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ON THE VARIABILITY OF THE CAPSULOGENOUS
GLANDS IN THE EARTHWORM
(*PHERETIMA HILGENDORFI*, MICHAELSEN)¹

BY

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(With 3 Text Figures)

蚯蚓の一種 *Pheretima hilgendorfi* の capsulogenous glands
の變異性に就いて

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In some species of *Pheretima*, the capsulogenous or mushroom glands are found. They exhibit one of the striking characteristics in their systematic relation. In *Pheretima hilgendorfi* the presence of the gland is indicated by a circular depression of skin found on the ventral median line as shown in Fig. 1. Within the depression several minute round papillae (about 10-40 in number) are closely gathered, each of which internally communicates with a mushroom-shaped glandular body by means of a long duct. Such a papillate, circular, depressed area is also found in few other species, as *P. grandularis*, and is called "Porenfeld" by MICHAELSEN. Some other species of *Pheretima*, *P. masatacae*, BEDDARD, *P. lewis*, GOTO et HATAI, *P. vittata*, GOTO et HATAI, etc., also possess glands of the same kind, but they scatter in the area near the male pore or the spermathecal pore, and are not gathered into a papillate circular area or "Porenfeld". However, such glands are not of common occurrence among earthworms. There is another group of *Pheretima*, in which the external

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papillae are present but they have not internal structure connected with them like the species above mentioned. *P. fuscata*, GOTO et HATAI and *P. campestris*, GOTO et HATAI, are examples.

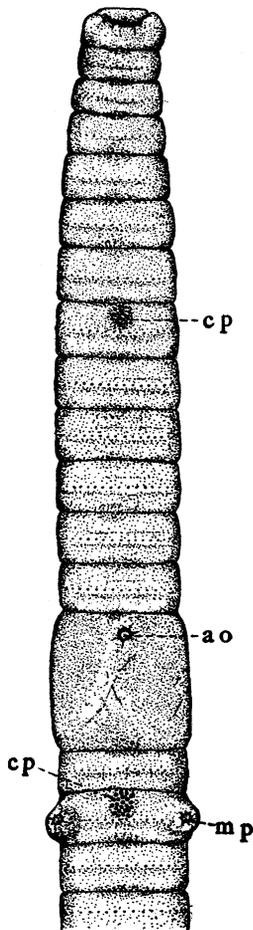


Fig. 1.

Ventral view of the anterior portion of *Pheretima hilgendorfi* $\times 2$. cp, openings of capsulogenous glands (circular depression). ao, aperture of oviduct. mp, male pore.

we find one more different group in *Pheretima*, as *P. communissima*, GOTO et HATAI; *P. sieboldi*, HORST; *P. acincta*, GOTO et HATAI. In these species neither external papillae nor the internal glandular structure can be discovered. So we see that there is a continuous series of development of the capsulogenous glands among the species included in the genus *Pheretima*.

On the other hand it is remarkable that the capsulogenous gland is variable in one and the same species. The fact that the number of capsulogenous glands (that is the number of the papillate circular areas,) and accordingly the position of the body segment on which the glands appear, is variable in *P. hilgendorfi*, is already ascertained by BEDDARD (1895), MICHAELSEN (1900), HATI (1929) and others. Now, the study of the variability of the capsulogenous glands is interesting enough in connection with evolution of the earthworm.

P. hilgendorfi, a common earthworm in Japan proper, is abundant in Hokkaido. During the Autumn of 1927 the present writer made a great collection of this species in the vicinity of Sapporo. The number was so great, being more than a thousand, that it was possible to study the variability of the capsulogenous glands satisfactorily.

In writing this paper the writer cordially thanks Dr. OGUMA, Prof. SHINJO and Dr. INUKAI for their kind advice and constant help during the work.

