GYMNOPLEURUS SINNATUS AS THE INTERMEDIATE HOST OF *SPIRURIDAE* FOUND IN THE VICINITY OF MUKDEN, SOUTH MANCHURIA

I Report

Gymnopleurus Sinnatus as the Intermediate Host of *Spirocerca Sanguinolenta* and Inquiry into Grassi's Experiment with *Blatta Orientalis*

S. ONO

(From the South Manchuria Institute for Infectious Diseases of Animals, S. M. R. Co., Mukden. Director: Prof. K. Kasai)

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That Grassi⁽¹⁾ in Italy pointed out *Blatta orientalis* as the intermediate host of *Spirocerca sanguinolenta* has never been called in question in Japan, while Seurat⁽²⁾ studying on the life histories of *Spiruridae* in Algeria recognized some dung beetles other than *Bl. orientalis* as the 1st intermediate host of the parasite under discussion and he supposed Grassi to have mistaken *Spirura gastrophila* occurring in *Bl. orientalis* for *Sp. sanguinolenta*.

Recently Faust⁽³⁾ in Peking examined the migration course of larvae of this parasite in the hedgehog and observed the primary lesion developing only in the wall of aorta, and when he found the same larvae in a species of dung beetles, *Canthon* sp., he was also inclined to discredit Grassi's experiment.

At nearly the same time, independently from Faust, we detected encysted larvae of several species belonging to *Spiruridae* in *Gymnopleurus sinnatus* (Fig. I) in the vicinity of Mukden and one of them was proved to be the same as that of *Sp. sanguinolenta* by infestation experiments with dogs and rabbits.

The results obtained from our experiments are briefly described below.

LARVAE DETECTED IN *Sp. sanguinolenta*

Within the present scope of observation, it is difficult to differentiate the larva of *Sp. sanguinolenta* (Fig. II A & B) from those of allied species morphologically.

The following table shows the total number of the mixed

larvae harbored in 47 out of about 400 dissected dung beetles.

Date of Examination	Infested No. Dissected No.	Number of Larvae			Total Number
		In Abdominal Tissue	In Thoracic Muscle	In Cephalic Muscle	
4/VII-9/VII	29/30	399	119	60	578
4/VIII-13/VIII	17/17	350	81	243	694

INFESTATION EXPERIMENT WITH DOGS.

About 50% of some 300 dissected dogs were found to be naturally infested with larvae of *Sp. sanguinolenta* forming the esophageal tumor, where in most cases also associated with the aortic tumor, and rarely showing the latter only. Two out of all dogs examined harbored adult worms in the thoracic cavity.

In spite of such an undesirable condition, we used for this experiment 2 dogs naturally reared and afterward fed about 2 months in our laboratory. This laboratory feeding was regarded as sufficient to make differentiate the lesions of natural infestation from the experimental ones.

The 1st dog was perorally given infested dung beetles and was found invaded by this parasite after 2 infestations (51 and 11 days respectively) as follows: About 40 larvae within tunnels in the intima and media of the arch of aorta and the thoracic aorta (Fig. III A), about 10 immature worms forming tumors in the externa of the arch of aorta (Fig. III B) and about 20 adults in esophageal tumors.

The 2nd dog showed nearly the same result as the 1st.

In the foregoing experiment we may conclude that adult worms detected in esophageal tumors are originated in the natural infestation which took place long before the experiment and the larvae in the intima and media of aorta come from the materials experimentally ingested.

Three stages of the development of *Sp. sanguinolenta* are shown in Fig. III-VI. Here the most noticeable feature is that larvae contain the blood-colored fluid in their body cavities, which has been hitherto known as specific to adults of the present species.

As one of pathological changes in the invaded tissue of aorta the broken elastic lamellae are distinctly noted in the preparation

stained by Weigert's fuchsin-resorcin solution (Fig. III AA). The decrease thus to be induced in elasticity of the aorta seems to be the most important factors in producing aneurysma.

