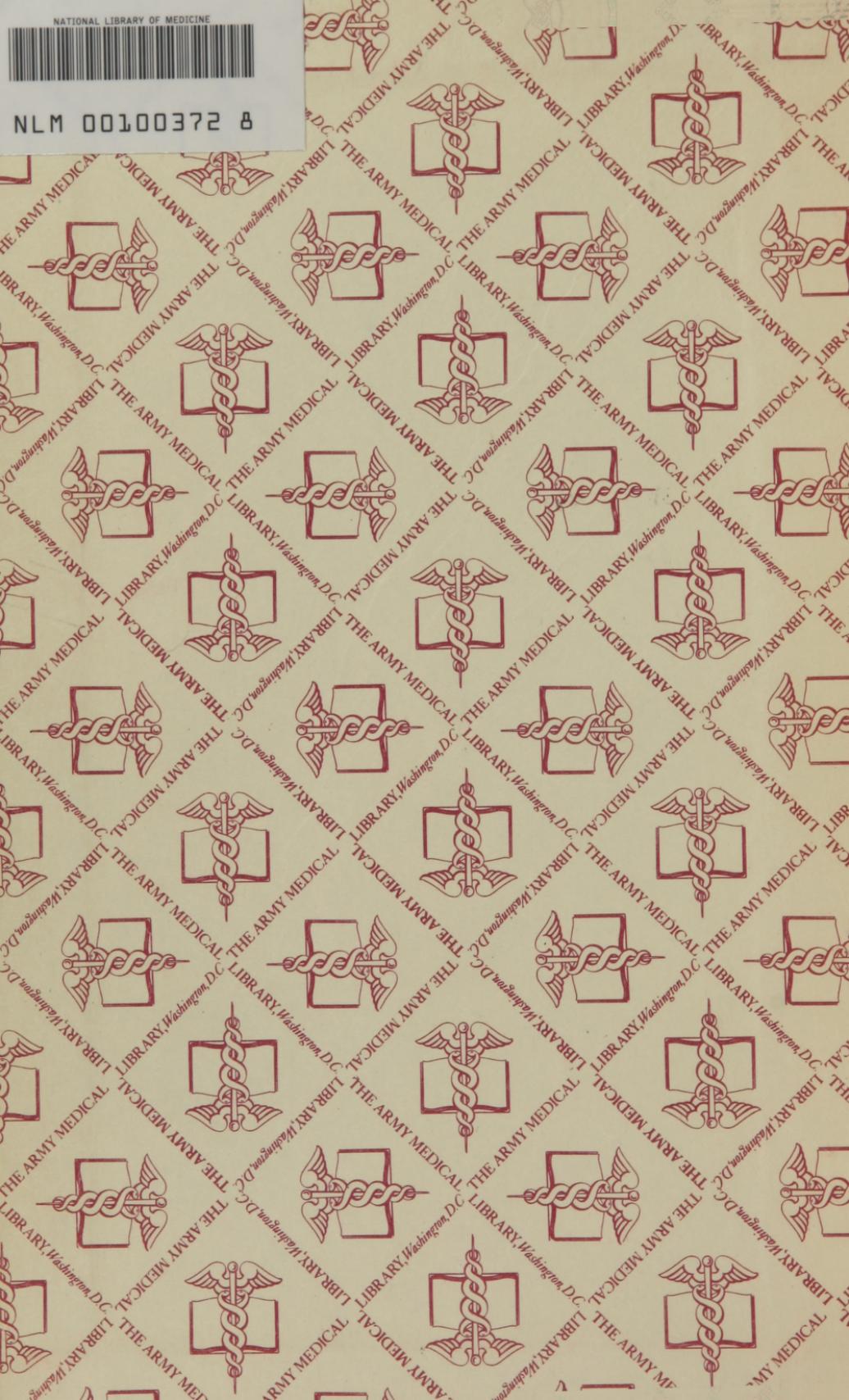




NLM 00100372 8



DUE ~~TWO WEEKS FROM~~ LAST DATE

MAY 28 1971

MAR 16 1976

APR 16 1976

JUN 30 1978

Parental

Gloss
U.S.
WC
258r
1881

ANNEX

Parasitology

1196

TREASURY DEPARTMENT, }
Document No. 84. }
Marine Hospital. }

UNITED STATES MARINE HOSPITAL SERVICE.

REPORT

ON

TRICHINÆ AND TRICHINOSIS.

PREPARED, UNDER DIRECTION OF THE SUPERVISING
SURGEON-GENERAL,

BY

W. C. W. GLAZIER, M. D.,

ASSISTANT SURGEON, MARINE HOSPITAL SERVICE.



PUBLISHED BY ORDER OF CONGRESS.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1881.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING,

In response to resolution of the Senate, copies of all documents touching upon trichinae in swine.

DECEMBER 16, 1880.—Referred to the Committee on Agriculture and ordered to be printed.

TREASURY DEPARTMENT,
December 15, 1880.

SIR: In reply to the following resolution of the Senate of the 13th instant—

“*Resolved*, That the Secretary of the Treasury is hereby directed to furnish the Senate with copies of any documents in the possession of that department, touching trichinae in swine, and the restrictions upon our trade with foreign countries in consequence of this disease”—

I have the honor to transmit herewith a special report on the subject of trichinae in American meat by the late Assistant Surgeon, W. C. W. Glazier, of the Marine Hospital Service, made under direction of the Supervising Surgeon-General, to whom had been referred certain correspondence of consular officers at different foreign ports with the Department of State.

This correspondence, herewith transmitted, shows that the action of certain foreign governments in the restrictions placed on importations of the products of swine amounts to prohibition.

The value of bacon and hams exported from the United States during the last fiscal year was \$50,987,603, and of pork, \$5,930,252, and of lard, \$27,920,367—in all, \$84,838,242.

The report of Assistant-Surgeon Glazier tends to show that this adverse action of the foreign governments in this regard is based upon erroneous information of the actual condition of these exported articles.

Very respectfully,

JOHN SHERMAN,
Secretary.

Hon. WM. A. WHEELER,
President of the Senate.

TABLE OF CONTENTS.

	Page.
A. History of the discovery of <i>Trichina spiralis</i>	9
B. Natural history	12
C. Theories of origin.....	54
D. History of trichinosis, statistics of epidemics, etiology, pathological anatomy, symptoms, diagnosis, prognosis, pathology, and treatment	74
E. Symptoms of trichinosis in animals	134
F. Prophylaxis, with laws governing the pork trade in Europe, with some of the results of the examinations of European and American pork.....	144
G. Recommendations as to precautionary measures to be observed in making examinations	163
H. Trichinosis in the United States.....	172

INDEX OF ILLUSTRATIONS.

	Page.		Page.
Fig. 1. Mature male intestinal trichinae . . .	12	Fig. 48. Unchanged muscle fiber containing a recently arrived embryo	43
2. Mature pregnant female intestinal trichina	13	49. Changed fasciculus showing granules, nuclei, and young trichinae	43
3. Fully developed female muscle-trichina	13	50. Normal fasciculus with changed fasciculi, containing worms in different degrees of development	43
4. Masseter of rabbit recently infected with trichinae	15	51. Changed and normal fasciculi	43
5. Human muscle with trichinae	16	52. Unchanged muscle fasciculus with an embryo escaping from the sarcolemma	44
6. Calcified trichinae capsules	16	53. Muscle trichina having reached a length of 3 ^{mm}	45
7. Muscle trichinae in situ	16	54. Muscle trichina 4 ^{mm} in length	45
8. Cyst magnified 300 diameters	16	55. After a preparation from a human body dying during the Hedersleben epidemic	46
9. Calcified human trichinae capsules	17	56. Spindle-shaped tube before encapsulation commences	47
10. Sheath of sarcolemma with recently encysted trichinae from human muscle	17	57. First trace of capsule	47
11. Trichina capsule	17	58. Capsule formation showing lamination at extremities	48
12. Diagnosis of vessels surrounding a primitive fasciculus	19	59. Encapsulated trichina showing sarcolemma sheath and cell proliferation	48
13. Young trichocephalus dispar	19	60. Network of capillary blood-vessels surrounding sarcolemma sheath	49
14. Male trichocephalus dispar	20	61. Commencing calcification, deposit seen only at one extremity of the capsule	50
15. Transverse section through the posterior portion of a female intestinal trichina	20	62. Progressing deposit of calcareous granules now forming a watch-glass disk	50
16. Anterior extremity of trichinae	21	63. Preparation from muscle of rabbit 32 days after feeding	51
17. Beginning of the stomach	21	64. Pathologically changed trichinae capsules with thickened connective tissue envelope and dead worms	52
18. Posterior extremity of male trichina	23	65. Encapsulated calcareous concretions, the remains of dead trichinae	52
19. Receptaculum seminis	23	66. Cyst, containing a worm; very much altered and commencing to break into fragments, &c	53
20. Female trichina 24 hours after feeding	25	67. Only the angular fragments of the worm are seen	53
21. Lateral band, region of uterus	27	68. Cyst invaded externally and internally by fat vessels	53
22. Lateral band and cell pits of the oesophagus	27	69. The cyst has almost completely disappeared under the mass of fat globules	53
23. Piece of longitudinal band from fore part of trichina	27	70. Fever curve of a case of trichinosis	115
24. Section from middle of female trichina	27	71. Range of temperature in case of enteric fever	115
25. Posterior extremity of young male intestinal trichina	28	72. Fever curve of a mild case of trichinosis	115
26. External male genital organs	28	73. Preparation from a corpse in Hedersleben	166
27. Anterior extremity of a young intestinal trichina	29	74. Muscle trichinae from a hog three months after infection	166
28. Entrance from oesophagus to stomach	29	75. Preparation from a ham from Illinois	167
31. Posterior of the female organs of generation	30	76. Psorosperms	167
32. Brain with nerves	31	77. Single psorosperm	168
33. Posterior extremity of a male muscle trichina	32	78. Reniform sausage and irregular granules from sac of the psorosperm	168
34. Testicle, vas deferens, &c	32	79. Tyrosin crystals in hams from Westphalia	169
35. Intestinal sexual organs of young male	32	80. Calcified granules from hog's muscle	170
36. Mother cells and seminal elements	32	81. Cyst of the cysticercus cellulosa	170
37. Posterior extremity of a young male intestinal trichina	33	82. Free larva of tenia solium enlarged	170
38. Anterior portion of developing vagina	33	83. Vinegar eel, sometimes mistaken for trichina spiralis	170
39. Central part of the female genital organ, &c	34	84. Embryo of strongylus filaria; ascaris lumbricoides	170
40. First appearance of the formation of the vagina towards the vulval opening	34	85. New-born embryo of ascaris lumbricoides, &c	170
41. Portion of a female muscle trichina in which Farres' body is found, &c	35	86. Young of trichocephalus dispar	171
42. Development of the embryo; ovum; vitellus; segmentation of the vitellus	36	87. Filaria sanguinis hominis	171
43. Development of the embryo; further segmentation of vitellus; outline of embryo distinguished	36	Map of Germany showing trichinae centers	81
44. Development of the embryo: the plump embryo consisting of a layer of chitin filled with cells; position of oesophagus	36		
45. Development of the embryo: trace of outer portion of alimentary canal; chitin tube and brain vesicles	37		
46. Development of the embryo: posterior portion of a growing embryo	37		
47. Development of muscle trichinae: embryo from abdominal cavity of a rabbit	42		

ORDER.

TREASURY DEPARTMENT,
OFFICE SUPERVISING SURGEON-GENERAL,
U. S. MARINE HOSPITAL SERVICE,
Washington, July 22, 1879.

SIR: You are directed to investigate and report to this office upon the subject of trichinæ in American pork and other meat. Your report should be thorough, and, to enable you to appreciate the importance of the subject to our American commerce, I inclose herewith thirteen communications, with their inclosures, received from the Department of State, being copies of reports from United States consular officers abroad. These inclosures will be returned with your report, when completed.

Very respectfully,

J. B. HAMILTON,
Surgeon-General, M. H. S.

Assistant Surgeon W. C. W. GLAZIER,
U. S. Marine Hospital Service, Charleston, S. C.

LETTER TRANSMITTING REPORT.

U. S. MARINE HOSPITAL SERVICE,
DISTRICT OF THE GULF,
Port of Key West, Fla., Surgeon's Office, July 10, 1880.

SIR: In pursuance of instructions contained in a letter dated Surgeon-General's Office, July 22, 1879, which transmitted letters from consular officers in various cities of Europe concerning the occurrence of the nematode *trichinæ spiralis* in American swine products, I have the honor herewith to transmit my report on this subject, which I have divided into seven sections, designated by Roman capitals. Section A contains the history of the discovery of the *trichinæ spiralis*. Section B its natural history. In section C will be found the theories of some of the most noted observers as to its origin; following in section D with a history of the disease caused by the parasite, with a mention of its occurrence in epidemics, with statistics of the same, following with the views of actual observers as to its etiology, pathological anatomy, symptoms, diagnosis, differential diagnosis, prognosis, pathology, and treatment, giving the history of the disease as complete as possible with

my limited access to the literature of the subject in the United States. Section E gives the symptoms observed in animals and shows a possibility of its occurrence in an epidemic form in swine in the United States. In section F, under prophylaxis, &c., I have given some of the laws governing the pork trade in different parts of Europe, with some of the results of the examinations of European and American pork, with some remarks on the latter, and have tried to show the necessity of a thorough investigation of the subject in the United States, giving the opinions of eminent observers as to the best method of procedure, concluding in section G with recommendations as to methods and precautionary measures to be observed in examinations.

Very little of this paper is original. In fact, so much has been written and so well written on trichinæ and trichinosis that for their proper understanding it would only be necessary to read any of the many exhaustive monographs written by one of those close observers and extensive experimenters, of whom so many have given their attention to this very important subject. It is from a close study of such works and the perusal of current literature that I have derived the facts and opinions on which this paper is based, adapting them to the end in view, *i. e.*, to show the importance of a thorough investigation of the subject in the United States to establish (1) the occurrence or non-occurrence of trichinæ centers, (2) to prevent the spread of the parasite from such centers, and (3) if possible to diminish their area if not entirely eradicate the worm.

The subject of history, &c., has been more thoroughly examined than would otherwise have been necessary in this paper on account of some inaccuracies, found by comparison, in the American literature of the subject.

The free translation from German authorities in this report, Leuckart, Pagenstecher, Gerlach, and others, is due to the fact that original experiment is less necessary at the present time than a knowledge of the established facts, and the Germans have had greater experience with the disease trichinosis, and in experimentation on the propagation of trichinæ than any other nation.

For the bibliography of the subject I would respectfully refer to Cobbold, *Parasites, &c.*, London, 1879, p. 174. Davaine, *op. cit.*

Very respectfully, your obedient servant,

W. C. W. GLAZIER,
Assistant Surgeon, M. H. S.

To the SURGEON GENERAL,

U. S. Marine Hospital Service, Washington, D. C.

REPORT
ON
TRICHINÆ SPIRALIS.

SECTION A.—HISTORY OF THE DISCOVERY OF TRICHINÆ.

Small calcareous bodies were noticed in the flesh of a human cadaver as early as 1828 ("H. Peacock made a dry preparation of the sternohyoideus muscle to display the specks; this is still preserved in Guy's Museum." Dr. Hodgkin, quoted by Cobbold, *Parasites*, Lond., 1879, p. 151), and is said to have been calcified trichinæ capsules, of which there is little doubt, although I have found no account of a microscopic confirmation. Helry Hilton (*London Med. Gazette*, vol. xi, 1833, p. 605) also wrote of "a peculiar appearance observed in human muscles (in 1832), probably depending on the presence of very small cysticeri." In this, as in the first case, there has been no proof offered that the small bodies actually contained trichinæ, excepting the general assumption that all such bodies always do contain them.

Tiedemann, in 1821 (*Froriep's Notizen*, i, p. 64, article translated in Cobbold, *op. cit.*, p. 151), described concretions found in the body of a brandy drinker who had suffered from severe and repeated attacks of gout. They were much larger than the trichinæ capsules as usually represented, viz, 4 to 8^{mm} in length; while the length of the latter has an "average of 0.33^{mm}." (Davaine, *Entozoaires*, Paris, 1877, p. 734.) Berkan (*Virch. Arch.*, B. xxxvii, p. 1, 1866) says that such enlargements of the trichinæ capsules never occur from inflammatory processes, while Müller (*Virch. Arch.*, B. xxxvii, p. 253) found trichinæ in capsules two or three times the usual size. Roeper (*Deutsche Vierteljahrsschrift für öff. Gesundheitspflege*, B. 6, H. 2, 1874, p. 282) found small crystalline bodies in American hams; he does not give their size, but says they were more abundant in those containing trichinæ. Leuckart (*Untersuchungen über Tr. sp.*, 2. Aufl., Leipzig, 1866, p. 3), however, denies the identity of Tiedemann's bodies with trichinæ capsules, while Pagenstecher (*Die Trichinen*, Leipzig, 1866, p. 4), although doubting the probability of the capsules forming centers of gouty deposits, thinks there might have been an error in the measurements, and, with Diesing

Kuchenmeister, Davaine, and Cobbold, considers them to have been true trichinæ capsules. At all events, these cases, as well as the claims of Kleuke (Cobbold, *op. cit.*, p. 152), although they give evidence of two probable cases, and possibly epidemics, of trichinosis, in no way aided in the discovery of the trichinæ, and are of no particular importance except to show how little the microscope was resorted to in those days to clear up obscure points in diagnosis, as there is sufficient evidence to prove that trichinæ must have existed in the human body long before this period.

Sir James Paget was the first to see (in 1834) the parasite coiled up in its capsule (London Lancet, March, 1866, p. 269, and Brit. & For. Med-Chir. Review, vol. i, 1870). It was during the following year (1835) that Professor Owen examined specimens furnished by Mr. Wormald, who was contemporary with the then *Mr.* Paget in Saint Bartholomew's Hospital, furnishing a description and giving it its present name. (London and Edinburg Phil. Magazine, 1835, & Transactions of the Zoological Society, vol. i., p. 315). The description was incomplete, as "it placed the entozoon, through the simplicity of its organization, lack of alimentary canal, &c., in the lowest scale of the animal kingdom, and it agreed with the helminths only in its modes of life." (Leuckart *op. cit.*, p. 2.) And Kestner (*Étude sur le trichina spiralis*, Paris, 1864, p. 5) says: "The illustrious naturalist gave a very imperfect description of the parasite, which according to him had neither arms, distinct alimentary canal, nor organs of generation. Farre (Lond. Med. Gaz. Dec., 1835, p. 382) described not only an intestinal tube divided into three parts, but also organs that he recognized as ovaries. (Kestner, Leuckart *l. c.*, Scoutetten, *Étude sur les trichines*, Paris, 1866, pp. 14, 15). See also Cobbold *l. c.* and Davaine. Bischoff (*Medicinische Annalen*, B. iv, 1840, § 232) confirmed Farre's statement in regard to the organization of the worm, and Luschka (*Zeitschrift für wissenschaftliche Zoologie*, 1851, B. iii, § 73) determined by careful observation of the motion of the worm that the slender extremity was the anterior, which had been previously suggested by Bischoff (*l. c.* p. 239), who said that by analogy with other nematodes the mouth should be found in the smaller end. Luschka, however, at the same time denied the existence of a mouth or arms. This question was affirmatively settled by Bristowe and Rainey (Trans. Path. Soc. Lond., 1854, vol. v, p. 278), who also discovered the œsophagus. Kuchenmeister confirmed these later observations on the structure of the worm, and noted especially the similarity between the *trichina spiralis* and trichocephalus. (Leuckart, *op. cit.*, pp. 3-8.) In 1859 Virchow (Compt. Rend., etc., t. 49, p. 660, t. 51, p. 13; Gaz. Méd. de Paris, No. 28, 1860, p. 440; Virch. Arch., B. xviii, p. 345) described the sexually mature worms.

The question as to whether the *trichina spiralis* was the embryo of some other nematode having been settled so decidedly in the negative, the subject is not mentioned here except to refer to Kestner, Scoutetten,

and especially to Leuckart, Renz, and Virchow for the able discussions on the subject.

In 1835 Harrison (Dublin Journal) gave an account of 6 cases of trichinæ occurring in the cadaver. In 1836 Buveaud Riafrey (Revue Méd.-Chir. Anglais, Paris, p. 33) published 14 cases furnished by Professor Owen. Turner in 1860 (Edinburgh Medical Journal, vol. vi, p. 209, 1860) published 19 cases. Cruveilhier (Anat. Path. Générale, t. ii, 1852, p. 64) saw them in considerable numbers in France. (See, also, Arch. Gén. de Méd. 1862, p. 716.) According to Delpèch (Les Trichines, &c., p. 12), besides those reported by Cruveilhier, two other observations were made in France, viz, by Auzias-Turenne, quoted by Moquin-Tandon and Koeberle. In 1841-'42 they were seen in Charleston, S. C., by Professor Chazal, then demonstrator of anatomy in the Medical College of South Carolina. (See letter in section E.) (†)

The following list includes nearly all cases in man observed prior to the year 1860 :

Year.	Reporter.	No.	Where reported, &c.
1821..	Tiedemann	1	Froriep's Notizen, i, p. 64.
1828..	Peaveels	1	Cobbold, Parasites, &c., 1879, p. 151.
1832..	Hilton	1	Lond. Med. Gazette, vol. xi, 1833, p. 605.
1834..	Paget	1	Lond. Lancet, 1866, p. 69, B. F. Med. Chir. Rev., vol. i, 1870.
1835..	Owen	3	Lond. & Edin. Phil. Mag., 1835; Trans. Zool. Soc., vol. i, p. 315.
1835..	Wood	1	Lond. Med. Gazette, 1835, p. 190, May.
1835..	Farre	1	Lond. Med. Gazette, 1835, p. 382, December.
1835..	Harrison	1	Dublin Journal, viii, 1835-6; Lond. & Edin. Phil. Mag.; Am. Jour. Med. Sc., 1836.
1835..	Henle	1	Müller's Archives, 1835, p. 526.
1836..	Knox	1	Edin. Med. Surg. Journal, vol. xlv, 1836, p. 89.
1836..	Curling	1	Lond. Med. Gazette, February 13, 1836.
1840..	Bischoff	1	Medicinische Annalen, B. iv or vi, 1840, p. 232.
1841-2	Chazal	3	Personal letter. See section E.
1842-3	Bowditch	3	Bost. Med. & Surg. Journal, vol. xxvii, 1842, pp. 117-241, 1848
1842..	Allman	1	Mic. Jour. & Struct. Record, 1842, p. 92.
1843..	Marster & Svitzer	1	Bib. for Lager, Copenhagen, 1843, p. 336.
1851..	Luschka	1	Zeitschrift für wissenschaftliche Zoologie, 1857, 873.
1852..	Bellingham	1	Dublin Med. Press, &c.
1852..	Cruveilhier	3	Anat. Path. Gén., t. 2, 1852, p. 61, &c.
	Auzias-Turenne	1	Delpèch, Les Trichines, &c.
	Korherle	1	Do.
1853..	Gardner	1	Monthly Journal Med. Sc., vol. xvi, 1853, p. 473; Edin. Phil. Soc., 1853.
	Miller	1	See Kestner, p. 11.
1854..	Bristowe & Rainey	1	Trans. Path. Soc., Lond., vol. v, p. 218.
1854-5	Henle	1	Zeitsler für rat. Med., n. F., B. vi, 1855, p. 247.
1855..	Zenker	4	Virchow's Archives, B. xviii, p. 561.
1859..	Virchow	6	Die Lehre von den Trichinen, Berlin, 1866.
1859..	Wagner	1	Archiven der Heilkunde, No. 1, 1864.
1860..	Turner	6	Edinburgh Med. Journal, September, 1860.

Herbert found trichinæ in the cat in 1845, and Guelt in 1849.

In the hog, trichinæ were found in 1846 in the United States by Professor Leidy (Proc. Acad. of Natural Sciences of Philadelphia, 1846, p. 107), and (Ann. and Mag. Nat. Hist., 1847, p. 358). Diesing (Systema Helminthum, i, 1851, p. 114) erroneously referred the worm to another species called *trichinæ affinis* (see Leuckart quoted in section C).

SECTION B.—NATURAL HISTORY, ANATOMY, AND PHYSIOLOGY.

Trichina spiralis, the name given to this nematode by Professor Owen, seems to be that most generally accepted by writers in all languages on this subject, although various other names have been suggested and adhered to by some. "Pagenstecher proposed 'trichinitæ' as a class with one genus and a single species. Diesing placed it in the genus *Prostheosacter*, and Davaine proposed to place it in the genus *Pseudalius* of Dujardin" (Delpech, p. 13) *Genu. Trichine*, pl. *Trichinen*, *Fr. Trichine*, pl. *trichines*. Spanish authors (Solá, *Patología General*, Madrid, 1877, p. 122) and translators (C. Houel, *Anatomía Patológica gen. y Aplicada* por Estaban Sanches Ocana) translate to *triquino espirol*.

"Genus TRICHINA (Owen)," (Davaine, C. I.)

"Body very small, slender, cylindrical, attenuated from behind forwards; skin smooth, mouth small, unarmed; tail of male furnished with two lateral appendages; no penis. Female larger than male; vulva situated in the anterior fourth of body; a single ovary.

"TRICHINA SPIRALIS Owen," (Davaine, C. I.)

"Adult state.—(Figs. 1 and 2). Body scarcely visible to the naked eye, cylindrical, anterior half gradually decreasing in size to the extremity; mouth round, unarmed, very small; posterior extremity truncated and rounded; anus terminal; intestinal tube straight, in three distinct parts; the first with the thin walls enlarging and diverging from before backwards, offering a triangular section, is the œsophagus" (Mundrohr, Pagenstecher, Leuckart); "the second part has walls formed of very transparent cellulæ, each with a distinct nucleus, occupies the anterior median portion of the body, corresponds to the small intestine" (œsophagus, Leuckart, Pagenstecher); "the third portion longer and narrower, with muscular walls enlarged at its origin and before its termination, corresponds to the rectum" (stomach, intestine and rectum. Pagenstecher, Leuckart).

"The male (Fig. 1) is 1.5^{mm} long on an average, and 0.04^{mm} in diameter; it differs in form from the female only in the posterior extremity, which offers in the male two digital appendages situated laterally, and between which passes the cloaca, which is reversed during copulation; penis absent; genital tube simple, with a single seminal vesicle in one mass, and a very long vas deferens.

"The female (Fig. 2) is 3^{mm} to 4^{mm} in length and 0.06^{mm} in diameter;



FIG. 1.—Mature male intestinal trichinæ.

the vulva is situated near the end of the anterior fifth of the body; ovary simple; the ovules, seen through the integuments in various degrees of development, have a diameter of 0.02^{mm} ; the embryo hatched in the uterus is 0.12^{mm} long and 0.001^{mm} (7 micrometers) 7μ thick in the middle and 3μ near the mouth, measured within 4μ of the anterior extremity.

"*Larval trichina* (Fig. 3).—A worm known for a long time; spirally coiled, 1.0^{mm} in length, and about 40μ in diameter; the three portions which constitute the intestinal tube are about equal in length as the three regions of the body to which they correspond; in the third portion, the rectal region (?), is observed a kind of tube which opens by a small slit anterior to the third region, near the termination of the small intestine (æso-phagus, L. & P.). This tube, mentioned by Luschka, figured by Bristowe and Rainey, then studied by Ordoñez, is the rudimentary genital organ. In the adult, the first and second portions undergo no changes except an increase in their diameter, but the third portion, when the sexual organs are developed, is elongated so as to form one-half of

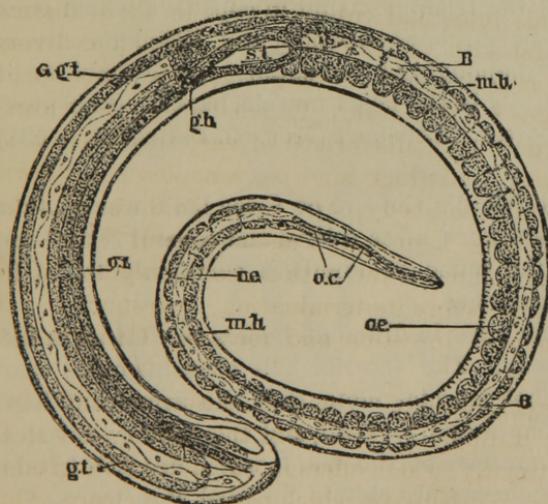
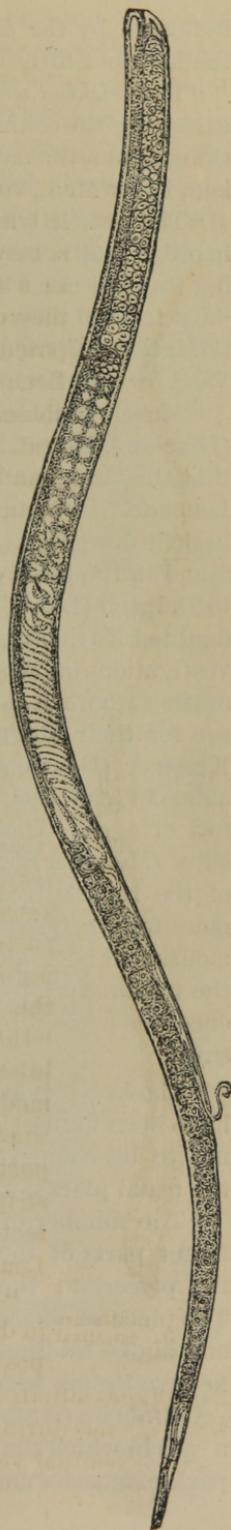


FIG. 3.—Fully developed female muscle-trichina: *oc*, oval cavity; *oe*, oesophagus; *m b*, median band; *st*, stomach; *g b*, granular body of Farre; *gt*, genital tract.

the body in the male and four-fifths of the body in the female. The orifice of the vulva,

FIG. 2.—Mature pregnant female intestinal trichina (Teuchkarf).



indicated by the slit in the larva, is thus drawn in the adult in front of the last four-fifths of the body."

"The *trichina spiralis* is the most dangerous of all parasites, not even excepting the echinococcus, and it behooves the physician to know something about the nature, origin, and development of this entozoon" (Aitken, Pract. Med., vol. i, p. 153). "Man's most dangerous enemy" (Kratz).

"The muscle trichina (Fig. 3) is the larvae of the *trichina spiralis*, and in order that it may become a fully-developed animal capable of producing its kind must be swallowed by some other animal" (Kestner, p. 16). "Up to 1860 they only were known, and we owe our first knowledge of the intestinal trichinæ and their manner of development to Professors Virchow and Leuckart" (Delpech *op. cit.*, p. 92).

"Muscle trichinæ occur exclusively in the striated muscle fiber" (Leuckart, Mensch. Parasiten B. ii, 3, p. 530). It has, however, been said that they are found in the heart. Virchow, Thudicum, Fiedler, Zenker, Leuckart (Untersuchungen, etc., p. 48), also Harrison *l. c.* Müller (Jahresbericht der gesamt. Med., B. i, 1870, p. 494) reports numerous trichinæ found in the heart of a hog in Magdeburg. Virchow has since remarked to Delpech (Les trichines et la trichinose, Paris, 1866, pp. 13, 14) that he doubted if trichinæ are found in the heart, and that while pursuing investigations on this subject a worm may easily be transported to a preparation where it does not belong, and gives sufficient anatomical reason for their absence, viz, the lack of connective tissue in that organ. Kraemer (Deutsche Klinik, 30, 31, July, August, 1872) found five trichinæ in (on?) the muscular substance of the heart, and one of them was full of eggs. Their presence was due to carelessness in cleaning the slips (Meissner Schmidt's Jahrbücher, No. 165, 1875, p. 285). In none of the reported cases were the trichinæ found in capsules, which goes more fully to prove Professor Virchow's opinion, and Krämer's case is mentioned here with the accompanying proof against the probability of the trichinæ occurring naturally in the heart muscle, because their presence was noticed by the reporter. Leuckart (Mensch. Parasiten, p. 531) says:

"The heart is as good as free, for the two or three little worms that have been found (Fiedler, Leuckart) after a long and careful search are not to be compared with the immense numbers commonly found in the usual places of their occurrence.

"The number of trichinæ varies in different bodies as well as in different parts of the same body. The anterior half contains more than the posterior; the abdominal muscles more than the arms and legs. The place of choice is the diaphragm, cervical, and masticatory muscles, and above all the smaller muscles of the trunk which are rich in connective tissue, which in some cases are closely crowded with worms."

Cohnheim (Arch. für path. Anat. und Physiol., Bd. 36, § 168) mentions a case in which the trichinæ were more numerous than the fasciculi. The parts of muscles most infected are where the fibers join the tendons (*L. l. c.*).

Professor Dalton (Trans. N. Y. Acad., 1864) found 12 trichinæ in a piece of muscle $\frac{1}{2}$ inch square by $\frac{1}{50}$ inch in thickness, giving 85,000 to a cubic inch. Leuckart (Untermelle, etc., p. 34) in 0.006 gram of muscle found "not less than 60 worms, and yet in no place did it appear strongly trichinosed, and estimated that 1.5 kilos. would contain about 15,000,000 trichinæ, or about five million to one pound. Bowditch (Boston Medical and Surgical Journal, vol. XXVI, 1842, p. 121) estimates 7,680,000 in his first case." Thudichum estimated 40,000,000 in the body of a German who died in the London Hospital, and Cobbold (*op. cit.*, p. 161) thinks "that 100,000,000 would come nearer the figure, as a needle could scarcely be thrust between the capsules, they were so abundant," and p. 170, that "an ounce of hog's muscle from Dr. Dickinson's case contained 85,000 trichinæ." Belfield and Atwood (Report of the Chicago Board of Health, 1878) found 35 to 13,000 parasites in a cubic inch of muscle. Sutton (Report on Trichinosis, Reprint from Trans. Indiana State Med-Soc., 1875) estimated 100,000 in a cubic inch of muscle taken from the gastrocnemius of a female patient. Schaan (Thèse de Paris, 1872, p. 20) counted 19 trichinæ in 0.05 gram of meat, and estimates, allowing two-thirds for fat and bones, that a hog weighing 150 kilos. (300 pounds) would contain 13,000,000 trichinæ. Leuckart says (Mensch. Parasiten, p. 532, B. II):

"Owens's estimate [100,000,000] was behind the reality, for in one case observed by myself there were about 1,200-1,500 trichinæ capsules in one gram (15 grains) of flesh, which, allowing 40 pounds for the weight of the muscle, would give 30,000,000. * * * Fiedler estimated 94,000,000



FIG. 4.—Masseter of rabbit recently infected with trichinæ 150 diameters (Kestner).

in Zenker's case, * * * and these estimates, although large, will not be doubted by any one who, like myself, has had the opportunity to count 60 trichinæ in a strip of muscle weighing 10^{mgr}, or 12-15 capsules in a piece scarcely more than a millimeter in diameter torn with a harpoon from the masseter of a trichinosed rabbit." According

to Vogel a piece of muscle the size of a pin's head may contain 12,000 trichinæ. Leuckart (*Untersuch.*, note p., 83).

"These worms may be found free in the muscular tissue in recent



FIG. 5.—Human muscle with trichinæ (Virchow).

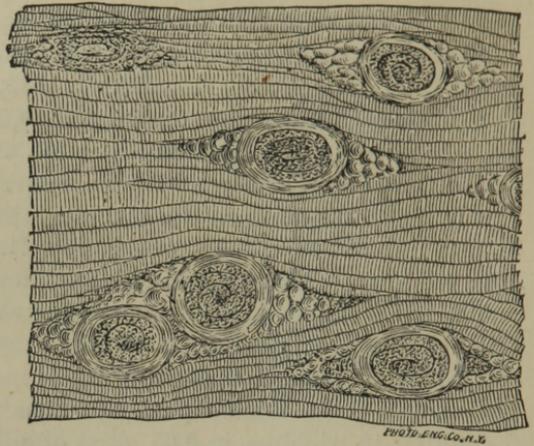


FIG. 6.—Calcified trichinæ capsules, oval and round, X 30 (Leuckart).

cases (Fig. 4), but as a rule they are encapsulated. In old cases the capsules may be seen with the naked eye as small white dots in the red of the surrounding muscle (Fig. 5). This appearance is due to the deposit of particles of lime salts, which by the addition of a weak

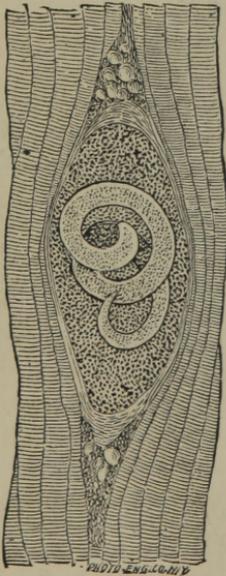


FIG. 7.—Muscle trichinæ in situ (Leuckart).

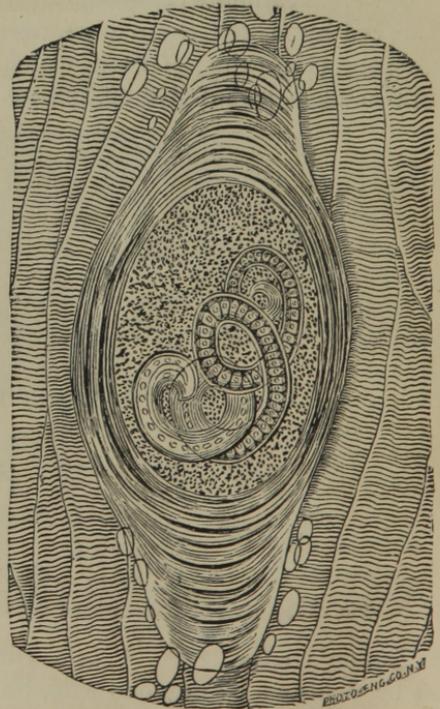


FIG. 8.—Cyst magnified 300 diameters, commencing deposit of fat cells at the extremities of the cyst (Kestner).

solution of HCl, are dissolved when the bodies lose their opacity. Previous to calcification the capsules cannot be seen by the unaided eye.

Under the microscope with a power of 10 to 12 diameters these points appear as oval or spheroidal cysts, inclosing a small round worm, coiled spirally, whose outlines are more or less distinct according to the degree of calcification (Fig. 6). Leuckart (Mensch. Parasiten).

“The capsules found in human muscle are oval, as a rule, with the long

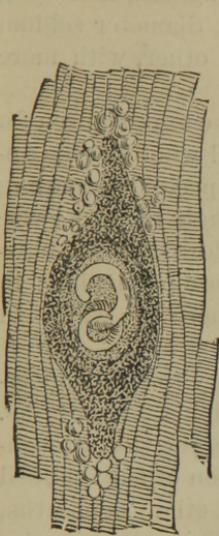


FIG. 9.

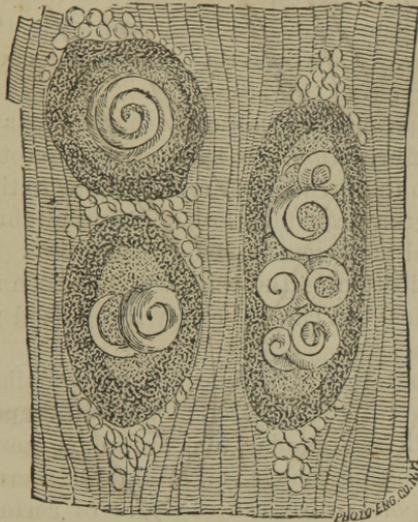


FIG. 9.

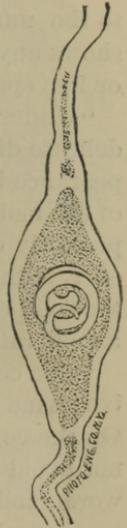


FIG. 10.

FIG. 9.—Calcified human trichinae capsules of different forms, 1×200 (Leuckart).

