THE EVOLUTIONARY CHANGES IN THE NEPHRIDIAL SYSTEM OF PHERETIMA KINBERG, 1867 (OLIGOCHAETA, MEGASCOLECIDAE)

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Bahl, when doing the first research on the nephridial system of *Pheretima posthuma*, *Ph. hawayana*, and *Ph. Corticus* in 1919 had discovered three kinds of meronephridia: *closed tufted meronephridia* flowing into oesophagus; *open septal meronephridia* flowing into intestine and *closed integumentary meronephridia* running outside through body-wall (Bahl, 1947). These kinds of meronephridia are also mentioned in *Ph. Hupeiensis* (Grant, 1955 quoted from Easton, 1979). In 1979, when amending the taxonomy of Acoecata group (Pheretima without caeca), Easton added data about nephridial system of *Ph. sentanensis*, *Ph. neoguinensis*, *Ph. taprobanae*, *Ph. elongata*, *Ph. Stelleri* and another species in Pheretima group, *Pleinogaster horsti*. Easton added in Bahl's nephredial system diagram some variation of each kind of meronephridia in Acoecata group:

- Pharyngeal meronephridia may have either 3 pairs or over 3 pairs: 5 pairs in *Ph. Neoguinensis* (from segment IV to VIII); 6 pairs in *Ph. Sentanensis* and *Pleionogaster horsti* (from segment IV to IX). Three pairs of anterior pharyngeal meronephridia flow into pharynx; posterior pairs run outside through body wall.

- The first segment containing integumentary meronephridia can change depending on each species, from segment II to X. To some species *(Ph. sentanensis, Ph. taprobanae)* integumentary meronephridia of some last segments flow into a pair of semiannual lateral sinuses.

- The location of septal meronephridia is both on anterior and posterior septal faces *(Ph. sentanensis, Ph. neoguinensis)* or only on anterior faces for starting septum changes according to species. In *Ph. Elongata* and *Ph. Stelleri* this kind of meronephridia runs outside through body wall.

Thus, basing on the common diagram of the nephridial system of Pheretima Bahl had proposed the specific expression about its diversified forms and quantity demand to calculate many species of this genus and species from different ecosystems in order to imagine the general evolution of this complex organ system.

In this article, the features of nephridium observed are:

- *Septal meronephridia:* the attached location of meronephridia; the location of meronephridia funnels (on anterior or posterior septal faces); the first septum to carry; the number of septal meronephridia attached on anterior and posterior septal faces; the change in the number of septal nephridia along body, the number of supraintestinal excretory ducts and measurement of meronephredial funnels.

- *Integumentary meronephridia:* the first septum to contain and the change of their number in the successive segments.

- *Pharyngeal meronephridia:* the number of pairs of pharyngeal meronephridia; location of first pair and ways of fluid flowing into pharynx.

All the observations are carried out under the binocular magnifier with the enlargement from 8 to 56 times. The measurement of meronephridial funnels is the average of 10 × 3 times, measured on 3 individuals in each species under the microscope based on ocular and objective micrometers in order to count up the real measurement. Supraintestinal excretory ducts and pouring location of meronephridia are determined on the serial transversal and longitudinal slices through the middle section (segments XXX - XXXII), the head section and tail section of 3 individuals in each species. The slice's thickness is 20μm, colored by hematoxylin - eosin.

The observations are carried out on 71 species. Among them, there are 9 species in Acoecata group. 62 species in Coecata (Pheretima with caecum), consist of 46 species with simple caecum (including 4 species in Planapheretima), 8 species with lobed caecum and 8 species with manicate or plumate caecum. The species observed and the number of specimen observed in each species are shown in table 1. The quantitative data are processed by statistics and introduced by M ± m (average ± change of average).

THE RESULT OF RESEARCH

I. The change of kinds of meronephridia in Pheretima

Table 1 shows the change of kinds of meronephridia in Pheretima. The degree of changes varies according to each kind of meronephridia.

- *Septal meronephridia:* About attached location, septal meronephridia can attach either on the body wall or on septum at different height from the foot of septa to a position near intestine. Meronephridia can attach on both anterior and posterior septal faces with larger number on posterior or on anterior septal faces. As to *Ph. Dacnomonntis*, meronephridia only have on posterior septal faces. Septal meronephridial funnels are both on anterior and posterior or only on anterior septal faces. The diameter of nephridial funnels is rather stable in each species, but variable among species. Meronephridia begins to have from different septum depending on species, largely from septum 15/16 but it can begin earlier (from septum 14/15) or later, even very late (in *Ph. Grandisetosa* and *Ph. Colonensis* beginning from septum 70/71).

There can be two or one supraintestinal excretory ducts (figure 1. A, B). We don't find septal meronephridia running outside through body wall as Easton's statement about 2 Acoecata species (Easton, 1979).

Considering the change in the number of septal meronephridial along body, the number of septal meronephridia rises to the maximum in certain septa (depending on species, about from septa 30/31 to 70/71) and then falls to the end of body (figure 2). However, in some cases, it reduces from the head to the end of body *(Ph. morrisi, Ph. plantoporophorata, Ph. samphoni, Ph. thaibinhensis, Ph. Uncipenifera* from Coecata and *Ph. tani, Ph. Taprobanae* from Acoecata).