INFESTATION EXPERIMENT WITH RABBITS

Two rabbits fed with the normal diet were ingested with infested dung beetles. The Ist one was found infected with unknown encysted larvae of nematode in the outer wall of the stomach, but it showed no lesion caused by *Sp. sanguinolenta* in the aorta after 3 peroral infestations (8,5 and 3 days respectively) and the IInd one also showed the same result as the Ist after 4 infestations (7, 6, 2 and 1 days respectively). These encysted larvae may be those of *Spirura* sp. After excystation in the stomach, they are reencysted in its outer wall in order to probably preserve their lives in this improper host.

The IIIrd rabbit fed with the special diet (10 g lanolin every day being mixed with the normal diet) contracted infection with larvae of *Sp. sanguinolenta* forming aneurysma in the aorta after 5 infestations (44, 43, 41, 39 and 38 days respectively). Moreover in this case we detected 2 other species of *Spiruridae* in the stomach and many encysted larvae in the muscles of several parts of the body and in the mesentery.

The IVth rabbit fed with lard showed aneurysma in the aorta, but without harboring any parasite therein, after 6 ingestions (135, 132, 127, 124, 122 and 121 days respectively).

From the above experiment it seems likely that the rabbit naturally insusceptible, if fed with lanolin or lard, becomes infested with larvae of this parasite forming aneurysma, but larvae thus invaded can not develop to its mature stage in this host and dies out within 4 months after infestation.

DISCUSSION OF GRASSI'S EXPERIMENT

Grassi described results of his experiment as follows: "Indem ich die Hunde nach dem Verlaufe von 5, 10 bis 15 Tagen (von dem Tage an gerechnet, an welchem ich ihnen die in Rede stehenden Cysten zu verschlucken gegeben) tödtete, erhielt ich junge Spiropteren noch im Magen oder der Speiseröhre entlang und mehr oder weniger tief in die Wände derselben (Speiseröhre) eingegraben."

Seurat in his experiment with *Bl. orientalis* found larvae of *Spirura gastrophila* instead of *Sp. sanguinolenta*. Accordingly he concluded that larvae detected in *Bl. orientalis* by Grassi might have been that of *Spirura* sp. and they became reencysted in the stomach and esophagus of dogs to preserve their lives until finding a final host.

While the dog is the final host for *Sp. sanguinolenta* as well known, this animal then seems to behave as the preservatory host for Grassi's parasite under discussion, but not as the final host.

Faust's and our objection to Grassi is as follows: Grassi never called his attention to the arterial lesion to be primarily caused by the present larvae. Then there is no proof that the parasite found by Grassi is identical with *Sp. sanguinolenta*.

SUMMARY

1. It is proved by the infestation experiment with dogs that *Gymnopleurus sinnatus* is the intermediate host of *Sp. sanguinolenta* in the vicinity of Mukden, its larvae especially invading the wall of aorta.

2. Rabbits, if fed with lanolin or lard, also can be infested with larvae of the present parasite forming aneurysma, but these larvae can not develop to their mature stage in this improper host, being entirely destroyed within 4 months after infestation. Rabbits fed with the normal diet can not contract infestation with *Sp. sanguinolenta*.

3. The broken elastic lamellae are detected in the preparation from the invaded tissue of aorta stained with Weigert's fuchsin-resorcin solution.

4. The larvae of *Sp. sanguinolenta*, as the adults do, also carry the blood-colored fluid in their body cavities even 1 day after infestation.

5. It is deduced from various points of view that the parasite from *Bl. orientalis* pointed out as *Sp. sanguinolenta* by Grassi is in all probability one of allied species (*Spirura* sp. ?).

I tender my warm thanks to Dr. K. Kasai, Director of the Institute, and to Prof. S. Yoshida for their cordial guidance.