FIG. 10.—Sheath of sarcolemma with recently encysted trichinae from human muscle, (Dalton).

axis lying in the direction of the fasciculi (Figs. 7, 8); the poles are usually more or less drawn out to a pointed top, which sometimes gradually enlarges in the center to inclose the cyst, and at others butts against the body of the capsule so that the whole takes the form of a citron. By reduction of the pointed extremities, and an increase in the central portions, these oval capsules pass through various intermediate forms to the spherical, which are found mostly in cats and in rats, but are also found among the oval forms in man (Fig. 9). These capsules do not lie free in the connective tissue, but are contained within the sarcolemma (Fig. 10), which on account of the difference between its diameter and that of the growing capsule exercises more or less pressure on the latter, causing more or less deviation from the spherical form, as this pressure is exercised to a greater or less degree” (L. l. c.) (Fig. 11).

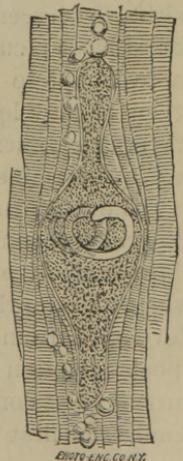


FIG. 11.—Trichina capsule of unusual form from rabbit (Leuckart).

“The size of the capsules varies even more than their form. With a diameter of 0.2 to 0.4^{mm} there will be a difference in length from 0.3 to 0.8^{mm}. The normal average may be taken at about 0.4^{mm} for length, and 0.26^{mm} for breadth. The difference in form relates more to the external outline than the cavity, which in almost all cases has a

simple, more or less, shortened oval form, which gradually decreases in size through thickening of the walls, which latter may reach a thickness of 28μ .

"When, as sometimes occurs, the capsule contains more than one worm—two (Bowditch), three (Farre), and even four and five worms have been observed in the same cyst—it is more or less elongated, according to the number of the contained trichinæ, while the diameter seldom shows any increase. As a rule they lie behind each other, with more or less space intervening (Fig. 9).

"Under higher powers the wall of the capsule has the appearance of a delicate diagonal fibrillation. It is, however, doubtful whether this appearance is due to the presence of real fibres or to the peculiar grouping of the molecular granules which are distributed through the otherwise perfectly clear and homogeneous basis substance. More distinct, however, is the stratification of the wall, which is seen more particularly in the solid extremities, but can be easily recognized where the wall is of a moderate thickness.

"The capsule containing trichinæ bears no similarity to the connective tissue envelopes of the cysticercus and other peripheral helminths. On the contrary, it is so similar to a chitinous membrane that we cannot avoid the conclusion that it is a product of secretion of the inclosed worm, and corresponds with the capsules of certain other helminths, particularly the Tetrarhynchice and Trematodes. This view is also supported by its reaction with caustic alkalies, and also that it is changed but little by an increase of temperature."

The lime salts deposited, after a time produce a granular condition of the walls; but these lime granules should not be confounded with the molecular granules above mentioned, as they are larger and disappear with effervescence on the addition of the stronger acids. They are found most plentiful in the extremities and in the outer layers, and in more complete calcification the whole wall is thoroughly impregnated, when it may lose its transparency; yet the outlines of the inclosed worm can generally be made out and the true nature of the body be easily determined.

"The calcification is not uniform in any case, and, as may be seen by experiment, some capsules will be thoroughly impregnated, while others show scarcely a trace of the deposit. This will be the better understood when we remark that the capsule has an independent vascular system developed from the interfascicular capillaries. This network has no special relation with the capsule proper—which is independent of the surrounding connective tissue—but spreads over the envelope of sarcolemma, as first observed by Farre (Fig. 12). Sometimes this external envelope is very much increased in thickness, so that the diameter of the cyst is increased by one-half. At the poles of the capsules when the muscle fasciculi are separated to receive them will be seen numerous fat globules (Figs. 6, 7, 8). At the same time the vessels will be seen spreading over the surface of the capsule in the form of a network, which

has its greatest development in the equatorial zone. Generally only one vessel is seen at each pole, an afferent and an efferent, corresponding in size to the muscle capillaries, so that they may be considered as artery and vein. When more than one is found their combined caliber rarely exceeds that of a muscle capillary.

“The cavity of the cyst contains besides the worm a finely granular, tolerably clear fluid, with numerous ellipsoidal bodies 10 to 15 μ in length and 5 to 8 μ in diameter, which through the clearness of their outline and the existence of a distinct body, sometimes double, of a cellular appearance, and by its resistance to acetic acid, may be recognized as a nucleus. They are probably the nuclei of the disintegrated muscular fibers. This fluid, on the addition of alcohol or glycerine, coagulates to a jelly-like mass, in which we are sometimes so fortunate, after careful section, as to have a complete impression of the inclosed worm.

“In capsules taken from fresh, warm muscle there will be more or less motion of the anterior extremity of the worm, and it may even change the position of its whole body. In other cases the worm will be seen in coils of four or five turns, and motion will be observed, perhaps, only after moistening with warm water or solutions of caustic potash. This condition of rest is that most usually seen and generally depicted by observers.

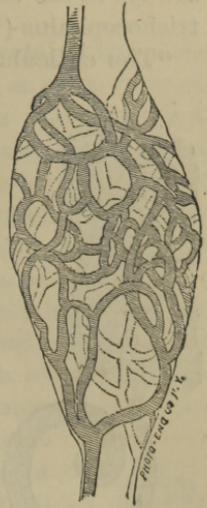


FIG. 12.—Network of vessels surrounding a primitive fasciculus just before encapsulation begins.

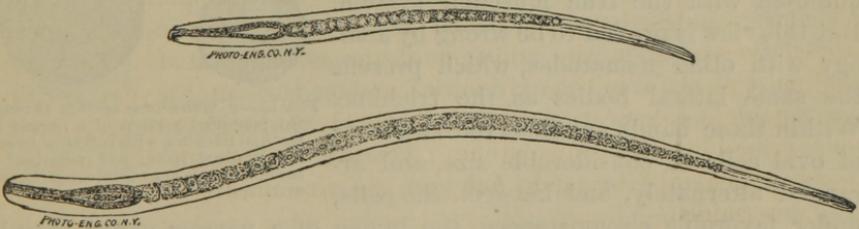


FIG. 13.—Young trichocephalus dispar 16 days after feeding, $\frac{2}{3}$ (Leuckart).

“The inclosed worm (Fig. 3) is 0.8 to 1.0 mm in length. The anterior half is more slender than the posterior (which measures 33 μ), and gradually decreases in size to the head, which can readily be distinguished at first sight from the posterior rounded extremity. At either end will be seen a small opening continuous with a delicate tube of chitin, which extends through the whole length of the body. The general external and internal organization resembles the early forms of the trichocephalus (Fig. 13), excepting that the latter is extended, while the trichina is more or less coiled up, and retains this position even when freed from its capsules, which is most readily accomplished by scraping and chopping the trichinous meat and washing out the worms. The position of the intes-

tine leaves no doubt that the concave side of the curved animal is the back, which, as has already been remarked by Bristowe and Rainey, is always in the same direction as is the case with the full-grown male trichocephalus (Fig. 14).

"The cuticula covering the body is thin (1μ), transparent, and, excepting its delicate annulated appearance, is of a perfectly homogeneous nature. The presence of the rings is easily overlooked, excepting where they are increased in depth by the contraction of the concave back of the worm. Internally the wrinkled cuticula is covered by a layer of tolerably clear substance, which in its deeper portions shows a distinct longitudinal striation, and incloses numerous bodies (nuclei?). I am not prepared to state whether this is muscle or not. Pagenstecher (see description of intestinal trichina further on) describes another layer of compact oval cells (1.5 to 3.6μ) within the so-called muscular layer, which serves as a lining to the cavity of the body (abdominal cavity).

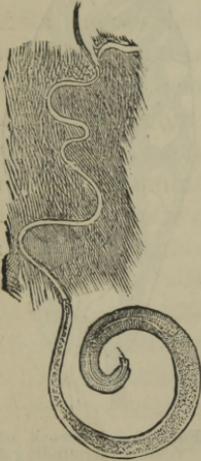


FIG. 14.—Male trichocephalus dispar (Leuckart).

"On the lateral surfaces the muscular coat is interrupted by two broad bands (12μ wide) (*b*, Fig. 3), which project into the cavity of the body as flattened tubes (*a*, Fig. 15), reaching from one extremity of the worm to the other. Bristowe and Rainey, who first observed them, thought that they were the muscles of the trichina, and Pagenstecher considered them muscular, although well acquainted with the true muscular system. But this view is proved to be wrong by analogy with other nematodes, which present the same lateral bodies as the trichinæ. Within these bands are observed two rows of oval cells of considerable size, and arranged alternately, and between the cells, under favorable circumstances, the lumen of a narrow vessel may be seen, whose serpentine form can be traced beyond the cellular band to a delicate opening in the ventral side of the body in the vicinity of the neural ring (brain) which surrounds the middle of the oval cavity (Mundrohr).



FIG. 15.—*a*, transverse section through the posterior portion of a female intestinal trichina, with intestine, ovary, longitudinal band, and muscles; *b*, same of female muscle trichina (Leuckart).

"Besides these bands we may also in the transverse section, on close observation, distinguish a couple of median lines (*b* Fig. 15), which separate the muscular layer through the whole length of the worm.

"The viscera fill the cavity of the body [abdominal cavity] so completely that their external surfaces are in contact with the inner surface of its wall; only at the extremities is there any space left, which, besides a few masses of cells lying against the wall, contains a clear, highly refractive liquid, which may be correctly considered the analogue

of the nutritious fluid of other nematodes. In many cases, also, a thin layer of this fluid may be seen under the lateral walls of the body.

"The intestines and organs of generation hang free in the cavity of the body, being attached only at their extremities.

"The most striking and peculiar part of the intestinal canal is the œsophagus (l'intestine grêle, Davaine) (*æ*. Fig. 3), which extends through more than half the length of the body, and except the posterior third, which incloses the stomach (Chylusmagen) (*st*. Fig. 3) and genital tube, leaves free only a small portion of the anterior extremity. The oval cavity (Mundrohr) (*o. c.* Fig. 3-16) from which this cellular body proceeds, appears as a clear cylinder of small diameter, which sometimes is straight and at others more or less crooked from contractions of the part which contains it, and fills up the space otherwise filled with the nutritious fluid. Within this cylinder is contained a double contoured narrow tube of chitin, which connects the almost punctiform mouth with the œsophageal tube; the latter, commencing at the anterior extremity of the cellular body and instead of a muscular coating, passes beside it through its whole length. The muscular nature of the oval cavity (l'œsophage, Davaine) is very indistinct; the wall appears clear, and, except the posterior part, which shows signs of radiating lines, is completely homogeneous.

"Near its middle this elongated cavity is surrounded by a clear annular body, containing distinct cells, which are connected with the wall. There can be no doubt that this is the nervous center of the trichinæ (B, Fig. 16), as Pagenstecher traced some nerve filaments which passed thence backwards and forwards on the wall.

FIG. 16.—Anterior extremity of trichinæ (Leuckart).



FIG. 17.—Beginning of the stomach (Chylusmagen) with lower end of œsophagus and cell body (Leuckart).

"The peritoneal covering of the first portion of the intestinal tube extends over the œsophagus and cell body in the form of a thin sheath, and on account of the swelling of the individual cells has an irregular, knotty appearance. Farre considered the œsophagus of the trichinæ as analogous to the colon. (See sec. A.) The cells are pressed together lengthwise and are about one-half as long as broad (30μ), and not infrequently are wedge-shaped.

"The contents of the cells are distinctly granular, sometimes clear and at other times darker, not only in different individuals, but in different cells in the same individual, showing a probability that they are subject to frequent and rapid changes in connection with the conjectured absorption of nutritious substances, which are easily seen on account of the thinness of the œsophageal tube. The sac-like nuclei of the cells 25μ in diameter, with their distinct nucleoli appearing as bright specks, are seen through the granular mass.

“The posterior end of the œsophagus forms at each side, at the beginning of the stomach (Chylusmagen), a nipple-shaped prominence, which is considered by many observers (Luschka, Küchenmeister, Pagenstecher) as a cæcal protrusion of the fundus of the stomach, although their solidity and the presence of a sac-like nucleus indicates that they belong to the cell body, and are nothing more than cells, distinguished from the rest by separation on account of lack of pressure, and consequently more prominent position.

“The posterior portion of the body is filled as completely by the stomach and genital organs as is the anterior part by the œsophagus, without, as might be expected, any considerable increase in the diameter. The stomach (Fig. 17) presents a flask-like enlargement at its anterior extremity, which is of nearly the same diameter as the œsophagus, and presents a large cavity, while that of the latter appears as a capillary tube.

“Covering this structure is a structureless *tunica propria*, a direct continuation of the peritoneal sheath of the œsophageal apparatus, within which is seen a moderately thick, sharply-outlined layer, containing a greater or less number of yellowish, shining, fat globules, which appear in some localities, especially in the fundus of the stomach, as a layer of flattened cells, as has been observed by Luschka.

“The posterior extremity of the intestine, although differing a little externally from the stomach, is histologically a very different structure. It has, like the oval cavity (Mundrohr), an external thick muscle-like wall, and is lined by a narrow tube of chitin which is continuous through the arms with the external cuticula. It forms the rectum of the trichina.

“The genital organs, which usually in the larval stage of nematodes are only primitive, have in the trichina an unusual development (Fig. 18). They consist principally of a gland in the form of a broad sac in the convex ventral side, which extends through the whole posterior part of the body and crosses the intestine to the opposite concave side of the body. Although thicker than the intestine and of a different appearance, it has hardly been seen by former observers, except Luschka, and even he gave a very imperfect description of it, because he overlooked the fact that this sac ended anteriorly in a thread like extension which represents the later developed excretory apparatus, and that through the peculiarity of its appearance the sexes might be distinguished. Yet they are very similar in the male and female. In both it consists of a cylinder of delicate membrane 25μ in diameter, filled with pale uncleated cells 3μ in diameter (Claus, Canstatt's Jahresbericht der Med. für 1865, B. iv, § 178,) and ends in a blind sac or pouch at the beginning of the rectum, lying free in the abdominal cavity. The anterior portion, which reaches to the fundus of the stomach, becomes narrower, and in the older muscle trichinæ, with calcified capsules contains a considerable number of sharply contoured corpuscles of irregular form and

strongly refractive, which was observed by Farre and thought by him to be the ovary (Fig. 19). The true nature of this structure is unknown. Even its chemical constitution has not been discovered, and it is uncertain whether it is an excretion or whether it is a result of a fatty metamorphosis of the cellular contents of the genital gland. Only so much is certain that they have no connection with the future growth of the sexual organs nor with the development of the ova, and are not reached by the larvæ.

“The excretory apparatus proceeding from the anterior extremity of the genital gland appears in the female muscle trichina (Fig. 2) as a direct prolongation of the genital sheath, while in the male (Fig. 1), at a short distance from the granular body of Farre, it turns sharply on itself and is connected with the anterior part of the rectum (Fig. 18). This duct in the female not only has another direction, but passes between the cell body and the ventral wall to the anterior part of the body. Its anterior extremity cannot be seen even with a microscope, and I think it is not yet in connection with the abdominal wall. The histological character of this body is not as yet well defined either in the male or female. It consists of a fine row of cells which only in the vicinity of the genital gland shows the traces of a lumen, but otherwise appears as a solid structure.”



FIG. 19.—Receptaculum seminis with sperm and ova (Leuckart).

“As long as the trichina remains in the muscle and occupies his cyst his condition remains unchanged.” (Leuckart, *Mensch, Parasiten*, ii, § 546.) Instances are recorded showing a remarkable tenacity of life in calcified capsulated trichinæ. Professor Leidy found the trichinæ alive in most cases observed by him. Virchow (*op. cit.*, p. 39) says, “In almost all cases in man where I have found calcified capsules the trichinæ were alive”; and Leuckart (*Untersuchungen*, etc., note, p. 63), “We have heard of cases of living trichinæ where the patient had been attacked 8, 13½,



FIG. 18.—Posterior extremity of male trichina with cloaca, and vesicula seminalis full of cells (Leuckart).

and even 18 years previously.” (See *Arch. für path. Anat.*, 1864, B. 29, § 602; B. 30, § 447; 1865, B. 32, § 363. *Vierteljahreschrift für gericht. und öffentlich. Med.*, 1864, B. 25, § 102.) Damman (*Deutsche Zeitschrift*, B. 3, § 92) found living encapsulated trichinæ 11¼ years after feeding. Trichinæ have also shown great tenacity of life in decomposed meat. (Report of Vienna Committee, 1867.) “After remaining for months in putrified flesh they did not lose their vitality.” Goujon (*Thèse de Paris*, 1866) succeeded in infecting with trichinous meat 80 to 100 days after it became putrid. Klopsch (*Virch. Arch.*, B. xxxv, § 609) reports live trichinæ after 25 years.

This shows a wonderful vitality for this minute worm, and when its surroundings are considered seems almost incredible. But the question might arise, "Are these the same trichinæ that were first deposited, or the product of a more recent infection? or is there an epochal development, as Cohnheim thinks, but reaching through a longer space of time; and may not the old decayed capsules and trichinæ in various stages of degeneration, observed by Bristowe and Rainey, as well as the non-calcified capsules and non-capsulated trichinæ found by Leuckart and others, be the result of separate infections or new generations?" (See, also, Renz, *op. cit.*, p. 41, and Cohnheim, *Virch. Arch.*, xxvi, 1866, p. 161.)

Muscle thus containing the encapsulated worms reaches the stomach more or less abraded by mastication, and is dissolved by the gastric juice which liberates the non-capsulated trichinæ, as well as the capsules containing trichinæ. By experiments outside of the body, Professor Wedl (Report to Med. Soc. of Vienna, 1867) found that the free trichinæ were acted on and killed by the gastric juice, while it only served to dissolve the capsules in other cases, and thus set free the contained worm. It may perhaps act in a similar way in the stomach; as Goujon (*l. c.*) has observed that encysted trichinæ are more liable to infect than the non-encysted. According to Leuckart (*Untersuch.*, p. 61), muscle trichinæ must be fully grown before they will be capable of producing infection. Davaine (*op. cit.*, p. 749) says that "the trichina has three phases of existence, and it is only in the cyst that it attains the full development of the second period which renders it capable of entering into the third," or mature sexual period. The irregularity of results in feeding by different observers may thus be due in some cases to the use of undeveloped muscle trichinæ. Pagenstecher (*op. cit.*, Tables, pp. 54-58-60) reports seven cases in which he fed animals with meat containing such worms without results, excepting in one case. The experiments of the committee of the Vienna Medical Society (Vienna, 1867, pp. 23-36) gave negative results after feeding with immature muscle trichinæ, and according to Davaine (*l. c.*) "Drs. Goujon and Legros have had nearly similar results after feeding rabbits, Indian pigs, and rats. The very small number of trichinæ found in these animals proving that a few only of the larvæ had attained their maturity." Pagenstecher (p. 81) thinks it possible that the nature and condition of the heat may have an influence in such cases.

The liberation of the trichinæ corresponds with the time required for the solution by the gastric juice of the albuminous substances of the muscle, which, according to Flint (*Text-book of Physiology*, p. 250), takes from one and a half to five hours. Renz (*op. cit.*, p. 27) says: "We will not be far-out of the way if we say that the trichinæ are liberated from their capsules in four or five hours." Virchow (*op. cit.*, p. 43) found free trichinæ in a cat six hours after feeding. Leuckart says: (*Mensch. Par. II*, p. 547) "They are found free in the stomach in considerable numbers three or four hours after feeding." There are

some cases wherein the symptoms commence very early, as in one case in Hadersleben two hours after eating the infected meat, which would lead to the conclusion that the trichinæ were liberated much earlier unless,

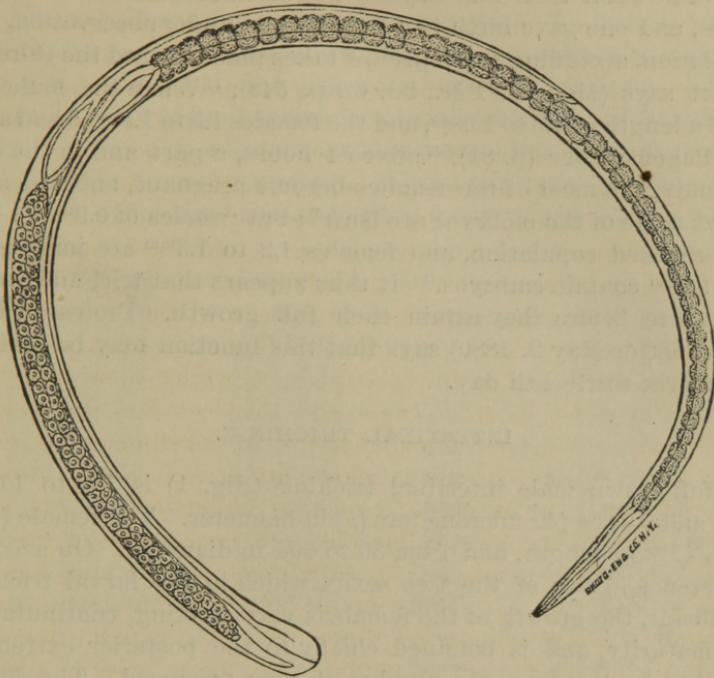


FIG. 20.—Female trichina 24 hours after feeding (Leuckart).

as is considered by Friedrich (*Deutsches Arch. für klin. Med.*, bd. ix, p. 459), who saw evidence of the eyelids on the first day, that these earlier symptoms are due to a poisonous substance liberated from the capsules; and Fürstenberg (*Wochenblatt*, etc., in den Königl. Preuss. Staaten, 1865, No. 21) thinks that some of the earlier deaths, when there is a small amount of peritonitis, are due to poisonous substances in the lymphatics (see section D, pathology). “After becoming free the trichinæ pass into the small intestine. Then commences the rapid increase in the size of the worm by the development of the sexual organs, and thus the increase in length is limited principally to its posterior portion, while the anterior increases in diameter only (Davaine, Pagenstecher), and in twenty-four hours after feeding (Leuckart, p. 39) they may have increased by one-half their former size (Fig. 20), and for the most part capable of procreation, although immature worms and even capsules may be found in the small intestine after the third day. Virchow (*op. cit.*, p. 10) found completely developed trichinæ in the intestine of a dog which died three and a half days after infection. Leuckart (p. 20, 21) found “no larvæ in the intestine of a dog which died on the fourth day after infection, but female trichinæ full of eggs and embryos, and (*op. cit.*, p. 76) mature trichinæ in a hedgehog on the

third day. Cobbold (*op. cit.*, p. 161) found sexually mature trichinæ sixty-nine hours after feeding, while Hun (Trans. N. Y. State Med. Soc., 1869, p. 138) found fully-developed male and female trichinæ in the intestine of a rabbit after four days." The females were full of eggs and embryos, and one gave birth to a brood while under observation.

Copulation, according to Delpesch, "takes place toward the third day." Leuckart says (Mensch. Par., bd. ii., p. 548), "When the males have reached a length of 1.2 to 1.5^{mm}, and the females 1.5 to 1.8^{mm}," and according to Pagenstecher (p. 81), "after 54 hours, a part and in the course of 90 hours, the most of the females become pregnant, and in less than five days some of the embryos are born"; but "males of 0.9^{mm} in length have performed copulation, and females 1.2 to 1.3^{mm} are impregnated, and at 1.5^{mm} contain embryos." It thus appears that trichinæ are sexually mature before they attain their full growth. Professor Dalton (personal letter May 2, 1880) says that this function may be performed as late as the thirteenth day.

INTESTINAL TRICHINÆ.

The full-grown male intestinal trichinæ (Fig. 1) is 1.5 to 1.6^{mm} in length, and 0.04^{mm} (40 micrometers (μ) in diameter. The female (Fig. 2) is 2.5 to 4.0^{mm} in length, and from 30 to 60 μ in diameter. On account of the difference in size of the two sexes, which in the larval trichinæ is insignificant, the growth of the female is very striking, continuing after sexual maturity, and is confined chiefly to the posterior extremity to make room for the immense number of eggs produced. The diameter changes but little. According to Pagenstecher (*op. cit.*, p. 81, *et. seq.*) its natural history, etc., is as follows:

"The body of the intestinal trichinæ increases in size from before backwards, but less rapidly beyond the middle, to end in a blunt rounded extremity, while the anterior extremity narrowing to 10.—12.5 μ ends in a constricted lip-like papilla (Figs. 27, 32).

"The external covering of the trichina, as of all nematodes, consists of a fine structureless transparent annulated membrane, the so-called chitin membrane. The annular structure becomes more apparent by rapidly drying the worm, or by evacuating its contents, and disappears when it is entirely filled, thus allowing the female to change her form when pregnant. The rings or wrinkles are more readily seen in the muscle trichinæ. The thickness of this layer in intestinal trichinæ is nearly 1 μ . Beneath this is a very thin muscular layer which, according to Leuckart, is striped longitudinally. Within the latter is a layer of finely nucleated oval cells closely pressed together, and having a diameter of 2.5 μ , and a length of 3.5 μ corresponding to the length of the body. It forms the lining of the abdominal cavity.

"In the muscular layer is seen a very peculiar band, which, commencing on one side, apparently near the muscular portion of the œsophagus, appears to blend with the muscular layer, and, passing backwards, curves

near the anus and passes forwards on the other side to the opposite side of the œsophagus. This band measures on an average one-half to one-fourth the diameter of the body; its borders appear as two well-defined lines. A closer examination reveals that it is composed of closely pressed alternating cells, measuring, when the body is stretched out, about $20\ \mu$ in the direction of its long axis, but otherwise may appear smaller and more round and present a very variable form. The cells show a small, very sharply defined nucleus, and are joined together by a very clear connective substance, and usually alternate, but sometimes are more closely pressed together. Within this band is seen the layer of small cells which line the abdominal cavity (Figs. 21, 22), and, run-

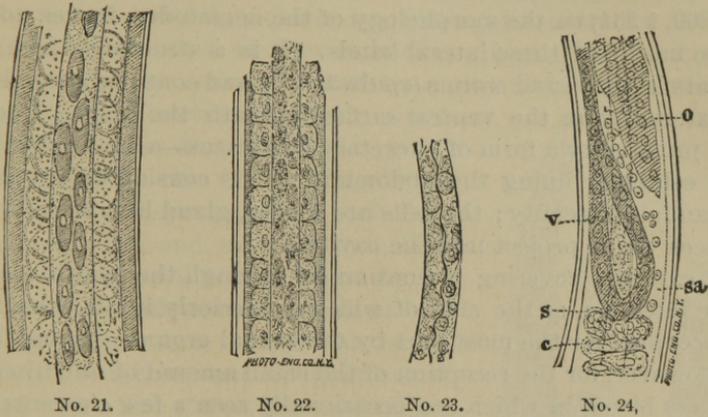


FIG. 21.—The lateral band in the region of the uterus showing ova and terminal elements ³²⁶ (Pagenstecher.)

FIG. 22.—The lateral band and cell bodies of the œsophagus.

FIG. 23.—Piece of longitudinal band from fore part of trichina isolated in the contracted condition.

FIG. 24.—Portion from the middle of a female trichina $\frac{1}{4}$ in; C, posterior extremity of cell body; S, the blind sacs; SA, blood globules; V, stomach; O, anterior extremity of ovary. (Pagenstecher.)

ning through it, sometimes a serpentine line is seen, which appears as an extremely fine canal (Fig. 23). I have as a rule failed to see this line, and never have seen either lumen or contents. This band or transverse section (Fig. 15a) appears very thin in proportion to its breadth, and does not give the impression of a vessel; an aperture has not been observed. On the contrary its contractility and the variable appearance of its elements shows that it is not passive during the changes of form which the worm takes on, and that it bears a close relation to the muscular system, and I am inclined to think that it is of a muscular nature, for it appears to me that the lighter changes of form, seen best in the ordinary motions of the head, in which the wrinkles appear and disappear, are caused by the action of the general muscular tunic; but on the other hand the sudden and violent bowing and twisting are caused by contraction of the side bands. This view is supported by the fact that it is lacking in those embryos having only a serpentine motion, that it is fully developed by the time the animal becomes fully coiled

previous to encapsulation, and continues in full operation up to the time of copulation, and afterwards, particularly in pregnant females, it takes on a somewhat relaxed appearance and becomes much less prominent. In case an aperture should be found, and consequently a canal exist, it might be presumed that its function was connected with encapsulation and intracapsular life."

[It would seem probable that the contraction of such a lateral band would bend the worm laterally, while, as before noticed, the animal is always coiled on his back, the belly forming the convex side of the coil. Leuckart (*Untersuchungen, etc.*, p. 76) says: "The opening with which we have lately been made acquainted, more particularly through the beautiful observations of Schneider (*Arch. für Anat. und Physiol.*, 1858, § 426, 1860, § 234) on the morphology of the nematodes, leaves no doubt as to the nature of these lateral bands. It is a structure which generally occurs in the round worms (*spulwürmen*), and contains a canal which opens externally on the ventral surface beneath the brain. The canal is in all probability a form of excretory apparatus—a kind of kidney."]

"The cell layer lining the abdominal wall is considerably developed at the caudal extremity; the cells are larger, gland-like, and form protuberances which project into the cavity.

"The external covering is continuous through the mouth and anus with the intestine, at the side of which posteriorly is left considerable space, occupied for the most part by the sexual organs. A small space is left, however, for the reception of the small amount of nutritious fluid or colorless blood, in which are occasionally seen a few elements in the form of granular corpuscles—the so-called colorless blood corpuscles (Fig. 24).

"In the male, where the vas deferens, a short distance in front of the anus, empties into the rectum, which latter acts as a cloaca, is developed a network of fine fibers between the muscular layer and the intestine, in which a few distinct bands are seen (Fig. 25), whose function seems to be the withdrawal of the projected cloaca after copulation—the *musculi retractores cloacæ*. Anterior there is no connection between the intestine and the outer wall.

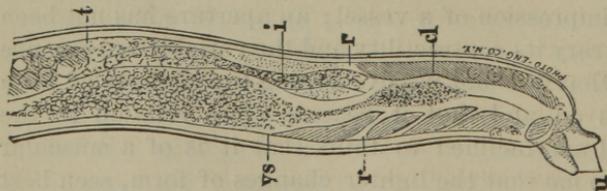


FIG. 25.

FIG. 25.—Posterior extremity of young male intestinal trichina, $\frac{3}{10}$: *u*, hooks; *cl*, cloaca; *r r*, retractores cloacæ; *vs*, vesicula seminalis; *t*, extremity of the testicle; *i*, intestine (Pagenstecher).

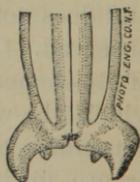


FIG. 26.

FIG. 26.—External male genital organs (Leuckart.)

"At the vagina the external walls are continuous with those of the sexual organs, and naturally the most external layer—the chitin layer—is continued as a lining of the digestive tract and sexual organs.

“The mouth is terminal. The body is more or less curved in one direction, and taking the female genital opening as a guide for the ventral surface the curve is always towards the back side, and it is in accordance with this that the terminal hooks of the male are found on the opposite side, and curving towards the convex and consequently ventral side. The anus is therefore terminal, although in the female on its dorsal side there is a small but distinct prominence. This is the rudimentary tail usually found in the nematodes. As a rule the posterior portion of the male is straighter or is curved in an opposite direction from that of the middle portion; especially is this the case during the period of sexual activity. It is then more firm, and displays a motion similar to that of the anterior.

“The male intestinal trichinæ are distinguished by the earliest observers by a pair of short curved hooks, or beaks, clear and colorless, which are attached by broad round bases on either side of the cloacal opening (anus), having a length somewhat less than the diameter of the posterior extremity of the body. They have a rotatory motion, yet as a rule their convexity is anterior and external, and their points are directed downwards and to the rear. At the inside of the base of each of these hooks there is a ventral and dorsal tubercle, so that the cloacal opening is surrounded with a line of four tubercles (Figs. 25, 26).

“The internal organs consist of the *intestinal canal*, the *brain*, and the *organs of generation*.

“The intestinal canal, with the exception of the cloacal portion in the male, is alike in both sexes, and has several divisions.

“The first portion consists of a muscular oval cavity (Munddarm), through which passes a lining of chitin, and after forming an annular widening at its commencement (Fig. 27) becomes very narrow until it passes the brain, when it becomes wider through enlargement of its lumen and thickening of its walls, in which cells now become very distinct, and by these changes gradually merges into the second portion. The second portion, less constricted than the first, has a very peculiar formation, concerning which authors have had widely different opinions, and which Luschka considered the ovary.” (Davaïne, *l. c.*, calls it the small intestine.) “The chitinous tube which lines the first part is distinctly seen passing through it. The surrounding layer of cells undergoes a peculiar change. It becomes one-sided and greatly developed. About 50 colossal cells, with one or several nucleated nuclei, filled with

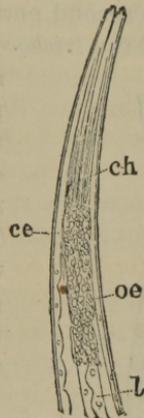


FIG. 27.

FIG. 27.—Anterior extremity of a young intestinal trichina ♀^0 ; *ch*, chitin, tube of the œsophagus; *ce*, broken; *oe*, œsophagus swelling up behind the brain; *l*, longitudinal band (Pagenstecher).



FIG. 28.

FIG. 28.—Entrance from œsophagus to stomach, with sacs, from a young intestinal trichina (Pagenstecher).

fine dark granules, form a single row, and are pressed together longitudinally, so that they sometimes appear to be wedged together, entirely surround this part of the chitinous tube, which lays at one side of the center (Figs. 1, 2, 3, and 20). These cells increase with the size of the body backwards, so that they entirely fill its cavity.

"These two parts of the intestine occupy in the young trichina about $\frac{2}{3}$ and in the older ones about $\frac{1}{2}$ the length of the body. If the body is shortened the anterior narrower portion becomes crooked to accommodate itself to the lessened length.

"The gradual transition of these two portions into each other leads us to believe that we have to do with no great peculiarity in the cellular surroundings of the alimentary canal. It is observed in other worms, as the *trichocephalus dispar*, and further comparative researches show that by a variety of development of these bodies there are many intermediate forms.

"I consider the second portion, as Leuckart Eberthe, the analogue of the œsophagus of the *trichocephalus*, except that the latter possesses a

more muscular and cellular or glandular part. It cannot be otherwise accepted than that the surrounding cells pour forth a secretion into the tube to be mixed with the nutritious substances contained therein. They may perhaps, at first sight, be likened to the salivary glands or to the simple glands of the stomach, although there is no common duct or other connection between the cells to show that they perform the same functions. Each cell must empty its secretion into the œsophagus through its walls. It must be borne in mind that for this apparatus, as well as for the lateral bands, the most characteristic appearance and complete functional activity is reached in the muscle trichinæ, and also that later its elements often appear less distinct and characteristic.

"In both sexes where the œsophagus ends in the third part of the intestine will be seen a pair of small pear-shaped sacs (Fig. 28), which, like the stomach, are lined with fine epithelial cells, and are thus distinguished from the cells which surround the œsophagus, although very similar to them in size and appearance. I find these

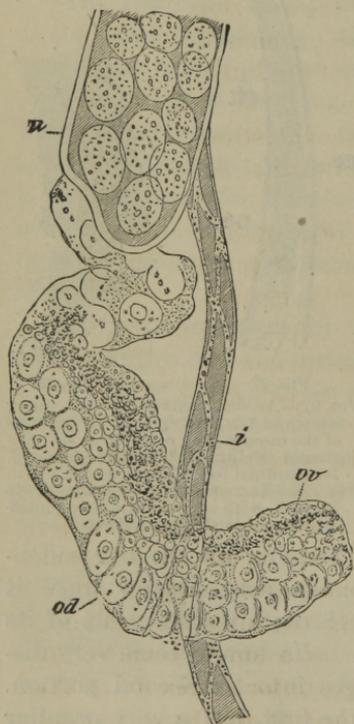


FIG. 31.—Posterior of the female internal organs of generation from intestinal trichina full of developed embryos, $\frac{3}{2}$: *ov*, line of egg production; *od*, oviduct; *u*, uterus; *i*, intestine, with elongated muscular elements in its walls (Pagenstecher).

as often and as complete as could be possible with such fine organisms.

"The beginning of the third portion of the intestinal tract can be

most properly considered the stomach (st., Fig. 29). It consists of a considerable pear-shaped widening of the canal, with thickened walls, its base towards the œsophagus, and between which the blind rows above mentioned are wedged. The stomach soon becomes narrowed to the form of an intestine, although its structure remains the same. It is lined throughout with fine nucleated cells, making its walls appear darker than the surrounding tissues (Fig. 30 *i*). The changes of form of this portion of the alimentary canal, independent of the contractions of the body, leads to the opinion that the epithelial lining is surrounded with a muscular layer, and the lower part sometimes shows the appearance of loose muscular fasciculi with intervening spaces (Fig. 31). While the œsophagus fills nearly the whole breadth of the abdominal cavity, and the first part of the stomach occupies over one-half of its diameter, the posterior part of the intestine of a full-grown female measures only 12.5μ . At the extreme end, whether the cloaca appears as in the male or not, the layer of chitina again becomes apparent, and in the male even to a greater extent. When the worm contracts itself, and the anterior part of the œsophagus takes a zigzag form to accommodate itself to the lessened space, the posterior part of the intestine forms a wavy line beside the genital organs.

"I have never seen a colored substance in the intestine, and it is probable that the worm feeds on the intestinal secretion and not on the remains of food.

"Leuckart's views concerning the presence of a brain I can most decidedly confirm. It appears as a mass of small round nucleated ganglion cells which surrounds the œsophagus where its walls begin to show the presence of cells, and from whose extremities a number of fine fasciculi can be traced a short distance. This body is inclosed in a special envelope (Fig. 32).

"The internal sexual organs of the male are completely formed during his larval life in the muscle, so that in the intestine it is only necessary that their contents become mature and the hooks developed in order that he may be ready for procreation. In the larval female these organs are only partially formed until it reaches the intestines, and thus different stages of completeness will be found among the intestinal trichina.

"The male organs (Figs. 33, 34, 35) consist of a single testicle, the base of which lies a short distance from the posterior extremity of the worm. It is long, cylindrical, somewhat widened at the base, and becomes narrower as it passes forward, and near the anterior portion of the stomach turns on itself, becomes still narrower, and passes backwards. In a full-grown male the testicle is 0.575^{mm} in length, while its average diameter is 35μ , but reaches 0.375^{mm} in some places, while in the vicinity of the vas deferens it is only 20μ . This gland in its whole length is lined and filled with small, strongly refracting seminal vesicles, which,



FIG. 32. — Brain with nerves extending backwards and forwards (Pagenstecher).

as mother cells, contain a brood of spermatic cell elements with nuclei (Fig. 36, *a*). The testicle merges into a vas deferens, which, in places, particularly before it empties into the intestine or cloaca, expands, and near its extremity forms the vesicula seminalis, and is filled with spermatic elements, which latter have not, as far as observed, been known to undergo any change of form (Fig. 36, *b*). The vas deferens, exclusive of vesicula seminalis, is 0.3^{mm} long, and when not distended is 12.5 to 15 μ in diameter, and when empty appears clear and lined with cells. Three-fourths of its length is occu-

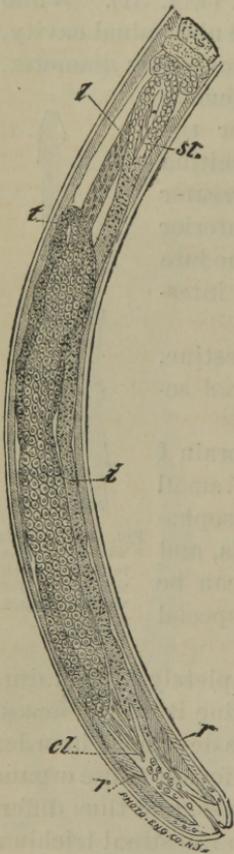


FIG. 33.