Table1: Features of the nephridial systems of some species in Pheretima Kinberg, 1867

(C: specimen have clitellum; A: specimen haven't clitellum; S: on septa; b.w: on body-wall; or faces, a.p.f: on both anterior and posterior faces; <: number of septal nephridia on anterior fever on posterior septal ≥: number of septal nephridia on anterior more or equal on posterior septal faces; r. rising; f.: falling; S4: on anterior septa 4/5; Ph5: on phryngeal in 5th segment; res.: respectively; up.d: upside- down.)

	Number of specimen observed	Septal meronephridia							Integumentary meronephridia		Phary meronep	
		Septal nephridia's location	Funnel nephridia's location	The first septa having septal nephridia	Comparative number of septal nephridia on anterior and posterior septal faces	Longitudinal changes in the successive septa	Diameter of funnels (M ± m) µm	Number of supra - intestinal excretory ducts	The first segment have	Tendency of numbers' change in successive segments after XXX	Number of pair	The septa phary neph
2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(1
cata												
lumate caecum												
, 1888)	3C	S	a.f	15/16	?	r. - f.	?	?	III	f.	3	S
1984	3C	S	a.f	15/16	<	f. - r. - f.	49 ± 1	1	III	f.	3	S
t Huynh, 1993	2C	S	a.f	15/16	<	r. - f.	?	?	III	f.	3	S
, 1936	3C	S	a.f	14/15	<	r. - f.	38 ± 1	1	V	r.	5	S
ensis Do et Tran, 1994	3C	S	a.f	14/15	≥	r. - f.	41 ± 2	1	III	f.	3	S
et Tran, 1986	3C	S	a.f	14/15	≥	r. - f.	49 ± 1	1	III	f.	3	S
1982	3C	S	a.f	15/16	≥	r. - f.	67 ± 2	2	III	f.	3	S
t Samphon, 1988	3C	b.w	a.p.f	15/16	<	r. - f.	31 ± 1	?	II	f.	3	S
caecum												
Thai, 1982	2C	S	a.f	14/15	≥	r. - f.	43 ± 1	?	III	f.	4	S
erg, 1867	2C	S	a.f	14/15	≥	f.	66 ± 2	1	III	f.	3	S
, 1892	30C	S	a.f	14/15	<	r. - f.	38 ± 1	1	III	r.	3	S
ensis Thai et Tran,	3C	S	a.f	15/16	≥	r. - f.	64 ± 1	1	III	r.	3	S
, 1891)	3C	S	a.f	14/15	≥	r. - f.	61 ± 1	1	III	f.	3	S
s Thai, 1984	1C	S	a.f	17/18	?	r. - f.	35 ± 1	?	III	f.	3	S
1872	3C	S	a.p.f	15/16	≥	r. - f.	86 ± 3	1	III	f.	3	S
rrier, 1872)	3C	S	a.p.f	15/16	≥	r. - f.	98 ± 1	1	III	f.	3	S

(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(1
e caecum												
35	3C	S	a.f	15/16	<	r. - f.	53 ± 1	1	X	f.	3	S
ata Thai, 1984	3C	S	a.p.f	18/19	≥		37 ± 1	1	IV	f.	4	S
ana Thai, 1984	3C	S	a.p.f	16/17	<	r. - f.	52 ± 2	1	V	f.	3	S
Thai et Nguyen, 1993	3C	S	a.f	16/17	≥	r. - f.	43 ± 1	?	IV	f.	4	S
hai, 1984	3C	S	a.f	16/17	≥	r. - f.	64 ± 1	1	III	f.	3	S
osa Rosa, 1896	3C	S	a.f	16/17	<	r. - f.	66 ± 1	1	III	f.	3	S
, 1946	3C	S	a.f	15/16	<	r. - f.	80 ± 3	1	III	f.	3	S
1872)	3C	S	a.f	15/16	<	r. - f.	25 ± 1	1	III	f.	3	S
984	3C	S	a.f	16/17	<	r. - f.	50 ± 1	?	V	f.	3	S
4	3C	S	a.f	20/21	<	r. - f.	42 ± 1	1	III	r.	3	S
ube, 1879	3C	S	a.f	15/16	<	r. - f.	32 ± 1	?	III	r.	3	S
, 1889	3C	S	a.f	15/16	≥	r. - f.	35 ± 1	1	V	f.	3	S
et Huynh, 1992	3C	S	a.f	15/16	≥	r. - f.	72 ± 1	1	III	r.	3	S
ai et Huynh, 1992	3C	S	a.f	14/15	only on posterior	r. - f.	42 ± 1	1	III	f.	3	S
et Tran, 1994	3C	S	a.f	15/16	≥	r. - f.	60 ± 1	1	III	f.	3	S
hai, 1994	3C	S	a.f	26/27	<	r. - f.	43 ± 1	?	III	f.	3	S
osa, 1890)	3C	S	a.f	15/16	≥	r. - f.	39 ± 1	1	III	f.	3	S
, 1984	3C	S	a.f	26/27	<	r. - f.	37 ± 1	?	III	f.	3	S
5	3C	S	a.f	14/15	≥	r. - f.	38 ± 1	1	III	f.	3	S
1890)	2C	S	a.f	15/16	≥	r. - f.	49 ± 1	1	III	f.	3	S
et Samphon, 1989	3C	S	a.f	14/15	<	r. - f.	67 ± 1	?	III	f.	3	S
Thai, 1984	1C+1A	S	a.f	15/16	<	r. - f.	38 ± 1	1	III	f.	3	S
nson, 1931	3C	S	a.f	15/16	<	r. - f.	40 ± 2	1	III	f.	3	S
38	3C	S	a.f	15/16	≥	r. - f.	42 ± 1	1	III	f.	3	S
heca Chen, 1938	3C	S	a.f	14/15	≥	r. - f.	33 ± 1	2	III	f.	3	S
ata Thai et Tran, 1986	3C	S	a.p.f	15/16	<	r. - f.	49 ± 1	2	III	r.	4	S
et Samphon, 1988	3C	S	a.p.f	15/16	≥	r. - f.	25 ± 1	2	IV	f.	3	S
et Samphon, 1988	2C	S	a.p.f	14/15	<	r. - f.	57 ± 1	1	III	f.	3	S
1994	1C	S	a.f	15/16	?	r. - f.	32 ± 1	2	III	f.	3	S
, 1867)	3C	S	a.p.f	15/16	≥	r. - f.	36 ± 1	2	III	f.	3	S
hai, 1984	1C	S	a.p.f	15/16	≥	r. - f.	31 ± 1	?	III	f.	3	S
et Samphon, 1988	3C	b.w	a.p.f	16/17	≥	r. - f.	45 ± 1	1	II	f.	3	S