In examining 1010 specimens it was noticed that the number of capsulogenous glands (that is the number of the papillate circular areas, was quite variable. Generally, one or two glands occur on either side

of the clitellum, in one individual, and in some more than two are found. In other cases no such glands are found at any segment. For the sake of convenience the glands are called anterior or posterior according to their position in relation to the clitellum.

The number of anterior glands varies from 0 to 6 and posterior from 0 to 4. The posterior gland, therefore, is less variable in number than the anterior. The result of the observation of the number of glands is given in Tables 1 and 2.

From the above table (Table 1.) we notice that the individual with only one anterior glands is most frequent, numbering 663; next come 288 individuals with 2 anterior glands. The number of specimens without the gland is 44. Those with more than 3 glands are very rare. As for the posterior gland, it is generally absent, this being true in 913 cases among the 1010. The number of examples with one posterior gland is 85. Two glands are found in only 10 specimens. Three or four posterior glands are quite rare.

It is clear that the multiple capsulogenous glands appear more frequently in the anterior body part than in the posterior. The total number of anterior glands found on 1010 individuals is 1294 while the occurrence of the posterior gland is only 112, that is, less than one tenth of the former.

Next, in connection with the number of glands, the position of the segment, on which the gland is found was observed. The anterior gland is found on the 6th to the 14th segments. It is to be noticed that usually the clitellum occupies the 14th, the 15th and the 16th segments in this species and so when the gland it present in the 14th, the clitellum is moved further to the rear. The posterior gland appears on the 17th to the 22nd segments. According to the difference in number and position of the gland, all 1010 individuals were grouped into 28 classes as shown in Table 3. In addition to this Table the feature of each class is drawn diagrammatically in Fig. 2.

Table 1.

Number of anterior glands	Number of examples
0	44
1	663
2	288
3	8
4	5
5	1
6	1

Table 2.

Number of posterior glands	Number of examples
0	913
1	85
2	10
3	1
4	1

Table 3.

Class	Number of glands	Order of segments	Number of individuals
I	no gland		42
II	1	8.	602
III	1	18.	2
IV	2	8, 18.	51
V	2	8, 9,	256
VI	2	8, 17.	1
VII	2	7, 8.	1
VIII	3	8, 9, 18.	25
IX	3	8, 9, 10.	4
X	3	8, 17, 18.	8
XI	3	7, 8, 18.	1
XII	3	7, 8, 17.	1
XIII	3	7, 8, 9.	1
XIV	3	7, 9, 10.	1
XV	3	9, 10, 18.	1
XVI	3	9, 10, 11.	1
XVII	4	8, 9, 10, 11.	1
XVIII	4	7, 8, 9, 10.	1
XIX	4	6, 7, 8, 9.	1
XX	4	8, 9, 10, 18.	1
XXI	4	8, 9, 18, 19.	1
XXII	4	8, 9, 17, 18.	1
XXIII	4	8, 17, 18, 19.	1
XXIV	5	7, 8, 9, 10, 11.	1
XXV	5	8, 9, 10, 18.	1
XXVI	5	11, 12, 13, 14, 22.	*1
XXVII	6	6, 7, 8, 9, 10, 11.	1
XXVIII	6	8, 9, 18, 19, 20, 21.	1

*In this individual the clitellum does not occupy the 14th segment.

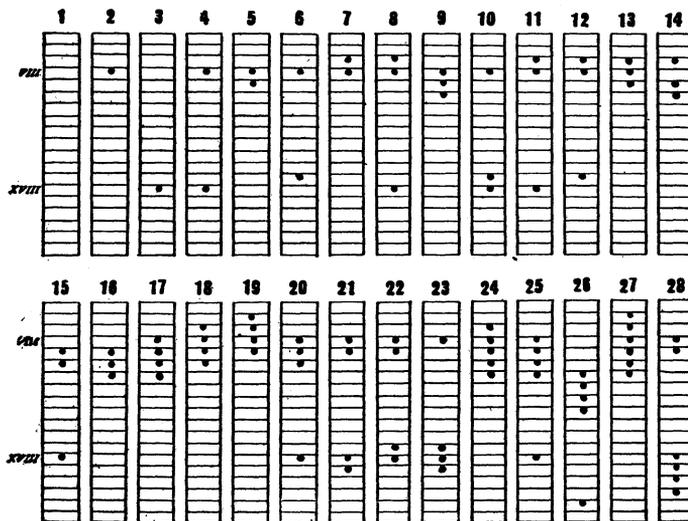


Fig. 2.

