c). Their presence has been noticed in all specimens (whole mounts and sections or following treatment with KOH), and even observed in metacercarial cysts.

Plate I. Artyfechinostomum surfrartyfex Lane, 1915. (Camera lucida drawings.) 1. Entire, showing 41 collar spines (from rat). 2. Head collar showing 43 collar spines (from rat). 3. Cross section, showing uterine seminal receptacle and Mehlis' glands (from rat). 4. (a) Excretory pore, end-on view (from rat). (b) Cross section of posterior end, showing spines around excretory pore (from rat). (c) Cross section of posterior end, showing spines around excretory pore (from pig).
**Artyfechinostomum malayanum**

(Leiper, 1911) Mendheim, 1943  
(Syn: *Echinostoma malayanum* Leiper, 1911;  
*Euparyphium malayanum* Leiper, 1911  
*Euparyphium sufrartyfex* Baylis, 1929)  
(Plate III. Fig. 6)

*Echinostoma malayanum* recorded by Leiper (1911) from man in Malaya is found to infest pigs and house-shrews. It has been experimentally infected in white rats, white mice, and hamsters. Lie Kian Joe (1963), discussing the characters of *E. malayanum* and *A. sufrartyfex*, considered the latter to be a synonym of the former. He retained the name *Echinostoma* not because the worm fits in one of the definitions for this genus, but because it is most often used in medical literature. Mukherjee and Ghosh (1968) independently regarded *A. sufrartyfex* and various closely related species and allied genera as synonyms of *E. malayanum*. Mohandas (1971), after studying the life history of *A. sufrartyfex* and comparing it with that of *E. malayanum*, has stated that *A. sufrartyfex* is a synonym of *E. malayanum*.

The genus *Echinostoma* Rudolphi, 1809, according to Yamaguti (1958), is characterized by having unlobed testes, cirrus sac not extending beyond ventral sucker, and vitellaria being confluent posttesticularly or otherwise. *Artyfechinostomum*, on the other hand, has deeply lobed testes, cirrus sac extending beyond ventral sucker, and vitellaria beginning at level of ventral sucker, confluent posttesticularly. Thus, the two genera have distinct characters, and it may not be feasible to include *A. sufrartyfex* in the genus *Echinostoma*. Only one species of the genus *Echinostoma*, namely, *E. malayanum*, has all characteristics of *A. sufrartyfex*. Accordingly, *A. malayanum* (*E. malayanum* Leiper, 1911) Mendheim, 1943 and *A. sufrartyfex* Lane, 1915 are synonyms.

**Artyfechinostomum indicum**

(Bhalerao, 1931) Mendheim, 1943  
(Syn.: *Testisacculus indicum* Bhalerao, 1927;  
*Paryphostomum indicum* Bhalerao, 1931)  
(Plate III. Fig. 7 a, b)

*Artyfechinostomum indicum* has been distinguished from *A. sufrartyfex* on account of cuticular spines extending up to ovarian zone; 42 collar spines arranged in double rows; vitellaria reaching near middle or posterior margin of ventral sucker; uterus with few coils and few eggs of smaller size. In *A. sufrartyfex*, as stated above, cuticular spines are denser in anterior half of body and sparser posteriorly; collar spines 41–45, arranged in alternating rows; vitellaria reach anteriorly from middle to posterior margin of ventral sucker; number of uterine coils and eggs depend on age of worms and on host species. Thus, distinguishing characters justifying the validity of *A. indicum* do not appear to exist. Accordingly, the latter is treated as a synonym of *A. sufrartyfex* Lane, 1915.