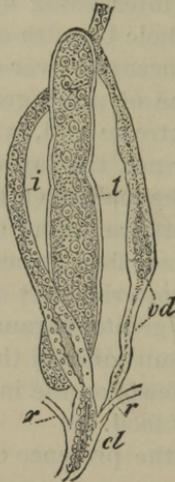


FIG. 34.

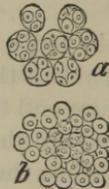


FIG. 36.

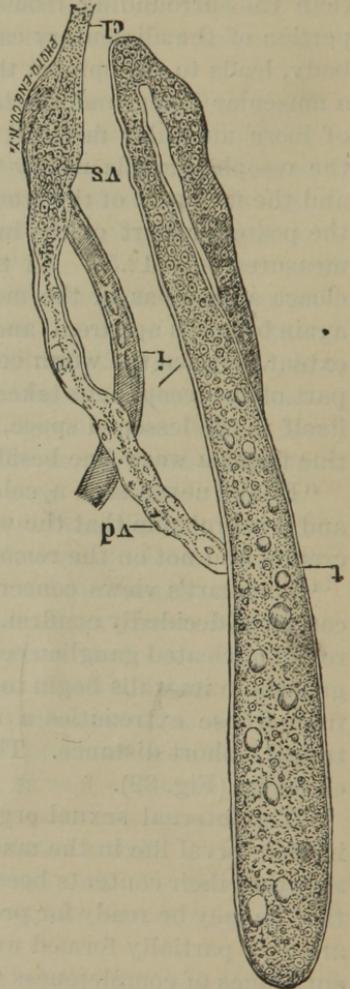


FIG. 35.

FIG. 33.—Posterior extremity of a male muscle trichina, 24^o: *l*, longitudinal band; *t*, the testicle passing into the vas deferens; *cl*, vas deferens ending in intestine; *i*, forming the cloaca; *cl*, *r r*, retractores cloaca; *st*, stomach (Pagenstecher).

FIG. 34.—The testicle, *t*; vas deferens, *vd*; cloaca, *cl*, with its retractores, *r r*; intestine, *i*.

FIG. 35.—Intestinal sexual organs of a young male intestinal trichina, 32^o: *t*, testicles; *vd*, vas deferens; *i*, intestine; *vs*, vesicula seminalis; *cl*, cloaca (Pagenstecher).

FIG. 36.—*a*, mother cells, 32^o; *b*, seminal elements, 19^o.

ried by the seminal vesicle, which, partly full and partly empty, with a constriction at its middle, reaches a diameter of 50 μ .

“When the vas deferens is seen thus enlarged but empty, and the hooks extended and spread out, it may be concluded that the semen has

been ejected. The great tenacity with which the male adheres to his place in the intestine, and the vivacity with which the female, already containing spermatie elements, views the approach of the male, shows that coition takes place repeatedly.

"The complete act of copulation I have never observed. I nevertheless have several times found masses of males and females entwined together, slipping over and encircling each other and performing a variety of motion. At the same time the posterior extremity of the male is stiffened and rhythmically projected and withdrawn, while his anterior extremity and the whole body of the female are very active, often coiling completely and uncoiling. The actions of the male while approaching the female consist in gliding the hind part of his body over the body of the female in a longitudinal direction, and embracing the latter with the terminal hooks, and when loosened, the cloaca is sometimes seen to project in the form of a minute bell or bladder, with seminal elements adhering (Fig. 37).

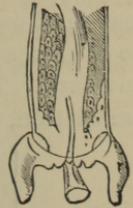


FIG. 37.—Posterior extremity of a young male intestinal trichina, showing the hooks, the line of tubercles around the anus and cloaca projected (Pagenstecher).

"The beaks or hooks on the posterior extremity of the male must be developed very rapidly, as they are seldom seen incomplete. Before their appearance the spot where they are to appear becomes thin, and then they are projected forth. When they are seen spread out it indicates that the worm is approaching or has performed the act of coition. Sometimes a slit may be distinctly seen on the posterior extremity of the female at the ventral side of the anus, on either side of which is a slightly projecting tubercle, the analogue of the hooks of the male.

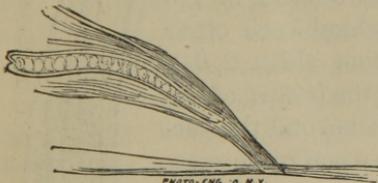


FIG. 38.—Anterior portion of developing vagina, with vulval opening (Pagenstecher).

"The female organs of generation consist of a single ovary, which is formed during its larval existence; a uterus, which develops from its anterior extremity; a vagina, which is developed independently backwards from the vulva, which already exists on the external surface. By a constriction between the ovary and uterus they are more perfectly separated than are the testicle and vas deferens, but the uterus merges gradually into the vagina. After complete development the uterus may be considered as a direct widening of the vagina. The whole series of organs lie in a nearly direct line.

"The ovary (Fig. 31 *OV*) in form and position bears a great similarity to the testicle, but reaches further to the rear—nearly to the rounded extremity of the body—but not so far forward, a large portion of the uterus lying behind the commencement of the stomach.

"The ovules—as Clann has correctly observed—are not produced exclusively in the vicinity of the fundus of the ovary, but are formed at one side of its wall in its whole length, where they first appear closely

pressed together in a narrow band (Fig. 31 *OV*), which on account of the fine molecules scattered among the cells has a darker appearance than the rest of the ovary, and near by are seen the more mature and detached ovules, so that the largest are found on the opposite side of the ovary and towards its anterior extremity. Thus the oviduct (Fig. 31 *Od*) is a part of the same organ. The ovules are roundish and contain a germinal vesicle with a very large nucleus surrounded by a clear vitellus and a very thin limiting membrane (Fig. 42 *a*). Between the ovules, seminal elements are sometimes seen in the lower part of the ovary. The cylindrical uterus is separated from the ovary by a constriction, so that the narrowed exit is somewhat bent (*geknickt ist*),

and its entrance into the uterus is overhung by the blind extremity of the latter. It is in this part of the uterus that the sperm is principally found after copulation, so that the ovules passing from the ovary must pass through it and be subjected to its fructifying influence (Figs. 2, 20). There occur thus in the uterus a further growth and development of the cells, and it is filled with ova in various stages of development, which, as they approach the beginning of the vagina, are freed from their envelope and appear as bent or curved embryos.

“A little in front of the posterior extremity of the œsophagus, where the uterus becomes narrower, they commence to straighten out and lie parallel to its long axis. Further on the narrowing becomes such (Fig. 38) that beyond in the vagina they lie singly behind each other and are born one at a time (Figs. 2, 39). During and after delivery the border of the sexual opening protrudes beyond the surface of the body forming a conical projection. The posterior lip is more fully developed than the anterior. The whole of the sexual tract is lined with small nucleated cells, which are somewhat elongated in the vagina and lie in the direction of its axis, but become somewhat indistinct at its extremity, so that at the vulva, which is only large enough for the passage of a single worm, no further structure can be seen.

FIG. 39.—Central part of the female genital organ of an intestinal trichina with the cell body surrounding the œsophagus, stomach, and lying over the uterus, which is filled with embryos, as is also the vagina (Pagenstecher).

“In animals of 1.4^{mm} in length, the passage between the ovary and uterus will be found about the middle of the body. The position of the vulva also changes in accordance with the size and degree of development of the worm. In trichinæ of 1.2 to 1.4^{mm} in length, in which as a rule the vulval opening is completed—

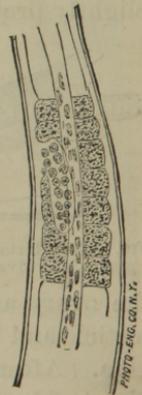


FIG. 40.—First appearance of the formation of the vagina towards the vulval opening (Pagenstecher).

although exceptionally some may have become pregnant when only 0.9^{mm} in length—its distance from the anterior extremity is between 0.175 and 0.3^{mm} ; in some 1.38^{mm} in length and almost 40μ ; in diameter it was 0.35^{mm} ; in one 1.9^{mm} the same; in one of 2^{mm} it was less than 0.5^{mm} . (In this case the uterus and vagina together measured 1^{mm} .) In one of 2.3^{mm} the distance was 0.4^{mm} , and 0.55^{mm} in one measuring 2.4^{mm} .

“The first appearance and growth of the vulva and lower part of the vagina can be clearly observed in young nematodes. At the place where the vulva is to appear there is seen an elongated mass of small cells, which is directed backwards (Fig. 40), but as yet no opening is seen. The uterus is now projected forward by the accumulating mass of ovules from the ovary. The separation of the uterus from the ovary is distinctly formed before the vulva is opened—about the time the worm coils up previous to encapsulation—but is not yet completed in some old muscle trichinæ. At this time there lies beside the stomach in the axis of the prolongation of the ovary, and separated from the latter by the constriction and Farre’s granular body, a small single row of about six or seven corpuscles, with distinct nuclei, which I have considered young ovules (Fig. 41), becoming more plainly visible after the worm has remained a short time in the intestine. At this time, before the two parts are joined, detached eggs of an oblong form may be seen. In forty-eight hours this phase of development is completed, and copulation may take place, followed by the birth of the young brood in five days.

“Many authors are of the opinion that there are many more females than males found in the intestine. This is true to a limited extent, although in our investigations the females, which are larger, and, on account of the contained brood, much darker and more readily seen, yet in the earlier periods I have found more males than females, for the former are not so easily evacuated with the diarrhœal discharges as the heavier females. In one case I found ten males to one female, but in others I have found many more females. I believe that in the beginning the sexes are very nearly equal, but that the males, whose functions are sooner completed, disappear earlier, and in later periods their number is more diminished than that of the females” (Pagenstecher, *op. cit.*, pp.81–89). Cobbold (*op. cit.*, p. 170) says: “One half become fully developed females in 48 hours after ingestion, &c.” Leuckart (*Mensch. Par.*, p. 548): “The males are more difficult to find than the females. In one case there were 5 times as many males as females, but in almost all cases more females are found, the more in proportion as we recede from the

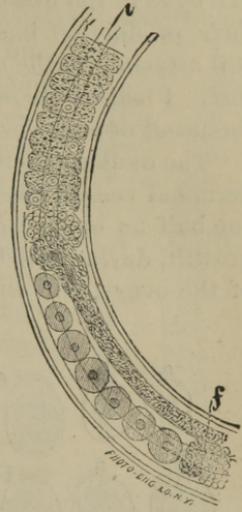


FIG. 41.—Portion of a female muscle trichina in which Farre’s body, *f*, is formed, and in which the 7 colossal cells which form the primitive trace of the uterus are seen; *l*, longitudinal band, 2^{q} (Pagenstecher).

period of infection. While in some cases 20 or 30 intestinal trichinæ may be examined without finding a single male, in others 4 and even 3 or 2 females only are found to one male." Delpech says "nearly nine-tenths of the muscle trichinæ are females."

DEVELOPMENT OF THE EMBRYO (PAGENSTECHEK).

"On account of the large number of eggs and the length of time during which they are produced, the development of the embryo from the ovule can be easily followed. We often count 500 to 600 embryos and free eggs in the uterus and ovary at the same time, even for weeks after their production has commenced and before its termination. Germs still attached to the ovarian wall may be seen eight weeks after infection. I believe therefore that one trichina may give birth to a couple of thousand of embryos at the rate of one to two each hour.

"The ovules, when detached, measure at least 10μ in diameter. The germinal vesicle about one-half as much, and the germinal macula about one-half as much as the germinal vesicle (Fig. 42 *a, b*). The further growth, during which the ovules are pushed towards the opposite side of the ovary, and towards the uterus, concerns more particularly the

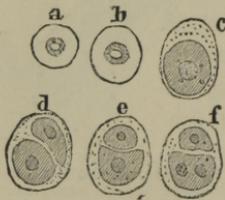


FIG. 42.

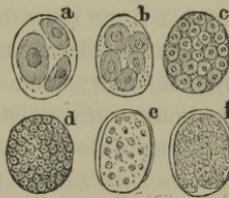


FIG. 43.

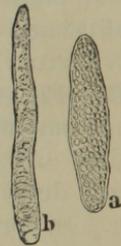


FIG. 44.

FIG. 42.—Development of the embryo: *a*, ovum, showing germinal vesicle and macula; *b*, the same increased to double its former size, with no material change in the vitellus; *c*, do. vitellus increased in size, with dark molecules, as it reaches the uterus; *d, e, f*, segmentation of the vitellus, 50° (Pagenstecher).

FIG. 43.—Development of the embryo. Further segmentation of vitellus; *f*, outline of embryo distinguished 50° (Pagenstecher).

FIG. 44.—Development of the embryo. *a*, the plump embryo consisting of a layer of chitin filled with cells; *b*, position of esophagus shown by a faint line of vacuoles 50° (Pagenstecher).

clear vitellus. After the ovule has increased to double its former size, and becomes somewhat elongated, a few dark molecules may be seen in the vitellus. By this time the ovule has passed into the uterus and becomes fecundated (Fig. 42 *e*).

"I have seen formations which lead me to suppose that the blastodermic cells result from the direct segmentation of the germinal vesicle. The vesicle is soon increased in size, and its outline becomes less distinct. The germinal spot can now only be seen on the addition of water. In eggs of a larger size is seen two vesicles, often of different sizes, with nuclei, which are flattened against each other so as to fill nearly the entire space (Fig. 42, *d, e*). The segmentation of the nucleus can be seen on the addition of water (Fig. 42, *f*). The segmentation goes on until as many as 50 cells may appear (Fig. 43, *a, b*). After

about 20 cells have been formed the nuclei are no longer visible even after water has been added (Fig. 43, *c, d*). If, contrary to my supposition, the germinal vesicle disappears, as Robin (Journ. de l'anat. et de la physiol., i, 4, 1864) describes it, before segmentation commences, the germinal vesicle in Fig. 42, *b, c*, would first be replaced by the vitelline nucleus."

[Küchenmeister (Parasiten des Menschen, 2 auf., Leipzig, 1880, 2. Lief., I. Abth., § 391) says the germinal vesicle disappears before the blastodermic layer begins to form.]

"The ova have now reached a length of about 25μ , and are somewhat less in diameter. The mass of blastodermic cells now becomes constricted on one side, and presents first a pyriform then a sausage-shaped outline, and by further crooking and then coiling is enabled to accommodate his increased length to his narrow quarters (Fig. 43, *e, f*). On the surface of the worm is now seen a layer of chitin; the interior is formed of uniform cells; its form is plump; the length scarcely exceeds 4-5 times the diameter (Fig. 44, *a*).



FIG. 46.—Development of the embryo. Posterior portion of a growing embryo 100μ (Pagenstecher).

As the body becomes larger, the organization is perfected by the development of the digestive apparatus. The future position of the œsophagus is marked by a line of transversely elongated vacuoles. The posterior portion is not yet developed from the blastodermic mass (Fig. 44, *b*). In further growth and differentiation the muscular portion of the œsophagus appears, and in it the chitin tube can be distinctly seen, the cellular body is completed, and the

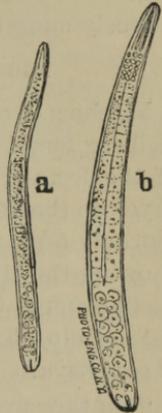


FIG. 45.—Development of the embryo. *a*, trace of outer portion of alimentary canal; *b*, shows chitin tube and brain vesicles 50μ (Pagenstecher).

stomach is separated from the external wall (Fig. 45, *a, b*), and the tube of chitin, showing its lumen, is seen in the rectum (Fig. 46). Thus the digestive apparatus is completed. I have also discovered the brain in such embryos. The embryos develop and increase in size while in the uterus and vagina. The size of the new-born trichinæ, which have only left their shell a half a day or a few hours previously, is from 0.08 to 0.12mm (80 to 120μ). The whole development occupies about three days."

Hun (*l. c.*) saw a female give birth to a brood on the fourth day. Renz (*op. cit.*, p. 31) says "from the fifth to the eighth day after infection, until the twelfth week, or even longer, the females bring forth their young," and Leuckart (Untersuch., etc., p. 62), "In Heidersleben, living intestinal trichinæ were found in the seventh week. I found them in the twelfth week after feeding." Dr. Mendel (Berl. Klin. Woch., 1874, xi, 12, p. 141) found intestinal trichinæ with numerous eggs, in the fourth week. Kratz (*l. c.*, p. 91) found female trichinæ full of larvæ, in the eleventh week. (See, also, Pagenstecher, quoted above.)

The number of embryos that each female may bring forth is variously estimated at from 60 to 2,000. Virchow says (*op. cit.*, p. 44), "The pregnant female has 100 living young in her body, besides numerous eggs, and she can reproduce young in three or four weeks. Allowing 200 young to every female, of which say 5,000 have been swallowed, which may easily be contained in a small piece of meat, and we have 1,000,000 embryos to commence their migrations." Falck (*Das Fleisch*, p. 515) estimates the number at 1,000; Cobbold (*op. cit.*, p. 170), 1,000; Gerlach, 1,000 to 2,000. (See, also, other authors above quoted.) Finally Leuckart says (*Mensch, Parasiten*, II, 3), "The number of trichinæ for each female was formerly estimated at 1,000-1,500. Pagenstecher believes that it will reach 2,000. To-day I almost believe that this number is scarcely more than a minimum.

MIGRATION AND DEVELOPMENT OF THE LARVÆ.

Virchow (*l. c.*) regards the act of generation as accomplished in a week. Colberg found fully-ripe embryos on the fourth and fifth day in the womb of the female, as also Hun, above quoted. Pagenstecher found embryos on the fifth day, and found them in the diaphragm on the seventh, but only after the twelfth or thirteenth day in other groups of muscles, showing that in some cases migrations may commence on the sixth day. Fiedler found trichinæ in the peritoneal cavity on the eighth and ninth days (Delpech, *op. cit.*, p. 28), and Leuckart (*Untersuchungen, etc.*, p. 73, *et seq.*) says:

"On the seventh and eighth days the expulsion of the larvæ from the mother's womb, commencing on the fifth, being well advanced, some embryos have penetrated the muscles in the neighborhood of the abdominal cavity.

"In the intestine the females are found in the mucus, while the embryos are found on the surface of the mucous membrane. Passing through the intestinal wall into the peritoneal cavity, and through the medium of the connective tissue, the embryos reach the muscles and penetrate and destroy the fasciculi. Within the fasciculus they develop in 14 days to muscle or larvæ trichinæ, when the persistent sarcolemma develops in a few days into the capsule. In 12 to 15 days after infection the migration of the young trichinæ and destruction of the muscle substance is at its height; then comes a remission through a decrease in the number and fruitfulness of the female trichinæ, until their final disappearance, which will be about the fourth or fifth week" (L. 83).

The opinion of Thudichum, that it was impossible to account for the rapid dissemination of the embryos throughout the muscular system except through the medium of the blood-vessels, has not been maintained, though apparently strengthened, by observations of Kühn, Colberg, Fiedler, Zenker, and others, and has not been generally accepted. Cobbold is reported as saying (*London Lancet*, vol. i, 1874) that trichinæ have formerly been hæmatozoa. Perhaps a misquotation, as there is nothing that would indicate such an opinion in his late works, "Para-

sites, &c.," London, 1879. Thudichum "found trichinæ in the pleural, peritoneal, and pericardial cavities on the seventeenth day after infection, and concluded that they reached their destination through the lymphatics and blood-vessels. Zenker found only one embryo in the blood. Fiedler, after a long search, found them only in the coagula of the right heart in three cases, in two of which he found one and in the other only two embryos. Colberg found them within the large muscle capillaries; also Kuhn found them in the veins of the mesentery, in the heart and liver, but only sparsely and after a long search" (Leuckart, *Untersuch.*, p. 48). If these observations are correct—remembering how Virchow accounted for the appearance of trichinæ in preparations of the heart muscle (see Delpech, *op. cit.*, pp. 13, 14)—the question might be asked whether isolated trichinæ found in the blood or blood-vessels in a half a dozen cases is sufficient ground to warrant the assertion or even opinion that they reach their destination through the vascular system. Evidence is lacking to prove that they often, if ever, bore through the walls of the blood-vessels, while they are always found, in the earlier periods, in the connective tissue, as is shown by Leuckart. Krämer (*l. c.*) says "the trichinæ lay more between than within the fasciculi on the forty-fifth day," and, further, "they often do not penetrate the fasciculi until their further progress in the intermuscular tissues is arrested by the insertion of the muscle into a bone or tendon." On the ground that the blood current passes directly to the fœtus during gestation, their absence in stillbirths caused by trichinosis has been brought forward to prove their absence from the blood. One case in Plauen in 1862 and one in 1863, have been reported, in which none were found in the fœtus (Virchow). This observation had been made before by Professor Aronssohn (*Thèse de Strasbourg*, No. 708, 1863, p. 11). See also P. Dengler, *hist. nat. and med. de la trichinæ*; Davaine, *op. cit.*, p. 746; Renz, *l. c.*, 30-31; Pagenstecher, p. 91.

"That the progress of the embryo is very rapid cannot be doubted. Not merely that myself and other observers have always found them present in the pleural cavity and the neighboring muscles when they were present in the abdominal cavity, but they possess the same relative size in the former as the few trichinæ in the latter cavity. This is taken by Fiedler as an indication that they pass through the blood-vessels. I believe that the migration of the trichinæ from the abdominal cavity to the remotest part of the body takes no more than twenty-four hours. Once through the intestinal wall the young animal has nothing in particular to hinder its progress. Its length, as also its diameter, is so insignificant that it can easily pass without disturbing the connective tissue." Leuckart (*Untersuch.*, etc., pp. 51-2). On page 49 he says:

"I have in many animals and in almost every preparation found free embryos in the connective tissue, and Fürstenberg (*Wochenblatt*, etc., in den Kön. Preuss. Staaten, 1865, No. 21) has lately, through numerous and conscientious investigations, come to the same conclusions. The embryo, first of all, in his course to the muscle must pass through the

intestinal wall; though not all will pass through all the layers; a part passing through the mucous membrane and muscular layer reaches the connective tissue of the mesentery, between the two layers of which they continue their way to the vertebral column, and thence to the muscles. I have (independent of Fürstenberg) observed free embryos among the vertebræ as a rule in young animals experimented. The remaining trichinæ take their way direct to the abdominal cavity, causing an inflammation of the visceral and parietal layers of the peritoneum, which, as the inflammation of the mucous membrane, never fails if the number of trichinæ is sufficiently large. There is usually in the peritoneal cavity a small amount of dirty exudation, in which are suspended numerous epithelial and fat globules." "These observations not only confirm my assertions in regard to the migration of trichinæ, but still more they prove that their transit causes a peritoneal irritation. What is not received from the zoologist must be accepted on the authority of the physician, and I consider it settled *that the intestinal trichinæ not only deposit their young in the alimentary canal, and that the latter spread thence through the body, but also that the progress of the embryos is active, and takes place through the connective tissue, although it may happen that single embryos will pass by means of the blood current into the muscles*" (Leuckart).

The most difficult point in the acceptance of Leuckart's theory by Thudichum and others seems to be the rapidity with which the embryos reach the remotest portions of the body. But when the minuteness of the worm is considered—its head is less than one-half the size of a red-blood corpuscle, viz, 3μ (Davaine *l. c.*)—especially as there must be some elongation and consequently diminution of the diameter of the body (which, according to Pagenstecher, is 5 to 8μ , and Leuckart 5.6 to 6μ in diameter, while a blood corpuscle is about 7μ in diameter)—in progression there cannot be much resistance to his progress in the cellular tissue. I have found by experiment that the common earth-worm placed on moderately compact sandy soil will disappear at the rate of one to five and a half centimeters in a minute. In several of the first experiments with about a dozen worms I obtained no results after a careful trial; but during the first week in June, 1880, I succeeded in making the following observations with two worms respectively 7^{cm} (No. 1) and 5.5^{cm} (No. 2) long:

Exp. I.—No. 1 disappeared in 7 minutes.	Exp. II.—No. 2 disappeared in 2 minutes.
III.—No. 1 " 4 "	IV.—No. 2 no result—worm seems to have been injured.
V.—No. 1 " 3 "	VII.—No. 2 disappeared in 2 minutes.
VI.—No. 1 " 2 "	IX.—No. 2 " $2\frac{1}{2}$ "
VIII.—No. 1 " $2\frac{1}{2}$ "	XI.—No. 2 " 1 $\frac{1}{2}$ "
X.—No. 1 " $2\frac{1}{2}$ "	XII.—No. 2 " 1 "
XV.—No. 1 " 2 "	XIII.—No. 2 " $1\frac{1}{2}$ "
XVII.—No. 1 " $1\frac{1}{2}$ "	XIV.—No. 2 " 2 "
	XVI.—No. 2 " $1\frac{1}{2}$ "
	XVIII.—No. 2 " $2\frac{1}{2}$ "
	XIX.—No. 2 " $2\frac{1}{2}$ "
	XX.—No. 2 " $1\frac{1}{2}$ "

The last three experiments, XVIII, XIX, and XX, were made under a glass cover, so that the motions of the body could be observed. In all cases the head of the worm would be projected nearly twice the length of the body before the posterior extremity would disappear, which would give the actual rapidity about twice as great as that stated above, and when the body was little less than half exposed, titillation of the exposed extremity would cause a sudden disappearance of the worm. The anterior extremity did not always take a direct course, but the head would often be extended and would explore in several directions before the contiguous parts of the worm would be projected forwards. While in motion under the glass the diameter of the worm did not seem more than one-half as great as when lying free on the surface, and when at rest under the glass, it was longer and more slender than usual. The head was projected about one-third to one millimeter at each forward movement, of which from 20 to 30 were made in a minute. If a comparison may be drawn between the motions of the trichina and the earth-worm (and no doubt under normal conditions the motion of the latter is much more rapid than the above figures show, for a worm of two or three times their length will often disappear in an instant when exposed in his natural home), as the annulated structure of the trichina would tempt us to do, then the latter, whose motions, though less extended, must be as infinitively more rapid, with a diameter a little over one-half that of a red-blood corpuscle, with just enough lateral pressure from the surrounding tissues to assist his progress, has only to pass through the space of little more than two-thirds of a millimeter in a minute (0.7^{mm}) to reach the remotest part of the body in 24 hours, and it does not seem to be necessary to remark that when the presence of the larvæ in the muscles is noted by millions, their track through the blood-vessels should be marked by the presence of a considerable number in the blood, and in some stage of progress through the walls of the arteries, if that were their natural course.

“The embryos in the developed condition before birth, measure about 10μ in length, and from 5.6μ to 6μ in diameter. As long as the embryo is within the body of the mother it will be difficult to understand its organizations completely. It appears as a delicate thread of a tolerably uniformly granular appearance, which later gives place to one more translucent. In the oldest embryos a delicate cuticula and an axial headed line can be distinguished, but the extremities are rounded and so nearly alike that it is difficult to determine which is the anterior. In the intestine they measure about 0.1^{mm} in length, occasionally 0.07^{mm} , with a diameter of 6μ .” (0.08^{mm} to 0.12^{mm} in length. Pagenstecher.)

“Within the abdominal cavity they are found 0.1^{mm} to 0.12^{mm} or even 0.16^{mm} in length, and in one case as high as 0.18^{mm} , while the diameter reaches 8μ . I scarcely ever have seen them less than 0.12^{mm} in the muscles. On closer examination it will be seen that the diameter is not uniform. According to analogy, with the full grown trichina the more

slender extremity should be called (and is according to Pagenstecher) the anterior. But it will be seen that the thicker end shows the exploring motion, and is projected in locomotion. It is more rigid than the thinner end, and when encountering other bodies becomes pointed, as if to penetrate them.

"The rigid condition of this extremity also accords with the position of the granular axial line which we look upon as the primitive trace of the alimentary canal. The anterior extremity has a uniform clear appearance, only modified by a fine thread of chitin which is continuous with the cuticula, and forms the first appearance of the chitinous lining of the oval cavity (Mundrohr). In the posterior extremity it is believed that a similar but shorter and more delicate thread may be observed (Fig. 47, Leuckart, Untersuchungen, &c., pp. 29-52, Mensch. Par. ii, 3, pp. 555-563). Later, the granular axial line shows a division into two parts by histological changes in the elements. The anterior portion represents the future cell body, and the posterior the stomach, &c. The sexual organs cannot as yet be distinguished. These embryos are found not only in the abdominal cavity, but also in the pleural cavity and pericardium, and their occurrence is so constant and in such numbers that these cavities may be considered as their normal stations. As a rule they are found most plentiful in the abdominal cavity, and this is in complete accordance with what might be supposed, for the little worms

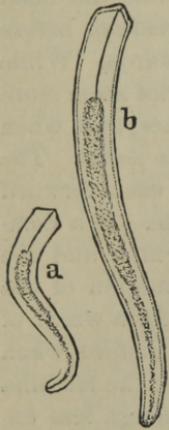


FIG. 47.—Development of muscle trichinæ: a, embryo from the abdominal cavity of a rabbit; b, the same worm further increased in size.

first pass from the intestines to the surrounding space, and subsequently migrate to the adjoining cavities. The manner in which this occurs is indicated by the anatomical structure of the diaphragm. It is through the openings which serve for the passage of the œsophagus and the large blood-vessels, and which are loosely closed by the surrounding connective tissue. As the embryos leave this connective tissue, sooner or later will they be found in the pleural cavity or pericardium, or, following the œsophagus, pass through the thoracic cavity into the cervical region, where I have often found them free in the loose connective tissue under the vertebral column and other places, as in the abdominal cavity. It is very probable that they follow the loose connective tissue which, in the muscular system, accompanies the vessels and nerves. The duration of the migratory period is difficult to determine, but it is evident that the progress is relatively very rapid, as embryos are found in the pericardium and pleural cavity, and neighboring muscles, as soon as in the abdominal cavity (see also Gerlach, Die Trichinen, p. 18). It terminates, according to the almost unanimous opinion of experimenters, on the 9th or 10th day (Leuckart, Mensch. Par. ii, 3, p. 568).

"The size and appearance of the embryos remain unchanged during migration. The first changes are observed after the worms have reached

the fasciuli and take on a condition of rest. That it is the fasciculus which is occupied by the parasite cannot be doubted because the embryos are occasionally seen in fibers, otherwise completely intact (Fig. 48), and we are enabled to follow step by step the changes which they, with their occupants, undergo, until the latter reach their full development as muscle trichinæ.

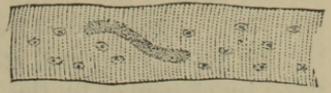


FIG. 48.—Unchanged muscle fiber containing a recently arrived embryo (Leuckart).

“The trichina thus inclosed in the sarcolemma destroys the inner parts of the fasciculus, not only in its immediate vicinity but also as far as the single fiber can be traced, sometimes over 5^{mm} or 6^{mm}. This destruction consists in a morphological metamorphosis (similar to that found in the so-called parenchymatous myositis); the fibrillar substance degenerates to a fine granular detritus, and all that can then be distinguished is the nuclei (Figs. 49, 50), which appear as small oval



FIG. 49.—Changed fasciculus showing granules, nuclei, and young trichinæ (Leuckart).

bladder-like bodies 10 to 16 μ long and 4 μ in diameter, with a sharply defined wall and with a sometimes single and sometimes double solid nucleolus.

When two nucleoli are present they are generally found at the extremities of the nucleus, and the wall will be more or less contracted in the middle; there can be no doubt that this is the beginning of a division into two new nuclei. This accounts for the fact that the nuclei are always more abundant in the degenerated fasciuli than in the normal. As the transparency of the fasciculus is interfered with by this change in its substance, it appears as a dark thread-like stripe. The changed fasciculus loses its

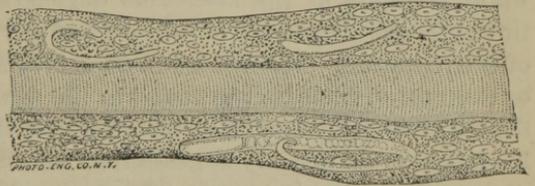


FIG. 50.—Normal fasciculus with changed fasciuli, containing worms in different degrees of development, on either side (Leuckart).

contractility, as is shown when the bundle is divided; the granular substance then projects sometimes to the extent of a millimeter (Fig. 51).

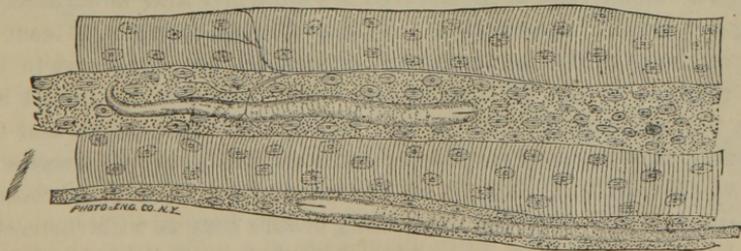


FIG. 51.—Changed and normal fasciuli. The normal are contracted while the altered ones project on account of their lack of elasticity (Leuckart).

contractility, as is shown when the bundle is divided; the granular substance then projects sometimes to the extent of a millimeter (Fig.

51), while the muscle substance is contracted nearly with the sarcolemma, and it is with this projection (Leuckart says later that the projection is caused by pressure) that muscle trichinæ are sometimes carried beyond the limits of the sheath and are then said to be free (Fig. 52). I have found free trichinæ often, but they were not developed beyond their embryonal state, and they are not found as often as those freed by chance or by the dissecting needle. When it is seen that the fasciculus is changed, not only in the immediate neighborhood of the worm, but for a considerable distance beyond, it might easily be concluded that the change has been produced by the progress of the worm through it, and this is the opinion of many observers. Zenker (Archiv. für Patholog. Anat. Bnd., 18, p. 566) says that it consumes the contractile

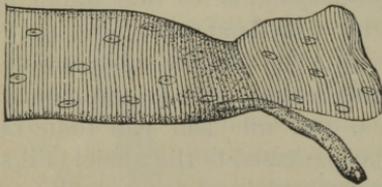


FIG. 52.—Unchanged muscle fasciculus with an embryo escaping from the sarcolemma (Leuckart).

substance of the fasciculus (also Gerlach, "Die Trichinen," p. 18); but the contents of the alimentary canal are fluid and probably are the result of endosmosis and are not swallowed, for I believe that the embryo after reaching the muscle falls into a condition of rest similar to that of a *chrysalis*, and that in spite of his motionless condition the

whole contents of the fasciculus degenerates, partly through the continuity of the contractile substance and partly through the continuation of the irritation. When the infection is of a high grade, not seldom two or even three trichinæ are found in the same fasciculus; sometimes the degree of development is so unequal that the younger must have found his home in an already degenerated bundle (Fig. 49). The occurrence of degeneration is in no way a hindrance to a new migration.

"Simultaneously with the degeneration of the fasciculus there commences a proliferation of small cells in the surrounding connective tissue, which extends over the whole length of the sheath, and in some cases to the neighboring fasciculi. According to Colberg the nuclei of the capillary vessels also partake of this change to such an extent that the distribution of the inflammatory products (as also of the blood) is interfered with. The blood-vessels themselves are enlarged and elongated, often taking a "cirroid" appearance. By many these changes, at least as far as the contents of the fasciculus are concerned, are supposed to bear a direct relation to the activity of the worm. Zenker, as stated above, thinks that the embryo eats its way through the fasciculus, and that it is possible that the oval corpuscles (muscle nuclei) may be masses of excrement (*Kothballen*). This is on the supposition that they retain their previous activity. But the same thing occurs here as with the cestoides and other helminths; after reaching their future resting place they fall into a condition of repose necessary for the growth of the body and further differentiation of the organs. The only motion observable after entrance into the muscle bundle is an exploratory vibration of the ante-

rior extremity; but this is soon lost, perhaps before the above changes are completed. Then begins, with the entrance of complete rest, such a rapid growth that the worm in the course of 12–14 days—about three weeks after infection—becomes a fully formed and matured muscle trichina. The body changes its form. While the embryo prior to migration showed a somewhat slender form (1.20), it now takes on a more plump appearance (Fig. 53). In trichinæ measuring 0.4^{mm} in length (Fig. 54), such as are

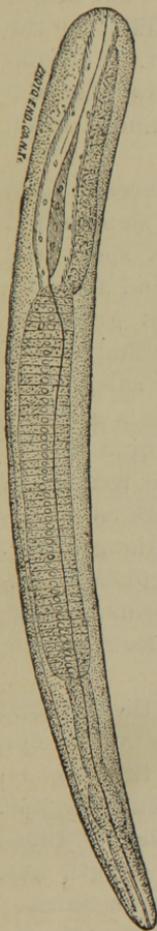


FIG. 54.—Muscle trichina 4^{mm} in length (Leuckart).

usually met in fourteen to sixteen days after infection, the relative thickness is nearly double (1.11), in the largest part of the body. The anterior third, however, is more slender in proportion to its former state, and diminishes in size to its extremity similar to the fully developed worm. The posterior end also begins to show the abrupt rounding of its future form. Similar changes also occur in the internal organs, which now not only become more distinct than before, but separate into oval tube (Munddarm), cell body, and stomach (*Chylusmagen*), and have a more or less complete distinction in histological character. Especially is this the case with the cell body whose large cells have a disk shape, 19μ in breadth and 1.5μ in thickness), and are ranged one above the other in a tolerably regular column. The thin chitin tube of the anterior extremity, extending through the cell body to the stomach, also may be seen, even in worms measuring 0.3^{mm} . The primitive sexual gland is seen in the form of an elongated sac, whose pointed anterior extremity either extends beyond the stomach, as in females, or in the male bends abruptly backwards. The opening into the rectum is first seen in worms of about 0.53^{mm} . The oval tube has a proportionate length, and near its middle shows distinctly the first trace of the nervous system, which in the form of an oval enlargement is distinguished from the cylindrical

mass.
“With the more complete differentiation of the internal organs is connected an in-

crease in the size of the whole body. The young worm increases more in length than in breadth, and its previous plump form gives place to a more slender appearance; at the same time the body becomes bent and curved until, after a more considerable increase in size, it finally assumes an irregular spiral position. In the larger sarcolemma sheaths the coiling commences soonest, when the worm is scarcely 40μ in length, but is more or less retarded when they are narrower, but it occurs in



FIG. 53.—Muscle trichina having reached a length of 3^{mm} (Leuckart).

the narrowest sheaths, even in those whose lumen scarcely exceeds the diameter of the worm. The sheath enlarges around the trichina, and this occurs in the largest sheaths as well as in the narrow ones. It is apparently due to the outward pressure caused by the worm. The spindle shape of the tube is explained by the elasticity of the sarcolemma, which has now lost its former delicate appearance. This increase in size stops when the worm comes to maturity, *i. e.*, two, to two and one-half weeks after the worm has reached the muscular tissue. The bright halo surrounding the worm, and which is now sharply limited by the inclosing muscle, is the optical expression of the enlargement. The contents consist, besides the worm, of the above-described granular material, which even at this period contains numerous muscle nuclei which are paler and more transparent than at first.

“The enlargements of the sarcolemma show many differences in form and size, sometimes slender and extended, sometimes short and bulging; in one the end abruptly truncated, in others gradually passing into the normal size of the fasciculus. As a rule, the diameter of the sheath is scarcely more than a fourth or a fifth of the length, while the remains of the fasciculus appears as an appendage fourtimes its length (Fig. 55). I have distinguished sexual differences in worms measuring 0.41^{mm} by the form of the genital sac.