Diagrammatic figure of various types, demonstrating the difference of the number and position of the glands of *Pheretima hilgendorfi*. Arabic numerals, the number of class. Roman numerals, the number of segment.

From the table (Table 3.) and the figure (Fig. 2) we see that the type of the 2nd class, in which just one anterior gland is found, is most frequent. Next comes the 5th class with two anterior glands and the 4th with one gland on the either side of the clitellum. Specimens without the glands appear in 42 cases. That is comparatively often. Next comes the 8th class which has 25 example. All the other classes are extremely infrequent. It is interesting to note, on the other hand, that the multiple glands generally occupy the segments in succession, with only one exception of the 14th class, where the first anterior gland is separated from the second and third by a segment without any gland.

Now, considering the table, it is noticed that the gland seems to occur more often on some segments than on the others. Table 3 was rearranged and thus Table 4 was obtained. Then a graph was drawn in order that one may see easily the frequency of the gland on any segment (Fig. 3).

Table 4.

The gland in the 6th segment	2 individuals
" 7th "	9 "
" 8th "	961 "
" 9th "	300 "
" 10th "	13 "
" 11th "	6 "
" 12th "	1 individual
" 13th "	1 "
" 14th "	*1 "
" 17th "	13 individuals
" 18th "	93 "
" 19th "	3 "
" 20th "	1 individual
" 21th "	1 "
" 22th "	1 "

* In this individuals the clitellum does not occupy the 14th segment, but occupies the segments 18, 19 and 20.

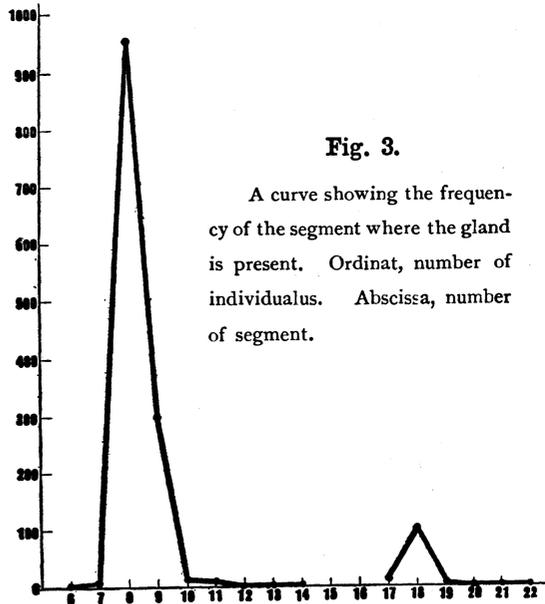


Fig. 3.

A curve showing the frequency of the segment where the gland is present. Ordinat, number of individualus. Abscissa, number of segment.

The curve starts from the 6th segment and from the 7th suddenly ascends to attain the maximum at the 8th segment. Then it descends abruptly to the 10th, passing the 9th on the way, and again becomes flat until the 14th. Here, it is interrupted, as the clitellum begins to appear. At the 17th the

curve come forth again and ascends suddenly to the second maximum which is much lower than the first. From the 19th it becomes flat to end at the 22nd.

It becomes clear that the most frequent position of the anterior gland is on the 8th segment and that of the posterior gland is usually on the 18th segment.

