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A discussion on the status of *Lytocestus rekhaensis* Nimbalkar et al. 2012

Umapati Sahay^{a*} & APV Khalkho^b

^aDepartment of Zoology, Ranchi University, Ranchi, Jharkhand, India

^bDepartment of Zoology Womens College, Kolhan University, Chaibasa, Jharkhand, India

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Abstract : *Lytocestus rekhaensis* Nimbalkar et al (2012)¹ a Caryophyllid cestode was described under the family *Lytocestidae* Wardle & McLeod (1952) . Unfortunately its placement in the genus seems to be an error inadvertently committed by the authors because in the genus *Lytocestus* male & female uterovaginal pores are separate with no post ovarian vitellaria. *L. rekhaensis* possess single genital opening & possess post ovarian median vitelline follicles vide camera lucida drawing of posterior end fig. 1. p.241. *Life Science Bulletin* 9(2): 2012. This placement under the genus *Lytocestus* has been discussed with a suggestion to keep *L. rekhaensis* a species under enquiry till certain informations are gathered.

Keywords : *Lytocestus rekhaensis*, status.

INTRODUCTION

Caryophyllideans (Caryophyllidea : Cestoidea) are monozoic tapeworms showing unique morphology, evolutionary status. high degree of endemism (only *Archigetes sieboldi* and *Glaridacris catostomi* are represented in more than one geographical region. Predominance of Caryophyllaeidae in nearctic, Caryophyllaeidae and *Lytocestidae* in Ethiopian, *Lytocestidae* & *Capingentidae* in Oriental region & *Lytocestidae* in Australian region have been noticed. They show extreme poor degree of structural anomalies yet they seem to be one of the most successful group of cestodes with high degree of genetic variability. The worm lack germinative region in neck (Wisniewski. 1930)³ so characteristic of polyzoic cestodes.

The worms are true cestodes having a single set of reproductive organs within a nonsegmented body and utilize aquatic oligocheates (annelid) as intermediate host for completion of Life cycle & therefore are in contrast with strobilate cestodes which utilize arthropod hosts under

*Corresponding author :

Phone: 9934157570

E-mail : sahayumapati@gmail.com

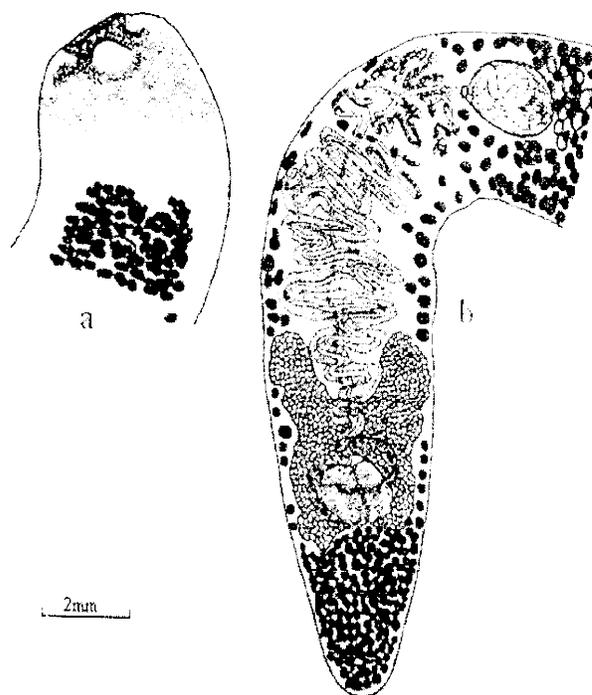


Fig. I. *Lytocestus rekhaensis* (a) Scolex (b) Posterior end (After Nimbalkar et al 2012)

order Caryophyllidea von Beneden (in Carus, 1863), following families have been included:-

1. *Caryophyllaeidae* Leuckart (in Luhe, 1910)⁵
2. *Lytocestidae* Wardle & McLeod (1952)²
3. *Capingentidae* Wardle & McLeod (1952)²

One of these, the family *Lytocestidae* * includes following genera:

1. *Lytocestus* Cohn (1908)⁶ (2) *Balanotaenia*** Johnston (1924)⁷ (3) *Monobothrioides* Fuhrmann & Baer (1925)⁸ (4) *Djombangia* Bovien (1926)⁹ (5) *Lytocestoides**** Baylis (1928)¹⁰ (6) *Bovienia* Fuhrmann (1931)¹¹ (7) *Khawia* Hsu (1935)¹² (8) *Stocksia* Woodland (1937)¹³ (9) *Bothrioscolex***** Szidat (1937)¹⁴ (10) *Notolytocestus* Johnston & Muirhead (1950)¹⁵ (11) *Atractolytocestus* Anthony (1956)¹⁶ (12) *Crecentovitus* Murhar (1963)¹⁷ (13) *Lucknowia****** Gupta (1961)¹⁸ (14) *Neolytocestus* Sahay (1979)¹⁹ (15) *Moravekia* Sahay et al. (1998)²⁰ (16) *Caryoaustralus* Mackiewicz & Blair (1980)²¹ (17) *Thollophyllaeus* Mackiewicz and Blair (1980)²¹ (18) *Introvertus****** Satpute and Agarwal (1980)²².

Out of the above serial number 2,4,5,7,8,9,10,11,12,16,17 are monogonoporate genera whereas rest show male genital pore and uterovaginal pore separate.

Nimbalkar *et al* (2012)¹ described *Lytocestus rekhaensis* a new species which they recovered from *Heteropneustes fossilis* of Jaikwadi Dam Aurangabad district Maharashtra showing following features: (all measurements in mms). "Body long, elongated tapering at both ends L-3. I x width 2.6~ head L2.6 x 1.4 wide, testes large oval' to round 3 10-330 in number preovarian in medulla, follicle 0.12 x 0.170, cirrus pouch large elongated pre-ovarian transversely placed 0.650 x 0.315, cirrus straight 0.640 x 0.03, vas deferens thin short 0.100

x 0.055. **vagina and cirrus pouch open in a common pore** which is oval 0.090x0.05, vagina 2.410x0.04. receptaculum seminis 0.92x0.06. ootype 0.087 (dia), ovary 'V' shaped bilobed 2.32x0.335. **uterus saccular** 2.61 x0.68. eggs non-operculate oval 0.070 (dia), vitelline follicles arranged in two rows".

I. The placement of *L.rekhaensis*" Nimbalkar *et al* (2012)¹ in the genus *Lytocestus* Cohn (1908)⁶ seems to be a mistake due to following reasons (1) In the genus *Lytocestus* the male and utero-vaginal pore open separately whereas in *L.rekhaensis* "**vagina and cirrus pouch open in a common pore known as genital pore**" claim the authors. If authors observation that *L.rekhaensis* is a monogonoporate worm under *Lytocestidae* Wardle and McLeod (1952)² is taken into consideration the placement of the said worm should have been discussed with monogonoporate genera of *Lytocestidae* viz. *Balanotaenia* Johnston (1924)⁷; *Djombangia* Brovien (1926)⁹; *Lytocestoides* Baylis (1928)¹⁰; *Khawia* Hsu (1935)¹²; *Stocksia* Woodland (1937)¹³; *Bothrioscolex* Szidat (1937)¹⁴; *Notolytocestus* Johnston and Muirhead (1950)¹⁵; *Atractolytocestus* Anthony (1958)¹⁶; *Crecentovitus* Murhar (1963)¹⁷; *Caryoaustralus* Mackiewicz and Blair (1980)²¹; and *Thollophyllaeus* Mackiewicz & Blair (1980)²¹. The statement of authors .. as stated above is against the set principle as laid on page -431 of Caryophyllidea : Cestoidea - a review by Mackiewicz (1972)²⁵ only three situations have been shown as in fig. 2 of the paper.

"If Nimbalkar *et al* (2012)¹ have placed *L.rekhaensis* in the genus *Lytocestus*, they indirectly admit that in the said cestode male genopore and utero-vaginal pore are separate (Report of a common pore is possibly a mistake),

*Hufeezullah (1993)²³ mentions only four Indian genera in *Lytocestidae* viz: *Lytocestus* Cohn (1908)⁶, *Djombangia* Boxvien (1926)⁹, *Lytocestoides* Baylis (1928)¹⁰, and *Bovienia* Fuhrmann (1931)¹¹ vide key on page 48. *Rec Zool Sur. India*. 1993.