2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14
i et Samphon, 1989	1C	b.w	a.p.f	17/18	?	r. - f.	41 ± 1	?	III	f.	2	S5
4	3C	b.w	a.p.f	15/16	≥	r. - f.	48 ± 1	1	III	f.	3	S4
et Samphon, 1988	3C	b.w	a.p.f	15/16	<	r. - f.	50 ± 1	2	III	f.	3	S4
pecies group												
Samphon, 1988	3C	S	a.f	15/16	≥	f.	35 ± 1	1	II	r.	3	S4
i et Samphon, 1988	3C	b.w	a.p.f	15/16	≥	f.	44 ± 3	1	II	r.	3	S4
ai, 1984	3C	S	a.p.f	15/16	≥	f.	38 ± 1	1	II	f.	3	S4
n, 1895	3C	S	a.p.f	15/16	≥	r. - f.	34 ± 2	1	II	f.	3	S4
nt, 1869)	42C+8A	S	a.f	14/15	≥	r. - f.	37 ± 1	2	III	r.	3	S4
nh, 1998	3C	b.w	a.p.f	15/16	≥	r. - f.	42 ± 1	1	II	f.	3	S4
875	3C	b.w	a.p.f	15/16	≥	r. - f.	59 ± 2	1	II	r.	3	S4
neretima												
a Thai, 1982	3C	S	a.f	14/15	<	r. - f.	44 ± 1	2	III	f.	3	S5
7	3C	S	a.f	14/15	<	r. - f.	50 ± 1	2	III	f.	3	S5
1946	3C	S	a.f	14/15	≥	r. - f.	54 ± 1	2	III	f.	4	S4
1946	1C	b.w	a.p.f	14/15	≥	r. - f.	48 ± 1	?	III	f.	5	S5
ecata												
1996	2C	S	a.f	14/15	<	r. - f.	47 ± 1	?	IV	f.	4	S5
	1C+1A	S	a.f	15/16	<	f.	43 ± 3	?	IV	f.	4	S5
am, 1996	2C	S	a.p.f	14/15	≥	r. - f.	72 ± 2	?	III	r.	4	S5
i, 1996	2A	S	a.f	70/71	<	r. - f.	?	1	VIII	f.	3	S5
1996	3C	S	a.f	70/71	<	r. - f.	?	1	VIII	f.	3	S5
Thai et Nguyen,	1C	S	a.f	15/16	≥	r. - f.	52 ± 2	?	VII	f.	3	S5
ddard, 1892)	5C	S	a.f	15/16	<	f.	55 ± 1	2	VII	f.	3	S5
, 1996	2C	S	a.f	15/16	<	r. - f.	42 ± 1	?	IV	r.	3	S5
, 1872)	18C+12A	b.w	a.p.f	15/16	≥	r. - f.	43± 1	1	III	r.	2	Ph