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EXPLANATION OF FIGURES

- Fig. I. *Gymnopleurus sinnatus* ($\times 25$)
Fig. II. A, B. Larvae in cysts ($\times 40$ & $\times 30$)
Fig. III. Infested aorta of dog (natural size)
Fig. III. A. Section of larvae in the media of aorta ($\times 100$)
Fig. III. AA. Section of larvae in the media of aorta, especially showing the broken elastic lamellae ($\times 30$)
Fig. III. B. Section of larvae in the externa of aorta ($\times 10$)
Fig. IV. A, B. Immature worm in the intima of aorta ($\times 100$)
Fig. V. A, B. Immature worm in the externa of aorta ($\times 100$)
Fig. VI. A, B, C. Adults ($\times 30$)
Fig. VI. D. Egg ($\times 500$)

南滿洲ニ於ケルすびるら科 (*Spiruridae*) ノ中間宿主トシテノばふんころがし (*Gymnopleurus sinnatus*) ノ研究

第 1 報

犬ノ血色すびろせるか (*Spirocerca sanguinolenta*) ノ中間宿主トシテノばふんころがし (*Gymnopleurus Sinnatus*) 特ニ Grassi ノごきぶり (*Blatta orientalis*) 説ニ對スル疑義

小 野 定 雄

(奉天滿鐵獸疫研究所 所長 葛西博士)

(昭和 4 年 2 月 15 日 受附)

滿洲デ有名ナばふんころがしハソノ糞食性ニヨツテ數種ノすびるら科ノ中間宿主トシテ家畜ヲ脅威シテイルノデアルガ此内デ犬

ノ血色すびろせるかノ中間宿主タルコトヲ證明シ得タ實驗ヲ報告シ殊ニ從來我が國ニ於テ信ジラレテイル Grassi ノごきぶり説ノ疑點ヲ指摘セント欲スルノデアアル

本實驗室ニ於ケル解剖野犬頭數 300 余匹中本虫ヲ寄生スルモノ約其半數ニ達シ寄生部位ハ食道腫瘍内ヲ最多トシ多クハ大動脈瘤腫ヲ伴ヒ又僅カ 2 例ニ於イテ胸腔内寄生ヲ見出シタ

故ニ實驗動物トシテ野犬ヲ用フルコトハ適切デナイノデアアルガ實驗室内ニ 2 箇月以上飼養セルモノ 2 頭ヲ用ヒ其初期感染ノ狀態ヲ檢シ次ノ結果ヲ得タ

1 頭ノ實驗犬ニ於テハ 2 回經口感染後（第 1 回感染後 51 日目第 2 回感染後 11 日目）ニ其大動脈ノ内膜中膜ニ於テ血色ヲ呈スル螺旋狀幼虫體 40 匹余及外膜ニ於テ更ニ成長セル幼虫體並食道腫瘍内ニ母虫ヲ見出シタ此後者ハ自然感染ニヨリ實驗以前ニ己ニ存在セルモノトスルモ内膜内ノ幼虫體ハ明カニ實驗感染ニヨルモノト考ヘラレル而シテ此等 3 虫體群ハ形態上明カニ發生ノ各階段ニアルコトヲ表示シテイル他ノ 1 頭モ略々同様ノ結果ヲ示シタ

次ニ 2 頭ノ家兔ヲ用ヒテ經口染感ヲ行ヒ同時ニらのりん及豚脂ヲ之ニ與ヘ又對照トシテ普通食ノモノ 2 頭ヲ用ヒテ試驗ヲシタノデアアルガ前者ノ 1 頭ニ於テハ 5 回ノ經口感染後（各感染後夫々 44 日、43 日、41 日、39 日、38 日目）ニ其大動脈瘤腫内ニ犬ニ於テ見出シタト同様ナ血色仔虫ヲ見出シ他ノ 1 頭ニ於テハ夫々 135 日 132 日、127 日、124 日、122 日、121 日目ニ當ル 6 回ノ經口感染後大動脈瘤腫ハ存在シテ居タガ仔虫ハ發見シ得ナカッタ對照ノ 2 頭ハ他ノすびろ科ノ再被囊シタ幼虫體ヲ胃外壁ニ見出シタ外何等ノ變狀ヲ大動脈ニ發見シ得ナカッタ