MICHAELSEN and BEDDART reported that the capsulogenous glands of *P. hilgendorfi* are found on the 8th, 9th, 17th and 18th segment. In the figure of OGAWA's work (1928) on *P. hilgendorfi* from Aomori the glands are found on the 7th segment. Quite recently HATAI (1928) also remarked in his work, in the variability of the external character of the *Pheretima vittata*, that in *P. hilgendorfi* the number and position of the gland is variable and usually it appears on the 7th segment. On this point the present result differs sharply from that of HATAI. However, the materials of the latter were collected in Japan proper. Therefore, it may be seen that *P. hilgendorfi* also exhibits a strong local variation with regard to the capsulogenous glands. Taking into consideration the frequency of individuals of the various types the present author concludes that *P. hilgendorfi* without the capsulogenous gland should be the ancestral type of the species from which the type with glands might be derived. Of the latter the type with the anterior gland may be the first and that with the posterior gland should be most advanced. Apart from the accidents which cause variation in the number of the glands and their position as well, perhaps regeneration, it is evident that there is a strong tendency to variability in the occurrence of the capsulogenous glands in *Pheretima*. From this tendency of the earthworm, the author believes that appears the various types of development of the analogous organ among the *Pheretima* species, as already explained at the beginning of this paper. The simplest type is the group with the external papillae only. Then there is the type of *P. hilgendorfi* and allied species which have the complex capsulogenous glands.

The physiological function of the capsulogenous glands has not yet been studied satisfactorily. However, it is quite significant if we consider that the capsulogenous glands are bound up with the problem of evolution of the earthworm.

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要 摘

通常 *Pheretima hilgendorfi* の略一定せる體節の腹面正中線には、微小なる數多の小乳頭の集合せる略圓形の部分あり。之れ數多の所謂 Capsulogenous glands の開孔する一局部にして、此等の腺はそれぞれ小乳頭の中央に開孔するものなり。斯くの如く此の種類に於ては Capsulogenous glands は常に一部に集合して存在するものにして、MICHAELSEN 氏は之等一群の腺の開孔する一局部に“Porenfeld”なる名稱を與へたり。

本研究は此の種類のカプスゲン腺の數(此の數は同じ“Porenfeld”に開く一群の腺を單位として考へたるものにして、從つて“Porenfeld”の數にて示さるべし。)及び此の腺の存在する體節番號の變異を調査せるものにして、材料は 1927 年の秋、札幌にて採集せる 1010 個の標本なり

觀察の結果に依れば Capsulogenous glands は環帶の前方及び後方に發見せられ、環帶の前方のみ存するもの、環帶の後方のみ存するもの、及び環帶の前後兩方に存するものあり。又或る個体にては何れの部分にも存せざる事あり。Capsulogenous glands の體節的位置は通常第八節(環帶前)及び第十八節(環帶後)を歸納し得たれども、其の腺の數及び位置に關しては甚だしき變異を示し、此の差異によりて全標本は二十八型に分れたり。而して第八節にのみ此の腺を有するものは大多數を占めたり。

Capsulogenous glands は札幌産の *P. hilgendorfi* に就きて以上の如き變異を示すのみならず、小川氏及び畑井氏の本州産同種に就いての觀察に依れば通常第七節に存在し、地方的變異と看做すべき差異を示すを知り得たり。何れにせよ、此の種類のカプスゲン腺の變異は著しきものにして、之の變異の事實より蚯蚓の進化に關する一、二の問題を論ぜり。即ち Capsulogenous glands の生理作用は未だ不明に屬すれども *Pheretima* 屬にはこの *P. hilgendorfi* と異なり腺が一部に集合せずして散在するものあり。又單に表皮に外乳頭を有し複雑なる腺構造を欠くものあり。又全くこれすらも欠くものありて、種類によりて夫々特殊なる形態を存し、茲に腺に就いて果進的な進化系統を得べし。これ上に示す蚯蚓のこの方向に對する變異性に因りて起りし、進化の方向を考へらるべし。