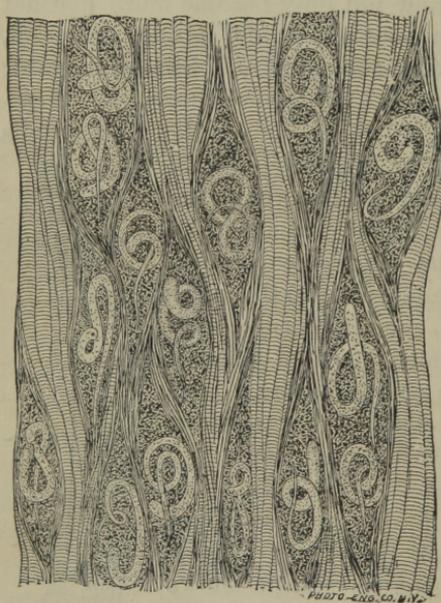


FIG. 55.—After a preparation from a human body dying during the Hedersleben epidemic. Trichinæ probably about seven weeks old, completely developed, but without a trace of a capsule; spindle-shaped enlargements of sarcolemma were present (Leuckart).

the slender end is more closely coiled than the posterior, which lies in the periphery of the coil.

“In the rabbit, after the sixth week, I have found no living trichinæ in the intestine, and only a few in the fourth and fifth. Fiedler gives 34 days and Pagenstecher 56 days as the last appearance of trichinæ in the intestine. I have found them in the hog in the twelfth week. In the Hedersleben epidemic intestinal trichinæ were found in the seventeenth week.”

Referring to this epidemic, Cohnheim (Virch. Arch. xxvi, 1866, p. 161) says: “The later-found trichinæ showed no essential difference from

those found earlier, but those found still later, besides the coiled or encapsulated muscle trichinæ, no free ones, or only those very much disintegrated, could be found," and thus concludes that there is a periodicity in their birth and distribution. Wagner (*Arch. der Heilkunde* II, 1864) found no intestinal trichinæ in two cases, one of which died on the twenty-third, the other on the twenty-sixth, day after infection. Dr. Bergen (*l. c.*) found encysted and free trichinæ about the fourth week. Vogel believes that the trichinæ die after exhausting their stock of eggs, and also seems to think that they belong to the class of animals that lay their eggs but once. But this is easily disproved by finding old worms with eggs and somewhat shrunken ovaries. Krämer (*Deutsche Klinik* 30, 31, 1872) found trichinæ free after the seventh week after infection; they lay more between than within the fasciculi, with here and there a trace of a capsule—and part of them were not mature—presumably of a later infection.

"In the fifth week, or as late as the sixth, after infection the trichina lies in the above-mentioned tubular sheath, which, on account of the presence of the parasite, has become spindle-shaped, and has a double contour. Besides the parasite, the contents consist of a granular mass, with the oval muscle nuclei. Sometimes the enlargement is long and slender, gradu-

ally lessening to the original size of the fasciculi, or it may be short and thick. The granular sub-

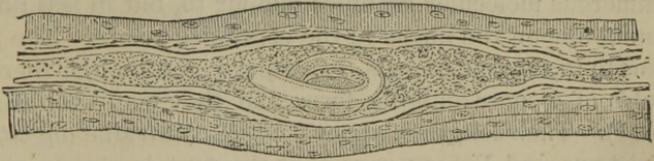


FIG. 56.—Spindle-shaped tube before encapsulation commences (Leuckart).

stance may fill the whole space (Fig. 56), or in other cases the enlargement, with a well-defined constriction near either end, has only scattered masses throughout the tube. I believe this constriction to be the first trace of the capsule, and that it consists of a deposit of a clear sub-

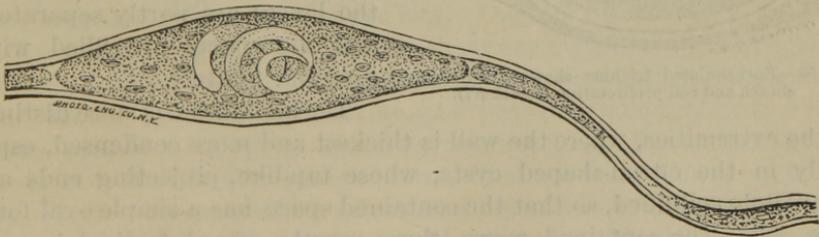


FIG. 57.—First trace of capsule.

stance in the inside of the sheath in the form of a ring at the capsule (Fig. 57), and the later capsule of the muscle trichina is produced by a peripheral consolidation of the contents of the changed sarcolemma sheath. This opinion is further strengthened" (see description of matured capsule in the first part of this section) "by isolation and treatment of older cysts with caustic potash, when a line of the same sub-

stance (chitin?) can be traced from one pole, around the periphery of the sheath, to the other.

"After seventeen weeks the trichinæ lie in a clear space, 0.4 to 0.5^{mm} long, inclosed at the extremities and having a clearly defined outline. The tubular portion of the sheath disappears, and in its place is seen only a line of connective tissue, rich in granules, abutting against the end of the connective tissue inclosure. But without a knowledge of the previous condition nothing abnormal would be suspected. The capsule, by proper and careful treatment with alkalis or acetic acid could be turned out of its sheath. These capsules are still thin, and sometimes of so little firmness that they may be bursted with slight pressure. Their walls consist of a clear, structureless, stratified membrane, with

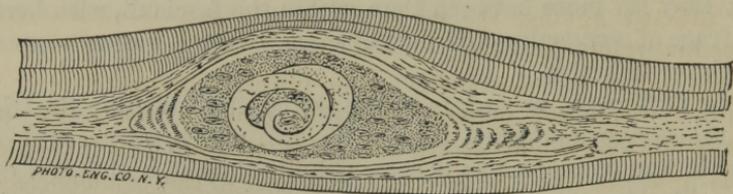


FIG. 58.—Capsule formation showing lamination at extremities (Leuckart).

numerous molecular granules similar to, but in less number than, those found among the nuclei in the contained space. The proportion of the length to the thickness is, as a rule, 4:3, although there are shorter capsules of a more bulging form, and they may even be spherical (Figs. 9-11). Their length is about 0.4^{mm}." (Davaine (*op cit.*, p. 735), quoting Bristowe and Rainey, says that the cyst is simple and the product of

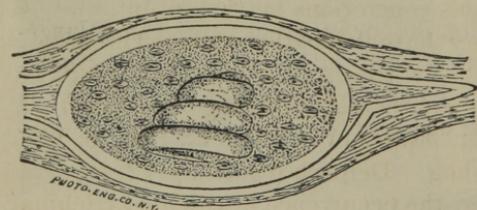


FIG. 59.—Encapsulated trichina showing sarcolemma granular matter) sheath and cell proliferation (Leuckart).

secretion of the worm. The walls are distinctly laminated, but the lamination is not sufficiently uniform to warrant the assertion that there are two walls. Generally the layers are partly separated, and the spaces are filled with granular matter). The lamination is more distinct at the extremities, where the wall is thickest and more condensed, especially in the citron-shaped cysts; whose tap-like, projecting ends are completely solidified, so that the contained space has a simple oval form (Fig. 58). The contained worm (three months after infection) is completely grown, but the granular body of Farre cannot as yet be seen. (See, also, Fig. 63.)

"The surrounding sarcolemma still retains its former appearance, and is about 1 μ thick over the lateral walls of the cyst, but projects beyond the ends, sometimes in a lengthened tip (Fig. 59), or may be more open, and shorter, as in Fig. 58. The latter is the most usual form. The ends appear as if cut off, but in many cases they can be traced for some

distance as delicate, pale tubes, apparently the remains of the original appendages. As a rule, these can be followed only a short distance from the capsule (Fig. 58). Sometimes they are very irregularly serpentine or coiled.

“After fifteen weeks the side walls of the capsule have a thickness of about 26μ . The inner surface of the capsule presents, in many cases, the appearance as if lined with pavement epithelium, occasioned by the presence of numerous muscle nuclei which are closely pressed against the wall, some of which also seem

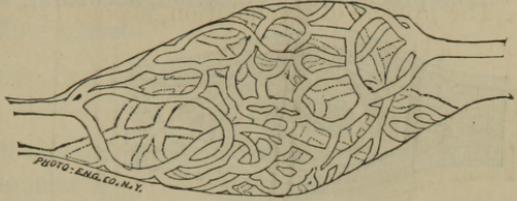


FIG. 60.—Network of capillary blood-vessels surrounding sarcolemma sheath (Pagenstecher).

to be inclosed in its substance. After injection, the connective tissue envelope shows a rich network of capillary blood-vessels (Fig. 60) described by Luschka, and which, according to Colberg's investigation, proceeds from the small proliferative cell seen in the commencement of the new formative connective tissue, &c. Each pole has an independent vascular system with afferent and efferent vessels, which connect with the muscle capillaries" (Leuckart, *Untersuchungen*, &c., and *Menschl. Parasiten*, ii, 3).

CALCIFICATION OF THE CAPSULE.

Fürstenberg saw the beginning of calcification in a rabbit eighteen months after feeding. Pagenstecher (*op. cit.*, p. 96) gives eighty days for the first appearance of calcareous concretions in the rabbit, and although it has been denied by Haubner that calcification occurred in the hog (see Pagenstecher, *op. cit.*, p. 9), he saw traces after one hundred days. [The first case in which trichinæ were observed in the hog (Prof. Leidy, *l. c.*) contained calcified capsules. Dr. Müller (*Virch. Arch.*, 1866, p. 253) found degenerated capsules in the hog. Delpech (*op. cit.*, p. 72) reports, on the authority of Dr. P. Niemeyer, the occurrence of calcified trichinæ capsules in the muscles of a hog confiscated in Neustadt in Magdeburg. Leuckart saw (*Untersuchungen*, &c., p. 67) traces of calcification in a hog five months after infection. See, also, reference from Nathusius *Ann. d. Landwirthschaft in den königl. preuss. Staaten*, 1865, Jahrgang, 23, p. 50.] Fiedler saw punctiform calcareous deposits in 17–18 months. Vogel found concretions in a dog after five months. Friedrich (*Deutsche Arch. für klin. Med.*, Bd. ix, p. 454) saw capsules with commencing calcifications on the one hundred and first day. Warfwinge (*Svenska Läkare Sällsk. Förf.*, p. 182) saw signs of calcifications after six weeks, and E. Wagner (*Arch. des Heilkunde* ii, 1864,) in two cases, after twenty-three and twenty-six days, respectively, claims to have seen trichinæ encapsulated and partly calcified. Gerlach (*Die Trichinen*, Hanover, 1873, p. 4) saw trichinæ capsules thirteen and a half years old in different degrees

of calcification; some were completely opaque, some partly transparent, and others having the deposit only at the poles, and says that it is an error to pretend that calcification occurs before the eighteenth month. Damman (Deutsch. Zeitschrift, Bd. 3, 1876, p. 92) found capsules uncalcified eleven and one-fourth years after feeding.

The process of calcification, according to Leuckart (*l. c.*), is as follows:

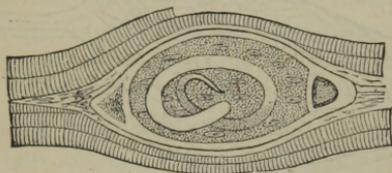


FIG. 61.

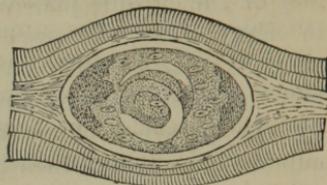


FIG. 62.

FIG. 61.—Commencing calcification, deposit seen only at one extremity of the capsule (Leuckart).
FIG. 62.—Progressing deposit of calcareous granules now forming a watchglass disk (Leuckart).

“There is seen beginning at either pole of the capsule a more or less flask-shaped or spread out accumulation of minute calcareous granules, which may remain isolated for some time or soon become a homogeneous mass, having the form of a disk and lying between the layers of the capsular wall. Sometimes, as in Fig. 61, this process takes place at one pole only. In all cases its margin is well developed, and from its different refracting power is readily distinguished from the surrounding mass. In a hog killed six and a half months after feeding [with trichinosed meat], I saw capsules in which there was not a trace of calcification; others were found as above, but in the greater number there was an irregular concretion which sometimes, with the adjoining uncalcified layer of the capsule wall, projected like a hump (buckelformig) into the cavity. These occurred mostly in the citron-shaped capsules, but in those more nearly globular the disks were more the shape of a watch glass (Fig. 62). I found the first trace of fat globules in this case. I cannot tell when the process is completed, but probably after fifteen or sixteen months more. In hogs this process commences after six months in most cases. Fiedler says the seventh and eighth, and Pagenstecher the eighteenth, month. Nevertheless, there is great variety and irregularity, perhaps due to idiosyncrasies. Sometimes capsules will be found without a trace of calcification in bodies, when the rest are completely calcified. The process does not stop with the calcification of the original capsule; the latter becomes thicker at the expense of its contents, and after a long time the worm itself may be changed (Leuckart, *Untersuch.*, &c.).

Gerlach (*Die Trichinen*, Hanover, 1873, p. 22,) says:

“The stage of capsule formation begins in the third and ends in the eighteenth month after feeding with trichinosed meat. At first, after the capsule is completed, there occurs a shrinking which lasts two months, the capsule becoming somewhat thicker and rounder, after which it remains unchanged for four or five months. In about six months, some-

times sooner, groups of fat globules are seen in the vicinity of the poles; after twelve to fifteen months the fat globules appear in the capsular walls. * * * The stage of calcification, beginning in the eighteenth month, in some capsules appears quite distinct in the second year. In the early months of the third year a few capsules are nearly opaque, and can be seen by the naked eye as small bright points about the size of a pin's head in the surrounding muscle."

RECAPITULATION OF PROGRESS AND DEVELOPMENT OF TRICHINÆ.—
GERLACH.

"Tenth day.—Completely developed intestinal trichinæ and a few embryos migrating towards the muscles.

"Twentieth day.—Muscle trichinæ about one-half their usual size; some embryos, none capable of development to muscle trichinæ.

"Fourth week.—Oldest and most of the trichinæ fully developed; traces of capsules; high grade of myositis.

"Sixth week.—Sheaths begin to close up by condensation of nuclei against the wall, and from thence they project towards the middle forming an arch at the end (Fig. 63 *a a*); some trichinæ in open sheaths as in fourth week.

"Second month.—Capsules fully formed; some as in sixth week.

"Third month.—All the capsules are fully formed; inflammatory process is ended; surrounding muscle regains its normal appearance; finely granular substance at the poles.

"Ninth month.—The capsules become shorter and more round; greater or less number of fat globules are found particularly at the ends of the capsules, but they are absent in some cases.

"One to one and a half years.—Fat globules in the capsules and outside, especially at the poles; traces of calcification.

"After one and one-half years commencing, and after two years distinct, calcification, but not in all capsules."

According to Bristowe and Rainey, quoted by Davaine (*op. cit.*, p. 739), the collections of fat are composed of vesicles similar to normal adipose tissue. The vesicles are polyhedric from compression and contain a transparent liquid, soluble in ether, which runs in oily globules when the vesicle is broken. This fat is distinguished from that of normal parts, in that it contains fine acicular crystals in the center of the vesicles, probably consisting of stearin, and also that some of the vesicles show signs of vacuolation and division.

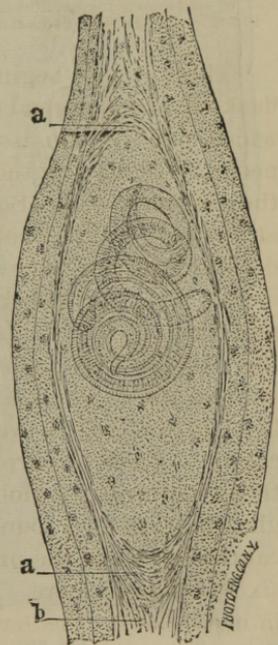


FIG. 63.—Preparation from muscle of rabbit thirty-two days after feeding. The spindle-form cells (*b*) condensing on the inside of the sarcolemma sheath, and forming arches *a a* at the extremities (Gerlach).

“Sometimes (Leuckart, *Menschl. Par. ii, 3, p. 575*) the connective tissue surrounding the cyst gradually becomes developed to considerable extent—so that it may be truly said that the trichina has a connective tissue covering—which often increases to such a degree that the capsule may appear as large as a millimeter in diameter, and may be seen with the naked eye. In these cases I have found the contained worm dead, and no doubt this bears a casual relation to the unusual connective tissue development, and the latter may thus be considered a pathological process. It is probable that these changes—the greater number at least—are the consequence of an unusual severity of the myositis due to individual peculiarities. It generally occurs early in the disease, and then the cysts proper fail to appear or are only incompletely developed.

Instead of the cyst the fibrous sheath incloses only a clear space with a more or less defined outline containing the usual granular substance and the dead worm (Fig. 64). In recent cases the worm distinctly shows the form and

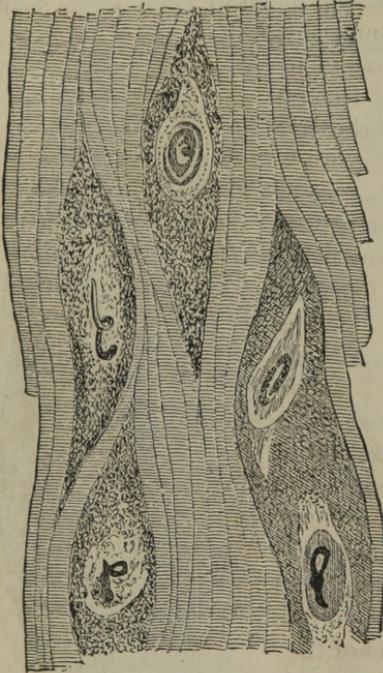


FIG. 64.

FIG. 64.—Pathologically changed trichinæ capsules with thickened connective tissue envelope and dead worms (Leuckart).

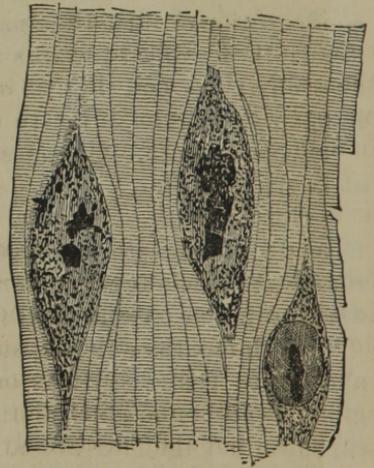


FIG. 65.

FIG. 65.—Encapsulated calcareous concretions, the remains of dead trichinæ (Leuckart).

characteristics of the muscle trichinæ, only that the body is more or less shrunken and assumes either wholly or partially a homogeneous, glittering appearance; they are apparently undergoing a fatty metamorphosis, which appears later, as does also a deposit of lime salts. The body becomes hard, friable, and shattered, and breaks under the glass cover and even by the muscular pressure, so that the growing connective tissue capsule is intimately mixed with it. Capsules are also sometimes found which, instead of a worm, contain only irregular, generally angular, calcareous concretions (Fig. 65). These concretions

are probably the remains of cysts, as open spaces and even distinct trichinæ may be seen in them. This calcareous deposit does not occur exclusively in the degenerated capsules, as it may occasionally be seen in normal cysts after ten years, but only after the cyst itself is completely calcified. In such cases the worm retains its characteristic form, although here it occasionally happens that instead of the worm there may be seen a number of sharp-cornered fragments, or one or several amorphous concretions of different sizes (Figs. 66, 67, 68, 69). Sometimes even empty cysts may be found in which the dead worm, instead of becoming calcified, has been absorbed. This last circumstance shows the possibility that the trichinæ may occasionally be absorbed during the excessive development of connective tissue, which opinion is supported by the result of the examination of a rabbit sent to me." (L. Menschl. Par. ii, 3, p. 578.)



FIG. 66.



FIG. 67.



FIG. 68.

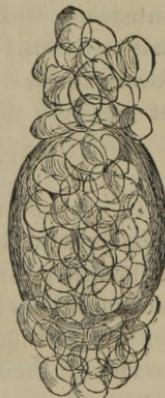


FIG. 69.

FIG. 66.—(Bristowe and Rainey) *a*, cyst, containing a worm, *c*, very much altered and commencing to break into fragments; in some places the worm is empty and flattened, some places filled with calcareous granules, and the anterior portion *c'* is swollen with a refractive calcareous deposit (Davaine).

FIG. 67.—(Bristowe and Rainey) only the angular fragments of the worm are seen (Leuckart).

FIG. 68.—(Bristowe and Rainey) $1\frac{1}{2}$ ° cyst invaded externally and internally by fat vessels. The worm has disappeared (Davaine).

FIG. 69.—(Bristowe and Rainey) the cyst has almost completely disappeared under the mass of fat globules (Davaine).

The question as to the acid of the calcareous salts deposited is thus treated by Davaine (*op. cit.*, p. 737, Note 6).

“According to Küchenmeister the granules are composed of calcic carbonate and an organic substance. Chlorhydric acid dissolves the salt and renders the presence of the carbonate apparent by the evolution of bubbles of gas. The effervescence observed by Küchenmeister

does not come from the granules contained in the walls but from the calcic carbonate, which is sometimes found free in the cavity of the cyst, for M. Bristowe says positively that the earthy granules of the walls are dissolved without effervescence; at least, they resist the action of acetic acid. However, the absence of effervescence and the preservation of the form of the body observed are not at all absolute characteristics of the non-existence of calcic carbonate. I have shown, in my *Recherches sur la génération des huîtres* (1852), that the calcic carbonate in a minute quantity cannot produce an effervescence by the action of an acid; the carbonic acid gas is dissolved in the surrounding liquid as soon as it becomes free. In this case, while an insoluble organic substance preserves the form of the body under observation, it might be thought that this lime salt did not occur; but the presence of a carbonate may be recognized by treating with concentrated acid after the substance has been thoroughly dried, or, better still, by treating in water previously saturated with carbonic acid gas."

Leuckart says that there is a development of gas on the addition of an acid. (*Menschl. Parasiten*, ii, 3, p. 536.) Gerlach (*Die Trichinen*, p. 20) says: "I have never seen air-bubbles appear on treating the granules with chlorhydric acid under the microscope. They therefore cannot be formed from the carbonate, but more probably consist of the phosphate." Pagenstecher (*op. cit.*, p. 96) says: "The nature of this substance was clear from the production of gas bubbles on the addition of acids." Scoutetten (*op. cit.*, p. 31) says: "The material which forms these deposits is soluble in chlorhydric acid with the evolution of gas."

SECTION C.—ORIGIN AND DISTRIBUTION.

In general, the question of the origin of trichinæ is perhaps of more importance in a scientific than in a medical or commercial point of view, although it is in relation to the latter that I have attempted to obtain information.

Several theories have been advanced on this subject: first, in regard to the original "hosts" or bearers; second, in regard to the country from which they originally spread; and, third, the means of distribution. The vegetable (Delpech, *op. cit.*, p. 47) as well as the animal kingdom has been searched for a clue to the first question. Schacht observed what he thought were trichinæ in the capsules found on the radicles of the sugar beet, but Virchow (*Virch. Arch.*, Bd. 31, p. 350) has demonstrated that they are not trichinæ. This has been confirmed by Kühn, and also later by Stein, who "has so exactly studied the animals found on the beet that all thought of any relation whatever must be abandoned. However, the beets diseased by becoming the home of the worm are often the cause of epidemics in cattle fed on them." (*Stenographischer Bericht d. Verh. ii. d. Trichinenfrage, &c.*, Berlin, 1866.) See, also, Virchow (*Lehre von den Trichinen, &c.*, p. 57.)

It is now generally admitted that the muscle trichina is found only in the muscles of the warm-blooded animals, and is mostly limited to the carnivora.

Their occurrence or propagation in the cold-blooded vertebrates is denied by Cobbold (Remarks on Dr. Elendenen's paper on "Trichinæ in Fish," London Lancet, November 16, 1878; see Cobbold, *l. c.*). Colin (Compt. Rend., lvi, 1867, p. 31) infected animals with the dejections of fish and reptiles to which he had previously fed trichinous meat, and which could not themselves be infected. Goujon (Journ. de l'anat. et de la phys., etc., 1867, No. 5, p. 529) gives an account of the trichinization of a salamander—whose body was maintained at a temperature of 30° C.—which Leuckart (Menschl. Parasit., II, 3, p. 513,) says, "this animal probably contained a trichosomum, which is very similar to the trichina. Meissner says (Sch. Jbr., 138, p. 110), "intestinal trichinæ do not develop in cold-blooded animals." The occurrence of trichinæ in fowls is also denied by Leuckart (*l. c.* and Untersuch., p. 74). Dr. Bryant (Richmond and Louisville Med. Journal, 1865) found entozoa in a hen, which appeared like the trichinæ found in human muscle. Bakody (Zeitschrift für wissenschaft. Zoologie) said he had seen trichinæ in the hen, but Gerstacher (Virch. Arch., xxxvi, p. 435) examined specimens sent to Professor Virchow and said they were the *trichina affinis*. Vogel (Path. Anat., etc., Leipzig, 1845) reports having found trichinæ in the mole; also Herbst (*op. cit.*, No. 12, p. 183). On this subject Scoutetten (p. 43, *op. cit.*) says: "Virchow and Fiedler tried in vain to find trichinæ in the mole. They found worms, but these when fed to hogs did not infect the animals. The results of those experimenters who claim to have found trichinæ in moles are doubtful." Delpech says (*op. cit.*, p. 47) "The larvæ of flies cannot serve for the transmission of trichinæ. * * * I eliminate also the mole, of which the parasites are found in the brain as well as in the muscles, and, as has been determined by Kühn, differ zoologically from the trichina as found in man and in the hog." Leuckart says (Untersuchungen, &c., note (†), p. 31), "What has occasionally been represented as *trichina affinis* is either identical with the *trichina spiralis* (as those found by Leidy in the hog) or is not a trichina at all. The genuine name 'trichina' has occasionally been applied to the larval condition of different nematodes. The trichina of the mole, for example, is an *ascaris*; that of the larvæ of insects is a *spiroptera*." (See, also, Leuckart, Menschl. Parasiten, II, 3, p. 513, and Davaine, *op. cit.*, xcix.)

In regard to the nomenclature of the trichina found by Professor Leidy in the muscles of the hog, he writes, May 7, 1880:

"Diesing, Systema Helminthum, ii, 114, 1851, refers to my notice of the above from the Ann & Mag. Nat. Hist., 1847, 358, and refers the worm to another species with the name *trichina affinis*. From the high authority of Diesing, I accepted this decision in Proc. Ac. Nat. Sc., 1856, 48. It was, however, a mistake, as there can be no question at present that the parasite of the pork was the *trichina spiralis*."

Cobbold (*op. cit.*, p. 157) says:

“Certain nematodes found in earth-worms have been described as trichinæ, and consequently pigs, hedge-hogs, and were said to become trichinosed through eating these annelids. The minute flesh-worms, described by Bowman, from the muscle of the eel are not true trichinæ any more than the somewhat similar parasites which Eberth found infesting the muscles of the frog. The same may be said of Dr. Salisbury’s ‘urinary’ trichinæ (*T. cystica*), which are the larvæ of *Filaria Bancrofti* (Fig. 88).” (See also Cobbold, *op. cit.*, p. 180; Delpech, *op. cit.*, p. 53.)

“Important errors in connection with the subject of trichinosis have been committed by the most competent men. These errors consist in confounding animals of essentially different species with trichinæ. The parasites of the earth-worm, mole, and the worms found on the beet have been sufficiently studied. Thus far none of these animals found otherwise than in the striated muscular fiber can be compared zoologically with the trichina, although resemblances more or less close might have deceived the first observers. This observation will apply to the parasite found several times in the *Trito cristatus* after ingesting trichinosed meat. Legros, quoted by Rodet, considered them as trichinæ. Pagenstecher has demonstrated that they are *anguillules*, and that he has met them as often in animals that have not ingested trichinosed meat as in those to whom it has been fed. Dr. Merland de Chaillé (Bull. de l’Acad. de Médecine, 1866, t. xxxi, p. 485) tried to show, contrary to the assertion of Virchow and of those authors who deny the presence of trichinæ in the herbivora, that the sheep contains them in large numbers. The cysts vary in size from that of a small hazel-nut to that of a pigeon’s egg, and, as he gave no description of the worm, I believe that they contain young strongyles (*strongylus filaria*). Also, Professor Tigri, in the same journal (p. 533), tries to prove the similarity of the same nematode with the trichina. I have determined the difference between the two in specimens shown me by Dr. Cornil. In the case where Lebert (Gazette médicale, 1866, l. v., No. 19) mentions the possible connection between the trichina and worms found in the pus of an abscess of the uterus in a woman suffering with cancerous ulcer of that organ there can be no doubt, as their form and appearance is entirely different.”

In two cases the vinegar eel (see section 26, *Anguillula aceti*), (Jahresbericht der ges. Med., &c., i, 1878, p. 514,) from the acetic acid used in making preparations, was mistaken for trichinæ. Davaine (*op. cit.*, p. 754) says:

“In a great many cases the observers, not knowing that a number of nematodes live encysted in the organs, or free in the earth or in vegetables, were mistaken in the species of the worm that they saw. It is not sufficient that they should inhabit a cyst to be called trichinæ; and those cases reported without a sufficient description of the worm might

also be called in question; as in the case of Vogel, 'trichinæ in the owl;' of Herbst, in the mesentery of the *strix passerina*; of Diesing, in the horse; of Von Siebold, in several birds; of several observers, in the mole; of Bakody, in the intestines of domestic fowls" (Repert. de Stuttgart, 1875, et Recueil, p. 147, 1874).

Finally, Virchow (*op. cit.*, pp. 56, 57) says:

"Inaccurate observers would certainly find trichinæ everywhere. There is a number of small round worms which, in their occurrence, size, and form, are similar to trichinæ, but which are not on that account trichinæ; *e. g.*, formerly every round worm which occurred anywhere in the meat, or which was small and undeveloped, and perhaps spirally coiled, was called trichinæ. In the primitive bundles of the eel (Bowman, Cyclopædia of Anatomy, vol. ii, p. 512) and frogs (Kuhn (Virch. Arch., Bd. 36, p. 222) Eberth, Zeitschrift für wiss. Zoologie, Bd. xii, § 530, Taf. xxx, vij.) occur round worms which are similar to trichinæ, yet may be easily distinguished by characteristic peculiarities. Langenbeck, of Hanover, supposed that he had discovered trichinæ in many of the lower animals, viz, in the greater number of the earth-worms, and that hogs roaming at large became infected by eating them, especially the Hungarian hogs, but I do not find that these are more apt to be infected than others. However, earth-worms do not contain trichinæ, although microscopic round worms are found in them. The well-known *ascaris minutissima* is no more a trichina than the later described *dicilis*. I have, with Dr. Gerstacher, made observations and determined the intrinsic differences. Other observers (Virch. Arch., 1865, Bd. 32, p. 341) have come to the same conclusions." (See also sections G and H).

With such facts before us we might be led to inquire if there is not a possibility that other mistakes less amenable to correction might have occurred.

The occurrence of trichinæ in the rabbit is explained by that animal sometimes becoming carnivorous during the winter, when deprived of its proper food: Meissner (Schmidt's Jrbr., No. 138, p. 110) says that vegetarian animals are very likely to develop trichinæ.

Trichinæ have been found in the cat by Voget (Traité d'anat. path. générale, p. 409, note, Paris, 1847), Güelt, in 1849 (Nachtrage, etc., und Lehrbuch, der path. Anat. der Helminthes, Berlin, 1849, p. 144), and Herbst, 1848-50 (Nachrichten, etc., Gottingen, 1854, p. 419). Leuckart (Untersuch, p. 71) says Güelt found a natural "host" in the cat, and that he had only lately observed spontaneously trichinosed cats. Rupprecht and Kühn also found trichinæ in cats.

In the dog.—W. Erb (Centralblatt für die med. Wissen, No. 61, 1864), Perroncito (Bern, Zeitschrift, 1877, p. 200) reports having found trichinæ in a dog in Turin. This was stoutly denied by Sylvester (Jahresbericht, etc., i, 1877, p. 601). Gaillard in spaniel in Algiers (Movm. Med., 1866, p. 490). Davaine (*op. cit.*, p. 753) says if the adult dog cannot become trichinosed he certainly can in his youth, and cites numerous experiments.

A case is reported (see Bost. Med. and Surg. Journal, November 12, 1874, p. 471) where an old woman in Germany became thoroughly infected by eating the flesh of a dog.

Goose.—Sixty soldiers (see Phil. Med. Times, April 13, 1878), at Thiersville, were taken sick with trichinosis from eating the flesh of a goose.

Polecat.—One case in Westphalia (Jahresbericht, i, 1877, p. 601); one by Womberg (see Leuckart, Untersuch, p. 72), O. V. Linstow (Virch. Arch., 44, 1868, p. 579); also, Virchow and Wedl, Report to Med. Soc. of Vienna, 1867.

Foxes.—Several were shot (Allgem. Med. Cent. Zeitung) which contained trichinæ in large numbers, also a case reported by Ficinius (Virchow, *l. c.*) and Leuckart (p. 11, note) and Prof. Wedl (*l. c.*).

Wild boars were killed in Saxony (Jahresbericht, etc., i, 1875, p. 645) containing numerous trichinæ; also, Erfurt-Staat Esterode Eulenberg (Vierteljahrsschrift f. Ger. Med., 1878, p. 149), and a case of trichinous infection in Leppspringe from eating wild hog. (See Jahresbericht, etc., 1878, p. 574.)

Horse.—Trichinæ found in a horse's eye (Bost. Med. and Surg. Journal, November 12, 1874, p. 471. See also section G, 6 "differential diagnosis").

Ape.—Panstecki found trichinæ like encapsulated round worms in a West African ape (Jbt. der gesamt. Med. i, 1868, 194.)

Herbst (*l. c.*) found trichinæ in the crow and badger. Heller (Ziemssen iii, p. 628.) Wedl in the raccoon and marmot, and Ficinius in the marten. (See Leuckart, *l. c.*)

Rats.—Leisering (Sach. Bericht, p. 97) examined 133 rats in Saxony. Of 42 from 7 different flayers, 4 from 3 different yards contained trichinæ and 11 infected among those from slaughter-houses. The rest were free. (Jbt., etc., i, 1868, p. 505. In Saxony one-half of the rats from flayers contain trichinæ; 20 per cent. of all rats caught contained trichinæ.

Adam (Woch., 1866, p. 65).—Of 13 rats caught in Augsburg none infected; of 5 from flayers 2 were infected.

Röll (Oert, 36, p. 88).—Of 175 rats from Vienna and vicinity 4 contained trichinæ, also 16 out of 20 rats in Moravia, 4 in Bremen, 2 from flayers, and 2 from a house in which a patient had died of trichinosis. (Jahresbericht, etc., 1866, i, p. 452.)

Rektorzek (Wochenbl. der Zeitschrift, etc., Wien, No. 47).—Of 105 rats from Lemberg 4 infected, and all but 17 of the remainder contained parasites of some kind. *Op. cit.*

Stirling (Journ. d'anat. et de la physiol., May, 1872, p. 425) found one case (Jbr., i, 1872, p. 601).

Renz (Wurtemb. Med. Corr. No. 1, 2, 1866).—Of 31 rats in Wurtemberg 3 contained trichinæ (*op. cit.* i, 1867, p. 309).

Keylow (Deutsch. Zeitschrift, iii, 1876).—In Jaroslav, in Russia, 2 out of 26 rats, and in Charkov 3 out of 7, contained trichinæ.

Goujon (Thèse de Paris, 1866).—Of 72 rats caught in the ditches of Paris 5 were full of trichinæ.

The Vienna committee (Bericht des zur Erforschung der Trichinen—Krankheit von der k. k. Gesellschaft der Aertze Comités, Nov. 2, 1866, Wien, 1867, pp. 6, 7) report: “In Moravia, in the neighborhood of Ostrau, 9 out of 12 rats were highly trichinosed, and of 8 from the city of Ostrau 7 were infected in the highest degree. This is a great market place for hogs in the summer and fall. In Klederling, a suburb of Vienna, 7 out of 47, and in Untermeidling 2 out of 31 were found infected. In other places a few rats were examined with negative results. In the meantime 39 hogs of different ages were examined, and only 1—an old and unusually fat one—found infected. See Meissner (Schmidt's Jahrbücher, No. 130, 1866, p. 118), who quotes N. E. Forssell (Hygiæa, xxvii, ii), 4 out of 5 rats caught in Skara were highly trichinosed; also, Kühn, Adam, Röhl, Wedl, *et al.*, and Renz, *op. cit.*, 44, 45. Besides these, many other cases are reported, and there is no telling how far this list might be extended if examinations were common in rats as in hogs. In Saxony 20 per cent. of all rats are trichinosed, while Reinhard (Arch. der Heilkunde, xviii, § 241) says “about 1 hog in 983 contains trichinæ.”

Gerlach (Die Fleischkost, etc., Berlin, 1875), pp. 73-76 gives a table showing that 664 trichinosed hogs have been found, principally in Germany, in eleven years, 1864 to 1874, inclusive. Of these 84 were found in the province of Prussia; 19 in the province of Brandenburg; 29 in the province of Pomerania; 20 in the province of Posen; 11 in the province of Silesia; 95 in the province of Saxony; 6 in the province of Westphalia and the Rhine provinces; 44 in Hanover; 27 in Kurhessen and Holstein; 92 in Brunswick; 46 in Weimar, Altenburg, Saxony, and Mecklenburg-Schwerin; 100 in Sweden; 39 in Denmark; 2 in Hamburg, and 1 each in Bremen, Lubeck, Switzerland, and England, 4. Excepting 100 found in Sweden (the whole number secured in the year 1865), and 37 of 39 occurring in Denmark (found in 1866), the largest number in a single year was found in 1867, viz, 170; 12 were found in 1864; 132, including 100 in Sweden, in 1865; 79 in 1866; 170 in 1867; 55 in 1868; 36 in 1869; 19 in 1870; 59 in 1871; 88 in 1872; 55 in 1873; 59 in 1874.

In the Duchy of Brunswick, from January, 1866, to Easter, 1876 (Uhde Virchow's Archives, Nos. 38, 43, 48, 52, 57, 58, 59, 64, 65, 70), 781,611 hogs were killed; 125 of them contained trichinæ—1 to 6,253—(and 250 were otherwise diseased and unfit for food). Of 6 infected hogs found among 87,111 examined in 1868-69 (*op. cit.*, No. 52, 1870, p. 439) 5 were found in the city of Brunswick. In every year the proportion of trichinosed hogs in the city far exceeds that of the remainder of the Duchy.

In 1871-72, in the city it was 1 to 4,839; outside of the city, 1 to 13,401 (Virchow's Archives, No. 58, 1873, p. 325).

In 1872-73, in the city it was 1 to 1,502; outside of the city, 1 to 3,807 (Virch. Arch., No. 59, 1873, p. 160).

In 1873-'74, in the city it was 1 to 1,272; outside of the city, 1 to 5,129 (Virch. Arch., No. 64, 1875, p. 570).

In 1874-'75, in the city it was 1 to 1,449; outside of the city, 1 to 7,004 (Virch. Arch., No. 65, 1875, p. 548).

In 1875-'76, in the city it was 1 to 6,618; outside of the city, 1 to 13,182 (Virch. Arch., No. 70, 1877, 157).

It would seem from this exhibit that whatever cause operated to decrease the number and proportion in the city exercised a corresponding influence outside. Berkan (Virch. Arch., Bd. 42, 1868, p. 352) reports that of 60,000 hogs killed in Brunswick in the preceding four years only 7 were infected. In Blankenburg, 8,000 were examined and 9 found infected, and 15 trichinosed hogs were found in the remainder of the duchy. In Rostock, Petri (Virch. Arch., Bds. 44, 45, 49, 52, 54, 57, 59, 62, 66, 70, 72) reports that the whole number of hogs killed in eleven years (1867 to 1877, inclusive) was 67,427. Of these, 42 contained trichinæ—1 to 2,107. The highest proportion was reached in those examined from November 1, 1867, to April 30, 1868 (Bd. 44, 1868, p. 136), 1 to 336. Of 6,555 killed in 1872 (Bd. 57, 1873, p. 296), and 7,165 in 1876 (Bd. 70, p. 156), none contained trichinæ.