上記ノ實驗ノミカラ觀察スル時ハらのりん或ハ豚脂飼食ハ恰モ兔ノ本寄生虫ニ對スル抵抗力ヲ弱メタ様ニ見エル勿論此狀態ニ於

テモ血色すびろせるかハ其初期發育ヲナスノミデアツテ己ニ4箇月余ヲ經過セルモノニ於テハ其動脈瘤内ニ虫體ヲ發見シ得ナカッタノデアアル然シナガラ此實驗ニヨツテ從來幾何カノ疑點ヲ殘シテイタ犬ノ動脈内膜内ノ血色幼虫體ガ兎ノ夫レト全ク同一デアリ從テ之ハばふんころがし内ノ被囊虫體ヨリ行き得ルモノデアルコトヲ判然セシメ得タと思フ

次ニ起ル疑問ハカクノ如クシテ先ヅ大動脈壁ニノミ表ハル、幼虫ガ如何ナル時期ニ食道腫瘍ヲ形成スルカトイフ問題デアアル此點ハ更ニ追試ヲ要スルモノデアアル

サテ從來信ジラレテイル Grassi ノ實驗ヲ考察スルト氏ハ次ノ事ヲ論據トシテイル

1. ごきぶりヲ投食後 5 日、10 日、15 日目ノ犬ノ胃内及食道内壁ニ幼虫體ヲ見出シタコト

2. 此幼虫體ハ形態上母體ト同様ノ乳頭ヲ有スルコト
之ニ對シテ本實驗ニ於テ檢出シタコトヲ比較スレバ

1. 感染後 11 日目ノ犬ノ大動脈内ニ螺旋狀幼虫體ヲ發見シタ外食道或ハ胃内ニ幼虫體ヲ檢出シ得ナイ此事實ハ自然狀態ニ於テ本虫ニ犯サレナイ兎ニ人工的ニ寄生セシメタ時ニモ表ハルル現象デアツテ如何ニモ本虫ノ特異性デアル様ニ思ハル、

2. 此幼虫體ハ血色すびろせるカノ特有性デアル血色樣體腔液ヲ既ニ有ツテオリ其形態ニ於テ母虫ヘノ階段ヲ示シテイル

若シ感染初期ニ於ケル大動脈寄生ヲ本虫ノ特異性トスル時ハカノ Grassi ガごきぶりニ見出シ犬ノ食道及胃ニ直接感染セシメタ幼虫體ハ何デアアルカ Seurat ガごきぶりヲ檢シテ猫、狐及はりねずみニ寄生スル *Spirura gastrophila* ノ幼虫ヲ見出シ遂ニ血色すびろせるカノ夫レハ發見シ得ナカッタコトヤ此等すびるら科ノ通性ハ本宿主ニ非ザル類似動物ニ攝取サル、時ハ其體內ニ於テ脫被シ且再

被囊スルトイフコトナドカラ考ヘテ見レバ Grassi ハ誤謬ニ陷ツテ
イタ様ニモ思ハレル

最後ニ犬ノ血色すびろふてらノ中間宿主トシテハ余ノ例ヲ加ヘ
テ次ノ數種ガ認メラル、コトニナルト思フ

滿洲ニ於ケルばふんころがし (*Gymnopleurus sinnatus*)

北京附近ニ於ケル *Conthon* sp.

あるせりあニ於ケル *Scarabaeus sacer*, *Scarabaeus variolosus*; *Akis*
goryi, *Geotrupes douei*, *Copris hispanus*, *Gymnopleurus sturmi*.

Fig. 1

Fig. 11 A

B