** Now raised to family rank as *Balanotaenidae* by Mackiewicz & Blair (1978)²⁴.

*** *Lytocestoides tangenyika* Baylis (1928)¹⁰ kept under "Incertae sedis" by Mackiewicz (1972)¹⁵.

**** *Bothrioscolex prussicus* Szidat (1937)¹⁴ has been kept by Mackiewicz (1972)²⁵ under "Incertae sedis".

***** *lucknowia fossilisi* Gupta (1961)¹⁸ was considered by Hafeczullah (1993)²³ to be a synonym of *Lytocestus*. Mackiewicz (1981 b)²⁶ had doubts regarding pre & post ovarian vitellaria, absence of operculum & polar filament in the egg of *lucknowia fossilisi*. Agarwal (1985)²⁷ opined that cortical post ovarian vitellaria in *L.fossilisi* is the characteristic of *Lytocestus lucknowia* & held it valid.

else the authors would have compared this specimen with monogonoporate genera or *Lytocestidae*.

It is to be noted that in the genus *Lytocestidae* post ovarian vitellaria are absent. One should keep in mind how vitellaria are distributed. Normally, following situations are seen as regards vitellaria .

In *L.rekhaensis* Nibalkar et al. (2012)¹ vitellarial follicles are arranged in two rows whereas in the camera lucida drawing vitellaria are arranged in the cortical area upto posterior wing of ovary and median post ovarian vitellaria are present or preovarian cortical vitellaria are in continuation of post ovarian vitellaria. In the genus *Lytocestus* post-ovarian vitellaria are absent.

Median post ovarian vitellaria are also found in *Lytocestus fossilis* Singh (1975)²⁹ which was challenged by Tandon et al (2005)³⁰ and its status in the genus has been questioned.

Whether vitellaria commence earlier than testicular follicles in anterior region or not is not mentioned in *L.rekhaensis*.

In the family *Lytocestidae* the position of uterus with respect to cirrus pouch is an important criteria in both generic and specific level. One has to see if :-

I. Uterus reaches the anterior level of CS (position may vary with the state of maturity of the cestode). Kennedy (1965)³⁵ found in case of *Archigetes* (not a member of *Lytocestidae*) that ova can extend the uterus beyond its normal position hence Mackiewicz (1969)³⁶ suggested to observe immature and maturing individuals in the family *Lytocestidae* particularly in the genus *Lytocestus* where uterus hardly extend anterior to cirrus sac.

II. Uterus does not reach anterior to cirrus sac.

In *Lrekhaensis* uterus has been shown to be “saccular, diverticular filled with numerous eggs” whereas in camera Lucida drawing it is coiled/looped (uterine coils does not extend anterior to cirrus sac in figure), also in the literature of *L.rekhaensis* cirrus has been shown to be transversely placed but in camera Lucida drawing it is longitudinally placed.

The present authors thus have discussed the present status of *Lytocestus rekhaensis* Nimbalkar et al (2012)¹.

RESULTS & DISCUSSION

Presuming that *L.rekhaensis* Nimbalkar et al (2012)¹ is a monogonoporate cestode its placement has to be done after comparing with monogonoporate genera of *Lytocestidae*.