In Gotha, from 1865 to 1876 (Schuchardt, Thur. Corr. Bl., vi, 9, 1877, p. 223), 391,913 hogs were killed, and 46 contained trichinæ—1 to 8,520. Of these, 98,173 were killed in the city of Gotha, and 34 of the 46 infected hogs were found there, a proportion of 1 to 2,887, leaving only 12 to 293,740—1 to 24,479—in the remainder of the province.

In the whole of Prussia (Eulenberg, Vierteljahrsschrift, f. ger. Med., etc., xviii, 1, 1878, p. 149), in 1876, 1,728,595 hogs were examined, and 800—1 to 2,160—were found infected; in Guesen, 1 to 141; in Königsberg, 1 to 149; in Posen, 1 to 207; in Bromberg, 1 to 323. In 1877 (Eulenberg, quoted by Falck, "Das Fleisch," Marburg, 1880, pp. 622, 623), of 2,057,272 hogs examined in Prussia 701 were found trichinosed—1 to 2,800 (by 12,865 official inspections). Of this number, 997 were killed in Cöslin, of which 3 were found infected, 1 to 332; 17,162 in Königsberg, 46 infected, 1 to 373; 2,043 in Danzig, 5 infected, 1 to 408; 66,692 in Posen, 163 infected, 1 to 409; 37,015 in Marienwerder, 77 infected, 1 to 480; 24,157 in Bromberg, 44 infected, 1 to 544; 36,323 in Frankfort, 52 infected, 1 to 698. On the other hand, in 1871, in Stettin, 2,251 in Stralsund, 3,973 in Oppeln, 37,173 in Stade, 2,743 in Aurich, 19,424 in Münster, 8 in Wiesbaden, 1,004 in Trier—68,447 hogs—no trichinæ were found. In 1865-'66 the total number (Muller quoted in Jahresbericht, etc., i, 1868, p. 505) of trichinosed hogs reported was 50. In 1875 (Jbt., i, 1876, p. 555), 54 trichinosed hogs were found among 59,230 hogs examined in Cassel—about 1 to 1,100. In the jurisdiction of Breslau (Edward Wolff, "Die Untersuchungen des Fleisches," etc., Breslau, 1878), 244,840 hogs were examined (by 1,499 official inspectors) in 1876, of which 63 contained trichinæ (and 1,710 were measly); 40,904 of this number were killed in the city of Breslau, and 18 found trichinous—

1 to 2,276—while for the remainder of the district the proportion was 1 to 4,532. In 1877, the whole number was 271,669; 54 trichinous (1,992 measly); of these 44,951, including 23 infected with trichinæ, were killed in the city—1 to 1,954—with a proportion of 1 to 7,378 for the remainder of the district.

In Stockholm, from 1865 to 1875 (Warfvinge, "Nord. Med. Ark., vii, 3, No. 18, 1875), 55,200 whole hogs were examined, 111 contained trichinæ, 2 to 1,000; 6,547 half hogs were examined, 19 contained trichinæ, 3 to 1,000; 45,788 hams were examined, 47 contained trichinæ, 1 to 1,000.

"Of the whole hogs 2,000 were raised in Stockholm, and 58 of the 111 infected hogs were of this number, 2.9 per cent. Ten of the remaining 53 were found among 300 hogs from Tannefors, 3.3 per cent. Among those raised in the villages the proportion was 0.92 per cent. The nativity of 29 of the infected hogs was not known. To divide these proportionately would give for Stockholm 3.9 per cent., and for Tannefors 4.3 per cent. It thus appears that Stockholm and other cities really form trichinal centers, while the occurrence of trichinæ in the country is purely accidental. Of 74 whose antecedents were known, 22 were raised by butchers, 15 by millers, and 12 by bakers. In 12 cases 2 infected hogs, in one case 4 (raised by a miller), and in another 3 hogs were traced to the same pen."

In 7 cities of Sweden (Key, Virch. Arch. No. 41, 1867, p. 362) Stockholm, Linköping, Gothenburg, Norköping, Falun, Malmö, etc., 39 trichinosed hogs were found, 1866.

In Copenhagen (H. Krabbe, Zeitschrift für Vet., bd. xv, Hft. 3, 4, 1867) of 8,174 hogs examined 15 contained trichinæ—1 to 545. Thirty-nine trichinosed hogs were found in different places in Denmark in 1865-'66; 28 of these contained prosoperms.

In Charkov, Russia, Krylow (Deutsch. Zeitschrift für Thiermed. iii, 1876, p. 392) reports 3,550 hogs were examined and 5 contained trichinæ—1 to 710—and thinks if examinations were obligatory in Russia that trichinæ would be found more numerous than in Germany.

The list of cases in section A, where trichinæ have been found in the human cadaver, the table of epidemics, and cases in section D, will show to what extent trichinæ have occurred in man, although probably many cases have been overlooked. Reinhard (Ark. der Heilk. viii, 3, 4, 1877, p. 241) gives the number of cases in Saxony at 1,267 for sixteen years, 1860-1875, and thinks many trichinosed hogs are consumed without producing the disease. Delpech (*op. cit.*, p. 81) says: "Wagner assured us (D. and Reynal) that he had met trichinosed corpses in the proportion of 4 to 6 per 100." Leuckart *l. c.*, p. 88. In many cities of Germany, Dresden, Berlin, etc., the number of trichinosed corpses is as high as 3 per cent. Virchow (*op. cit.*, p. 29) says: "I found half a dozen corpses in 1859 containing trichinæ, and very soon had seen more cases than the whole literature of the world had reported. In three months of 1863 seven new cases had died in charity hospitals; these were all found

post mortem without a suspicion of their presence during life." Zenker found (*Arch. für path. Anat.*, 1860, 330) trichinæ in 4 out of 136 dissections. In Dresden City Hospital 2 to 2½ per cent. of dissections show encapsulated trichinæ, although sometimes found with great difficulty (Meissner Schmidt's *Jahrbucher* No. 138, p. 103, quoting Fiedler *Arch. d. Heilk.* vii, 1866, p. 448). Wagner of Leipzig (quoted above—*Arch. der Heilk.* No. II, 1864) saw 30 or 40 cases, according to *Am. Jour. Med. Sciences* 48, 1864, p. 225, and in the same journal vi, 1865, p. 503, found 1 in 30 to 40 bodies. D. Scheiber (*Virch. Arch.* No. 55, 1872, p. 462, 463) reports 1 case of trichinosis in Perth and 3 cases in Bucharest in 1868-69; also that trichinæ have been found in 1 case in the cadaver every year since 1867 in the dissecting-room in Perth, giving an average of 0.5 per cent. In Vienna 2 cases in 1866; first case of trichinosis occurred in 1867. In Russia-Rudnow 3 cases in 150 dissections (Meissner *l. c.*, Haller *l. c.*). Kroft (*Jahresbericht, etc.*, i, 1867, p. 310) 3 cases in cadaver in Copenhagen, 1 diagnosed during life." Key (*Virch. Arch.* xli, p. 302. In the universities of Sweden trichinæ are often found in the cadaver. Gaillard reported (*Gaz. Hebdom.*, 1867, No. 41) 1 case in (in a Spaniard) Algiers. In Scotland 2 per cent. of the dead bodies examined for the five years ended September, 1860, contained trichinæ. Haller, in Ziemssen, iii, p. 629. In England 30 or 40 cases had been found post mortem, but no case of trichinosis had been recognized during life until the report of Dickinson's case in 1871. Cobbold *op. cit.*, p. 169. The figures given above on the authority of Zenker are very remarkable compared with the results of his later observation. According to Dr. Karl Müller (*Inaug. Dissertation Statistik der menschlichen Entozoën*, Erlangen, 1874) they show only 0.95 per cent. of cadavers infected in Dresden and 0.11 per cent. in Erlangen, *l. c.*, in ten years, 1852 to 1862. Two thousand and two cadavers were examined in the Dresden City Hospital, and only 19 found infected from October 1862 to the end of September 1873; in 1,812 dissections in the Institute of Pathological Anatomy in Erlangen only two bodies were found infected (Meissner, Schmidt's *Jahrbücher*, bd. 168, 1875, p. 297). For reported cases in the United States, see section E.

An examination of the results of observation on rats and hogs given above, and consideration of the large percentage of trichinosed rats, would readily lead to the conclusion that the rat was the original host of the parasite. Leisering (quoted by Meissner, *l. c.*) says, "to exterminate the rat is to exterminate trichinæ." Leuckart (*Untersuchungen, &c.*, p. 119), "the rat is its principal host and the chief cause of infection"; and further (*Menschl. Parasiten*, ii, 3, p. 605), "many persons, struck with the frequency of trichinosed hogs, have claimed that it was the hog and not the rat which was the original host." Gerlach was of this opinion and said (*Die Trichinen*, p. 70), "when trichinæ occur in rats, trichinosed hogs or other carnivora will be found, but it does not necessarily follow that trichinosed rats will be found where trichinæ are

found in hogs. The rat may be a means of propagation from hog to hog"; and says the general spread of trichinæ in Germany has some connection with the importation of rats in ships from countries previously infected, but, as a rule, the hog is infected by his own species. But, later (Die Fleischkost, p. 77), "almost every place where trichinosed hogs are found, and the rats have been examined, trichinæ are found in them, and even trichinosed rats are found in the flayer's establishments and other places without the occurrence of trichinosis in either man or the hog." Zenker thinks that the hog was the original host, and rats are affected from the offal from slaughter-houses, &c. Prof. A. Key (*l. c.*), says, "trichinosed rats occur wherever trichinæ are found in hogs." (See Falck *l. c.*) Delpech (*op. cit.*, p. 49) and M. R. Heckler (Thier, Corr. Bl.) found trichinæ in the excreta of hogs, and the latter suggests the action of intermediate carriers, and the former says (*op. cit.*, p. 48), "I insist on the spontaneous trichinization of rats and mice, and that they influence the infection of the hog." Fürstenberg (Landsw. au. Woch., No. 25) thinks that rats become infected from human excrement. Dr. O. V. Linstow (Virch. Arch., Bd. 44, 1878, p. 349), is of the opinion that hogs, cats, rats, and foxes become infected from man. In the report of the Vienna committee (Bericht, &c., p. 30) it is said: "It is not improbable that in due course of time a chain of animals may be found in which there is a reciprocal infection, and it is possible that foxes and other wild animals may become infected through rats and mice living in the vicinity of men."

Of course, the whole question of trichinization has relation to the infection of man through the hog. There does not seem to be much ground for the supposition that hogs are infected from kitchen-slops, as there is nothing essentially different in them from the food eaten by the family. Such infection must presuppose the existence of the parasite in the food prepared for the table, as they cannot exist in the washings of vegetables. In such a case the family would be as liable to primary infection as the hog or even more so, unless, perhaps, that in the washings of highly-trichinosed pork—which cooking rendered innocuous to the family—some trichinæ might be added to his food.

The exclusive rat theory is less adhered to at present than formerly, and opinions seem to be modified in regard to any exclusive theory. But that in most cases rats do contain a large percentage of trichinæ cannot be overlooked. The fact that rats found in flayers' establishments are always found trichinosed in the greatest proportion and often in the highest degree when often other rats in the same town contain no trichinæ, does not support the theory that they are the original hosts, but it does show that they get them from the offal or carcasses there, otherwise the parasite would not be so closely confined to such places. In Vienna (Bericht, &c., Comité, pp. 5, 6) only one trichinosed rat was found among 162 rats taken from Vienna and suburbs in 1866. In Klederling, near Vienna, 7 out of 47 rats caught in the flayer's estab-

ishment were highly trichinosed. In Untermeidlung, where large numbers of hogs are collected from different parts of the country, only 2 out of 31 rats were found infected. This shows that while trichinosed rats are generally found in cities, and especially where they have access to offal, they do not always occur even in those places, and that they must become infected from what they find to eat in certain places only, for even the presence of a large number of hogs, as in Untermeidlung, does not seem to have had much influence. To the last category belongs, even to a greater degree, the occurrence of large proportions of trichinosed hogs in Dearborn and Ohio Counties (Sutton, *op. cit.*) in Indiana, where the largest known percentage of trichinosed hogs were found; 42 rats were examined and not a trichina found; 3 out of 4 cats examined "were found to be swarming with trichinæ, and the trichinæ from one of them were seen to be in motion." On this subject Virchow (*op. cit.*, p. 61) says:

"Should further observations prove that hogs, as a rule, get their trichinæ from rats and mice, the question will arise where do the latter get their infection? and it will be difficult to explain otherwise than the rats and mice become infected from trichinosed meat which they pick up in their wanderings."

Hogs are as apt to meet with dead cats, as with dead rats in some places, and especially, but in less numbers, in those places where the offal of cities is stored, and no other animal is oftener seen lying dead in the streets. See, further, Virchow, pp. 61, 62; Renz, 44-46; Kratz., 64 a.

It might seem that the way to determine the question of priority would be to find out in what animal the nematode was the most abundant, taking it for granted that the animal or class of animals showing the greatest number was the cause of the infection in the others. This would immediately point to the rat as far as the examinations of that animal have been undertaken. But rats, when chosen for examination—excepting, perhaps, only those examined in Vienna in 1866—have been taken from places most favorable for the dissemination of trichinæ. Besides the number examined has never been large. On the other hand, the number of human corpses found to contain trichinæ by Wagner, Fiedler, Zenker, and others, would point to man as a probable original host. Pagenstecher (*op. cit.*, note, p. 47): "It seems that man is the creature in which trichinæ thrive best." This seems to have been adopted by Fürstenberg, v. Linstow, above quoted, and others. But it seems difficult to support a theory of the origin of trichinæ on such statistics, for later observations have shown that all the known cases occurring in man, with a few not very clearly defined exceptions, have resulted from eating trichinosed pork. (See section D, Etiology.)

In regard to the geographical distribution of trichinæ there are widely different opinions, but a large number of observers do not think that it is confined to any particular locality. In regard to their occurrence in

Germany Meissner (Schmidt's Jahrbucher, Bd. 130, 1866, p. 118) says: "According to Fuchs, trichinæ were imported during the last century by the nomadic rats, but if Fehr's observations are to be referred to trichinæ, they occurred in Germany before that time." Gerlach says (Die Fleischkost, &c., p. 65):

"Prior to 1830 there were no trichinæ in Europe; from 1830 to 1850 there were isolated cases in the human corpse, and they were found once in the hog, the dog, and cat, and it was only after 1860 that they got a firm hold. * * * It is more than probable that trichinæ were imported from China or America either in hogs or pork. The hogs in England and North Germany, as well as in the province of Saxony, have since 1820, 1830, been crossed with the small Chinese breed. If now trichinæ are frequent in China (see Gerlach, Die Trichinen, p. 74, quoted later) it is the most natural thing in the world that they should emigrate with the Chinese hogs. Trichinæ might also have originated in America. * * * From the number of trichinæ found in American pork they must be very frequent in American hogs, and it is just as likely that they have been imported in former times in pork as at present.

The argument used by Gerlach (p. 65) against the early occurrence of trichinæ in German hogs, viz, that ham and sausage were eaten raw before the discovery of trichinosis, applies equally to a probability of its non-occurrence in the United States, for it is probable that the large German population of this country have not left any of their habits and customs at home, and the Germans of America have probably eaten raw pork here as much as they did in their native land, yet but few epidemics have been recorded here, and those mostly among the Germans who eat pork raw. But the absence of recorded cases of trichinosis cannot be taken as a guarantee that hogs were not infected or that cases or even epidemics did not occur in man, for as will be seen further on Virchow, Leuckart, Pagenstecher, and others did not consider the disease a new one, but that "the knowledge of it was new." There are only 39 epidemics recorded (Reinhard, *l. c.*) in 16 years (from 1860 to 1875) in Saxony, which in all probability occurred from 39 hogs. Yet in the whole of Prussia, in 1876-1877, 1,501 trichinosed hogs were found (see Eulenberg, *l. c.*). These figures show that either trichinæ have always been quite abundant in Germany, or that they are rapidly increasing in numbers. The result of the examinations of hogs in this country, although showing trichinæ in a large proportion of the animals under observation, have not been extensive enough to base an opinion upon as to whether they might be found in a large number of cases if searched for. The assumption that 8 per cent. found infected in the examination of 100 hogs in Chicago (Report of the Board of Health, Chicago, 1878) can be taken as a guide for the whole country is incorrect, for it probably will apply only so far as a particular drove, with their mode of life, food, and surroundings, are concerned. The occurrence of large numbers of trichinosed hogs in Dearborn and Ohio Counties in

Indiana (Sutton, *l. c.*, and Proc. Ind. State Med. Soc., 1874) would lead to the inference that a trichinæ district of large extent had been discovered, as was the case reported by the Vienna committee above referred to; but as these counties border on the Ohio River, and are not a great distance below Cincinnati—a great pork-packing center—it is not surprising when it is considered that a large amount of offal from slaughter-houses is used for feeding hogs in such neighborhoods. This is mentioned by W. Focke (Berl. Klin. Woch., quoted by Bollinger Jahresbericht, &c., Bd. i, 1874, p. 718) who gives it as a probable cause of the large numbers of trichinæ found in hams imported into Germany. (See, also, Flitner Anleitung zur Mik Untersuch. des Fleisches, &c., 3 Aufl. Lippstadt, 1877, p. 10.)

Not being satisfied as to the correctness of this theory as applied to the present time, I wrote to the president of the Chicago Board of Health, and received a letter dated April 15, 1880, from Mr. B. L. McVicker, the secretary of that body, in which he states that such offal “from all the large establishments is worked up into fertilizers, this being the most profitable use possible. Formerly the material in question was much used for feed, and in some isolated instances, and from some few of the ham-packing houses, is still sent into the country for pigs.”

At the same time I made inquiries as to the practice in Cincinnati, and Dr. Minor, the president of the board of health, sent me the annual report (thirteenth) for 1879, which (p. 82) shows “that the refuse of these establishments (slaughter-houses), including bones, pluck, and blood, is largely utilized. The blood is fed to hogs or used for blood puddings (blutwurst), being shipped for this purpose to Europe, or, when wasted, is run off in covered sewers into the waters of mill creeks. All extraneous waste is turned over to the fertilizing company;” p. 83, “The refuse of some abattoirs is fed to hogs kept for the purpose.” It is on this last account that Roher (Deutsche Vierteljahrsschrift für öff. Gesundheitspflege, N. J. 2, 1874, p. 255) says: “For in the American slaughter-houses there is a system of propagation scarcely less effective and productive than if instituted by design.” Probably the cause of infection in Dearborn and Ohio Counties, as may possibly be found in other counties in the vicinity of Cincinnati, may be found in the offal from the city slaughter-houses, which formerly, much more than at present, must have been thrown or wasted into the Ohio River; at least, before the present sanitary laws were enacted, and before fertilizing companies rendered it innocuous. But it appears that any general estimate based on the examination of one locality must be erroneous, and more extensive investigations should be made before any reliable figure can be given. For, as might be expected, hogs getting any of the offal from Cincinnati—which would be easy enough in localities below, bordering on the Ohio River—would be more or less trichinosed. From the statistics given above it will be seen that hogs raised in cities and vicinity are more lia-

ble to infection than those living in the country. It is not necessary to make any particular charge against the cities on this account, because its explanation is readily found in the aggregation of hogs, with coincident difficulty in keeping them and their pens clean. The hogs are thus placed in the best possible position for the spread of the disease, and if kept in the same pens with the same number and the same unsanitary conditions, the infection would spread the same in the country as in the city. Whatever may be said of the influence of rats as carriers—Gerlach (*Die Fleischkost*, p. 65) thinks that the trichinæ are passed back and forth from rats to hogs, and from hogs to rats—there can be no doubt that hogs thus kept in large numbers may become more or less trichinosed in the course of time from the excreta of trichinosed animals. In regard to experiments on this subject, Leuckart (p. 36) says that “the results are not uniform.” This may be due to various causes, and in some cases may be due to digestion of the trichinæ, as Leisering and Fiedler (*Pagenstecher*, p. 43) have shown occurs when they are consumed by maggots. Virchow (report of a letter by Professors Mosler and Fürstenberg to the assembly of the associated butchers of Berlin, December 15, 1865, Berlin, 1866) remarks that the results of such experiments have been variable, but enough of a positive nature has been seen to show that animals may become infected in this manner.

Kühn (*Mittheilungen des land. Lut. der Univ. Halle*, 1865, p. 1, 31) denies that animals can be infected in this way. “Professors Gerlach and Gunther (*Delpech, op. cit.*, p. 49) placed two hogs in the same pen; one of them had recently eaten trichinosed meats, the other was sound. In a short time afterwards the other hog was found to contain trichinæ. There can be no doubt as to the manner of infection of the second animal. They also determined the existence of trichinæ in excrement in four out of twelve observations.” See also, Mosler (*Virch. Arch.*, Bd. xxx, p. 624), Pagenstecher, *op. cit.*, Kühn (*Virch. Arch.*, xxvi, 222), Virchow (*Lehr, &c.*, pp. 49 and 61), Haubner (*Ueber des Trichinen*, 1864, p. 20).

Further, it is actually proved that animals put in pens in which trichinosed hogs have been kept, will become infected. Gerlach (see *Jahresbericht, &c.*, i, 1866, p. 451) gives a case where a trichinosed hog was killed; another hog afterwards kept in the same pen was found infected. This one was destroyed, and after a time another one was put in, which also became infected. With such facts before us it will be easy to explain why such large numbers of trichinosed hogs are found in Chicago, for the filthy condition of the stock-yards in that city is a matter of public comment (see Dr. O. C. De Wolf, *New Orleans Medical Surg. Journ.*, Jan. 1880, p. 691, and Dr. Elisha Harris’s “*Sanitarian*,” Nov., 1877). What may be considered as fairly proven for Chicago, may reasonably be assumed for Cincinnati and other pork-packing cities. And if one-half is accepted concerning the influence of rats on the spread of trichinæ (see especially Gerlach (*l. c.*, 67), who says that “rats spread the infection

within narrow limits, while hogs are the cause of their transfer to greater distances," and "where there are trichinosed hogs, trichinosed rats will not fail," then it must be acknowledged that the infection as found by Dr. Sutton, in Dearborn and Ohio Counties, was of a recent date, as no trichinosed rats were found. If they are not found there to-day, then the "rat theory" receives a death blow. Of course there is a possibility that trichinosed rats might have been found if more extensive observations had been instituted. If the disease was transmitted from hog to hog, then the theory of Fuge, who thinks (*Jahresbericht, &c.*, i, 1874, p. 718) that "a single hog might, in the course of fifteen years, be the cause of infection in 16,384 others, and at this rate, in a few years, all the hogs in America would become infected." But such excessive infection does not occur; and if such a theory were true, Germany would show a larger percentage of trichinosed animals, for even in wild animals there trichinæ are often found, and in Hildersheim (*Jahresbericht, &c.*, i, 1876, p. 505) the law governing the examination of pork is made to include the wild boar. Large percentages of trichinosed hogs are found in certain places in Europe as well as in America, as will be seen by examination of the reports from Sweden, above mentioned. In Stockholm 3.9 per cent. Tannefers 4.3 per cent.

Dr. Rine, of Linten (Meissner, *Schmidt's Jahrbücher*, No. 130, p. 118), reports "of forty-five hogs three were found infected, and a fourth was known to be infected only after five persons had been poisoned," nearly 9 per cent.; and Warfwinge (*Nord. Med. Ark.*, vii, 3, No. 18, 1875) reports 3 out of 112 Bavarian hams trichinosed, nearly 3 per cent. This will compare with the average, and is higher than the result obtained from the examination of 800 American pork sides (very much higher when we consider the relative frequency of trichinæ in the intercostals and the muscles of the posterior extremity), in which only 18—2.25 per cent.—were found infected.

It is very probable that the number of trichinosed hogs found in some other special localities in Europe would equal the largest number found in isolated cases in the United States if the former were separated from the surrounding country, but by taking a number of places or a larger extent of country the general average may be small, although some places or sections may be highly infected, as is stated by von Linstow (*Virch. Arch.*, 44, 1868, p. 379.) In 1867, 23 trichinosed hogs were found in Holsteïn. There were none found in the Duchy of Lauenburg, although in the immediate vicinity, in Lubeck, trichinosis has appeared in man. Also the figures given above for Sweden, with an average of 1 to 22 to 40, the country-raised hogs show only 1 to 5,000. This will also be corroborated by the statistics given above for Prussia by Eulenberg, and in fact nearly all places where examinations have been made. Thus, if the State of Illinois were taken with the city of Chicago, and the remainder of the State of Indiana were included with Dearborn and Ohio Counties, the average would probably compare

favorably with the result of examinations in Europe. But the numbers of trichinæ reported in Germany are entirely too small. In 1872 Meissner (Schmidt, No. 152, 1872, p. 94) said: "Although the examination of hogs is obligatory in Saxony, not over one-half of the hogs are examined. This is made more apparent by the number of epidemics occurring in places where all the hogs are supposed to be examined—at Hanover, Diessenhofen, Neugersdorf, Magdeburg, Hasselbach, Rapendorf, Lissa, Berlin, Grotzingen, Bleidengen, Trebur, Etzalsroda, Putzlängen, Gross-Weehungen, Forstham, Königsthal, and Nordhausen. (See further particulars in sections D and G).

Whatever may be said of the number of trichinosed hogs found in the United States, the epidemics of Germany are almost uniformly traced to the ingestion of freshly-killed German pork. The epidemic in Bremen (Dr. G. W. Freke, Berlin, klin. Woch, x, 36, 1873) was said to be traced to American ham. This ham was not of good quality, as it was sold at auction, and apparently the reporter satisfied himself that the ham was American, that it contained trichinæ, and that they were capable of producing infection. He claimed that the trichinæ in the center of the hams were still alive. Several children were taken sick in Freiburg (see consular letter, Manheim, No. 86, May 3, 1879), and it was reported that they were infected by eating trichinosed American ham. They all got well, and no positive evidence was offered on the subject. Also (*l. c.*) "40 soldiers were taken sick in Mayence. Although the disease was laid to American pork, no trichinæ could be found in two cases which died. * * *" The consul further states: "In this district cases of trichinosis occur, sometimes resulting in death; yet, after close inquiry and investigation, in no case can I find that death or even sickness can be traced to American meat." This is more probable when it is considered that as a rule trichinæ lose their power to infect after the meat has been properly cured.

In view of the discussion of trichina in American hams, in connection with the Bremen epidemic, Professor Roper (*Deutsche Vierteljahrsschrift für off. Gerundsheitspflege*, vi. 2, 1874, p. 280) instituted a series of experiments with American trichinosed ham. He "fed two rabbits with some of the meat, and found a slight redness of the intestines, but neither intestinal nor muscle trichinæ;" "two cases have been reported in Offenbach and two in Worms, where trichinæ were found in American meat" (consular letter).

Considering the above observations as to the relative frequency of trichinosed hogs in the United States, it might be asked "How will you explain the large number of infected hams, &c., found in Germany?" I should not attempt to explain it until I was satisfied that the hams examined were really American. The finding of trichinæ in the hams examined cannot be questioned, but the other point is questioned. The American consul at Manheim says (letter of May 3d, No. 86): "There is an evident disposition on the part of German authorities to discredit

American meats. * * * The least appearance of trichinæ in American hams is taken notice of, published in the newspapers by the authorities and those interested in discrediting it." The consul-general at Frankfort says (No. 128, March 31, 1879):

"I made explicit written inquiry of various experts and veterinarians as to whether trichinæ had at any time been discovered in American pork imported at Frankfort. The responses were unanimous and emphatic in the negative. One of the gentlemen questioned, a well-known veterinarian, who is commissioned by the army contractor here to examine American hams and sides of bacon, declared that he had never in the course of a long experience of this kind found trichinæ in American pork, and that he had not heard of such discovery in such pork imported here."

The consular agent at Mayence, who at my request also made inquiry about this matter, writes as follows:

"According to the official statement of Dr. Wollpert, the veterinary surgeon of this district, he examined between the first and twentieth of January last some eighty pieces of American ham, and discovered no trichinæ in any of them. Neither has he heard of trichinæ being discovered in American pork imported at any subsequent time at this place."

Further by the same:

"Well authenticated cases have come to my knowledge of rumors of the finding of trichinæ in American pork, resulting upon examination in proving that the meat infected was *not American at all, but German*. It is not improbable, however, that in some exceptional cases trichinæ have actually been discovered in pork from the United States, and of course the greatest possible use has been made of these cases by the German pork interest. * * * A few days ago the butchers of Mayence requested the burgomaster of that place to caution the public against the use of American refined lard as possibly infected with trichinæ. They also asked that octroi duties be levied upon American lard admitted within the walls of the city. The burgomaster was obliged to reply that trichinæ never appeared in refined lard, and that octroi duties would be illegal; but the petition illustrates the extreme anxiety and jealousy of the butchers. Even the alleged outbreak of pleuro-pneumonia among American cattle is cited in a precautionary and alarming way."

According to a letter from the United States consul at Leeds (No. 19, August 20, 1878), samples of American hams taken promiscuously from wholesale dealers by the sanitary superintendent (Report to the Sanitary Committee of the Leeds Town Council, August, 1878) were examined by the borough analyst and found free from trichinæ.

These quotations are not produced to carry the idea that *no* trichinæ are found in American pork abroad, but to show the possibility that the number of diseased swine is over-estimated through the manipulation of

persons, perhaps those most interested, the German pork dealers and producers. The opinion that American pork is fearfully trichinosed is so prevalent in Europe that statements unjustifiable by facts are made and eagerly received. They are made also by men of high ability, whose authority on such subjects should not admit of a suspicion, yet are open to severe criticism, as in the case of Professor Heschl, of Vienna, who, in a letter published in the *Wiener med. Wochenschrift*, June 8, 1878 (see letter from consul-general at Vienna (No. 94) June 24, 1878), informed the public that one in every 5 or 10 American hams was infected with trichinæ, "and the probability exists that several epidemics owe their origin to this fact." Professor Heschl afterwards declared that he had no personal knowledge of the subject to which he called public attention, that he had never seen an American ham, and that he relied upon the examinations made in Germany. He was thereupon invited to examine some American hams, and after a careful examination he said there were certainly no trichinæ in them, and that they were sound and good. The substance of the first letter was telegraphed to the *London Times*, and has been quoted in the European press generally (see *London Lancet*, vol. i, 1878, p. 913) in such a manner that readers would not suspect that its author wrote it before he had seen an American ham.

Trichinosis is a terrible disease, and the press of any country would be doing very little of its duty if it failed to warn the people of such a danger. But how often the interest of some particular dealer has been the cause of impositions on the public through the press is a question that presents itself; and how often mistakes, as above mentioned, have occurred in regard to the nativity of the meat examined is a question that in this country there is no means of determining. We must accept the results obtained in Europe until after proper investigation we can state definitely and officially just how many hogs contain trichinæ from year to year, and the disposition that is made of them; and until that time the American pork interest will be at the mercy of any one who may be induced to give the support of his professional position to any assertion however wild.

If adverse legislation is any proof of inferiority of pork products America does not stand alone, for in Russia it was forbidden (*Schmidt's Jahrbücher*, Bd. 138, p. 104) by law to import ham or sausage from Germany under a penalty of 100 roubles for the first offense, 200 for the second, and after offending the third time, the dealer's license to be annulled. And in 1871 (*London Lancet*, i, 1871, p. 843) "the importation of German pork sausage into England produced enough cases of trichinosis to attract the attention of Mr. Simon, who commissioned Dr. Thudichum to investigate."

But even if it could be proven that all that has been asserted of American swine products were true, it does not solve the question of the origin of trichinæ. As to priority, there is every reason to believe that

trichinosis has been more or less common in Europe for a long time. In fact, there is positive evidence of it in the occurrence of epidemics or single cases, verified by post mortem examinations in after years, as at Jussen, Wegeleben, Hamburg, and Dresden. (See Virchow, *op. cit.*, p. 36 to 49, who mentions other cases, and section D of this report, 1, History, &c.) And further, this is the opinion of many observers. Kestner says (*op. cit.*, p. 31): "The principal centers have been, for some reason, difficult to explain, Prussia, Saxony, and recently Hanover"; and page 46: "The ancient country of Mansfield, of which Hettstadt forms a part, seems to enjoy the sad privilege of a permanent possession of this parasite." Renz (*Die Trichinenkrankheit des Menschen*, Tübingen, 1867: "In the vicinity of Hedersleben there is a trichinæ nucleus of old date, and if we could have a correct history of trichinæ for the whole province of Saxony there would be some interesting developments as regards Magdeburg and Messeburg and the surrounding regions." Dr. O. V. Linstow (*l. c.*) says: "It is probable that our land is the natural home of the trichinæ."

According to a communication from an agriculturist (Bay. ärztl. Intel. bl. Bd. 6, Feb. 1866) quoted by Meissner (*op. cit.*, No. 130, p. 114), trichinosed hogs were known in Saxony between 40 and 50 years ago.

"After a dry season, or when the hogs were kept in a very dry place and the wallowing places became more dry, they seemed to have more worms, but were cured with hemp-seed. The meat was not generally eaten, but sometimes it was noticed that such meat when eaten gave a sensation of sand between the teeth. No cases of trichinosis occurred in man because the meat was well cooked."

Kertuco (*op. cit.*, p. 47):

"Competent observers see in the crossing of foreign races the cause of the propagation of trichinæ. Hungarian pork, supposed to be the source of trichinæ, is not more infected than German pork, and in Bavaria, where this pork is imported on a large scale, trichinosis has never appeared. The English breed, generally raised with a great deal of care, has shown an unhappy aptitude to the introduction of trichinæ on the continent, on account, perhaps, of its close relation with the American breeds" (which came from England). "Leuckart thinks that North America is the true source of trichinæ, but in *Menschl.*, par. ii, 3, p. 591, says the cause of the first infection in Hettstadt was a half-blooded English sow. (NOTE.—In Sweden the proportion of trichinosed hogs is only equalled by that of some places in North America, viz, in Chicago, the so-called Porkopolis)."

Pagenstecher (*op. cit.*, p. 38) says:

"It cannot be conceived, as Klenke has believed, that trichinæ were first imported from England, as Harle found trichinæ in corpses in Berlin, as indicating an ancient infection, almost at the same time that they were discovered in England—or that they might have been spread by American meats because they were first found there in the hog, as they

had been seen in man in numerous places in Europe. This is a hypothesis wholly untenable, as there is no indigenous American animal, except the guinea-pig, which could harbor them." (Leuckart, Menschl., Par. ii, 3, Note, p. 591, Pachent.)

On this subject Delpech (*op cit.*, p. 45) says:

"The geographical distribution of the helminths is a fact too well known to be longer insisted on."

While the *tania solium* is almost exclusively met with in France, England, Prussia, Austria, Spain, and Greece, the *bothriocephalus* is found with it in Holland and Sweden, and almost exclusively occupies Switzerland and Russia.

The *ascaris lumbricoides*, very common in Cayenne, Hayti, Brazil, the French Antilles, Mauritius (l'Île de France), Reunion (l'Île de Bourbon), Sweden, and certain parts of France, is very rare in Paris.

There is nothing more curious than the distribution of the human entozoa *fila via Modinensis*. The east side of Africa, at Senegal and Guinea, eastern Egypt, the central parts of Asia, Arabia, the shores of the Persian Gulf, Persia, Hindostan, and farther east in Tartary, constitute the zone in which it has been observed. It is confined absolutely on the south by the equator; in the north it is bounded by the eastern shore of the Caspian Sea, and stops at the forty-seventh degree of north latitude, while in Africa it only attains the thirty-third degree.

Iceland is the place of predilection of *hydatids*, which affect one-fifth of the population.

The *cysticercus cellulosa* of man is frequent in Berlin, according to Rudolphi, Knappe and Virchow, while Brenner could never find it in Austria. That of the hog is universal in France, but occupies certain regions by preference.

The *trichina spiralis* does not escape the peculiar conditions which result from temperature, alimentary habits of the people, regular transmission of the parasite in proportion to its development, and other causes not completely understood. Prussia, especially in the vicinity of Magdeburg and Merseburg, takes the first place as a trichina district. Then come Brunswick and Saxony; then England, Denmark, Austria, and Bavaria. North America is not exempt, and the cases which occurred in Hamburg, from an infected hog brought from Valparaiso, show that it occurs in South America.

"The disease exists in India, and Dr. Gordon (Times, December 14, 1874) describes the habits of the Hindoos, who allow filth and offal of all kinds, dead bodies of domestic animals, and even human corpses to lie on the ground, which are devoured by the swine without hindrance." (In the latter days of 1864 news was received that several cases of trichinosis had occurred in the English hospital at Calcutta, and that it was quite frequent in the natives.—Pagenstecher, *op. cit.*, p. 28; also, Gerlach, die Tr., note, p. 73.)

"Finally, Lebert (Gaz. Med. de Paris 1866) notices the occurrence of the disease in Switzerland, in 1829.

"France, up to this time (1866), remains outside of the limits of this distribution."

Later reports show that trichinæ have been found in rats in Paris (Goujon, *l. c.*), and in Russia. Krylow (*l. c.*) reported cases in St. Petersburg, but P. V. Maydell (*l. c.*) denies that they received the infection in that country. Rudnef (see Pagenstecher, p. 40) reports trichinæ; and, again, Krylow (*Deutsch. Zeitschrift*, iii, 1876, p. 392) found 5 out of 3,550 hogs infected, and thinks that if the examinations for trichinæ were obligatory in Russia, trichinæ would be found to be more numerous than in Germany. Scheiber (*Virch. Arch.*, No. 55, 1872, p. 468) says the same of Roumania. Gerlach (*Die Trichinen*, note p. 74) says that according to the statement of a ship captain, who often visits China, trichinosis occurs among the filthy lower classes. They have been found in Africa and Italy (see above reports) and (Heller, *l. c.*) in Australia.

Finally, I will quote Falck (*Die Fleisch.*, p. 523): "Trichinæ do not belong to those animals which are confined to any particular place; they are cosmopolitan." Pagenstecher (*op. cit.*, p. 38): "Because a place has not suffered from the ravages of trichinæ is no guaranty that it will not, for it has become cosmopolitan with man, hogs, rats, and mice"; and Heller (*Ziemssen's Encyc.*, iii, p. 628): "*Trichinæ have been found in all countries where search has been made for them.*"

SECTION D.—TRICHINOSIS.

1. HISTORY.

a. History in general.

The first hint of a connection between the *trichina spiralis* and disease in the human body was given by H. Wood in 1835 (*Lond. Med. Gaz.*, May, 1835).

In 1860 Professor Zenker, of Dresden (*Deutsche Arch. für Klin. Med.*, viii, p. 389), treated what was supposed to be a case of typhus fever, with the unusual complication of excessive muscular pain and œdema, etc. He was thus, after the death of the patient, led to make a microscopic examination of the muscle and found the whole muscular system swarming with trichinæ. He at once inferred that not only the peculiar symptoms but the whole disease was caused by their presence and called it trichiniasis (*trichinenkrankheit*).

Leuckart (*Untersuchungen, etc.*, p. 34) inaugurated a series of experiments which established beyond a doubt the causal relation between the parasite and the disease.

"Friedrich (*Virch. Arch.* 25, 1862, p. 399) in 1862 first diagnosticated the disease and determined experimentally the presence of trichinæ during the life of the patient." (*Scoutetten, op. cit.*, p. 52.)

Closely following the publication of Zenker's case the symptoms of many previous epidemics, hitherto not clearly understood, were ex-

amined critically and found to correspond so closely with those of this case—which now was becoming known, as his report was copied far and wide—that the epidemics in question were unhesitatingly referred to trichinæ and pronounced trichinosis. The earliest of these cases, previously considered as a result of injection of some poison peculiar to meat (Wurstgift, etc.; see Diagnosis, p. —), occurred in ———.