**Artyfechinostomum mehraii** Jain, 1960  
(Syn.: *Paryphostomum mehraii* Jain, 1957)  
(Plate III. Fig. 8 a, b)

Jain (1960a) placed *A. mehraii* and *A. indicum* together, and distinguished these from *A. sufrartyfex* because collar spines in former were in double rows while, in latter, in a single row. He kept *A. mehraii* distinct from *A. indicum* as vitellaria extended to posterior margin of ventral sucker in former and to middle in latter. Further, *A. mehraii* has numerous eggs and a small seminal receptacle (Jain, 1960b). He distinguished the three species on: number and arrangement of collar spines (39 in single row in *A. sufrartyfex*, 42 in double rows in *A. indicum*, and 43 in double rows in *A. mehraii*); ratio of suckers, and num-

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Plate II. *Artyfechinostomum sufrartyfex* Lane, 1915. (Camera lucida drawings.) 5. (a) to (e). Testes showing variations in lobulations in specimens from rat. (f) to (g). Testicular lobulations in specimens from pig.
ber of testicular lobes (Jain, 1960 a). In A. sufrartyfex, as mentioned above, collar spines 41–45 arranged in alternating rows dorsally; ratio of suckers 1:2.5 to 1:4, covers that found in A. mehraii; extent of lobulation in testes, and number of eggs depend on stage of maturity of the worm and on host; vitellaria extend anteriorly to posterior region of ventral sucker, as in A. mehraii; a uterine seminal receptacle, observed in A. sufrartyfex, is often mistaken for a seminal receptacle. Thus, the three species cannot be distinguished on these characters. Ahluwalia (1962) believed that A. mehraii was not distinct from A. sufrartyfex. Present authors also agree with Ahluwalia in treating A. mehraii as a synonym of A. sufrartyfex Lane, 1915.

_Artyfechinostomum paradoxuri_
Baugh, 1962  
(Plate III. Fig 9 a–c).

This species, based on about half a dozen specimens from palm-civet (Paradoxurus hermaphroditus), has been distinguished chiefly by characteristic body spines; collar spines 41–42 arranged in a single dorsally uninterrupted row; presence of seminal receptacle, and spines around excretory pore.

The body spines, in A. sufrartyfex, have been observed to be large and broad as in A. paradoxuri; arrangement of collar spines in specimens of A. paradoxuri has been observed to be in alternating double rows; presence of uterine seminal receptacle and spines on excretory pore have already been discussed above in A. sufrartyfex. Thus, A. paradoxuri does not differ from A. sufrartyfex with which it is synonymized.

_Artyfechinostomum varanum_
Simha and Deshpande, 1964  
(Plate III. Fig. 10 a, b)

This species has been differentiated only from _A. indicum_, which also parasitizes a reptilian host, on account of preacetabular portion being sharply marked off; collar spines 40; ratio of suckers 1:3; cirrus sac extending to second quarter of body, and uterus having many larger eggs.

These characters, however, come within the range of variations detected in _A. sufrartyfex_, as discussed above. _A. varanum_ is, therefore, held identical with _A. sufrartyfex_ Lane, 1915.

_Artyfechinostomum munshii_
Deodhar et al., 1967  
(Plate III. Fig. 11 a–e)

This species, obtained from small intestine of dog, shows affinities with _A. sufrartyfex_, _A. indicum_, and _A. mehraii_ on account of general body surface; position of gonads; shape and size of cirrus sac and cirrus, according to Deodhar et al. (1967). It is stated to differ from them in having cuticular spines extending to end of anterior testis; collar spines 38; and testes with seven to nine lobes.

In _A. sufrartyfex_, body spines in posterior part of body become significantly sparser. Collar spines 41–45 are frequently lost during handling. As Deodhar et al. (1967) have probably studied preserved material, there is every possibility of spines being lost. Details of arrangement of dorsally uninterrupted collar spines have not been given. According to Yadav (1959), anterior testis of _A. sufrartyfex_ has