L.rekhaensis can not be placed under genera *Balanotaenia*, *Djombangia*, *Stocksia*, *Notolytocestus*, *Crecentovitus*, *Tholophyllaeus* because in these genera post-ovarian vitellarial follicle are absent. (In *Balanotaenia* cirrus sac extends ventral to ovarian commissure, gonopore opens posterior of ovarian commissure, ovarian lobes dumb-bell shaped with commissure generally arched anteriorly, internal seminal vesicle small, seminal receptacle distinct dorsal to commissure and generally anterior to gonopore. In *Djombangia* scolex is globular with terminal glandular sucker, neck distinct, uterus partly glandular, coils in median fields of medulla and extend far anterior of CS, vitellaria in cortical parenchyma of testicular & ovarian zone, testes medullary in lateral medulla from behind neck to ovary; in *Stocksia* Woodland (1937)¹³ scolex is flat, pointed with dense apical cushion and a long narrow groove on each flat surface, uterus mostly preovarian with prominent accompanying cells coating the walls, vitellaria extend in lateral fields between two layers of muscle sheath largely in testicular zone, forming a crescent in transverse section, some follicles may intrude into the medulla lateral to testes or into cortex through outer layer of muscle sheath. In *Notolytocestus* Johnston and Muirhead (1950)¹⁵ scolex is undifferentiated and narrower than rest of the body tholate (dome like) aloculate, neck absent, inner longitudinal muscles in a ring around testes, uterine coils medullary medial to testes partly glandular extends far anterior to CS, vitellaria in cortical field of testicular zone fewer in median fields, in *Crecentovitus* Murhar (1963)¹⁷. Scolex is filiform, ovary shaped like inverted . A posterior arm not joined. Schmidt, (1970)³⁴ however described it to be U shaped, follicular in *Tholophyllaeus* Mackiewicz & Blair (1980)²¹ Scolex is tholate aloculate both external seminal vesicle and seminal receptacle are absent, uterus primarily post ovarian, gonopore between arms of ovary, preovarian vitellaria in lateral and medullary position).

L.rekhaensis Nimbalkar et al. (2012)¹ cannot be accommodated under *Lytocestoides* and *Caryoaustralus*

Mackiewicz & Blair (1980)²¹ as in these genera though mediaon post ovarian vitellaria are present but these are continuous with pre ovarian cortical vitellaria [in *L.rekhaensis* post ovarian vitellaria are medullary]. In *Lytocestoides* Baylis (1928)¹⁰ - scolex is short, conical with longitudinal grooves devoid or locular depressions, **uterus coiled posterior as well as anterior to ovary not extending to cirrus pouch**. In *Caryoaustralus* scolex is choanocampanulate, gonopore is in anterior half, uterus not extending anterior to cirrus sac primarily post ovarian, cirrus in anterior half, annular vitellaria, post ovarian vitellaria present, external seminal vesicle absent but seminal receptacle present. In *Atractolytocestus* Anthony (1958)¹⁶ scolex is more or less triangular bulbate (swollen knob or bulb like) testes are randomly distributed in *A.huronensis* 6-18 or 20.”

A comparison between *Khawia* Hsu (1935)¹² & monogonoporate *Lytocestus rekhaensis* is needed as both are having post ovarian vitellaria. Keys provided by Gupta (1961)¹⁸; Hafeezullah (1993)²³. Jadhav *et al.*(2007)³⁷ and Singh and Sahay (2007)³⁸ drags the present author to place the cestode in question under the genus *Khawia*.

According to Mackiewicz (1972)²⁵ the genus *Khawia* Hsu (1935)¹² includes following species.

(1) *K. sinensis* Hsu (1935)¹².

(2) *K. japonicus* (Yamaguti, 1934)³³. Hsu (1935)¹² [*Bothrioscolex japonicus* (Yamaguti, 1934)³³ according to Szidat (1937)¹⁴]

(3) *K. iowensis* Calentine & Ulmer (1961)³⁹

(4) *K. parvus** (Zmeer,1936)⁴⁰ Kulakovakaya, (1961)⁴¹.

Other species reported by Yamaguti (1959)⁴² are

(5) *K. baltica* Szidat (1941)⁴³

(6) *K. dubia* Szidat (1937)¹⁴ syn. *Bothriscolex*

(7) *K. prussica* Szidat (1937)¹⁴ and

(8) *K. rosittensis* Szidat (1937)¹⁴

In *Khawia*, however, the scolex is provided with fimbriae, ootype is surrounded by smaller serous (23) and larger mucous gland (240) in *K iowensis* Calentine & Ulmar (1961)⁴⁴.

Both types communicate via individual ducts into the lumen of ootype (these glands are associated with egg shell formation, biochemical composition of the secretions of these glands are not yet known, Mackiewicz (1972)²⁵

mentions the presence of ‘X’ cells adjacent to oocapt, distal vitelloduct and proximal portion of uterine duct of *Khawia iowensis*, ova of *Khawia iowensis* has spines, testicular follicles are 328-490, but these are histological details, may not be true in all the species of *Khawia*.