Württemberg in 1665, in which four cases, three fatal, occurred.—Fehr. (Miscell. Med. Phys. Cur. Acad. Nat., etc., I Ann. vi, 1677, Obs. 181, p. 269). This is considered by Heller (*l. c.*) as an undoubted epidemic of trichinosis. In

Gröbzig, near Dessau, 1818: 7 or 8 cases.—(Dr. Kahler's Hufeland's Journal, vol. v, p. 44.)

Adelfingen, 1829.—Lebert (Gaz. Med. de Paris). [See Section C.]

Strasburg, 1831: 300 cases, 36 deaths.—(Hollstein Deutsche Klinik, 14, 1863.)

Neidermittlau: 1834, 34–5 cases called gastro-rheumatic fever. C. Wagner (Arch. der Heilkunde, 1864, p. 278, and Husemann, Deutsche Klin., 8, 9, 10, 1864).

Wurzen, 1837.—(Meissner, *op. cit.*, 1866, p. 117.)

Dresden, 1842: 4 cases, 2 deaths. One of the victims, a lady, moved to Breslau, and was operated upon for cancer, and died 25 years afterwards. At the autopsy numerous trichinæ were found in the muscles. Two servants died in 1842, and the butcher who sold the meat was taken sick, all with the same symptoms. Klopsch (Virch. Arch., 35, 1867, p. 609).

Halberstadt, 1844. Described by Dr. Abel as influenza or grippe. (See Renz, *op. cit.*, p. 50.)

Quedlinburg, 1844. Dr. Abel (see Renz, *l. c.*).

“Jessen, 1845: 7 cases, 4 deaths. A. Lücki (Vierteljahresschrift für ger. u. öff. Med. Bd. 25, 1864, p. 102.) Trichinæ were found in one of these cases by Langenbeck during an operation. A merchant had invited the members of a board of school commissioners to lunch with him; seven of the eight were taken sick and four died. The suspicion of poisoning was so strong that the merchant had to leave the country.” (Virchow, *op. cit.*, p. 49.)

Leipzig, 1848: 26 cases, 2 deaths. Wagner, quoted by Delpech, p. 36. Mügeln, 1848, Meissner (*l. c.*).

Oschatz, 1848. Wagner (Arch. der Heilkunde, 1864, p. 278), Virchow, p. 50.

Wegeleben, 1849. Mosler (Virch. Arch., No. 33, 1865, p. 215), Virchow, *l. c.*: 164 cases and 27 deaths, treated by Rudolph, called “English sweat” and “black death,” the latter because the bodies became black after lying some time. Renz (*op. cit.*, p. 4): “There was a fever and a miliary eruption; cases first observed in the employés of a sugar factory. Rupprecht found trichinæ in one of these cases 16 years after.” (Meissner, *op. cit.*, No. 130, p. 109.)

Reichenbach, 1849-50. Meissner (*l. c.*).

Quedlinburg, Halberstadt, 1851. Dr. Abel (Preuss. Vereinzeitung, November 15, 1857) described as a peculiar epidemic influenza in the neighborhood between the Harz (Hay Meissner, Reuz, *l. c.*).

Hamburg, 1851: 9 cases, 3 deaths. Tungal says (Virch. Arch., 23, 1863, p. 391) as the judicial examination failed to show the cause of the disease it was called "schinkengift," as the meat was of bad quality and sold cheaply on that account. One of the patients who recovered died in the Hamburg mad-house in 1865, and numerous trichinæ were found in the muscles. (Virch. Arch., 32, 1865, p. 363, and Pagenstecher, 30, 31.)

Celle, Hanover, 1855: 12 cases. (Letter of Dr. Baring to editor of Zeitschrift für pract. Heilk. Hanover, 1864. 2d Aufl., Gerlach Landwirthschaftliche Zeitung, No. 381, 4073.)

Schweitz, Merschede, 1855.

Breslau, 1858. Meissner (*l. c.*).

Magdeburg, 1858. Scudler says (Deutsche Klinik, No. 27, 1862, No. 2, 1863, also Schözl, *l. c.*) the disease was called "acute epidemic œdema of the subcutaneous cellular-tissue and muscles."

Blankenburg, 1859: Nearly 150 cases. Schözl (Deutsche Klinik, 17, 1854), "Dr Abel called it rheumatic fever, with acute œdema of the muscles and cellular tissue." (Reuz, *op. cit.*, pp. 4-5.)

In addition to these epidemics generally accepted as trichinosis, there occurred in Paris in 1828-'29 a severe epidemic called "*acrodynia*," "*mal des mains et des pieds*," "*érythéma épidémique*," "*phlegmaric gastro-cutanée aigue multiforme*," etc., and lately has been called trichinois by Le Roy de Mericourt. (Arch. gén. de Med., ii, 1865, p. 620.) [This epidemic has been generally accepted as one of trichinosis, but according to Meissner, *l. c.*, and Med. Times and Gaz. (London), vol. i, 1866, p. 622, Delpech (Report to Acad. de Sc. de Paris) not only denies this, but in the latter is made to say there are no trichinæ in France. In a later work (*Les trichines et la trichinose*, etc., Paris, 1866, p. 80) he does not deny the discovery of trichinæ in the cadaver, but says: "We, M. Raynal and myself, were perfectly correct when we said that no cases of trichinous infection had been known to occur on our soil.]

"The symptoms of *acrodynia*, according to Dernos (Nouveau Dic. de méd. et de chirurg. prat., éd. Jacoud, Paris, 1864, i, p. 375), occur in three series: Disturbances referable (1) to the alimentary canal; (2) to the nervous system; (3) to the cellular tissue of the external and internal covering—skin, conjunctivæ, pharyngeal, bronchial, and urethral mucous membranes. In the beginning there are digestive disorders—loss of appetite, obstinate œdema of the face, at times conjunctivitis and bronchitis, often vomiting and diarrhœa. Then follows stiffness of the joints, with sensation of formication, which gives way to superficial and deep hyperæsthesia, painful, often convulsive sensations of various kinds—contraction, twitchings, convulsions, erythematous redness, es-

pecially of the hands and feet; later, anæsthesia, weakness, paralysis. The erythema gives place to a yellow, blackish scaling of the skin; fever usually absent; intelligence clear. The results of post-mortem examinations entirely negative.

Bascome, in his *History of Epidemic Pestilences*, London, 1851, although giving his descriptions of diseases only in a general way, and for this reason not so available for statistical purposes, yet when similarities occur are the more striking, because he makes no attempt to follow any particular theory. He says, p. 156:

“This year (1827) a singular malady, a sort of a rheumatic fever, occasioning great agony, broke out in the island of St. Thomas, West Indies, and affected almost every one of a population of 12,000 persons. It obtained from the negroes the cognomen of ‘dandy fever.’ It was rarely fatal. A similar disease prevailed the year following in Paris * * *. A writer thus describes the malady * * *. It was generally unaccompanied with any great degree of fever, but affected the whole nervous system in a most peculiar manner, especially by a most painful sense of formication of the hands and feet, as well as a degree of numbness which seized first upon the members and thence extended over the whole body. The formication and painful numbness of the extremities were so characteristic of the complaint that at Paris and elsewhere in France it was known by the name of ‘mal des pieds et des mains.’ The cellular tissues in this disease became affected after a while; the hands and feet swelled, and œdema attacked the face and several other parts of the frame. Immense numbers suffered from it in France. The sensations were compared to those caused by the punctures from the points of a thousand needles or of some such sharp instrument. An intense degree of heat aggravated the sufferings, and many could scarcely move their body or extremities without great agony; cramps and spasmodic contractions were present in many cases; the digestive organs were greatly disordered, and symptoms of cholera morbus were sometimes developed in the course of the disease; eruptions of various kinds occurred on the body; sleep was prevented by the excessive pain and general disturbance of the system; delirium sometimes supervened; the sight and hearing and the sense of smell were altogether lost in some, but in others only partially impaired. In some, convalescence followed in a few weeks; in others, not until several months had elapsed. Great numbers fell victims to the malady, and many perished ultimately from its *sequelæ*.”

This disease “was observed (Heller, *Ziemssen’s Cyc.*, iii, p. 619) as a widespread epidemic in Paris in 1828-’29, and afterwards in various other districts of France, as, for instance, in Coulommiers, Pèrre-Champenoise, Montmirail, and Vitry; in 1846 in Belgium, and in 1854 in the Crimean army. In order to recognize that this view is correct, it is only necessary to read the name and recollect that the prevailing epidemic in Magdeburg and vicinity in the year 1858, and subsequently, was de-

scribed by Scudler" (*l. c.*) "as acute epidemic œdema of the subcutaneous cellular tissue and muscles. We may thus compare it with an epidemic of 'febris desquamatio typhoides' in 1863 in Zullichau and vicinity, described by Frank as 'epidemic morbid desquamation of the epidermis,' which without doubt is to be considered as trichinosis."

Virchow, Leuckart, Pagenstecher, and other able observers do not doubt the previous occurrence of this terrible disease, and Zenker very naturally says that (Heller, *l. c.*) "cases of encapsulated trichinæ are to be considered as healed cases of trichinosis." Thus the 50 cases recorded in section A may represent not only 50 cases of trichinosis in man, but 50 epidemics. Some of them might have resulted from very light infection, or, when the number of trichinæ was large, from several such infections, no single one of which might have presented more than a passing disturbance of the digestive organs, or each one may have resulted from infection during a more or less grave and extensive epidemic, as in the cases from Jessen, from Hamburg, Dresden, and Wegeleben, etc. Thus, as Leuckart says (*Untersuchungen, etc.*, p. 18), "The disease has not failed to appear in former times, only the explanation of the symptoms was different. Typhus, influenza, gastro-rheumatic fever, rheumatism, gout, œdema of the muscles, and poisoning were the diagnoses, according to the most prominent symptoms, until the discovery of trichinosis furnished a clue to their nature and etiology."

Referring again to Bascome (p. 86), it will be seen that the disease called "English sweat" or "sudor anglicus" occurred in England in 1485 (p. 70), and prevailed at the same time in Ireland. It also occurred in 1505 (p. 75), 1517 (p. 77), and the last time in 1551 (p. 86). "The symptoms (p. 70) were those of a violent inflammatory fever, which, after a short time, caused great prostration of strength. There were also present oppression at the stomach and violent headache, accompanied by lethargic stupor, and the body was covered with a profuse fœtid perspiration. The progress of this singular malady was very rapid, a crisis always taking place within the space of a day and a night. The internal heat from which the patient suffered was intolerable, yet everything cold, or even cool, was certain death. No one was exempt. Many of those who recovered from the first attack were attacked a second, and some even a third time." There are some points in these symptoms widely different from those of trichinosis. Yet, in regard to the progress, it is possible that some of the earlier symptoms may have been overlooked, and in regard to the danger from "cold" it will be remembered that it is only recently that a low temperature has not been considered dangerous in all forms of fever. It is possible that the remarks of Heller, referring to what was called by the same name in Wegeleben in 1849, will apply here as well. He says (*op. cit.*, p. 619), "The descriptions of this disease present such a striking resemblance to trichinosis that we are compelled to consider them the same even if important symptoms are omitted, or if others seem to be grouped anomalously."

(Compare Hirsch, *Hist. Geog. Path.*, i, p. 468, 1860, *Virch. Arch.*, 8, p. 18). "The sweating plague (Bascome, p. 81-2) also occurred in Hamburg, Lubeck, Stettin, Zwickau, and Brussels in 1529." Most of these places, it will be seen further on, have recently been the seat of trichinosis. "In 1525 (Bascome, p. 79), the sweating sickness, which had been for some time raging in England, extended to other parts of Europe, and in the course of five years spread over Lower Germany, the Low Countries, Holland, Zealand, Brabant, Flanders, Denmark, Norway, and France. Six hundred and upwards would sometimes be seized in a day, while of this number, when so seized, rarely more than six recovered, so destructive was it. In 1527, 'deadly fevers were rife in London, which, in the autumn, degenerated into sweating sickness. It invaded Cork in Ireland, and Italy also. In 1528, an epidemic prevailed in France.' The disease was a highly inflammatory form, which proved fatal in a very short time, very frequently in the space of a few hours. In many cases of those who recovered, the hair and nails dropped off, and convalescence was tedious, leaving the constitution much impaired. The symptoms were evidently the same as those observed in what was termed 'dandy fever,' which prevailed in later times in France and in the West India Islands in the year 1828" (referred to above).

Other epidemics to which trichinosis, in some of its symptoms, was so similar that it has been misnamed for them, as influenza, catarrh, etc., have been prevalent many times in different parts of Europe. In the year 1570 there prevailed in Spain an epidemic similar to the "febris diaria," and another called "sudorific fever; then the miliary pestilence which prevailed in Hungary in 1672, and Hamburg in 1675, and the miliary or sweating pestilence," which "committed great ravages in Stuttgart, Dusseldorf, Erfurt, and Jena in 1690 (B., p. 114). The miliary fever in Berlin in 1674, and the miliary or sweating pestilence in Breslau in 1700." In 1708 a universal catarrh overspread all Europe and America. Lancisius relates that a similar epidemic appeared and raged with much severity in Italy, especially in Rome; he describes the malady as beginning with a running at the nose, or coryza, attended with pains in the limbs, extending over the whole body, but felt more especially in the chest. In Stockholm and Copenhagen many died of the "sweating sickness" in 1710 (*l. c.*, p. 119). In 1712 a miliary or "sweating pestilence" raged at Mümpelgart; in 1720 in the Canton de Bray, in Lower Seine; in 1723 in Frankfort; in 1728 influenza was prevalent in Spain; in 1736 (p. 125, *op. cit.*) ergotism "again 'broke out in Silesia, in Subborth, and at Waltenburgh, in Bohemia.' Dr. Saine describes the disease as beginning with a disagreeable titillation of the feet, as if ants were creeping on them (formication), which was soon succeeded by a violent cardialgia, or pain in the stomach; the hands were next affected, then the head; many cried out that their hands and feet were on fire; epilepsy was one of the concomitants of the disease."

In 1788 there were epidemics in America; one was described by Dr. Manson, thus: "Slight influenza, stinging pain in the jaws and limbs, soreness of the muscles of the neck, attended with severe fever; in Röttingen, in 1802, the young and strong were suddenly seized with pain and anguish at the heart; with violent palpitations and lacerating pains in the nape of the neck; profuse, sour, ill-smelling perspiration, broke out over the entire body, and a suffering as though a violent rheumatic fever had seized on the tendinous expansions, accompanied the terrible malady; in the worst cases a spasmodic trembling ensued, the patient fainted, the limbs became rigid and death closed the scene frequently within twenty-four hours from the commencement of the attack" (*op. cit.*, p. 147).

In the lack of complete histories of these epidemics, many of them appear from the symptoms given, strikingly similar to trichinosis. The symptoms mentioned being probably the most prominent are the same as those most likely to be noticed in that disease. Excruciating pains in different parts of the body, profuse perspiration, especially if fœtid in character, with the œdema, are insufficient to lead to a suspicion of trichinosis. Such a disease, with severe dysentery and acute pains in all parts of the body, anguish and great depression of both mind and body, occurred among the Carthaginians sent (B. C. 427) to subjugate Sicily (Bascome, p. 8).

Possibly if fuller particulars could be obtained the symptoms in many of the above epidemics would show a great dissimilarity to trichinosis, especially in those in which vast numbers perished in a short time, *e. g.*, in Copenhagen and Stockholm, where 30,000 and 25,000, respectively, died in 6 months in 1710, as also in Göttingen, 1802, and in France in 1528, when the short course of the disease would make a diagnosis of trichinosis extremely doubtful, although more minute information might reveal the occurrence of early symptoms of considerable duration. In the epidemic on the continent of Europe, especially in France, and the Low Countries in 1525-'30, the intense mortality does not correspond with that of trichinosis. It is possible that the only similarity the epidemic of Wegeleben bore to "English sweat" was the profuse diaphoresis. But it is just as probable that an epidemic of trichinosis might have been at some time confounded with any one of them, admitting that they were distinct and independent diseases.

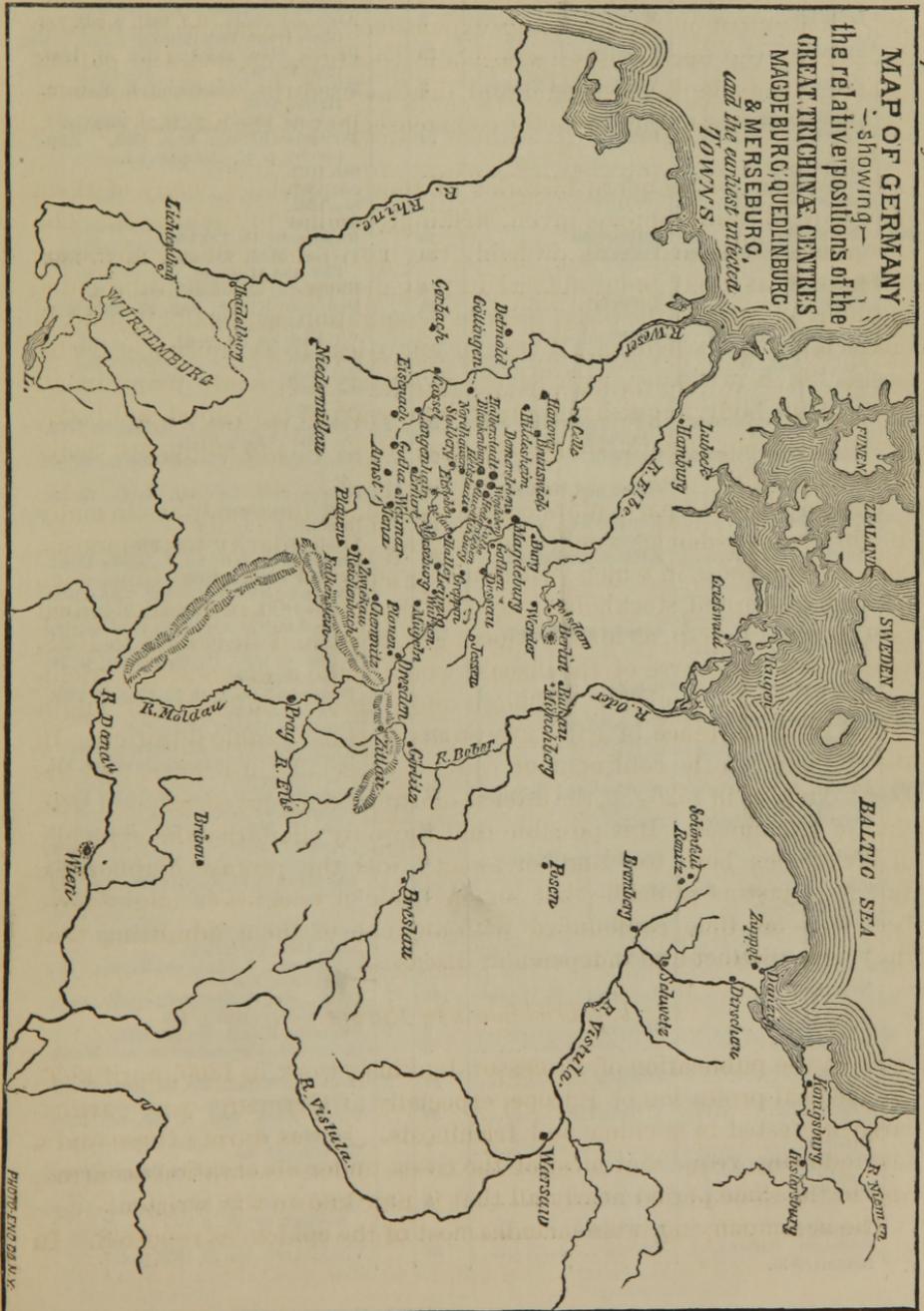
b.—Trichinosis in Europe.

From the publication of Professor Jenkins's work in 1860, until 1866, the medical profession of Europe, especially of Germany, were particularly interested in trichinæ and trichinosis. It was during these and a few following years that most of the cases under observation occurred, and in the same period nearly all that is now known was written.

The accompanying table includes most of the epidemics reported. In

many cases the name of the first reporter only is noted, but the figures given by some later report are introduced.

The accompanying map will show, to some extent, the close grouping of the places first reported as infected. A matter of great interest in this connection would be a knowledge of the facilities of communication between towns situated near each other and the exact order of infection.



List of epidemics in Europe since 1860.

[See section E for cases in United States.]

Year.	Town or city.	Reporter.	Number.	Deaths.	Where reported or found.
1860	Dresden and Plauen	Zenker	4	1	Virch. Arch. Bd. 18, p. 561. See Rupprecht, Pagstr.
	Leipzig	Wunderlich	2		Arch. der Heilk., ii, 3, 1861, p. 262. (4 cases Rupt. Rundblick.)
	Stolberg	Ficinius	26		Preuss. Med. Zeitung No. 81, 1863. (See Virch.)
	Cerbach	Waldeck and Zenker	3		Bericht der Gesellsch't f. Natr. u. Heilk., 1861.
	Quedlinburg	Scholz			Deutsche Klinik, 18, 20, 21, 1860 (1).
	Rügen	Landois	30		Deutsche Klinik, 4, 8, 1863. Rupprecht, p. 67, Davaine, i. i.
	Magdeburg			See 1862.	
	Blankenburg			See 1862.	
	Neustadt			See 1862.	
	Buckau			See 1862.	
1861	Hettstadt	Rupprecht	16		Rupprecht die Trkkht.
	Custen and Wurmsdorf	Franckel	40	1	Preuss. Med. Zeitung, 16, 17, 1863, Davaine Museum.
	Mansfeld		8		Rupprecht Rundblick, etc., p. 9.
	Rügen	Landois	20		Deutsche Klinik, Jan. 25, 1863, Gerlach D. Tr., p. 7.
	Garz neighborhood	4 epidemics			Virchow, <i>op. cit.</i> , p. 62.
	Magdeburg				See 1862.
	Blankenburg			See 1862.	
	Neustadt			See 1862.	
	Buckau			See 1862.	
1862	Plauen, S. W. Saxony	Königsdorfer and Boehler.	30	2	Trkkht, etc., Arch. d. Heilk., iv, 1862, p. 575. Rupt. Rbkl.
	Plauen, near Dresden	Gerlach	26		Die Trichinen, etc., 30 cases, 1861-2, p. 7.
	Calbe	Simon and Herbst	38	11	Preuss. med. Zeitung, N. F., 38, 39, 1862. Gerlach, &c.
	Hettstadt	Rupprecht	18		Rundblick, etc., p. 9.
	Heidelberg	Friedrich	1		Virch., Mch. 25, 1862, p. 399.
	Burg	Kluremann Scholz	50	11	Preuss. med. Zeitung, 50, 1863; Deutsche Klinik, 2, 1863.
	Magdeburg				Deutsche Klinik, 27, 1862. The whole number for Magdeburg, Neustadt, Buckau was 300 to 400, from 1858 to 1862. Constatt's Jahresber, vii, 1861, p. 100. Pagenstecher, p. 28, Davaine, <i>l. c.</i>
	Neustadt		350	2	Deutsche Klinik, 49, 50, 1862; 37, 1863; 18, 21, 24, 1864.
	Buckau				Deutsche Klinik, 17, 18, 1864.
	Blankenburg	Scholz			Deutsche Klinik, 27, 1862; 2, 1863. Zeitschrift für wissen. Zoölogie, xii, 2, 1862, p. 255.
From 1858 to 1862. See Pagenstecher (<i>l. c.</i>) and Rupprecht, Rundblick, etc.	Griepenkerl Seudler Knoch		278	2	Deutsche Klinik, No. 47, 1863, Pgtr. Rupprecht, etc.
1863	Plauen, S. W. Saxony (Voigtl'd.)	Boehler and Königsdorfer.	21		Arch. d. Heilk., v, 517, Rupprecht Rundbl., p. 31.
	Plauen, near Dresden	Fiedler	3		Koönigsdorfer (<i>l. c.</i>) Virchow, p. 62; Kestner, p. 37, Rupprecht.
	Falkenstein	Bascher and Pinter	4		Rundblick, p. 31, Pgtr. Meissner, <i>l. c.</i>
	Jena, 4 cases. See Thuringia.	Seidel	4		Landwirthshafliche Zeitung, No. 381, 4073, Du Trich.
	Celle	Gerlach			Lehr, etc., 5 small epidemics. See Meissner, <i>l. c.</i>
	Weimar, 10 cases. See Thur.	Seidel, Virchow			Trich., etc., in Hettstadt ep. W. Arch. D. Nülk, v, 1863, p. 183.
	Hettstadt	Rupprecht, E. Wagner	158	37	H. Fucher, Pagenstecher, see Meissner, <i>l. c.</i>
	Quedlinburg	Behrens	9	1	Deutsche Klinik, No. 30, 1863.
	Berlin, Q. ep		5		Deutsche Klinik, No. 30, 1863, Wentzel Meissner <i>l. c.</i>
	Rügen	Landois	20	2	Virch. Arch. 1864, p. 215, see Rupprecht <i>l. c.</i>
	Posen	Y. Sampter	50		Meissner (<i>l. c.</i>).
	Dreslau		1		Meissner (<i>l. c.</i>), died in Prague Hosp.
	Selschranick (Slezanka!).		1		Virch. Arch. 29, 1864, p. 224. (See Kestner <i>op. cit.</i> , p. 29.)
Hamburg	Tungel	5	2	See 1864.	
Leipzig	E. Wagner			Virch. Arch. No. 26, 1863, p. 437.	
Zwickau, Seitendorf, Sommerfeld.	Franck	88			

List of epidemics in Europe since 1860—Continued.

Year.	Town or city.	Reporter.	Number.	Deaths.	Where reported or found.
1863	Thuringia, Halle, Gotha, etc.	Dr. Alf. Nobilung	103		Sch. Jahrbücher I, 1871, p. 95.
	Eisleben, see 1864	Rupprecht			Rundblick, etc., p. 28; Pagenstecher, p. 31.
1864	Eisleben, 1863, 4	do	18	2	Rundblick, p. 29; Pagenstecher, Da- vaine, Kestner, p. 39.
	Hettstadt	do	8		Rundblick, p. 29.
	Quedlinburg	Wolff, Mosler	120	2	W. D. Klinik, 1864, xvi, p. 151; xviii Rup. M. Virch. Arch., 33, 1865, 414. Die Trkkt, 1864, p. 12; Rupprecht, <i>l. c.</i>
	Halle	J. Vogel			Meissner (<i>l. c.</i>), Allgm. med. Cent- rtztg., iv, 1865.
	Domersleben		20		Jahresbericht, etc., I, 1866, p. 15; Meissner, <i>l. c.</i>
	Calbe	Simon	2	1	Meissner (<i>l. c.</i>); Pagenstecher, p. 38. D. Klinik, 1864, No. 18, 20, 21. (See Pagenstecher, p. 37.)
	Dersau in Anhalt	Maun	60	3	Berlin Klin. Woch., No. 37, 1864; Prag. Vjscht. Pgrtr.
	Blankenburg	Scholz	6		Meissner, Sch. Jahrb., 130, 1866, p. 47. (See Cobbold <i>op. cit.</i> p. 169.)
	Werder	Mollendorf	5		Rupprecht Rdblk., p. 30.
	Hanover	Baring T. Schuchard, 419.	157		Meissner, <i>l. c.</i> , many cases.
	Celle	Schiller, Baring	8		Arch. d. Heilk., 1864, No. 2. Meissner (<i>l. c.</i>) Papr. Am. Jour. Med. Sc., 4 v., 1864, p. 226; Rundblick, p. 31.
	Lichtenthal	A. Räf			Rupprecht, p. 30, Virchow, Meissner (<i>l. c.</i>).
	Leipzig, 1863-64	E. Wagner	14	2	Rupprecht (<i>l. c.</i>), Meissner.
	Berlin	Cronfield 3, Frorcher 7	10		Virchow, <i>op. cit.</i> , 63. Davaine, Cobbold.
	Breslau (Dürrgoy)	Methner	4		Arch. d. Heilk., II, 6, 503, 1865, Meiss- ner (<i>l. c.</i>).
	Uselitz	Hallhoff	5		Pagenstecher, p. 39.
	Potsdam	Mollendorf	5		Rundblick, etc., p. 29.
1865	Dresden	Fiedler	12		Rundblick, Pagenstecher.
	Chemnitz	Gunther	12	2	Berliner Volkzeit, 1865, No. 12, Meiss- ner, Pgrtr.
	Hettstadt	Rupprecht	15	1	Meissner (<i>l. c.</i>) Jahresbericht, I, 1866, p. 15.
	Zittau and suburbs	do	33		Virch. Arch., 33, 426, 34, 1865, p. 230. Rundblick, 32, Meissner, Pgrtr.
	Dolan	Rhude	5		(<i>l. c.</i>). Pruss. Ann. d. Landw. Die Trichinen epidemie zu H. Leipzig, 1866.
	Calbe, 2 ep.	Simon	6		7 cases included in Hedersleben.
	Halle	C. Wolff	1		Meissner (<i>l. c.</i>) Renz., p. 6, Pgrtr. 39. Meissner (<i>l. c.</i>).
	Nordhausen	do			Scoutetten, p. 60; Pagenstecher, p. 39.
	Hedersleben	Kratz	337	100	Meissner (<i>l. c.</i>) Pagenstecher., 39. Meissner (<i>l. c.</i>) Pagenstecher., 39.
	Wegeleben	Gust			Meissner (<i>l. c.</i>) Pagenstecher Meissner (<i>l. c.</i>) Pagenstecher
	Magdeburg	Voigtel	*4	1	Virch. Arch. 34, 1865, p. 230, Meissner Pgrtr.
	Gotha				Meissner (<i>l. c.</i>) 3 Ep. Virch. 62, Rup. 32.
	Berlin, 3 ep	Cohnheim, Pgrtr	18	1	Pagenstech., p. 38, Meissner (<i>l. c.</i>).
	Münchburg	Virchow	1		Pagenstech., p. 38, Meissner (<i>l. c.</i>).
	Buckau		6	1	Pagenstech. Virch. Arch. 34, 1865, 730 (<i>l. c.</i>).
	Greifswald	Mosler, Kouk	6	2	Pagenstech. Virch. Arch. 34, 1865, 730 (<i>l. c.</i>).
	Zoppol	Benzler			Pagenstech. Virch. Arch., Rupprecht (<i>l. c.</i>).
	Schönfeldt	C. Wolff	23	2	Pagenstech. Virch. Arch., 34, 1865, 730 (<i>l. c.</i>).
	Intersburg	do	5		Pagenstech. Virch. Arch., 34, 1865, 730 (<i>l. c.</i>).
	Königsburg	Samuelson	1		Pagenstech. Virch. Arch., 34, 1865, 730 (<i>l. c.</i>).
	Dirscham		80	1	Pagenstech. Virch. Arch., 34, 1865, 730 (<i>l. c.</i>).
	Goslitz				Pagenstech. Virch. Arch., 34, 1865, 730 (<i>l. c.</i>).
	Henef		1	1	Pagenstech. Virch. Arch., 34, 1865, 730 (<i>l. c.</i>).
	Langenheim	Hanter	2	1	Pagenstech. Virch. Arch., 34, 1865, 730 (<i>l. c.</i>).
	Canel		6	3	Pagenstech. Virch. Arch., Rupprecht (<i>l. c.</i>).
	Lubeck	Erhenberg, Wolff	10	3	Pagenstech. Virch. Arch. 34, 1865, 230. Pagenstech. Virch. Arch. 34, 1865, 230.
	Friedland		34		<i>l. c.</i>
	St. Petersburg	Krylow	1	1	Meissner, Sch. Jhrb. 138, p. 101.
	Feuz	Klob	9	2	Meissner, Sch. Jhrb. 138, p. 101.
	Rattmansdorf		6		Meissner, Sch. Jhrb. 138, p. 101.
	Gronottersleben		3		Meissner, Sch. Jhrb. 138, p. 101.
	Grossqueenstadt		6		Meissner, Sch. Jhrb. 138, p. 101.
	Nietleben	Delpech	*2	2	Meissner, Sch. Jhrb. 138, p. 101.
	Worbis	Wolff	12		<i>l. c.</i>
	Weimar	Frommann	3		Virch. Arch. 53, 501.
	Hettstadt	Rupprecht	15		Rundblick, &c., p. 2.
	Gross-Jägensdorf		5		Pagenstecher, p. 39.

List of epidemics in Europe since 1860—Continued.

Year.	Town or city.	Reporter.	Number.	Deaths.	Where reported or found.
1866	Leipzig	.....	2	.....	Leipzig Nach., v. 14, Mch., 1866, Rup.
	Groppin	Dippe	4	.....	Meissner (<i>l. c.</i>).
	Zinten	Risse	4	.....	Meissner (<i>l. c.</i>).
	Breslau	Stadthagen	5	.....	Meissner (<i>l. c.</i>).
	Prague	Politzer and Boner	3	.....	Allg. Wien. med. Ztg. 6, 1866, and Klob.
	Brünn*	Ulob.	8	2	Wien. med. Woch., No. 11.
		Kalmus and Boner	.....	.....	Virch. des Vereins in Brünn, v., 1867, p. 173, and Virch. Arch. No. 43.
	Huy	.....	3	.....	Meissner, <i>l. c.</i>
	Chemnitz	Fluger	16	2	Ztschr. für chir. Med. u. Geb. No. 8, p. 52, 26, 31.
	Vienna	Flam	4	.....	Wiener med. Woch., No. 78, 87, 94.
Berlin	Hoffmann, 5	5	.....	Berlin. klin. Woch., 52, 547.	
Berlin	Pleuzer	61	.....	Berlin. klin. Woch., 24, 357.	
Neustadt	Hirsch	3	.....	Jahresbericht, &c., i, 1867, p. 379.	
Copenhagen	Krabbe	1	.....	Ztscht. f. Vet. Bd. xv, Hft. 3, 4.	
Heidelberg	Friedrich	1	.....	D. Arch. f. klin. Med., Bd. ix, p. 459.	
Lübeck	Dr. O. V. Linstow	7	1	Virch. Arch., 44, p. 379, 1868.	
1867	Copenhagen	Kraft	1	1	Jahresbericht, i, 1867, p. 310.
	Schönebeck	Flam	64	11	Wien. med. Woch., No. 95-8.
	Thuringia, 2 ep	Nobilung	.....	.....	<i>l. c.</i>
1868	Raveeshia	Dr. Zanger	5	4	Landbote of Winterther, Davaine.
1870	Liban	Kittel	90	.....	Allg. med. Ztscht., 32, 254.
	Zweibrücken	Maurer, Friedrich	2	.....	D. Arch. f. klin. Med., ix, 1872, p. 459.
1871	Heildburg, vicinity	Friedrich	5	.....	(<i>op. cit.</i>)
	Soenburg, Is. of Fühmen.	Peterson	1	.....	Hosp. Tidende, xv, 8, p. 17, 1872.
1872	Soenburg	Thanlow	.....	.....	Norsk Mag., etc., 142, 1872.
	Bovenden	Kraemer	28	1	D. Klinik, 30, 31, pp. 272, 289.
1873	.....	Schaumberg	70	2	Vtjhrscht. f. gerich. Med., 17, 1872, p. 281.
	Pankow	Dr. Mendel	67	.....	Berl. klin. Woch., xi, 12, 1874, p. 141.
1874	Neustadt	Dr. H. Mauzel	53	1	Thur. Corr., Bd. iii, 1874, p. 268.
	Graztungen	Dr. Grasenick	34	1	Thur. Corr., Bd. iii, 1874, p. 170.
	Nordhausen	do	43	.....	Thur. Corr., Bd. iii, 1874, p. 170.
	St. Petersburg	Knoch	7	.....	Virch. Arch., 59, 1874, p. 528.
	Moscow	do	70	.....	Virch. Arch., 66, 1874, p. 393.
1876	Minden Westphalia	Dr. Müller	3	1	Deutsche Zeitschr. f. prakt. Med., 14, 15, 1876.
1877	St. Petersburg	Veh	11	.....	St. Petersb. med. Wochenschrift. Jah. 178, 1878.
	Neugersdorf	.....	45	.....	London Lancet, ii, 1877.
	Diessenhofen	.....	109	9	Elsass-Lothr., Ber., § 24; Jht., 188, 1873, p. 616.
	Total	.....	3, 044	231	.....

* Many cases occurring previously and called typhus were now thought by the older physicians of Brünn to have been trichinosis.

In addition to this there were also cases near Hanover, 1875, where 400 persons were attacked and 50 died (Brit. Med. Journal, ii, 1875, p. 75); at Diessenhofen, 121 soldiers attacked (Brit. Med. Journal, i, 1877, p. 820); in Neugersdorf, 45 cases, butcher imprisoned one month (Lond. Lancet, vol. ii, 1877, p. 38); Magdeburg, 100 cases, all infected from the same shop (Brit. M. Jour., vol. i, 1873, p. 316); 9 cases in Hasselbach; several children in Ropendorf; 5 in Lissa (Brit. Med. Jour., i, 1874, p. 494); several cases in Berlin, 1 fatal at charity hospital; cases at Grotzungen, Bleidengen, Trebra, Etzalsroda, Pulzlängen, Gross-Wechsungen, Forstham, Königsthal; and 45 cases at Nordhausen (see list above—Brit. Med. Jour. ii, 1874, p. 182).

The above list comprises the most of the cases on record as having occurred on the continent of Europe. I have added from Gerlach (Die Fleischkost des Menschen, Berlin, 1875, pp. 77, 79) a list by states in which some towns are not named in the above. In many cases where

different authors report the same epidemic there may have been an error committed in quoting from one who gave the town or city, and another, as reporting a different epidemic, who gave the name of a suburb, or part of the same city. Often the people in several places are infected by the same hog, or at least at the same time, as is mentioned by Pagenstecher, p. 34, in regard to the Hettstadt epidemic, and no doubt an error may have been committed in mentioning the whole number, and afterward parts of the same number as occurring in independent epidemics.

By referring to the map of the earlier cases, it may be seen that these epidemics are closely grouped around Magdeburg and Merseburg, and a line of towns lying west-southwest of Dresden. This with the table from Gerlach will show the intensity of the infection by the numerous repetitions of epidemics, and it will show also that the disease has probably spread from certain nuclei. This may be more apparent than real, however, as the spread of knowledge of the disease may only have given a correct diagnosis to what had been constantly occurring, but misunderstood.

1.—PROVINCE OF PRUSSIA.

1865, several people, 1 died. 1867, one family attacked, 2 males died. 1872, 23 cases, 2 died.

Heiligenbeil, 1868, several cases; Griefenhagen, 1869, one family; Pra Holland, 1870, 8 cases; Danzig, 1871, 70 cases.

2.—BRANDENBURG.

Potsdam, 1868, different epidemics, 164 cases; 1867, a few cases in Berlin, 1 death. Frankfort and other places, 1874, great number of light cases.

3.—POMERANIA.

Rügen, 1861-'62, 1864-'65, 3 epidemics. Schlagtow, 1865, one family; Greifswald, 1865, one family, and 1866 a large epidemic, 140 cases, 1 death. Stralsund, one family.

4.—SILESIA.

Görlitz, 1866, epidemic, 80 cases, a few deaths.

5.—SAXONY.

Stolberg, 1860, 26 cases. Hettstadt, 1861-'62, 26 light cases, and 1863 160 cases, 28 deaths; also 2 epidemics in 1864-'65. Hedersleben, 1865, 337 cases, 101 deaths; Magdeburg, 1866-'67, 240 cases, 16 deaths; Asdersleben, 1867, 34 cases, 2 deaths; Halberstadt, 1861, 100 cases, 20 deaths; Calbe and Quedlinburg, 1867, 3 epidemics, over 150 cases, several deaths; Stanfurt, 1869, over 100 cases; Pr. Eichsfeld, 1869, 9 cases; Wernigrade, 1873, 100 cases, 1 death; Harsleben, 1873, 70 cases, 3 deaths; jurisdiction of Merseburg Kr. Leebenwerda, 1873-'74, one family, 2 deaths.