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Plate III. (Figures from original authors.) 6. _Euparyphium malayanum_, entire (after Skrjabin, 1956). 7. _Paryphostomum indicum_, (a) entire, (b) head collar showing arrangement of spines (Bhalerao, 1951). 8. _Paryphostomum mehraii_, (a) entire, (b) head collar (Jain, 1957). 9. _Artyfechinostomum paradoxuri_, (a) entire, (b) cephalic collar, (c) body spines (Baugh, 1962). 10. _Artyfechinostomum varanum_, (a) entire, (b) collar spines (Simha and Deshpande, 1964). 11. _Artyfechinostomum munshii_, (a) entire, (b) anterior end, (c) cirrus sac, seminal vesicle, and cirrus, (d) ovarian complex, (e) eggs (Deodhar et al., 1967). 12. _Repitliotrema primata_, (a) entire, (b) cephalic collar (Premvati, 1960). 13. _Repitliotrema tandani_, (a) entire, (b) head collar (Agarwal, 1963). 14. _Neoartyfechinostomum shubhrai_, (a) entire, (b) head collar, (c) arrangement of collar spines, (d) cirrus sac, (e) ootype (Agarwal, 1963). 15. _Pseudoartyfechinostomum larueiformis_, (a) entire, and two eggs, (b) anterior end showing head collar, (c) testes (Bhardwaj, 1963). 16. _Artyfechinostomum sufrartyfex_, (a) entire, with 41 collar spines, (b) head collar showing 43 collar spines (present authors).
up to 10 lobes; and in present studies, testicular lobes found to vary with age of parasite (Fig. 5 a–g of Plate II). Position of gonads, shape and size of cirrus sac and cirrus, also same as found in *A. sufrartyfex*. Besides, *A. sufrartyfex* has been reported from dog by Dubey et al. (1969) and by Nath (1969) from pup (experimental). Hence, *A. munsbhi* is suppressed as a synonym of *A. sufrartyfex*.

**Reptiliotrema Baschkirova, 1941**

* R. indicum (Bhalerao, 1931) Baschkirova, 1941;  
* R. primata Premvati, 1960;  
* R. tandani Agarwal, 1963

This genus, erected to include *P. indicum* Bhalerao, 1931, has two other species: *R. primata*, from rhesus monkeys, and *R. tandani*, from *Varanus monitor*. It is already stated that *P. indicum*, synonymized with *A. indicum* by Mendheim, 1943, is held identical with *A. sufrartyfex* by present authors.

**Reptiliotrema primata** (Plate III, Fig. 12 a, b), described from preserved specimens, has been distinguished from *R. indicum* by cuticular spines covering whole body; number of collar spines; broader anterior testis; greater posterior extent of cirrus sac; larger size of ovary; and presence of a seminal receptacle. These features, during present study, have shown intraspecific variations which warrant suppression of *R. primata* as a synonym of *A. sufrartyfex* Lane, 1915.

According to Agarwal, *R. tandani* (Plate III, Fig. 13 a, b) differed from *R. indicum* on account of cuticular spines covering whole body; testes equal in size; ovary bilobed; and presence of an elongated seminal receptacle. In shape and size, the two testes in *R. tandani* resemble those of *A. sufrartyfex* (Plate II, Fig. 5 a–g). Jain (1960b) stated that ovary was bilobed in *A. mehri* (a synonym of *A. sufrartyfex*). Body spines have been observed in all specimens of *A. sufrartyfex*. Thus all characters said to distinguish *R. tandani* are found in *A. sufrartyfex*. On re-examination, a uterine seminal receptacle has been observed in the genus *Reptiliotrema*. Since all the three species, under *Reptiliotrema*, have been synonymized with *A. sufrartyfex*, the genus cannot retain a status independent from *Artyfechinostomum* Lane, 1915.

**Neoartyfechinostomum**

* Neoartyfechinostomum Agarwal, 1963  
  * N. shubhrai Agarwal, 1963  
  (Plate III, Fig. 14 a–c)

This genus, with its solitary species *N. shubhrai* based on three specimens from local pig has been distinguished from closely allied genus *Artyfechinostomum* by having a pharynx larger than oral sucker; pear-shaped ovary; presence of seminal receptacle; and vitellaria extending anteriorly to hind end of ventral sucker. In *N. shubhrai* there is practically very little difference in the sizes of oral sucker (210–250 × 260–310) and pharynx (250–300 × 270–360) and these sizes are found in *A. sufrartyfex* also. The almost round ovary, when pressed, could assume a pear-shaped form and a uterine seminal receptacle could easily be mistaken for a seminal receptacle. Anterior extent of vitellaria to hind end of ventral sucker has been observed by present authors. The validity of the genus *Neoartyfechinostomum* is thus untenable. It is, therefore, regarded as a synonym of *Artyfechinostomum* Lane, 1915. The characters given for *N. shubhrai* do not support its retention even as a species distinct from *A. sufrartyfex* with which it is held identical.