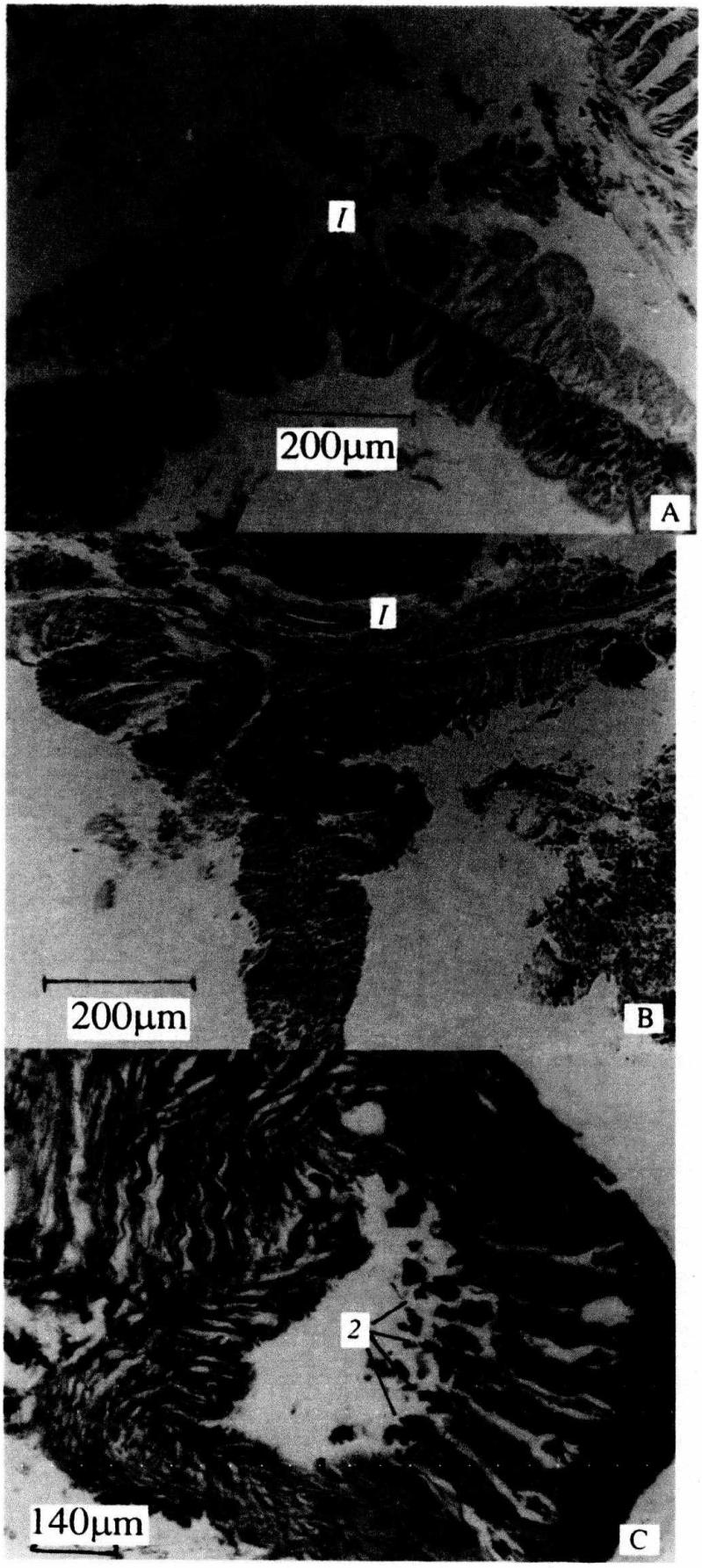


Fig.1 - Supraintestinal excretory ducts (1) and intergumentary meronephridia (2) of Pheretima. A - *Pheretima prava mungxenensis;* B- *Ph.tenebrica;* C- *Ph. bravicapitata.* (A,B- transversal slices through 30th segment; C- sagital slice through the caudal segments).