6.—WESTPHALIA.

Dortmund, 1867, 5 cases; Meschede, 1867, 3 cases; Minden, 1873-'74, 1 case, fatal.

7.—RHINE PROVINCES.

1872-'73, 50 cases, 3 deaths.

8.—HANOVER.

City of Hanover, 1864-'65, 3, and 1870, 1 epidemic, respectively; 300, mostly light cases; 60 and 54 cases, that came under treatment. Hildesheim, an epidemic; Celle, one family; Gottingen, 1872, several cases; Boweden, 1872, 26 cases; Linden, 1874, epidemic, 400 cases, over 40 deaths.

9.—KURHESSEN.

Vogelsburg, 1865, an epidemic; Merxhausen and Sand, 1869, 11 cases; Wickerhagen, 1869, 1 case, fatal; Cassel, 1871, 13 cases, 1 death; 1872, 2 fatal cases.

10.—BRUNSWICK.

City of Brunswick, 1869, 2 endemics; total number of cases 1864 to 1874 about 300; 4 fatal cases.

11.—KINGDOM OF SAXONY.

Chemnitz, 1874, 1 endemic, 194 cases; later, a family epidemic; 3 deaths.

12.—HAMBURG—BREMEN.

1870, several cases in Hamburg; an endemic in Bremen in 1873.

13.—AUSTRIA.

1866, Brünn, 8 cases, 3 deaths; an epidemic in Prague; 2 cases in Vienna.

14.—BAVARIA.

1872, 1 case.

15.—SWITZERLAND.

Reviechia, 1869, 6 cases, 5 deaths.

16.—DENMARK.

1864-'67, a few cases; 1 death.

17.—SWEDEN.

1865, a few endemics.

18.—RUSSIA.

St. Petersburg, 1872, 7 cases.

To these may be added the epidemic in Calcutta, 1864 (Röll, see Pagenstecher). Ten cases in a ship sailing from England to Alexan-

dria. The cook was arrested on a charge of poisoning. (Althaus Med. Times and Gazette, i, 1864, p. 161). One case reported by Dr. Dickinson in England, 1871 (Cobbold, *l. c.*). Also London Lancet, i, 1871, "Cases in England from German sausages;" p. 843.

The above list comprises about 140 epidemics with 3,044 cases, and 17 places where no number is given; allowing, according to Meissner, 3 cases each for places in which no number is given, the whole number will reach 3,095, with 231 deaths, making a total of about 150 epidemics, 3,800 cases, 281 deaths, and 700 cases and 50 deaths not in the list; and, as Gerlach says, such tables are far from being complete, and their imperfection lies principally in the fact that the figures fall below the actual numbers. These show, at least, the wide extent of the disease, and at the same time give an idea of the equally wide extent of the cause of this human infection, whether it occurred originally in the hog or rat. This dissemination must be even more extensive than the effect it produces, as the disease is not transmitted from one human subject to another, although many persons may be infected, and in some cases whole epidemics may be caused by one trichinosed hog. Reinhard (Arch. der Heilkunde, xviii, p. 241) says, "If we accept, as competent judges claim, that from 200 to 300 persons eat from every hog killed by a butcher, and compare therewith the number of cases in a single epidemic, it will appear that only about one-fourth of those eating the flesh from a trichinosed hog are affected with trichinosis, and it may be presumed that many trichinosed hogs are eaten without producing the disease. This is shown by a comparison between the number of diseased hogs killed and the number of epidemics. In Plauen, since 1862, 30,000 hogs have been slaughtered, and not one found to contain trichinæ. Yet these epidemics have broken out there. About one hog in 983 contains trichinæ" (see section C). He concludes that according to the comparisons with hogs killed in Saxony, only four cases of trichinosis occur for every one hundred trichinosed hogs found. Leuckart (Untersuchungen, &c., p. 91) says, "in this country we may presume that each man eats a portion of about 25 hogs in a year, and during an average life of 40 years he would thus partake of 1,000 different hogs. As there is found only about one trichinosed animal in every 10,000 hogs" (see tables, &c., in section C), we should find about 10 per cent. of trichinosed cadavers; but, as has been determined by Zenker, who found only 4 out of 136 bodies infected—about 3 per cent.—this would make it three times as great as it is in fact. Pagenstecher (*op. cit.*, p. 37) says, "5 per cent. of the cadavers in Berlin Hospital contain trichinæ."

2.—ETIOLOGY.

Trichinosis is the disease caused by the presence and activity of the *trichinæ spiralis* in the animal body. Of this there can scarcely be more of a doubt than of the cause of growing grain or vegetables.

The seed is sown, and the crop will be in proportion to the amount and viability of the seed, the nature of the soil, and other conditions necessary to propagation. The discovery of the cause of trichinosis is due to Zenker, Virchow, and Leuckart.

Leuckart says (Untersuch., etc., p. 88, *et seq.*):

“Whenever a case of trichinosis presents itself, there particularly an infection must have occurred. It is not always possible when a series of cases occur to refer them to the same cause of infection, owing to the irregularity of their application for aid, and consequently the time of infection may be somewhat uncertain. In all cases known the hog has been the source of the disease,” yet “it is not certain that all trichinæ come from hogs, as cattle and sheep may be the cause of infection. But they are susceptible to a less degree than hogs, and while the latter in almost all cases have shown their susceptibility to trichinosis, cattle and sheep have shown more negative than positive results. On account of the difference in the habits and feeding of cattle and sheep, which live mostly on hay, etc., and seldom on offal, they are less liable to spontaneous infection. The same holds good of the deer and roe, but to a greater degree. On the other hand, the rabbit and hare are scarcely behind the hog in susceptibility, and the hare becomes a mouse-hunter in the winter. It is probable, judging from the parallel of nature, that by means of hogs and rats trichinæ are spread over the whole earth. Rats are eaten by the gipseys, some of the South Sea Islanders, and New Hollanders. In Africa they are sold in the markets. As we do not eat rats, and only occasionally hares or rabbits, we may be sure that we get trichinæ from hogs. Among the inhabitants of cities, who eat by far the most meat (not always pork) very few would remain exempt if the parasites were not rendered innocuous by proper cooking.”

The cause of the Hettstadt outbreak was a half English blooded sow, 2½ years old, killed because she was sterile and hard to manage. At Quedlinburg the infecting hog had been sick for some time. At Halberstadt a trichinosed hog was found and eaten, but having been well cooked no disease resulted. Delpech (quoted by Meissner, *op. cit.*, No. 138, p. 102) gives cases where trichinosed hogs were found without the occurrence of the disease. In Minden (Müller, *Deutsche Ztscht. f. pkt. Med.*, No. 14, 16, 1866) the infecting hog had been sick 12 months previously, and was undoubtedly infected in the pen. Rats in the vicinity contained numerous trichinæ, and it was very difficult to say which was the original host. Trichinæ were found in the intestines as well as the muscles. In Zittau the disease was brought on by the flesh of badly-fed hogs. In Neitleben an old man killed a hog that he had raised, and which had fed on rats. Several severe cases resulted, among them the owner of the hog was taken sick and died. So it may be said of nearly if not all cases and epidemics, that they are caused by eating trichinosed pork, and in all but two or three of the epidemics reported in Germany the infection was caused by the meat from freshly-killed hogs. Simon

reports 2 cases of infection from beef at Calbe, and Rupprecht 2 at Hettstadt and 6 at Leipzig. It is supposed that the beef became infected from contact with trichinosed pork, as the larvæ of flies were thus infected at Munich and Dresden (Haubner, Ueber die Trichinen, etc., 1864, p. 15). Virchow (*op. cit.*, p. 59) says "such a thing as truly trichinosed beef is not known." Dr. Percy, of New York, gives a case in which trichinosis followed from eating beef fattened in a distillery. In Thionville, in Germany, 60 soldiers were taken sick with trichinosis after eating the flesh of a goose (Phil. Med. Times, Ap. 13, 1878). An old woman in Langenzalza was attacked with trichinosis after eating the meat from a dog (Bost. Med. Surg. Journal, No. 12, 1874, p. 47). Davaine says (Entozoaires, etc.): "The *débris* of an animal eaten by carnivora may become fatal to rodents, or a carcass near a marsh or rivulet may communicate the parasites to man or animals drinking such water. M. Urban, veterinary surgeon, at the meeting of the butchers of Berlin, Dec. 15, 1865, denied the danger to the human subject from trichinæ, as also Dr. Belfield (Rep. Dept. Health, Chicago, 1878, p. 25). A German butcher believed that trichinosed meat was harmless, and fed his family with it. Several of them died with trichinosis.

In all cases where trichinosis has occurred the meat containing the parasites was eaten in a raw or underdone condition. In some cases (Leuckart, Menschl. Par. ii, 3, p. 585) strongly trichinosed meat has been eaten raw with no dangerous results. Such a case is reported by Fiedler (Deutsche Arch. für klin. Med. i, p. 63). On the other hand, trichinæ have occurred in animals when it was only after extended search, and after several trials, that they were found, by Müller in Berlin, and Leisering in Dresden, though the animal was pronounced infected and seized by the authorities of Görlitz (Delpech, *op. cit.*, pp. 77, 78). Scheiber (Virch. Arch., No. 55, 1872, p. 468) thinks that trichinæ are more plentiful in Roumania than in Germany, although few cases of sickness occur from them, because the people cook their meat well.

There can be no doubt that there is a difference in individuals, as is shown to a certain extent in several epidemics, and probably a difference in the same individual at different times in regard to the susceptibility to trichinous infection, due, perhaps, to habits, and, to a great extent, to the digestive powers. Leuckart says (Untersuch., &c., p. 70) "single individuals are found that have a complete immunity to trichinæ, but what it consists in is not known; whether in age, sex, or race."

"Immunity may be general, as in birds and amphibia, which, according to Renz, are entirely exempt, or, as in the dog, in which only intestinal trichinæ are found, or special as in children; or, it may be individual, and finally it may be permanent or only temporary, as in the case of hogs, in which repeated attempts at incubation entirely failed (Fiedler), or sometimes succeeded and sometimes failed (Kühn). Also, in man there may be a temporarily diminished individual disposition, as ob-

served by Parinelli." (Meissner, *op. cit.*, 138, pp. 97, 98.) Mosler (Arch. für path. Anat. und Phys., Bd. 33, p. 416) says that children with the same amount of flesh ingested have less severe symptoms than adults. Kratz, Cohnheim, and others agree to this. (See Renz, *op. cit.*, p. 23, and Rupprecht, Rundblick, &c., p. 26.)

The susceptibility of animals is, as a rule, uniform for the same classes, although it is very possible that certain conditions of health may entirely change the normal aptitude. W. W. Cheyne, Brit. Med. Jour., says: "I have demonstrated that many forms of organisms will not survive if introduced into a healthy animal, yet, if an animal be previously in a state of ill-health these forms of organisms are not destroyed, but may be found alive in the blood or tissues." (N. O. Med. Sur. Jour., vol. viii, p. 282, September, 1880.) Experimenters have often failed in infecting animals which in their wild state have been found to contain trichinæ; *e. g.*, trichinæ have been found in wild foxes, Pyot. Pagenstecher did not succeed in infecting that animal, while Leuckart (Untersuch., p. 71) did so in three cases. Fiedler infected sheep, while Cobbold (*op. cit.*, p. 157) failed. Leuckart found pregnant female trichinæ in the excrement at the end of fourteen days. Leuckart, Fiedler, and Pagenstecher infected calves, but Mosler got negative results. Pagenstecher got only a few intestinal trichinæ from a goat after careful feeding. Haubner fed a horse with no result. Gerlach (Die Trichinen) gives a drawing of trichinæ from a horse fed by him. Pagenstecher fed rabbits with varying, but mostly positive, results, and Leuckart obtained positive results in all but 5 or 6 out of 100 rabbits, and says, p. 69: "Although I fed dogs, cats, mice, rabbits, and hogs, I found muscle trichinæ only in rabbits and hogs. I found intestinal trichinæ in all cases; a marten showed a few muscle trichinæ after seven weeks." Pagenstecher found pregnant intestinal trichinæ in a hare on the seventeenth day, and in the Guinea-pig, Leuckart (pp. 71, 72) found muscle trichinæ, as also Claus and Pagenstecher, the latter only in the diaphragm. Fiedler fed bats with trichinosed meat without result. "Weasels and moles gave negative results, but Kühn found pregnant intestinal trichinæ four days after feeding a mole. Badgers can be infected according to Herbst, and hedgehogs, according to Rollerton and Pagenstecher, but Leuckart's cases died in a few days. Virchow, Zenker, Davaine, Fiedler, Pagenstecher, failed to find muscle trichinæ in the dog, but Leuckart (p. 72), as also Herbst, Vogel, and Cobbold, obtained positive results; the former, in one of two cases, found trichinæ mostly in the diaphragm. Intestinal trichinæ are usually found in the dog after feeding."

"It is easy enough (Leuckart, Untersuch., p. 83, 84) to find intestinal trichinæ (after feeding) (Leuckart, Fiedler, Pagenstecher) in hens, turkeys, doves, and geese, but no one has yet succeeded in cultivating muscle trichinæ in birds. Pagenstecher did not even get intestinal trichinæ in jays and jackdaws. In frogs and waternewts no intestinal trichinæ were found by Leuckart, Claus, or Pagenstecher. In many cases the

trichinæ were found dead in their capsules, in others they were set free, but died without any further development. In the carnivorous insects and their larvæ, the ingested trichinæ, according to Pagenstecher and Probstmeyer, live a few days, but die without further changes." According to Fiedler and Gerlach the larvæ of flies digest the trichinæ. See also, Heller (*op. cit.*, 616). Prof. A. Key says (*l. c.*, 9) Bd. For. Med. Clin. Review, vol. i, 1869) "trichinæ spiralis never occurs in birds, fish, amphibious or invertebrate animals, and the latter cannot be artificially infected. Cobbold (*op. cit.*, p. 156) obtained no results in seven birds. "Trichinæ attain their sexual maturity in the intestines of fowls, but are not found in their muscles." He was also unsuccessful with 4 dogs, 1 pig, 3 sheep, 1 mouse, 1 crow, 2 chickens, 1 goose, 2 fowls, and succeeded with 4 dogs of different ages, 2 cats, 1 pig, 1 hedgehog, and 1 Guinea-pig. "Herbst, in 1852 (Kestner, *op. cit.*, p. 10), infected 3 dogs with the flesh of a badger; also, pigeons, jackdaws, and weasels with the flesh of the mole." In the pigeons he found trichinæ in the neck, wings, and thighs on the 18th day (see section C in regard to the parasite of the mole). The Vienna Committee (Bericht des zur Erforschung der Trichinen Krankheit von der k. k. Gesellschaft der Ärzte ernannten Comités, Wien, 1867) succeeded in infecting a calf, rats, mice, 2 foxes—trichinosed foxes also found in St. Pölten, Lower Austria—(p. 18). In the larvæ of flies they obtained no results at first, except that the trichinæ were digested. Afterwards they infected one of two young rabbits with the trichinosed larvæ. Gerlach (Die Trichinen, p. 45) fed 3 horses, 1 calf, 2 sheep, 1 goat, 12 hogs, two to three months to two and a half years old; 15 dogs, four weeks to three years old; 4 cats, 10 rats, 9 mice, a large number of rabbits, 2 ducks, 1 goose, 4 chickens, 1 pigeon, 2 sparrows, 3 buzzards, 4 crows, 5 frogs, 3 pike. With the exception of the goat, which died on the fourth day of another disease, and showing a large number of intestinal trichinæ, all the mammals showed numerous muscle trichinæ, and, what was very remarkable, they were as certainly developed in the herbivora as with the omnivora and carnivora, and even more so than the dog, which of all the domestic mammals is the least susceptible to the infection, but rather more so in early life than after two years of age. "Among the birds I never succeeded in finding muscle trichinæ, and the carnivorous birds never showed a trace of intestinal trichinæ. I found one muscle trichina in a dove after long and careful search. In a sparrow I saw a few trichinæ in their capsules in the small intestine, and towards the cloaca there were some without their capsules, but still coiled up and unchanged." No trichinæ were found in the fish. In the frogs the trichinæ were not few, but remained unchanged. It will thus be seen that muscle trichinæ are more or less readily produced in all mammals, never in birds, and least of all in the cold-blooded animals.

3.—PATHOLOGICAL ANATOMY OF TRICHINOSIS.

"In the first four weeks the microscopic appearance of the body is not at all characteristic, although the most prominent symptoms of the

disease are in progress at this time. Besides the subjective symptoms, pain, feeling of tension, dyspnœa, &c., two objective symptoms are especially prominent. The peculiar position on the back, with the angular contractions of the elbows and shoulder and light flexion of the hand, the complete extension of the thigh and leg, and the elasticity of the muscles, which continues after death. (Meissner, *op. cit.*, 138, p. 91.) Cohnheim found myositis, both parenchymatous and interstitial, in the third week, which at expiration of the fifth and sixth weeks was more extended. (The blood is more fluid than normal, but in the smaller veins thrombic coagulæ are seen.)

“In every body (Hedersleben) the number of trichinæ was incredible, and, as might have been expected, the number of those infesting the muscles was in proportion to the duration of the disease, and while in the fourth week they were limited to the trunk and head, in the sixth and seventh weeks they were found in great numbers in the extremities. There was nothing remarkable in the distribution. The number of intestinal trichinæ was also enormous, and in no case were they absent from the colon, while I have never been fortunate enough to find a single one in the evacuations of the patients. Even after the eleventh week numerous female trichinæ full of eggs and embryos were found.

“Stein, in two cases in Hedersleben, found no young migrating trichinæ. Kratz (*op. cit.*, p. 60) thinks they were overlooked; he found them most plentiful in the cases dying early; in those to whom benzine had been administered, they were fewer, but they were numerous in all. In all cases he found them in different stages of development, while Cohnheim (*Virch. Arch.*, 36, 1866, p. 161) in some bodies easily found trichinæ in all stages of development, from those of the earliest forms to those thoroughly encapsulated. In several cases, in spite of the most careful search of the probable localities, no difference could be found in the trichinæ.

“The anatomical changes in the alimentary canal, compared with the severe symptoms—vomiting, the severe and obstinate diarrhœa, which as often alternates with as obstinate constipation—are very insignificant. In the first four weeks there is only the appearance of a more or less fresh catarrh, pale grayish cloudiness of the mucous membrane, roundness and slight swelling here and there of the solitary follicles, small areas of hyperæmia or hemorrhagic spots. The lymphatics, perhaps, partake of the same general condition. The mesenteric glands are constantly swollen and infiltrated at first with a soft gelatinous substance, which in the later weeks is hard, grayish white or yellowish gray, as in ileo-typhus, returning in very late stages nearly to their former shape, yet somewhat enlarged, flattened, hard, and of a grayish white or pale gray color. These enlargements can be considered at first as a consequence of the severe enteric metamorphoses or as a consequence of the presence of the migrating trichinæ if, as Virchow believes, trichinæ occur in them, which, however, is denied by Cohnheim.

In six cases reported by Kratz (*l. c.*, pp. 61, 62) there was moderate œdema, rapid post-mortem changes, partially coagulated blood. The mesenteric glands showed active hyperæmia and marked increase in size. The peritoneal cavity contained a thin serous effusion, slightly tinged with blood; a similar fluid, but in less quantity, was found in the pleural and pericardial cavities. The heart, liver, and kidneys showed nothing abnormal, as also the intestinal mucous membrane, with the exception of spots here and there of capillary hyperæmia. In the lungs, in one case, there was double hypostasis with infiltration. In two other cases there was fatty liver, in one of which—that of a very fat woman—it was probably of prior origin; in the other case, a boy aged seventeen, there was a small recent tumor of the spleen, and cloudiness and incipient fatty metamorphosis of the cortical uriniferous tubules. There was also hypostatic pneumonia. In ten other cases dying after the fifth and sixth weeks—one of which showed an old mitral insufficiency, with stenosis and chronic catarrhal infiltration in both lungs, and considerable effusion in all the serous cavities, besides induration of the kidneys—there was imperfectly coagulated blood, never a buffy coat. In all cases there was double hypostatic œdema of the lungs, with single or double hypostatic pneumonia; the mesenteric glands, though not much increased in size, yet considerably swollen, were hard, flattened, and gray; the intestinal mucous membrane was mostly pale, or showed only a partial capillary hyperæmia; the spleen, though variable, was mostly healthy; and there was fatty degeneration of the liver. In one case this degeneration was confined chiefly to the periphery of the lobules, while the central portions were unusually dull and pigmented. In all cases there was a cloudiness of the cortical portion. œdema was considerable in all cases, with contractions of the elbow in most of them. The arteries and veins were normal. In one case, in which there was fatty liver and left hypostatic pneumonia, there was a purulent collection in the pleural cavity with development of gas, which escaped on opening into the cavity.

Stomach.—Kratz (p. 75, *op. cit.*) “found one case with ulceration of the stomach, but doubts its causal connection with the ingestion of trichinæ, and quotes a similar case in Quedlinburg.” Ebstein (Wien. Med. Presse, 13, 14) in one case “found numerous round ulcers in the stomach and duodenum.” Klob (Wien. Med. Woch., No. 11) reports one case in Brünn where “peritonitis followed the rupture of a duodenal ulcer.” Cohnheim found three cases of ulceration of the stomach, and Wolff (*l. c.*) found them “in a man previously sound who, during an attack of trichinosis, died of hæmatemesis, but there was an old ulcer in which the eroded artery, from which the blood came, was found.” Wyss found ulcers in the stomach of a cat. “Thus, ulcers of the stomach and intestine are not uncommon, and may lead to a fatal result” (Meissner, *l. c.*) In a case reported by Dr. Gilpin (see section E), “the stomach and intestines were empty, and showed evidences of prolonged

congestion. (See, also, Leuckart, who found irritation of the intestinal tract and peritoneum, with a "dirty" effusion in the cavity of the latter.)

Liver.—Of the above cases mentioned by Kratz, a fatty condition of the liver was found in nearly every one; and in only two cases observed by him were there any symptoms referable to that organ during life. Two cases by Maddren (*l. c.*) the liver was fatty. Hun (*l. c.*) found the liver clay-colored and very much enlarged. Boehler (quoted by Kes-leuch, p. 35) mentions one case of fatty liver in which death occurred after nine weeks. Dr. Gilpin, Milford, Ind. (*American Practitioner*, September, 1879), in one case there was only a slight congestion of the left lobe of the liver.

Spleen.—In Dr. Gilpin's case the spleen was swollen, darker and firmer than normal. Warfwinge (*l. c.*) found the spleen enlarged. Hun found it normal. Cohnheim, according to Renz (p. 39, *op. cit.*), found fatty metamorphosis of the spleen in one case. In one case (see Aitken, *op. cit.*, p. 160) trichinæ were found alive in the spleen. Maddren (Kings County, New York, *Med. Soc. Rep.*, 1879, p. 181) in one of two fatal cases the spleen was slightly enlarged; in the other it was normal, which is the condition in most cases reported.

Kidneys.—In Dr. Gilpin's case the left kidney was congested, with a small calculus in its pelvis. In two cases by Maddren (*l. c.*) there was congestion, and a small cicatricial nodule was found in one. Warfwinge (*l. c.*) parenchymatous nephritis in one case; Cohnheim, fatty degeneration, one case. (See, also, Renz, p. 39.) Otto (*Memorabilien*, No. 10) found considerable reddening of the pyramids and a purulent effusion in the pelvis. Other cases normal.

Bladder.—Generally, if not always, normal.

Peritoneum.—Mostly normal or slight reddening, "with (in animals) a dirty effusion containing embryos, pus, and fat globules." (Leuckart.)

Respiratory tract.—"The muscles of the larynx are notoriously infiltrated with trichinæ. In the fourth week there is not seldom a profuse bronchial catarrh, and a further inflammatory process in the parenchyma of the lung and pleuræ, which may cause death. Cohnheim (*l. c.*) found in most of his post mortems a reddening of the bronchial mucous membrane; the latter was also covered with a tough, glutinous slime, and there was hypostatic congestion and splenization of the lung, and in seven cases there was real infiltration." Meissner (*l. c.*). In fourteen cases examined in Hedersleben (Meissner, *op. cit.*, 138, p. 95), the pathological condition of the lung was due to hypostasis, while thrombosis and embolism, which Rupprecht says is the cause of trichinous pneumonia, did not occur. Of seven cases examined by Rupprecht fatal pneumonia existed in six, of which the left lung was affected alone in five cases, and a double pneumonia existed in one. The autopsy showed circumscribed conical infarctions in the affected lung, with the apex towards the root of the lung and the base towards the pleural surface. The branches of the pulmonary artery ending in two infarctions

were filled with embolic clots riding on the septum between the two branches at the bifurcations.

In Gilpin's cases (American Practitioner, September, 1879, p. 135) "The larynx and bronchi showed signs of catarrh. The right lung was congested, with dry adhesions between the pleuræ that were easily broken up. Warfvinge (*l. c.*) reports hypostatic congestion of the lung. In Hun's cases (Hun, *l. c.*), the lungs were bright red. Of Harrison's (Hun, *l. c.*), six cases (post-mortem), three had tuberculous disease of the lung and three had manifest signs of scrofulous ulceration. Campbell (Path. Soc., London, 1874) "A patient died of chronic phthisis and recent acute bronchitis. He had suffered with trichinosis nine years previously." In one of Boehler's cases (Obs., xiii) there were gangrenous infarctions of right lung, pleurisy of same side, bronchial catarrh, and pulmonary œdema. Virchow says (*op. cit.*, p. 34): "In a few cases I have examined the bodies of those said to have died of consumption, and have found, besides a marked lung disease, extensive trichinosis and extreme emaciation." (There seems to have been more or less emaciation in all cases where trichinæ have been found post mortem, and among the earliest cases it was so common that) Wood (*l. c.*) speaks of finding trichinæ in a robust subject as something remarkable. (See Pathology, &c.) In the single death reported by Dr. Münzet (*l. c.*), among 53 cases at Neustadt, there was meningitis and spots of softening of the brain, hypostasis and left-sided pleuritis, softening of the spleen, and fibrinous deposits in the mitral valves. "Dr. Wilson (Saint Louis Med. Reporter, July 15, 1856) found trichinæ in the lungs of a patient dying in Marion, Iowa." (Aitken, i, p. 160).

I have given the above pathological conditions as observed by different practitioners, to show the probability that in many diseases referred to obscure symptoms or causes, the death may really although perhaps remotely, be due to the presence of trichinæ; but the presence of such and such pathological changes—which may not in themselves be sufficient to account for death—may lead to a diagnosis which will be false if based on them entirely. It shows also that it may happen during an epidemic, that patients dying with trichinosis may present an immense number of pathological changes which may have no further relation with the disease than to make the patient less resistant to *any* cause of death, as in Cohnheim's case in Hedersleben, where a boy aged fourteen had endocarditis, mitral stenosis, chronic indurated pneumonia, and effusion into peritoneal cavity.

"The effect produced by the ingestion of trichinous meat varies with the number of trichinæ, the susceptibility of the individual, and the period elapsing prior to the onset of the disease." (Scoutetten, *op. cit.*, pp. 65, 66.) Renz (*op. cit.*, p. 87) divided all cases into two classes, according to the severity of the symptoms, one of which embraced all those cases usually described as typical by Rupprecht, Zenker, Virchow, Leuckart, Scoutetten, Kestner, and others; and the second, a light form

(which, according to Sutton, comprises by far the greatest number of cases) in which the symptoms from the ingestion of small quantities of trichinosed meat or idiosyncrasy of the subject are very slow in their progress and is called insidious (*schleichende*).

“Those suffering from the insidious form are greatly in the minority. They walk about, but feel tired and exhausted, have a good appetite, evacuations normal or but little changed, pulse normal or but slightly accelerated, sleep scarcely disturbed, drawing or lancinating pains here and there, especially in the nape of the neck and extremities, with or without rigidity of the deeper muscles. In short, they are neither sick nor well, and yet they feel something of which they can give no account. They belong to the same category as those of which nearly every epidemic of typhus, dysentery, cholera, &c., has its contingent, that either get well soon or after a time suddenly develop the severer symptoms of the disease. During this transition, when it occurs, the pains previously somewhat vague begin to be intensified and localized in the muscles, which now become more prominent—œdema appears, a chronic febrile condition sets in, and its further course differs from the typical form only in being less acute. In other cases—and these are the most terrifying—there occurs suddenly a high fever, with severe bronchial catarrh, and the patient succumbs to the attack in a few days. The interpretation of the causes of the disease while it thus maintains its apparently harmless character is not difficult—a small quantity of meat consumed, a method of preparation by which most of the trichinæ are killed, the early evacuation of the ingested food *per orem* or *per anum*, or a low individual predisposition. On the other hand, there are cases which, neither recovering nor following the regular course of trichinosis, suddenly take on a character difficult to explain. Kratz gives it as his opinion that, besides a profuse bronchial secretion, the lungs appear normal, there are no signs of thrombosis or acute œdema, and the brain is found intact, and leaving out the high fever there is nothing to account for death at this time unless it is accepted that a sudden paralysis of the muscles of respiration is caused by the invasion of a new brood of trichinæ. This view, held by Kratz, is founded on that of Cohnheim, who believes (*Virch. Arch.*, No. 36, 1866, p. 161) that the intestinal trichinæ may breed repeatedly at intervals, and that the migration of every brood gives a new impetus to the disease.” (See section B; Kuntz, *Trichinenkunde*, Stuttgart, 1866, p. 15, Leuckart.)

The typical form of trichinosis is divided into three stages (Rupprecht, Vogel, Leuckart, p. 85): 1st, stadium ingressionis; 2d, stadium digressionis; 3d, stadium regressionis. Boehler (*l. c.*) calls the first, stadium prodromorum et infectionis; second, stadium immigrationis; third, stadium obvelationis. Kestner and Scoutetten follow the division into four stages, the second and third of which correspond to the second stage of Rupprecht. The first stage is that of gastro-intestinal irritation; second, of muscular irritation; third, the typhoid period; fourth, that of anasarca

or anæmic œdema. Scoutetten limits the first stage to the development of the intestinal trichinæ, the second to the birth of the embryos and their escape from the intestine; third, their migration in the muscles; fourth, encapsulation of the trichinæ, corresponding very nearly with the model suggested by Renz. Renz (p. 86) mentions the possible division of the disease into four stages, viz: 1st, the prodromal; 2d, stage of intestinal irritation; 3d, stage of muscular irritation, and a 4th which marks the retrogression of the symptoms and convalescence of the patient, but adds—

“Such a stereotyped division does not correspond with a true conception of the course of the disease, for to be correct it would be necessary that in all cases, all of the intestinal trichinæ should become sexually mature at the same time; every female trichina should give birth to the same number of embryos at the same time, which should pass at the same time, by the same road, to the same muscles. But of the four possible stages none except that of muscle irritation is entirely certain.” (It failed in 22 of Kratz’s cases.) “Kratz (who did not make a general division into stages) observed a period of incubation lasting from a few hours to forty-three days, and even bad cases in which there were no disturbances of the digestive functions.”

I have therefore followed Renz in the symptomatology of the disease, but have introduced points from Leuckart, Kratz, Scoutetten, Kestner, and others, which as a rule are placed in brackets, with initials of author’s name.

“From a few hours to a few days after the ingestion of the trichinous flesh the patient is seized with symptoms of indigestion; complains of nausea, cardialgia, belching, diminished appetite; the tongue is coated; there is a fœtid breath, vomiting, or eructations; a feeling of general weakness, and prostration and utter exhaustion [or they complain of feeling so tired, Kratz, Rupprecht, Maddren, Sutton]; there are flashes of heat, rigors [perhaps a chill, Kratz], fullness of the frontal region [or headache, L.], vertigo, lancinating and flying pains in a few groups of muscles, particularly in nape of the neck and flexors of the extremities. After two or more days there appears a choleraic or diarrhœaic discharge from the bowels. The vomited matter is at first slimy, then bilious. The stools, at first brownish and streaked, take on the clay-like character of many typhus stools. Severe neuralgic pain is almost always present in the abdomen, and pain is felt in the arms and legs, and sometimes in the intestines.”

In the severest cases the patient may suddenly die at this stage of the disease with all the appearance of cholera, or from extreme exhaustion. Those who do not vomit now and then become by degrees excessively debilitated. As the stools become less copious and less frequent they still retain their clay-like appearance. The pain in the abdomen becomes somewhat duller. Thus pass the first eight days of the disease. The diarrhœa may pass off soon and give place to an obstinate constipa-

tion, or may continue into the second stage of Rupprecht. Jackson (*l. c.*) says if the bowels are constipated they remain so; if loose, the diarrhoea continues (see case in Brünn).

“The most important and constant symptoms of the second stage are œdema (which, according to Kratz, commenced oftenest on the tenth day) and profuse perspiration. The skin is covered with sweat, which is acid, persistent, abundant, and often of a nauseating odor” (K., p. 64). “This stage (Renz) is ushered in usually on the seventh or eighth day with œdematous swelling of the eyelids, which often spreads to the neighboring parts, and sometimes is associated with a light form of conjunctival catarrh; occasionally the pupils are dilated and photophobia is present.” The power of accommodation is diminished and the eyes may be fixed (Kittel, *l. c.*), indicating the presence of trichinæ in the orbital muscles. [Durr (*Zeitschr. für prakt. Heilk.*, ii, 1864, p. 230) found “a characteristic œdema of the papilla of the optic nerve.”] Pain in the orbital muscles, often occurring in the fifth or sixth week, especially in the morning, is present in all the severe cases, and subscleral ecchymoses sometimes appear. The œdema of the eyelids does not last long, and in some cases it is very light so that it may not be noticed—or it may be entirely absent—and sometimes it disappears to reappear after four or six weeks. “It reaches its maximum of intensity in persons of lymphatic temperament and in thin-skinned persons, as in women and children and is not dangerous unless it invades the larynx or meninges, which is most liable to occur in fat persons.” (K.) The fever suddenly increases, and may reach 40° C., with the pulse at 80 to 120 per minute or more, but is occasionally very light or even absent—(Jackson); an unquenchable thirst and an overwhelming sense of heat torments the patient; the tongue is furred, yellowish white, or covered with a black, sooty, clammy coating, soon losing all epithelium, becomes of a uniform dark brownish red; it is smooth and covered with papillæ or blisters—the latter manifestly not due to direct migration of trichinæ while eating the infected meat, as is held by Rupprecht (Meissner, *op. cit.*, No. 122, p. 222, No. 138, p. 93)—“and suddenly—generally in the night—there occurs extreme dyspnœa, often lasting for several hours and sometimes recurring daily for weeks” (sometimes the diaphragm sinks down and remains in a state of tetanic rigidity). The brain for the most part is undisturbed; or coma, due to disturbed respiration, may occur after attacks of dyspnœa. There is a total indifference to surroundings, but a great fear of death. Insomnia is present in adults, but does not often occur in children, who are more apt to be soporose. Colic and mesenteric neuralgia come on with migration of trichinæ in the second week. There is hyperæsthesia of the skin (see, also, Gilpin’s cases) (and pruritus often appears after the disappearance of the œdema); more rarely there is formication in the height of the disease, with tumefaction and œdema of the lower limbs, and, in one case, in the fifth or sixth week there was complete anæsthesia, lasting one day; singultus

was present once, through complications in the cerebellum" (Meissner, *op. cit.*, 130, p. 94). Pleurodynia is sometimes present and delirium is occasionally permanent. (Sc., p. 67, also, Kratz.) Hearing is frequently impaired (Meissner, *l. c.*). "If the patient previously has not been too much debilitated or exhausted by the disease he may pass through this ordeal, but many succumb in a short time. Then the muscles of the neck, loins, and limbs, particularly the flexors, show more or less stiffness and increasing tenderness, which latter is constantly found, on pressure, in the epigastrium. Œdema, commencing in the roots of the limbs, proceeds towards the digital extremities. Motion is extremely painful; the elbows are bent and the knees drawn up." (The contraction of the flexors, constant in the onset of the disease, is sometimes accompanied, in advanced stages, with a tetanic rigidity of the neck, back, and loins, and often by lockjaw. Kratz.) The patient finds ease only by lying flat on his back. (Children usually lie on the side with knees drawn up, the elbows flexed, and are plunged into a profound sleep. Rupperecht, Kratz.) "Extension of the ever-progressing myositis is indicated now by the trismus, stiffness of the tongue, difficulty of swallowing, hoarseness, the asthmatic cough, and arrested stools." Severe sweating occurs, sometimes followed by a miliary eruption. (Ischuria of a low grade often occurs—Meissner, *l. c.*) As a rule there is an extraordinary decrease in diuresis. Rupperecht found no albumen, but Maddren found it in one case and it has been found in others. Jessnitzer found involuntary diuresis five times. Kratz only once; then in the coma preceding death. (Jessnitzer gives cases of pustular eruption and herpes, petechiæ ecchyma, and furunculi, often seen after the subsidence of sweating. Warfwinge (*l. c.*) gives one case where the skin of one shoulder was swollen, red, and painful. In Friedrich's case (quoted by Kestner, p. 27) there were pustules surrounded by a red areola. Veh. (St. Ptrsbg. Med. Wochenschrift Jg. ii, No. 47) saw a large number of furunculi and numerous bluish suggillations. Kestner also (*l. c.*) speaks of furunculi containing trichinæ. In one of Boehler's cases the skin bursted in several places.)

"As a rule the disease will now turn (except in individual cases) towards a favorable termination and be completed in a few weeks. But in the severest cases, which frequently progress to a fatal termination, the pulse increases to 120–130 or more, per minute, and is small and weak; the fever takes an adynamic character and the patient becomes apathetic. Trismus, when it exists, is augmented; the tongue, though more movable, is dry and trembling; respiration becomes more labored, and the patient lies flat on his back. In short all the appearances of a fatal case of typhus fever are presented. In cases which progress towards recovery, there is a decrease of fever in the fifth week and the pulse sinks to 90 or less, the appetite improves (*becomes ravenous*, L. Kratz), the perspiration becomes less copious and the urine increases in quantity, sometimes suddenly, and then the œdema rapidly disappears, and the only

remaining symptoms are slight pains in a few muscles, emaciation, weariness, and lassitude.

“A large number of the cases reaching the seventh week progress regularly to convalescence; a few somewhat lighter or partly abortive cases are entirely recovered, and show only in their complete emaciation the appearance of having passed through a severe sickness. Very many of these attacked later are still confined to their beds with weak compressible pulse (96 to 132), little or no appetite, and troublesome thirst; the muscles of mastication are more or less swollen and rigid, and the still dry tongue can only, with difficulty, be projected. In some cases deglutition is difficult, the voice is still weak, suppressed, or hoarse; sometimes there is œdema of the skin of the thorax; pressure leaves no marks, or only those quickly effaced, and sometimes is extremely painful. The respiration is mostly superficial, short, and accelerated. The intercostal spaces do not recede on inspiration, and the thorax moves as a whole, as in unilateral pleuritic effusion, when motion of the intercostal muscles is interfered with by the pressure of the liquid; yet a really pleuritic effusion is never found in trichinosis; the peritoneal cavity shows signs of a greater or less degree of ascites; the urine is scanty and high colored; the bowels remain unopened on account of weakness of the abdominal muscles, and some patients cannot raise themselves under any circumstances, and when helped complain of pains in the back and loins, and show a tendency to double up. The lower extremities are greatly swollen, one often more than the other, half bent, or, if extended, then abducted; the skin readily yields to pressure, to a greater extent in most cases as the foot is approached; such pressure generally produces considerable pain. The legs often present the appearance of *phlegmasia alba dolens*. The arms are swollen more seldom than the legs, the swelling oftener confined to one side, and the forearms are generally half flexed; the flexion can be completed without disturbing the patient, but the slightest attempt at extension produces severe pain. The skin frequently changes in temperature and is often very moist from perspiration. In most cases the patients were very much relieved after sweating commenced. Then once or twice daily there occurs a most frightful paroxysm of depression, which, after intolerable heat and agony of suffocation, ends in a refreshing diaphoresis.”