**Pseudoartyfechinostomum**

* P. larueiformis Bhardwaj, 1963  
  (Plate III, Fig. 15 a–c)

This genus, with *P. larueiformis* as the only species, has been described from about 25 specimens collected from *Varanus*—believed to be an unreported reptilian host. It is distinguished from *Artyfechinostomum* on account of body tapering at two ends and covered with spines even below its last fourth; collar spines 39, with smaller terminal spines; prepharynx longer than esophagus; testes very irregular but never deeply lobed; and fewer eggs being largest.

*Artyfechinostomum*, as mentioned above, also occurs in reptiles: *U. hardwickii*, *V. bengalensis*, and *V. monitor*. In body shape, *P. larueiformis* closely resembles *A. sufrartyfex*. Large-sized prepharynx cannot be regarded as a character of generic value. Testicular lobulation and total number of eggs depend on stage of maturity. Size of egg 0.1245 × 0.0747 to 0.1077 × 0.0664 for *P. laruei-
formis by Bhardwaj; 0.135 × 0.075 for A. sufrartyfex by Yadav (1959); 90–159 × 60–93 for E. malayanum by Lie Kian Joe (1963); and 0.058–0.075 × 0.09–0.113 for P. sufrartyfex by Bhalerao 1931b, is nearly same. Pseudoartyfechinostomum does not possess any distinctive characters to uphold its validity as a genus and is considered as a synonym of Artyfechinostomum Lane, 1915. Pseudoartyfechinostomum larueiformis does not reveal any distinctive character even at species level, and is, therefore, held identical with A. sufrartyfex Lane, 1915.

The observations have necessitated a slight emendment of the generic diagnosis given by Yamaguti:

**Artyfechinostomum Lane, 1915**
(Syn.: *Reptiliotrema* Baschkirova, 1941; *Neoartyfechinostomum* Agarwal, 1963; *Pseudoartyfechinostomum* Bhardwaj, 1963)

**Generic Diagnosis:** Echinostomatidae; body elongate, broader posteriorly, indented near region of ventral sucker. Head collar reiform, with narrow ventral isthmus; with a crown of 39–45 collar spines arranged dorsally in uninterrupted, alternating rows, with five corner spines on each side. Oral sucker small, subterminal; prepharynx present; esophagus short; ceca terminating in front of posterior extremity. Ventral sucker prominent, in anterior fourth of body. Testes large, tandem, deeply lobed, in posterior half of body, cirrus sac long, club-shaped, extending beyond ventral sucker, enclosing prominent seminal vesicle, short prostatic duct, coiled ejaculatory duct ending in eversible cirrus carrying minute spines. Ovary pretesticular, submedian, oval; seminal receptacle present; Laurer's canal present. Uterus coiled, ending in well-developed metraterm; eggs numerous, large; vitellaria lateral, extending from region of ventral sucker to hind extremity, with follicles confluent posttesticularly. Excretory pore armed with eversible, lanceolate spines; excretory bladder Y-shaped, main stem extending to posterior testes with cornua extending near oral sucker. Intestinal parasites of reptiles and mammals.

**Genotype:** A. malayanum (Leiper, 1911) Mendheim, 1943. (As A. malayanum has taxonomic priority over A. sufrartyfex, it is retained as type species.) [(Syn.: E. malayanum Leiper, 1911; A. sufrartyfex (Lane, 1915); P. indicum Bhalerao, 1931; A. indicum (Bhalerao, 1931) Mendheim, 1943; A. mehrae Jain, 1960; A. paradoxuri Baugh, 1962; A. vanam Simha and Deshpande, 1964; A. munshii Deodhar et al., 1967; R. indicum (Bhalerao, 1931) Baschkirsova, 1941; R. primata Premvati, 1960; R. tandani Agarwal, 1963; N. shubhrai Agarwal, 1963; P. larueiformis Bhardwaj, 1963].

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**Literature Cited**