Mackiewicz (1972)²⁵ observes “*K.sinensis* has successfully been established in western USSR through the introduction of carp from China Kulakovskaya and krotas (1961)⁴⁴ but it is surprising that there are no other carefully documented cases of this sort.” Bauer and Gusav (1969)⁴⁵ opines that “possibly *Khawia* was introduced in North America in Carp from Western Germany, are common in palearctic and nearctic.

But report of occurrence of *Khawia* from Oriental region has not been documented thus considering *L.rekhaensis* to be a *Khawia* species becomes doubtful.

It is worth if *L. rekhaensis* is also compared with bigonoporate genera (where male aperture and uterovaginal aperture are separate) such as *Lytocestus* Cohn (1908)⁶, *Bovienia* Fuhrmann (1931)¹¹, *Monobothrioides* Fuhrmann & Baer (1925)⁸; *Lucknowia* Gupta (1961)¹⁸; *Neolytocestus* Sahay (1979)¹⁹, *Moravekia* Sahay *et al.* (1998)²⁰ and *Introvertus* Satpute and Agarwal (1980)²².

Presuming that *L. rekhaensis* Nimbalkar *et al* (2012)¹ is bigonoporate (Single pore is an observational mistake) comparison with bigonoporate genera is needed.

In *Lytocestus* Cohn (1908)⁶ scolex is undifferentiated, uterine coil are post-testicular with very thick coat of accompanying cells and ductus ejaculatorius is enclosed in compact parenchymatous bulb. In *L.rekhaensis* though the scolex is undifferentiated but the uterus has been shown to be saccular, diverticular filled with eggs, no mention of accompanying cells has been made. Hence its accommodation in the genus *Lytocestus* is not possible, also *L.rekhaensis* possess post ovarian vitellaria (not met in the genus *Lytocestus*). Placement of *L.fossilis* Singh (1975)²⁹ in the genus *Lytocestus* is also wrong as it possess post ovarian follicles as mentioned earlier.

In *monobothrioides* Fuhrmann & Baer (1925)⁸ receptaculum seminis vaginae is present.

scolex is provided with numerous longitudinal furrows & terminal introvert. uterine coils are medullary with glandular coat. *L.rekhaensis* cannot be placed under this genus due to scolex difference. Besides this, according

to Wardle and McLeod (1952)² two species of *monobothrioides* have been reported by Fuhrmann & Baer (1925)⁸ from African Siluroids.

These are *M. unningtoni* Fuhrmann and Baer (1925)⁸ from *Auhtenoglasia occidentalis* (Cuv & Val) in Mtondwe Bay. lake Tanganyika (Fuhrmann & Baer (1925)⁸ and *M. chalmersius* (Woodland. 1924)¹³ Hunter, 1930⁴⁷ from *Clarias anguillaris* (Linn) in the Nile river at Khartoam (Woodland. 1924)¹⁵

Mackiewicz and Burton (1967)⁴⁷ reported yet another species *M. woodlandi* from *Clarias mellandi* Boulenger (Cypriniformes : Clariidae) in Lake Chali, Zambia Africa. There is no report of *Monobothrioides* from Oriental region.

Hafeezullah (1993)²³ considered *Lucknowia fossilis* under the genus *Lytocestus* that too with post ovarian cortical vitelline follicles ? It must be noted that presence of post ovarian cortical vitellaria is the characteristic of *Lucknowia* opines Agarwal (1985)²⁷ although Mackiewicz (1981b)²⁶ doubted the existence of both post ovarian vitelline follicles and polar filaments in the egg of *Lucknowia fossilis* Gupta (1961)¹⁸. In *Lucknowia* Gupta (1961)¹⁸ head is stumpy bluntly rounded, ovarian follicles cortical, isthmus medullary, cortical vitellaria extends upto posterior end. genital pores are situated at the beginning of last 7th body & receptaculum seminis vaginae is absent. *L.rekhaensis* cannot be accommodated under the genus *Lucknowia* because of the presence of receptaculum vaginae, median post ovarian vitelline follicles, scolex different. & no filament in egg.