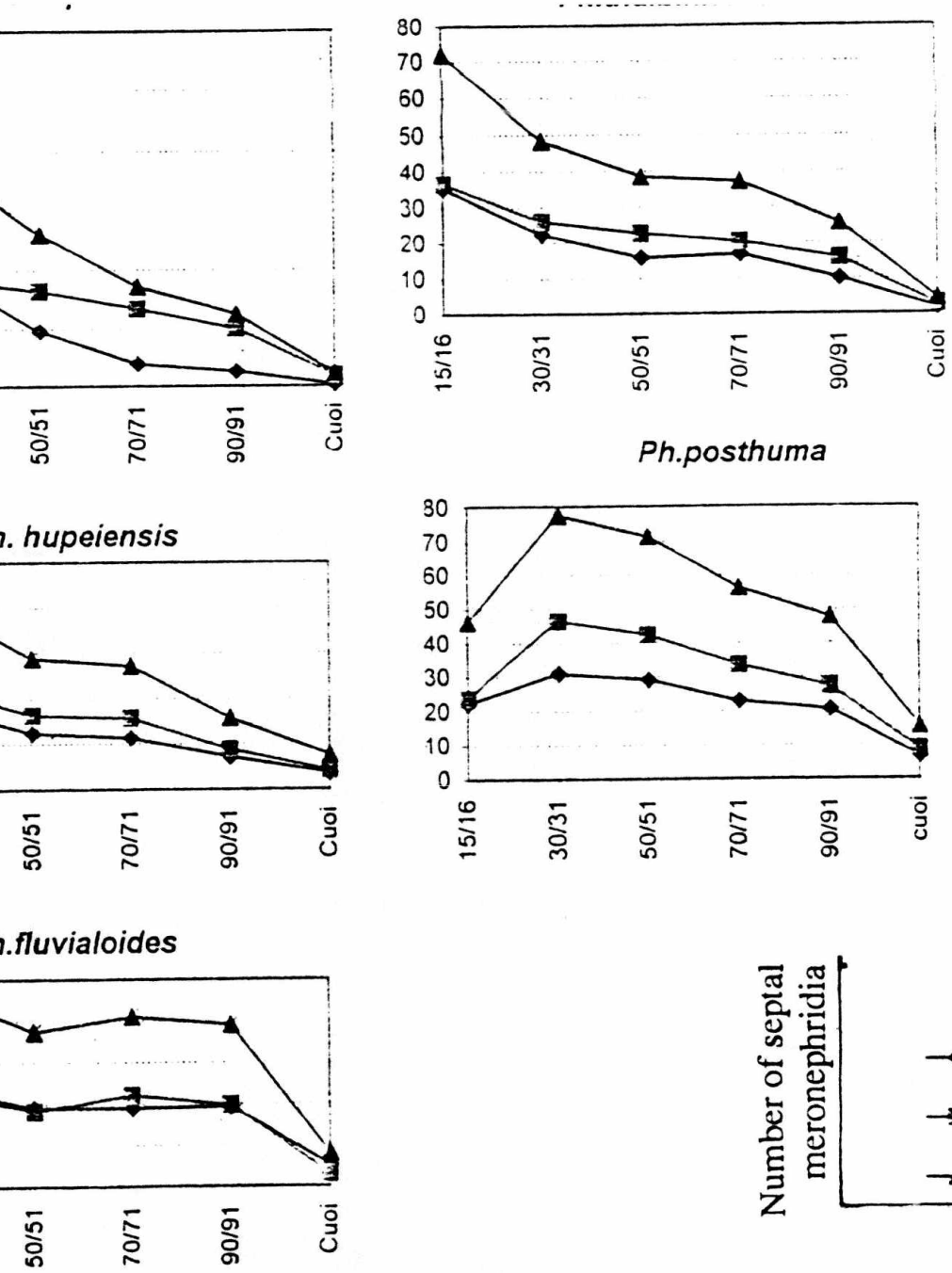


Fig.2 – The change in the number of septal meronephridia along body in Posthuma species-group of Pheretima

Regarding to the biological significance of longitudinal changes in the number of septal meronephridia, some guesses when comparing nephridial system among species of Posthuma-group (sensu Thai Tran Bai, Samphon: 1989, 1991) are that species-group appearing in Mekong river basin are both close in evolution and clearly divided in living environment. Among 8 species known in this group, 3 species live in river banks near the water - edge (*Ph. samphoni, Ph. Uncipenifera* and *Ph. Thaibinhensis*), 2 species live in river or spring banks and in the garden or in path at edge of ricefield on river side (*Ph. juliani, Ph Fluvialoides*), 2 species outside of river bank, which largely distribute also in biotopes anthropogenic (dry ricefield, garden, short-term planting soil ...) of alluvial soil (*Ph. posthuma, Ph. Hupeiensis*) and *Ph. Fluvialis* discovered in spring bank in Chiengsen Kao, Thailand in 1972 by Gates also empty into Mekong river. Considering the nephridial system of these species (table 1), species living near the water-edge have the maximum number of septal meronephridia from the first segment, and then gradually reduce to the end of the body, while the 4 remaining species that expand their living environment to the other biotopes on the river bank have the number of septal meronephridia increase gradually to the maximum at any septum and then reduce little by little to the end of the body. It is possible that groups whose living environment is wet alluvial soil on the river-side haven't got the clear division between the front and back of body in excreting function of septal meronephridia, but groups expanding their living environment to the land originated from the river alluvial have early separated by the division of excreting function between front and back part of body. The peak of these groups extending living environment is *Ph. Posthuma* and *Ph. Hupeiensis*, whose meronephridia had deplaned up to septa (see more Thai Tran Bai, Tran Thi Thanh Binh, 1998).

- *Integumentary meronephridia*: Most integumentary meronephridia begin from the 3rd segment, however, it can begin earlier (from segment II) or later (from one of the segments IV to X). The number of integumentary meronephridia increases to the maximum in the ditellum segments, and then decreases sharply in segments behind clitellum (XVII) and then continues suddenly falling (or sometimes rising in a few species) to the end of the body. All integumentary meronephridia of observed species pour outside through body wall (figure 1.C). We don't see the pairs of lateral semicircular sinuses at the end of body as Easton, 1972 saw in *Ph. Taprobanae.*

- *Pharyngeal meronephridia*: often has 3 pairs, the first pair attaches on anterior faces of septum 4/5, but in a few species, it only has 2 pairs *(Ph. thevedaensis, Ph. elongata)* or 4 -5 pairs. The anterior ducts of 3 pairs of pharyngeal meronephridia discharge respectively in Acoecata or by upside-down way in Coecata. For Planapheretima, pharyngeal meronephrydia also flow respectively into pharynx as in Acoecata.

Thus, in Pheretima, the location and number of each kind of meronephridia can change many sides on each segment as well as along the body.

II. Features plesiomorph and apomorph in evolution of meronephridia of Pheretima

In order to imagine the evolutionary changes of meronephridia in common evolution of Pheretima, it needs to determine the features plesiomorph and apomorph in the forms of meronephridiả. The method of carrying out is to compare the rich level of forms in the same category among groups proved more ancient or more evolutionary in Pheretima. In Pheretima, Acoecata is considered more ancient than Coecata and inside Coecata, caecum evoluded in the direction of gradual complexity, creating more ancient simple caecum group than lobed caecum; pectinate and plumate caecum are the most evolutionary (Sims and Easton, 1972 [13]; Thai Tran Bai, 1982 [3]). The set of seminal receptacles has been proved evolutionary in the direction of oligomerization of the number of spermathecal segments and development of the mecanism of sperm transfer. Thus, according to spermathecal segments, 4 spermathecal segments groups are the most ancient, then reducing the number of spermathecal segments to 3, 2 and 1. Considering the rich level of species which features of meronephridia in the same category are different in features of caecum and spermathecal segments is the basis to determine the features plesiomorph and apomorph in nephridial system of this group. However, the number of analyzed species in each group doesn't account for the same representing rate, in case of doubt, we analyzed more detail or had personal discussion in order determine property plesiomorph and apomorph in the features pairs.