In *Neolytocestus* Sahay (1979)¹⁹ scolex is differentiated rounded anteriorly glandular, testicular follicles extend posteriorly to posterior margin of cirrus sac makes an arch over cirrus sac. ovary medullary (a transverse band), vitellarial follicles in two sets, 1st set terminate at post testicular level, 2nd set commence at anterior extension of uterine coil upto a little distance ahead of posterior extremity, eggs non operculate and there is no terminal introvert. *L.rekhaensis* cannot be accommodated in the genus *Neolytocestus* because of absence of two sets of vitellarial follicles, possession of median post ovarian vitellaria, testes does not make an arch over CS.

In *Bovienia* Fuhrmann (1931)¹¹ scolex is undifferentiated, uterus without thick coat of

accompanying cells. ductus ejaculatorius not enclosed in bulb, thick walled covered with spines or not. ovary H shaped cortical, receptaculum seminis vaginae present, post ovarian vitellaria absent but previtelline follicles extend from head end to near ovarian lobes. In *L.rekhaensis* post ovarian median vitelline follicles are present which is not found in *Bovienia* hence *L.rekhaensis* cannot be accommodated under *Bovienia* too.

In Moravekia Sahay *et al.* (1998)²⁰ scolex is flat triangular and pear shaped, testes in median field anterior to cirrus sac, male aperture is not confluent with uterogonial pore, ovary- a transverse band swollen in middle, vitellaria in lateral field between two layers of muscle sheath. are cortical represented by oval follicles obliquely or transversely placed (from behind the anterior margin of cirrus sac but cortical area ahead of cirrus pouch is provided with double or triple rows of follicles getting thin to a single row anteriorly, uterine coils posterior to cirrus sac extending almost to posterior end therefore, *L.rekhaensis* cannot be accommodated under this genus too.

In the genus *Introvertus* holdfast is differentiated with a pair of longitudinal grooves and a terminal introvert, genital pore separate, bilobed ovary (ovarian follicles cortical) and thus restrict *L.rekhaensis* to be placed in this genus too.

It would not be out of way to look to some other genera which does not belong to *Lytocestidae* yet possess post ovarian median vitelline follicles and other features resembling *L.rekhaensis*.

Under the family *Caryophyllaeidae* Leukart (1878)¹⁹ the genus *Paracaryophyllaeus*, Kulakox askaya (1961)¹¹ possess post-ovarian vitelline follicles like *L. rekhaensis* but uterine coil⁷ in *Paracaryophyllaeus* extend anterior to cirrus sac and genital pores are separate whereas uterine coils in *L.rekhaensis* never extends anterior to cirrus sac & genital pore is single hence *L.rekhaensis* cannot be accommodated in *Paracaryophyllaeus*. *

CONCLUSION

There is a gross mistake committed by Nimbalkar *et al.* (2012)¹ while describing *Lytocestus rekhaensis* placing the worm in the genus *Lytocestus* Cohn (1908). It appears that the said species be transferred to the genus *Khawia*

* *Paracaryophyllaeus leptocephali* was originally described as *Lytocestoides leptocephali* by Kundu (1985)⁴⁸ but Hafeezullah (1993)²³ transferred under *Paracaryophyllaeus* which present authors do not agree because in *Lytocestoides* uterine coils are posterior as well as anterior to ovary .

Hsu (1935)¹² but the zoogeographical distribution of *Khawia* depicts that *Khawia sinensis* has become successfully established in the western USSR through introduction of carp from China Kulakovskaya and Krotas (1961)⁴⁴. Mackiewicz (1972)²⁵ states “Only species common to nearctic and palearctic is *A.sieboldi* which also occurs in a tubificid. *Khawia. Caryophyllaeus. Monobothrium*, have also been recorded from both regions. He further asserted that according to Bauer and Gusev (1969)⁴⁵, *Caryophyllaeus, Monobothrium, Glaridacris & Biacetabulum & possibly Khawia* introduced in north America in Carps from West Germany are common to palaeartic & nearctic.

Placement of *Lytocestus rekhanensis* if transferred to *Khawia* poses another question as to how it has come to oriental region?

Thus authors place the said species *L.rekhaensis* under enquiry until informations regarding genital pores. disposition of vitellaria & muscles are made available.

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