- *Pharyngeal meronephridia*: analyzed according to caecum groups (table 2), we can see clearly that Acoecata, more ancient group, have the respective way of ducts flow into pharynx that is different from the upside down way of Coecata and have the number of pairs and beginning location of pharyngeal meronephridia disperse more than those of Coecata. In this feature, Planapheretima (understanding as the meaning of quotation in table 1) is similar to Acoecata.

More dispersing property is also shown in the beginning segment of integu-mentary meronephridia (table 2), they scatter in many segments in Acoecata and begin to concentrate from segment III in Coecata and especially in Planapheretima. In this feature, Planaperetima is similar to Coecata rather than Acoecata. Analyzing more the features of integumentary meronephridia in the Pheretima groups that are different in the number of spermathecal segments (table 3), we can see clearly the rate of species whose integumentary meronephridia begin from segment II and III is highest in groups with 4 spermathecal segments (ancient groups) and then lower in groups with 3, 2 and 1 spermathecal segments along with the increase of the rate of species whose integumentary meronephridia begin from the behind segments.

- *Septal meronephridia of Pheretima* (table 2, 3), species with 2 supraintestinal excretory ducts account for higher number in the more ancient groups (Acoecata and groups with many spermathecal segments) and this rate reduces in more evolutionary groups (Coecata and groups with a few spermathecal segments) with a supra intestinal excretory duct. About the attaching location of septal nephridia and anterior or posterior septal location of nephridial funnels, data drawn out from groups distinguished by spermathecal segments (table 3) shows that the attaching location of meronephridia on body wall

and location of nephridial funnels on anterior and posterior septal faces make up more than in ancient groups (4-3 -spermathecal segments) and less than in more evolutionary groups (1-2 spermathecal segments). However, when comparing this rate in Acoecata and Coecata, it shows upside down tendency even through the uneven degree of rate is not great (table 2). However, considering the rate of groups with different types of caecum in Coecata (table 2), the conclusion still coincides with remarks drawn out from groups different in spermathecal segments.

Table 2 : The rich level (realized by the rate of species have similar features among the total number of observed ones) of forms of meronephridia in groups different in the development of the caecum

Group of Pheretima / Characters Of diverse meronephridia	Acoecata	Coecata				Plana-pheretima*
		Simple caecum	Lobed caecum	Pectinate and plumate caeca	Total of coecata	
Number of observed species	9	42	8	8	58	4
Pharyngeal meronephridia						
- Number of pair (2/3/4/>4)	11/56/33/0 **	2/91/7/0	0/88/12/0	0/88/0/12[1]	2/90/6/2[1]	0/50/25/25[1]
- Location of first pair (s4/s5/s≠)***	67/22/11[2]	98/2/0	100/0/0	100/0/0	98/2/0	25/25/50[3]
- Way of fluid flowing into pharynx	respectively	upside-down	upside-down	upside-down	upside-down	respectively
Septal meronephridia						
- Septal nephridia's location (on body-wall/on septa)	11/89	17/83	0/100	12/88	14/86	25/75
- Funnel's location (a.p.f/a.f)***	22/78	38/62	25/75	12/88	33/67	25/75
- Number of supra-intestinal excretory ducts (2/1)	25/75	17/83	0/100	20/80	15/85	100/0
Integumentary meronephridia Location of their first segment (2/3/≠)	0/22/78[4]	17/66/17[5]	0/100/0	13/75/12[6]	14/72/14[7]	0/100/0

* : Planapheretima : by mean of division II sensu Easton, 1979 (haven't *Ph. arboricola*).

** : *Ph. neoguinensis* have 5 pairs of pharyngeal meronephridia, *Ph. sentanensis* and *Pleionogaster horsti* have 6 pairs of Pharyngeal meronephridia (by Easton, 1979).

*** : See the footnotes of table 1;

[1] : 5 pairs; [2] : on the pharynx in 5th segment; [3] : from 3rd septa; [4] : starting from segment 4,7 or 8 with proportion 3/2/2; [5] : starting from segment 4,5 or 10 with proportion 3/3/1; [6] : starting from segment 5; [7] : starting from segment 4,5 or 10 with proportion 3/4/1.

Table 3 : The rich level (realized by the rate of species have similar features mong the total number of observed ones) of forms of septal meronephridia and integumentary meronephridia in groups divided according to the number of spermathecal segments

Pheretima groups	number of spermathecal segments			
tures of meronephridia	4	3	2	1
umber of observed species	22	26	15	8
septal meronephridia				
ptal nephridia's location ı body-wall/on septa)	18/82	20/80	7/93	0/100
nnel's location (a.p.f/a.f)*	41/59	35/65	27/73	12/88
ımber of supra- intestinal :retory ducts (2/1)	31/69	31/69	0/100	?
gumentary meronephridia				
e starting segment (2/3/4/≠)	14/81/0/5[1]	12/73/12/4[1]	7/67/0/26[2]	0/38/37/25[3]

[1] : from 5th segment
[2] : from 5th, 8th ,10th segment by rate 1/2/1
[3] : from 7th segment.
* : see the footnotes of table1.

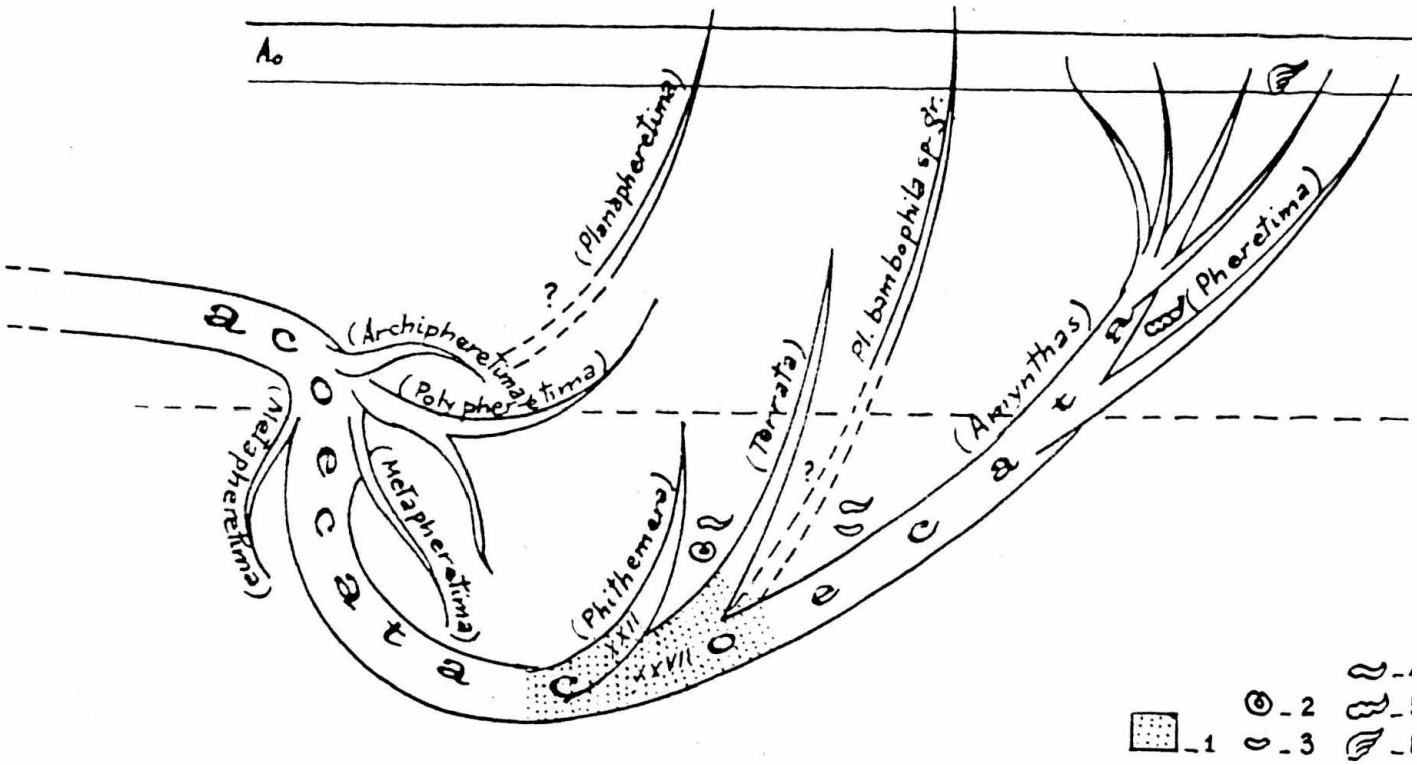
From above analysis, we can determine features plesiomorph and apomorph in nephridial :m of Pheretima as follows (table 4).

Table 4: Features pleisiomorph and apomorph in evolution of meronephridia of Pheretima

Features	Pleiomorph	Apomorph
ryngeal meronephridia		
ımber of pair	Dispersing : from 2 - 6 pairs	Concentrate : 3 pairs
cation of the 1st pair	Dispersing : from 3rd -5th septa	Concentrate : from 4th
y of fluid flowing into pharynx	respectively	upside-down
tal meronephridia		
ptal nephridia's location	on body-wall	on septa
nnel's location	anterior and posterior faces of septa	anterior faces of septa
ımber of supra- intestinal secretory ducts	2	1
gumentary meronephridia		
e starting segment	Dispersing : from 2nd -10th segment	Concentrate : from 3rd segment

III. Features of nephridial system in evolutionary process of Pheretima

In 1983, basing on evolutionary changes of organs belonging to the reproductive system : the testis sacs, the set of seminal receptacles (Thai Tran Bai, 1983); the locomotive system: setae, morphology of muscular tissue, thickened and reduced septa of the anterior body region (Thai Tran Bai, 1982,1983); the digestive system: caeca, typhlosole, gizzard (Thai Tran Bai, 1982), he had made out a evolutionary diagram (Thai Tran Bai, 1983) of Pheretima (see figure).



Evolutionary diagram of Pheretima Kinberg (by Thai Tran Bai, 1983)

1: The region where forming the caecum ; 2 : Testis sacs U-shaped; 3 : Testis sacs ventral; 4: Simple caecum ; 5 : Lobe caecum ; 6 : Plumate and pectinate caeca XXII : 22nd segment ; XXVII : 27th segment.

In this diagram, the ancestor of Pheretima is supposed a group of freshwater oligochaeta living in the beds of tropical shallow aquatic habitat with a dry season. In the process of evolution they changed from the life in mud to the life in soil; from taking as food humus mixed in mud to humus mixed in soil in order to form Acoecata group. This stage formed thickened septa in anterior body region, the appearance of muscular gizzard in segment VIII, along with the disappearance of some septa in this area, and the appearance of complex typhlosole of intestine. Next evolutionany step is to move to take food on the ground, firstly still live in soil (burrowing - cave group) then more to live in decaying cover (decaying cover group). In this evolutionany step, along with change of food source, typhlosole reduces and a new organ appears to secrete digestive enzyme of decaying cover in the early dissociating stage. That is caecum. This forming process is also seen clearly when comparing the appearance of caecum in intestine area from segment XX to XXX in Planapheretima. Due to changes in living environment and the move underground or on the ground and the arrangement of muscular cells and distribution

of of setae on the segment also change and reduce the number of spermathecal segments in order to complete the sperm - transferring process. In Coecata and Acoecata, many parallel groups change from life in the ground taking food from humus mixed in soil to pieces of plants in decaying stages on the surfaces. Take 2 groups of Planaperetima as an example, Planapheretima on the islands of South-east Asia was evoluted from Acoecata but Planapheretima in the continent of Asia from Coecata at the stage of forming simple caecum.

Data about meronephridial system consolidates this evolutionary diagram of Pheretima.

The difference between Coecata and Acoecata is also shown clearly in the features of nephridial system. 3 anterior pairs of pharyngeal meronephridia of Acoecata flow respectively and those of Coecata flow by upside down way into pharynx. Besides, features of all kinds of meronephridia show more dispersing in Acoecata and more concentrating in Coecata. Planapheretima in continent, group with simple caecum, on the way to be formed from intestine - wall, keeps many features of nephrydial system that are similar to Acoecata. From these two great groups, there are evolutionary groups parallel from life underground to life on the ground. In this transferring step, excreting organs have changed according to following directives:

- Pharyngeal meronephridia: from 2 - 6 pairs beginning from the septum 3/4, 4/5 or 5/6 to 3 pairs beginning from the septum 4/5.

- Septal meronephridia: from the location on body wall to the location on septa, from the foot of septa to a position near intestine, nephridial funnels from the place on both anterior and posterior faces of septa to that on anterior face, and from 2 supra - intestinal excretory ducts to only 1.

- Integumentary meronephridia begin from the 3rd segment instead of 2nd - 10th ones.

It is possible to use features of nephridial system to clarify the relative relationship of some species - groups of Pheretima such as Posthuma-group (Thai Tran Bai, Tran Thi Thanh Binh, 1998) and Planapheretima group in the continent of Asia (Tran Thi Thanh Binh, 1999).

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BIẾN ĐỔI TIẾN HÓA CỦA HỆ BÀI TIẾT CỦA *Pheretima* KINBERG, 1876 (OLIGOCHAETA, MEGASCOLECIDAE)

Thái Trần Bái, Trần Thị Thanh Bình

Khoa Sinh học, Trường Đại học Sư phạm Hà Nội

Bài báo giới thiệu đặc điểm hệ bài tiết của 71 loài giun đất (9 loài trong nhóm Acoecata và 62 loài trong nhóm Coecata) trong giống Pheretima. Các đặc điểm của hệ bài tiết đã được quan sát là:

Vi thận vách: vách bắt đầu có và vị trí bám của vi thận; biến đổi số lượng của vi thận dọc c thể; kích thước của phễu thận và vị trí của phễu thận ở trước hoặc sau vách đốt và số ống bài tiết trên ruột.

Vi thận thành: đốt bắt đầu có và biến đổi số lượng của vi thận thành dọc cơ thể.

Vi thận hầu: số lượng, vị trí và kiểu đổ vào hầu của vi thận hầu.

Phân tích so sánh hệ bài tiết của các loài trên nền tiến hóa của giống Phretima bài báo đã cho các kết luận:

- Giữa Acoecata và Coecata sai khác về hệ bài tiết thể hiện trên đặc điểm đổ thuận hay đổ ngược của ống dẫn vi thận hầu vào hầu và độ phân tán của các đặc điểm của các loại vi thận của Acoecata so với mức độ tập trung hn ở Coecata.

- Nhóm Planapheretima ở lục địa Đông Nam á (không kể *Pheretima arboricola*) về hệ bài tiết còn giữ nhiều đặc điểm gần với Acoecata.

- Từ Acoecata và Coecata đã có các nhóm tiến hóa song song từ cuộc sống trong đất lên cuộc sống trên mặt đất. Trong bước chuyển này, các cơ quan bài tiết đã biến đổi theo các hướng sau:

- Vi thận hầu từ có 2-6 đôi bắt đầu từ các vách 3/4, 4/5 hoặc 5/6 đến có 3 đôi bắt đầu từ vách 4/5.

- Vi thận vách từ bám trên thành cơ thể sang bám trên vách, chuyển dần từ chân vách lên gần ruột; từ phễu thận có ở cả trước và sau vách sang phễu thận chuyển toàn bộ sang phía trước vách và từ 2 ống sang 1 ống bài tiết trên ruột.

- Vi thận thành bắt đầu có từ đốt II-X đến bắt đầu có từ đốt III.