In addition to these symptoms Kestner (p. 60, *op. cit.*) mentions symptoms of peritoneal irritation, and as the abdomen becomes bloated and tender the disease may be taken for a typhoid affection; carphologia and hiccup announce the approaching end. In his “fourth stage” the symptoms all diminish. In those cases in which the fever has not diminished in intensity towards the sixth week pleuritis or bronchial catarrh are liable to appear as complications. Pleurisy, observed oftenest on the right side, is slight, as is also the bronchial catarrh, although the latter may be prolonged for several weeks. The debility is still great, and there generally appears around the malleoli an œdema due

to blood-poisoning and perhaps to certain changes in the liver, as lately has been observed by Cohnheim in Hedersleben (Leuckart Unt., p. 87), which often extends to the sexual organs or even to the umbilicus. This new œdema is essentially different from that observed in the beginning of the first week, of which the duration was not more than eight days; it is as much more extensive and prolonged as the anæmia, of which it is the expression, takes a greater or less time to disappear. If the impoverishment of the blood has been considerable, and the destruction of the muscular tissue great, the œdema attains the proportion of an anasarca or of a general hydropsy. "Pneumonia (Kestner, p. 68) is announced at the commencement of the fourth week by a sudden pain usually in the left side; the pulse becomes fuller and more frequent; the respiration is superficial, painful, and reaches 40 to 56 in a minute; perspiration is increased and a cough occasionally supervenes, rarely accompanied by expectoration; the sputa differ from those of true pneumonia in being composed mostly of blackish blood. The base of the lung on the affected side shows dullness on percussion, rales with or without bronchial respiration. This state may last for several days without any noticeable change in the local symptoms; the exhaustion of the patient increases visibly from day to day; the least movement aggravates the dyspnœa and paralysis comes on, almost always without delirium, five or six days after the lung is invaded.

The abortive (Rupprecht Rundblick, p. 26) rheumatoid cases, mostly moving about, and, as a rule, without intestinal symptoms, are ushered in with œdema of the lids about the third week after infection with mydriasis and soreness of the muscles.

Trichinosis of children is characterized by less danger, very copious collateral œdema, considerable mydriasis, lessened muscular pain, ability to lie on the side, sleepiness, and rapid convalescence.

5.—DIAGNOSIS.

Pagenstecher (Die Trichinen, Auf. Leipzig, 1866, p. 38) says: "There is no certainty that because trichinosis has never been discovered in a place the people have nothing to fear from it, as it is more than likely that in the general lack of knowledge of the disease, cases may have been unnoticed (misunderstood), as it has become cosmopolitan with man, hogs, rats, and mice." Virchow says (Lehre, etc., p. 50): "The sickness existed long before anything was known of trichinosis, so that what is new in the matter is not the disease, but the knowledge of it." Before the disease was known, numerous mistakes had been made in giving it a name which corresponded to one or several of its most prominent symptoms at the time. In many of the epidemics thus misnamed the symptoms have since been closely analyzed, and found to correspond so closely with those of trichinosis that there can be no longer a doubt as to their etiology and pathology, as in some cases the diagnosis of trichinosis has been confirmed by the history and post mortem examina-

tion of individual cases surviving such epidemics, as in Dresden in 1842, and Jessen in 1845; also in Wegeleben after sixteen years, and Hamburg after fourteen years.

In some of the earlier epidemics the fact of a disease arising from the use of certain meat was very apparent, and as there was no other explanation at hand, the cause was laid to a peculiar poison in the ham (*Schinkengift*) or sausage (*Wurstgift*), perhaps, as Wagner says (*Delpech Die Trichinen*, p. 36) in regard to finding copper in the intestines of cows in Leipzig in 1848, in order to give it a name. Virchow asks (*op. cit.*, p. 48): "Is there a ham poison? No one can say so with certainty, for no one has ever isolated it." Scoutetten says (*op. cit.*, p. 72): "Since the discovery of trichinosis no mention of *Schinkengift*, *Wurstgift*, etc., is heard, although this poison was said to have been isolated by different chemists;" and according to Dengler (*Dissert. inaug. Strasbourg*, 1863, p. 66), quoting Van Hassel (*Thiergifte*, 1862, p. 136), says: "Its toxic principle, according to some authors, is cyanhydric acid, according to others picric or sebacic acid, according to Buchner and Kerner butylinic acid, and according to Heller it is the *sarcina noctiluca*." (*Jour. med. chir. Brussels*, 1854.) Diseases caused by these meat poisons have often been referred to. Epidemics of *Wurstvergiftung* have often occurred in the eastern part of Germany, and in Württemberg alone since 1793 634 cases have been reported, of which 260 were fatal. The symptoms correspond to those of trichinosis, excepting in the absence of fever, abrupt invasion, and shorter duration; but there is a possibility that some of the earlier symptoms may have been overlooked. If these were really cases of trichinosis then some of those mentioned in the first part of Section I of this report can be received more readily, and Gerlach's views as to the recent introduction of trichinæ into Germany must appear incorrect. But Rupprecht (*Trichinen Krankheit*, etc., p. 36) says: "I have treated nineteen cases of *Wurstvergiftung*, all of which recovered. In no case have I observed œdema of the eyelids and face, so characteristic of trichinosis, so that none of the nineteen cases could have been due to trichinæ. My cases commenced usually with diarrhœa and vomiting, and were marked by feebleness, vertigo, burning and dryness of the throat, colic, pains in the limbs, dysuria, and icterus. Recovery followed in eighteen cases at the expiration of the first or second week, and in one it was prolonged for four weeks, the patient exhibiting great weakness, pain in the joints, slow pulse, constipation, sleeplessness, loss of appetite, and anæmic œdema."

Kratz (*op. cit.*, p. 106) says: "I believe that to *Wurstvergiftung* many other kinds of poisoning which assimilate trichinosis may be added." Whether or not there is a special poison developed in certain meats, there are certainly cases on record in which diseased meat has been eaten, some of which have resulted in death, *e. g.*:

"(1) The spleen of a cow dying of symptoms of typhoid fever was eaten. (2) Two men ate the flesh of a fowl dying of choleraic symptoms;

both taken ill. (3) The flesh of a cow wounded in the udder and hopelessly sick, was eaten. (4) Near Zurich 27 persons died from partaking of the flesh of a five-day-old calf, born of a sick cow; one man ate of the liver, almost raw, and died on the eleventh day. (5) A cow which was taken sick after delivery, and was killed after 36 hours, infected 49 persons who ate of the flesh; 1 fatal case. (Gerlach, Fleischkost, &c., pp. 91, 92.)”

An old woman ate of the flesh of a sick dog, and other animals, cats, etc. (Bost. Med. Surg. Journ., Nov. 12, 1874, 471.) Many other such cases are reported. (Jahresbericht, etc., 1878; Schmidt's Jahrbuch, 1878.) It is very possible that in times of excitement about trichinosis other diseases may be pronounced trichinosis, as in Havana in 1866-67. (Oral communication to the writer by Dr. Finley, of Havana.) Also in four cases of gastric catarrh (Kratz, p. 103) with rheumatic pain, when no trichinæ could be found in the remains of the meat eaten, and patients fully recovered in four days, and in some cases perhaps spoiled hams may have been the cause of sickness referred to trichinæ. What was reported as trichinosis from American hams in Bremen (Focke, *l. c.*) was caused by ham that was otherwise poor in quality, and on this account sold at auction.

Trichinosis has been called acrodynia, gastric fever, rheumatism, gastro-rheumatic fever, cholera, as at Hedersleben; typhoid fever, influenza or *grippe*, as at Blankenburg; typhus fever, Zenker and others; “English sweat,” as at Wegeleben; nervous fever, Plauen, 1862, and in 1874 in Gratzungen.) (Dr. Grazenick, *l. c.*) In the epidemic occurring in Bovenenden, 1874, Dr. Kraemer (*l. c.*) says the first case was diagnosed “catarrhal rheumatic affection, with angina.” In Calbe in 1863 the diagnosis was made after dissection of the first victim had revealed the true character of the disease. Rupprecht, although familiar with the typical form of trichinosis, overlooked two epidemics in Hettstadt in 1861 and 1862, and this occurred in a country where the attention of the medical profession was being constantly called to actual epidemics of a disease which at that time was beginning to excite the fears of the whole population. In the epidemic of 1863 the first symptoms were diarrhœa and vomiting, which he says had not before occurred in trichinosis. The thermometer ranged (in the first part of October) from 32° R. (40° C.) at noon to 13° R. (16.25° C.) at midnight; and owing to this condition of the weather he considered it an epidemic of acute gastro-intestinal catarrh. (See differential diagnosis for further particulars.) Jessnitz also at Hedersleben persisted in calling the disease cholera, even after it had been pronounced trichinosis by Kratz and others. Now, it does not seem possible for such diagnoses to be made by persons who have read anything of the course of trichinosis. But these facts are only mentioned to show the possibility of other mistakes of the same character occurring in other places and passing by wholly unrecognized; also to show how it may be that many hard-worked physicians, both in the

cities and in the country places, who may have theoretically known the disease by its symptoms, and yet have hardly thought of it in connection with their cases. Of his first cases in 1861-'62, Rupprecht (*op. cit.*, p. 2) says:

“I considered the disease with its peculiar mixture of gastric catarrh, muscular rheumatism, anasarca, and spinal symptoms (slight trismus, paraplegic condition of the lower limbs with fornication, &c.), a new one. It was apparently contagious, as it almost always affected several members of the same family. Although the disease recalled trichinosis, which was familiar to me through Zenker’s celebrated case recorded in Leuckart’s writings and Virchow’s Archives, I was misled in my diagnosis because the grave typhoid symptoms—which I believed were constant in this disease—were not present, and because the cases were light and all of them recovered, while at this time I believed trichinosis was always a dangerous disease and almost constantly fatal.”

It may thus be seen that it is not impossible that errors of diagnosis may be committed in this disease, especially when due consideration is given to other cases where mistakes have been made. Kratz (*op. cit.*, p. 57), after the observation of 280 cases, says: “The first symptoms (in an epidemic) occur in so many widely different aspects that one is led to suspect totally different causes for them.” The physician with an imperfect ideal type of the disease in his mind, or perhaps entirely unfamiliar with its characteristic symptoms, is at first struck by the derangements of the alimentary canal, and gastric, or typhoid, or other fever may be the diagnosis given, and when the diarrhœa is the more prominent symptom, cholera morbus, or even cholera, as at Hedersleben, will be suggested. Especially will there be a liability to error if the patient dies early, or rather in the stages which precede the development of the actual symptoms of the disease; *i. e.*, before œdema, pain, &c., appear, as many cases no doubt die at this time from irritation of the alimentary canal—of which Meissner (*op. cit.*, No. 138, p. 91) mentions two cases, as well as Kratz, Renz, and others, as will be seen further on—or, as Fürstenburg thinks, through the reception of certain deleterious substances in the lymphatics, because the intestinal irritation is not always sufficiently well marked to account for death. It may also be possible that many cases of trichinosis in man, having an uncertain routine of symptoms, or because the symptoms were so light, pass without special observation. Leuckart (*Untersuch.*, &c., p. 103) says of the symptoms in animals on which experiments had been made: “My first case (*L.*, *op. cit.*, p. 32) showed specific symptoms, as in man. The next two showed no particular symptoms to distinguish trichinosis.” Also Haubner, Gröls, and Kühn show cases in which the symptoms would not warrant the diagnosis of trichinosis. While many cases of slight indigestion, so called, may be due to this infection, and the chronic tenderness in the epigastrium or left hypochondrium, of which so many people complain, may be due to a chronic infection, the commencement of which was one of the so-called attacks of indigestion augmented by many recurrences—perhaps every

time a glass of lager, and a sandwich from half cooked or raw ham are taken—and which may have its end in one of the several forms of lung or pleural disease so apt to complicate or follow the acute form of this disease (see Scheiber, Virch. Arch. 55, pp. 464–6, and other cases hereafter quoted), and it might be expected that these cases would be the ones which finally in old age succumb to disorganization of the lungs, or to pleuritis, or are debilitated by disorders of nutrition, which make them an easy prey to other diseases. Such cases almost always die very much emaciated, and so usual was this condition in the bodies examined by the earliest observers, that Wood (*l. c.*) was very much surprised to see trichinæ in the cadaver of a robust subject. This class of cases, as well as the more severe but still not typical cases called *schleichende* by Renz, would be the ones most likely to occur in this country, as pork is usually well cooked before being eaten, and very few trichinæ, even where the meat is very strongly infected, would retain their vitality.

In case the physician has been called during an epidemic, or to a typical case of trichinosis, there will be no difficulty in forming a correct diagnosis, although it may be confounded with some other well-known disease as in Zenker's case and others; or, as in Rupprecht's, the symptoms may be taken for the foundation of a new disease. In nearly all epidemics the symptoms have been clearly noted, and they correspond very closely with each other. Formerly the only difficulty was to know to what disease to refer them. But, as before stated, some of the most important symptoms may be absent. In fact the patient may die without presenting any of the characteristic symptoms of the disease. This has been shown to have been the case in animals, as rabbits, calves, etc. (Virchow); in rabbits, mice, hedgehogs, dogs, and pigs (Leuckart, *Untersuch.*, etc., pp. 8, 32, 42, 46, 138); one cat died 36 hours after feeding (Turner, *l. c.*); of 31 hogs fed by Gerlach (*Die Trichinen*, p. 31) 41 per cent. died of intestinal irritation, and there have been other cases mentioned by various authors leading to the conclusion, where it is not expressly stated, that it is not uncommon for such animals to die in the stadium prodromorum. Cases of death in this stage are not so uncommon in man, although Virchow (*Lehre*, etc., p. 41) said that "up to this time (1866) such cases have not occurred." Leuckart says (*Mensch.*, par. ii, 3, p. 587): "Death in the first stages rarely occurs, and only after very severe infection, as in a few cases in the Hedersleben epidemic." Renz says (*op. cit.*, p. 30, 31): "All observers agree that we have to deal with a more or less severe gastro-intestinal catarrh, * * * and in the severest cases death may follow from exhausting dejections, mostly per anum alone or per orem and anum. Jessnitzer treated the first cases that came to him in Hedersleben for cholera, and the discussion, according to Renz (*op. cit.*, p. 7), was very warm regarding the diagnosis of this epidemic, Jessnitzer and the health officer holding to the diagnosis of cholera, etc.,

and Kratz and his friends calling it by its true name. The following are the symptoms of one of Jessnitzer's cases, as described by himself (Kratz, *op. cit.*, p. 4):

"I was called to the laborer R. on the morning of November 3. He was complaining of severe vomiting, profuse diarrhœa, with which he had suffered since the 30th of October. In the course of the day he had severe cramps in the calves, cold extremities, intense thirst; towards evening dyspnœa, palpitation, anxiety, profuse perspiration, ischuria, for the past twenty-four hours; at 6 p. m. the legs, nose, ears, hands, and cheeks became cold, and every effort made to warm them without effect. Diarrhœa and vomiting ceased two hours ago. About 8 p. m. urine voided; there was dysphagia and trismus, attacks of suffocation, and the patient died of exhaustion at 9 p. m."

Another case:

"Laborer M. was attacked on the 2d of November with muscular rheumatism, constipation. On the 4th there was fever, diarrhœa, and the usual sense of lameness or fatigue; after the 6th there was typhoid fever, swelling (œdema) of the eyes, face, legs, scrotum, and penis. Death on the 7th, with previous disturbances of consciousness and respiration; also the laborer K. was attacked with severe diarrhœa and vomiting on the 31st of October, and died on the 8th of November from debility; no muscle symptoms, consciousness undisturbed."

Renz says (p. 89, *op. cit.*), "in the severest cases a few die under symptoms of cholera, or from extreme exhaustion." Kratz had three cases die from "gastro-intestinal irritation before any appearance of peritonitis or migration of trichinæ was presented." Rupprecht reported one death on the fifth and one on the eighth day after infection. Meissner (*op. cit.* 133, p. 91) mentions two cases "which undoubtedly died of intestinal irritation."

Often when they do not cause death, the early symptoms are so severe that a strong suspicion of poisoning is entertained, as at Jenin in 1845, and Hettstadt. In Hedersleben also, several cases might have been taken for intentional poisoning. (See Virchow.)

The severe vomiting and diarrhœa (cholera trichinotica—Renz, Kratz) may have an entirely different effect, for (Mosler *l. c.*) it is nature's method of getting rid of the cause of the irritation. Virchow (*op. cit.*, p. 41) says the trichinæ may nearly all be evacuated. One of the cases at Hedersleben (No. 181 of Kratz's table) recovered after severe vomiting. A dog fed by Leuckart (*op. cit.*, p. 49) vomited and gradually recovered, and also two cases reported by Frerichs (Renz *op. cit.*, p. 149). The partial immunity of children may be due to failure to digest the capsules or even the meat containing them, as particles of undigested meat are often seen in their frequent evacuations. (Cohnheim, Mosler). (Virch. Arch. 36, p. 164—33, p. 416). Renz (*op. cit.*, pp. 23—143). Virchow (Virch. Arch. 32, p. 368). But "the symptoms of the first eight days have nothing in their character to separate them from an ordinary irritation of the stomach and intestines, which might be produced by any accidental cause. Even in cases when the symptoms occur suddenly from the liberation of a large number of larvæ, there is nothing to distinguish them from those caused by the presence of any other

foreign substance in the bowels, as the symptoms which mark the disease are not developed at that time." Friedrich (*Deutsche Arch. f. Klin. Med.* Bd. ix, p. 459) reports a case in which œdema occurred on the first day, which he refers to the presence of a poisonous substance contained in the capsule. Kratz also says: "A part of the symptoms developed in the alimentary canal were not characteristic and might have been taken for those of gastro-intestinal catarrh." And Meissner (*op. cit.* 138, p. 93) states: "These early symptoms, the appearance of the tongue, the gastro-intestinal catarrh, with the peculiar appearance of the countenance, show how difficult a diagnosis would be if no other symptoms appear."

But even these symptoms may fail entirely, as Frommann (*Virch. Arch.* 53, p. 501) has shown in three cases in Heidelberg in 1865-'66, or there may be some uneasiness or slight gastro-intestinal disturbances when the first symptom which attracts the attention will be the œdema or pain. Also in epidemics when the alimentary symptoms are present as a rule, there may be cases when they do not all appear, and if they do they may be very irregular in their advent. Rupprecht (*Rundblick*, etc., p. 26) says: "The abortive rheumatoid cases are without alimentary symptoms." Leuckart (p. 41) says the number of trichinæ is small in such cases.

In the Hedersleben epidemic vomiting occurred in only 37 of 280 cases. Of this number 5 had vomiting on the same day of the infection, with simultaneous diarrhœa in 2 of them; 5 on the second day with diarrhœa; 2 others had diarrhœa after 24 hours more; 3 on the third day all with diarrhœa; 3 on the fifth day, 2 of which were attacked with diarrhœa on the day of infection; 5 on the sixth day, 2 of them with diarrhœa; 1 on the tenth day with diarrhœa; 1 on the fourteenth day; and 1 on the fifteenth, with diarrhœa on the ninth. The remaining cases were suffering with vomiting on the first visit, and all had diarrhœa, 1 on the third, 2 on the fourth, 2 on the tenth day.

Diarrhœa was absent in 157 out of 280 cases recorded by Kratz. Of 123 cases with diarrhœa 9 were seized on the day of infection; 20 on the second day; 21 on the third day; 3 on the fourth day; 2 on the fifth; 10 on the sixth; 8 on the seventh; 11 on the 8th; 4 on the ninth; 2 on the tenth; 3 on the eleventh; 3 on the thirteenth; 1 on the fourteenth; 4 on the fifteenth; 1 on the twenty-first; and 1 on the twenty-fourth day. Of 20 other cases where the exact date of the onset was unknown, but in which it was present at the doctor's first visit, 1 before the second day; 2 before the fourth; 3 before the fifth; 1 before the sixth; 5 before the seventh; 1 before the eighth; 2 before the ninth; 1 before the fifteenth; 2 before the sixteenth; 1 before the eighteenth, and 1 before the twenty-fourth.

Of the whole number, diarrhœa and vomiting occurred together in 30 cases, and simultaneously in only 11 cases, viz: 2 on the day of infection,

2 the next day, 2 on the third day, 1 on the fourth, 2 on the fifth, 1 on the ninth, and 1 on the fourteenth day.

Vomiting and diarrhœa were absent in 128 cases, and of these 21 were fatal; 5 of the latter had no œdema of the face or eyelids; another (No. 273) had neither œdema nor muscle symptoms; one of the former had muscular symptoms on the first day, and œdema of the lower extremities on the nineteenth, and died on the thirty-seventh day; another on the fifth, dying of asphyxia on the thirty-fifth; and 2 on the tenth; No. 70 died on the forty-eighth, and No. 168 on the forty-sixth day; No. 109 had œdema on the fourteenth and died asphyxiated on the thirty-fifth day.

In one case vomiting commenced in two hours after ingestion of the trichinosed meat. In another it lasted two weeks, but as a rule passed off after a few days.

In one case in Hedersleben, diarrhœa lasted three months, and in Knoll's case (Knoll, *l. c.*) it lasted from the fifth to the fourteenth week. In Hedersleben, it was mostly uninterrupted during the first four or six weeks; involuntary stools occurred only with delirium or stupor. In Hettstadt, diarrhœa was not one of the prominent symptoms. In Brooklyn, in 1879 (Dr. Maddren, *l. c.*), "the pain, vomiting, and diarrhœa appeared in 24 hours after eating trichinous meat, the large, feculent, greenish stools changing later to very thin, clay-colored, or rice-water discharges." Rupprecht (p. 13, *op. cit.*) reports in his cases: "the stools are yellowish brown, passing without pain." Dr. Gilpin (*l. c.*) in one case met with diarrhœic stools as in the third week of typhus; all stools like beaten eggs. In Hedersleben there was bloody diarrhœa in three cases, in one of which it lasted four weeks. One of Gilpin's cases had neither vomiting, diarrhœa, nor fever. "Constipation often supervened on a previous diarrhœa, and in some cases was one of the initial symptoms." (Kratz, p. 71.) Wunderlich (*l. c.*) reports one case (No. 2) with constipation, dysuria, and vomiting. "Pain in the abdomen and borborygmus were constant with diarrhœa; occurring also when there was neither vomiting nor diarrhœa." Of the remainder of the 128 cases in which alimentary disturbances were not present (*viz*, 107) muscle symptoms appeared in the following: On the fifth day, one case, with œdema on the fourteenth day, and death by asphyxia on the nineteenth day; two cases on the seventh day, both œdematous, death from paralysis of lungs occurring on the twenty-second and twenty-eighth days, respectively; five cases on the eighth day, with œdema on the eighth day; one case on the twelfth day, death from marasmus on the fifty-seventh day; one case on the fifteenth day, death from exhaustion on the fifty-fourth day; two cases on the sixteenth day, one of which died on the twenty-fourth day of paralysis of the muscles of respiration, the other on the forty-ninth day of exhaustion; one case on the twenty-second day, died on thirty-third day, scrofulous; one case on the ninth day, with simultaneous œdema, died from exhaustion on the forty-ninth day;

two cases, first seen on the ninth day, œdematous, one died on the twenty-seventh day of collapse, the other on the thirty-ninth, of paralysis of muscles of respiration; two cases on the tenth day, one œdematous when first seen on the eleventh day, died of paralysis of respiratory muscles, and the other œdematous when first seen on the nineteenth day, died on the thirty-seventh day, of paralysis of the brain; one case on the eleventh day, with œdema on the twenty-fifth day, died on the forty-fifth day; and one case, first seen on the twenty-first day, with œdema on the twenty-fifth day, died on the one hundred and thirty-first day.

“The second stage in a diagnostic point is the most important, and in light cases is the only one present.” * * * “Its advent is marked by a swelling of the eyelids, face, etc., which in typical cases occurs with the beginning of the second week. If the number of migrating trichinæ is small, these symptoms may not appear until the first two (3, Rupprecht) weeks have passed, or even later.” (Leuckart, *Mensch.*, par. ii, 3, p. 587.) Delpech (p. 28 *op. cit.*) says:

“œdema is an indication of the presence of the parasites in the facial muscles. In severe cases it may appear on the seventh day, in lighter ones on the eleventh, or even as late as the twenty-second. It is sometimes very fleeting, especially when not prominent, and probably it is owing to this circumstance that it was not seen in the only two cases (Friedrich and Behren's) in which it was reported absent. All observers that I have consulted consider it characteristic. In one of Friedrich's cases œdema of the face, hands, and feet appeared on the first day. Pressure and burning in the eyes and swelling of the lids and face were among the first symptoms observed by Fiedler, and one of his cases was marked by great subcutaneous extravasations in the extremities, which came on shortly after the disappearance of the œdema of the face.”

Renz (*l. c.*) reports cases in which the œdema was very light. Sungel (*Virch. Arch. Bd.*, xxix) says: “The most characteristic signs are those exhibited as the different groups of muscles become successively attacked. When they are situated under a fascia the œdema is felt deep-seated before exhibiting itself under the skin. When the muscles of the face are affected, it at once appears there. œdema may, however, be entirely absent. It failed in the face in one case out of every $5\frac{1}{2}$ in Hedersleben (18 per cent.). It failed entirely in 28 cases, viz, in all the light ones and in the severest ones where death occurred early.” It failed in the eyelids and face 68 times (and 72 times in the extremities). “It commenced oftenest on the ninth and tenth days, and disappeared in a few days. In four cases it reappeared after four or six weeks,” and “in severest cases returned in the lower extremities, reaching even to the scrotum, and sometimes remaining for weeks or months.” (Meissner, *l. c.*) In St. Petersburg (Veh, *l. c.*) “œdema was not always present, and when it occurred, there was loss of hair on the part affected. The

sailors from the Valparaiso ship, treated in Hamburg, had no œdema." (Scoutetten, p. 64, *op. cit.*)

Perspiration, which Meissner says is a constant symptom, was absent in Dr. Gilpin's cases, and "the skin became moist only as convalescence progressed." Kratz does not give this symptom a place in his table of symptoms.

Pain, soreness, or muscular weakness appeared in 258 cases in Hederleben, showing that it was the most constant symptom (it occurred on the day of infection in 1 case, No. 62), but it failed in one out of every 13 cases. Fullness or tension of the limbs present in 214 cases, and in No. 74 it was the only symptom present. In No. 51 there were neither muscle symptoms nor œdema, but diarrhœa, headache, and swelling of the lips and tongue. In No. 106 diarrhœa and œdema, and in No. 131 vomiting, were the only symptoms present. One of the Hamburg cases had no pain.

Dyspnœa comes on in the second week through the formation of bronchial catarrh. It increases to asthma-like attacks, which may recur every 3, 6, or 24 hours, often continuing 8 days. It occurred in 95 cases, while the catarrh continued a week very severe, with profuse expectoration, in 111 cases. (Meissner, *l. c.*)

6.—DIFFERENTIAL DIAGNOSIS.

Next to the discovery of what a disease is, is the finding out what it is not. "In the different degrees of intensity of trichinosis, according to the number of migrating trichinæ, it presents similarities to rheumatism; a light nervous fever, and in severest cases begins like cholera, and afterwards appears like nervous fever." Many epidemics of this disease have been wrongly interpreted and called by various names, as influenza, rheumatism, gastric fever, etc. It will therefore be necessary, when epidemics or even single cases occur with the leading symptoms of these diseases, to study them carefully and compare their symptoms with those of trichinosis.

Influenza—Would not be apt to be accompanied by severe stomach or intestinal symptoms, while its own peculiar symptoms would be the most prominent ones present. "The cough in this disease is severe, and sputa, profuse and yellow, most troublesome at night, and accompanied with a severe headache. The inflammation generally commences in the ocular and nasal mucous membranes and extends downwards, and when lung symptoms occur they are marked by well-defined physical signs" (which is not the case in trichinosis), "and it may terminate in diarrhœa, while trichinosis is more apt to commence with diarrhœa, or vomiting, or both." (Aitken, *Pract. Med. i.*, p. 706.)

Rheumatism.—"The parts affected by acute rheumatism are for the most part the joints and such textures as are composed of white fibrous tissue." Fever often precedes by twenty-four or forty-eight hours the "inflammation of the joints, but the local and general symptoms may

be contemporaneous." (Aitken, Flint.) "In a certain proportion of cases only fever is present." It may be "preceded by chilliness, which soon passes away; perspiration may be copious, but only partial" (A., F.). "The urine is scanty and high-colored, and deposits, on cooling, deep-colored sediments of urate." In trichinosis the urine may be absent or small in quantity, is dense and high colored. Albumen may be present in rheumatism, while it very rarely occurs (Rupprecht says never) in trichinosis. Albumen occurred in one case by Warfwinge (*l. c.*), one by Maddren (*l. c.*). Rheumatism pursues no particular course after invasion. Extreme cases, however, may simulate trichinosis in general characters; but in the former only a few joints will be found to be affected, while the latter affects the bodies of the muscles (the pain when it appears is diffused, as a rule, Kratz), and pain on passive motion is due to motion of the inflamed muscles on each other. The sub-fascial œdema will not be present in rheumatism, while the joints will be hot, red, and swollen. Pain is not usual in præcordium, and when present in rheumatism other signs of cardiac inflammation will appear. Rheumatism will not occur as an epidemic.

"*Gout*—Does not often attack any joint but the first one of the great toe; in other words, it is rare for the first attack instead of being a *podagra* to be a *chiragra*, *gonagra*, or *omagra*" (Niemeyer.) "The previous history of a case would have a strong influence on the diagnosis, yet a previous history of gout should not necessarily preclude the possibility or even probability of trichinosis, as high livers are apt to lunch often, and raw or underdone ham is frequently used in public places for lunches. In trichinosis the pain commences centrally and presses towards the extremities."

Sudor Anglicus, or sweating disease (Niemeyer), with which the endemic at Wegeleben (and probably in other places) was confounded, has many symptoms in common with trichinosis, but they seem to commence in a regular order—commencing on the "sides of the neck and upper and front part of the chest, thence spreading to the belly and back and limbs." In a few instances the disease is preceded by languor, headache, soreness of the limbs, loss of appetite, indigestion, etc. Much more commonly it breaks out suddenly without precursory signs. The patient awakes at night bathed in a profuse perspiration, which may have been preceded by a slight chill. There is a painful constriction about the præcordium, and an indescribable terror and restlessness. The countenance is reddened, the skin is hot, pulse frequent, and urine scanty and concentrated, thirst is not always much augmented. In most cases there is headache and a feeling of stiffness about the nucha; there may be mental confusion, dizziness, roaring in the ears, palpitation, and painful spasms in the extremities, as in cholera. These cases are accompanied by a more characteristic symptom, a sense of numbness and pricking of the skin, particularly in the fingers and over the regions where the eruption afterwards breaks out most profusely. The

sweating is so copious as to saturate the clothing and bedding, and sometimes the mattress. A peculiar odor has been ascribed to this perspiration by some, who compare it to the smell of rotten straw or musty vinegar; but most probably the odor proceeds from decomposition of the sweat which soaks the bedding. At the end of the third or fourth day the eruption appears, preceded by an aggravation of all the above symptoms, but particularly by an increase of the sweating and the prickling of the skin. Scattered here and there among the spots of the eruption, solitary sudamina appear, limpid vesicles filled with sweat, beneath which the skin appears so natural that one might mistake them for drops of water. The vesicles soon become pearly and turbid. The bowels are generally confined throughout the disease. This disease is limited to certain parts of Europe, and rarely, if ever, occurs in isolated cases. When its presence may be suspected, a thorough examination of food and a close study of the history of the cases would lead to a correct diagnosis; but the existence of the premonitory symptoms, with those conditions of the muscles and skin most characteristic of trichinosis, would be the most reliable guide, as an epidemic of any magnitude would hardly occur without some of these symptoms being present.

“Post mortem: the spleen is enlarged, the liver full of blood, and rarely pneumonic infiltrations are found in the lungs.”

Cholera.—The similarity of trichinosis to cholera was so great in the Hedersleben epidemic that it led to a false diagnosis in many cases, and cholera morbus, having for its cause an irritation of the mucous membrane of the alimentary canal, and which generally shows its effects in the night, might easily be mistaken for the former disease. In cholera morbus the treatment would necessarily be very different from that of trichinosis, as may also be said of true cholera, as the use of astringents in any form of trichinosis would tend to make the prognosis more unfavorable, as was the case in some of the early instances in Hedersleben. In all such attacks it would be well to give due consideration to a possibility of trichinosis, with especial inquiry regarding the ingesta of the previous day. A possibility of cholera invasion would be increased by its previous occurrence in other, especially neighboring localities. The pain on pressure occurs in cases where there is no diarrhoea or vomiting. The peculiar stitching pains and feeling of tension in trichinosis develop later. The remission of pain and tension in cases of cholera, after perspiration occurs and absence of pain in epigastrium, would then settle the question. (See Rupprecht.)

Typhus fever.—This disease materially differs from trichinosis, besides the most apparent symptom of the former, is the rash, which appears from the third to the fifth, or as late as the seventh day. (But the rash is absent in 25 per cent. of cases below 15 years, 14 per cent. from 18 to 22 years. In cases above 25 years it is always present. Aitken). In “the cough of typhus the sputa is of tough mucous, occasionally mixed with blood” (Niemeyer), while that of trichinosis will be negative, as it

is due to irritation of the larynx. The temperature in typhus is high during the first weeks, whereas in trichinosis it is not much elevated until after the first week. In typhus the spleen early shows signs of enlargement, but there are only two or three cases of such an enlargement in trichinosis; but in the latter the liver may exceptionally be very much enlarged. (One case at Hedersleben, Kratz). Œdema, muscular tension, and contraction is absent in typhus, while in trichinosis the arms are generally flexed. "In typhus the arms lie beside the body helpless." (Niemeyer, Pract. Med.)

"The only important symptom of typhoid fever said to be absent in this disease" (trichinosis) "is enlargement of the spleen, and it is very probable that some of the so-called epidemics of typhoid fever in former days were caused by the propagation of trichinæ in the human body. But the epistaxis, the pain and gurgling on pressure in the right iliac region, the rose-colored eruption of typhoid fever, cannot exist in trichinous diseases, while the earlier irritation of the stomach and bowels, with œdema of the face and severe muscular pain, especially on motion, with breathlessness, increasing to dyspnoea or almost asphyxia, ought to render the parasitic disease easy of diagnosis from enteric fever." (Aitken.)

Although all of the symptoms of enteric fever may not be present at the same time, one or more of its characteristic symptoms may be of sufficient prominence to mislead the practitioner unless the *ensemble* of the symptoms of trichinosis is firmly fixed in his mind. Warfvinge (*l. c.*) found enlargement of the spleen. Hun found the spleen smaller, darker, and firmer than normal—a condition which was probably preceded by enlargement. Epistaxis was observed by Rhoda (Centralblatt f. Med. Wissen, No. 17), who gave ergot where it occurred, and by Kratz shortly before the death of the patient (see Friedrich below). Pains in the ileocæcal region observed by Wolff (*l. c.*); also by Kratz and Rupprecht in the lower part of the belly, but they diminished as the trichinæ reached the limbs. There have been various symptoms seen in trichinosis (Meissner, *l. c.*), but none perhaps like the eruption of typhoid, but in the latter it may be absent. It has been seen that the only symptoms referred to the stomach and bowels may be wholly or partly absent, as also the œdema and even the pain.

Friedrich (Deutsch Arch. f. Kl. Med. Bd. ix, 1872, p. 459) reports a case admitted to hospital for typhoid fever in which trichinosis was suspected only when the severe pain and profuse perspiration came on. In the height of the disease there was epistaxis and spitting of bloody mucus.

Knoll (Prager Vierteljahresschrift, Bd. iii, p. 144) reports the case in Prague Hospital of a woman aged 52 years from fifth to fourteenth week of the disease. There was a diarrhœa of long duration. Pulse high to tenth week, always above 100 and often reached 120. Temper-

ature in first seven weeks showed a regular morning remission and evening exacerbation. Urine scanty; convalescence tedious.

In four cases reported by Fiedler (*l. c.*) the evening exacerbation of temperature agreed with those of a light case of typhoid fever.

Kestner (*l. c.*, p. 41) speaking of the case of a soldier at Quedlinburg reported by Behrens (*Deutsche Klinik*, No. 30, 1863) says: "The symptoms at the beginning of the disease assumed a typhoid character to such an extent that an error would have been excusable. Independent of the early pain in the ileoæcal fossa, the dryness of the tongue, fever, loss of appetite, a severe diarrhœa, which was followed, after several days, by constipation, would be sufficient to mislead the most expert physician.

In Pankom (Mendel, *l. c.*) in the severe cases the temperature rose to 40.5° C., with delirium, sleeplessness, and great prostration.

Warfvinge (*Hygiëa xxxviii*) reports a case of trichinosis in a woman, dying, after delivery, of what was at first supposed to be puerperal fever and later was called typhoid fever. There were no rose-colored spots, cough, or digestive troubles; 45 trichinæ were found in one gram of flesh (*Annales d'hygiène publique, &c.*, Dec., 1879, p. 508).

Coupland (*Path. Soc. London*, June 6, 1874) reports a case in Middlesex hospital dying of "chronic phthisis and acute bronchitis when numerous trichinæ were found. Infection probably nine years previously in New York, when he suffered a nearly fatal case of enteric fever with constipation."

In one of Bøhler's cases (case viii, Kestner, p. 32, *op. cit.*) the symptoms, on the eleventh day, took on a light typhoid character. In Marengo, Ill. (*N. Y. Med. Journal* xi, 1870, p. 107), the symptoms were like typhoid fever, excepting swelling and pain in the muscles.

In three of the cases reported by Sutton (*op. cit.*, pp. 6, 7) the patients had been treated two weeks for typhoid fever. One of them, H. T., was taken, a few hours after eating trichinosed meat, with vomiting and diarrhœa. When first seen by Dr. S., 14 days after infection, face pale, countenance shrunken, great emaciation, diarrhœal discharges serous and yellow every three hours, unrestrained by astringents, occasional nausea and vomiting, loss of appetite, thirst, tongue red but not remarkably dry, pulse feeble, 110 to 120, temperature 98° to 100° F., mind clear, apathetic, complaint of feeling tired, tenderness of abdomen, slight hyperæsthesia, but no œdema or eruption; died after four weeks.

The fever curves as presented in Figs. 70 and 71 show some similarity between trichinosis and typhoid fever, as also how easy it might be to mistake one for the other. In Fig. 70, from Hillar (in *Ziemssen Cyclopædia, &c.*), the first observation was taken on the tenth day of the disease; but this really corresponds more nearly to the temperature of trichinosis than if taken on the day of infection; for in the latter case it should be compared to that of the incubation period of typhoid fever,

for the earlier gastro-intestinal symptoms do not really occur in the characteristic period of trichinosis, and as stated above by several

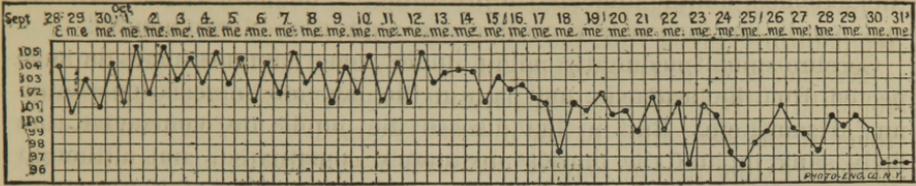


FIG. 70.—Fever curve of a case of trichinosis beginning about the 10th day of the disease (after Friedreich in Ziemssen, iii, p. 631.)

authors—Kestner, Kratz, and others—do not differ from those caused by the irritation of any other foreign substance in the alimentary canal.

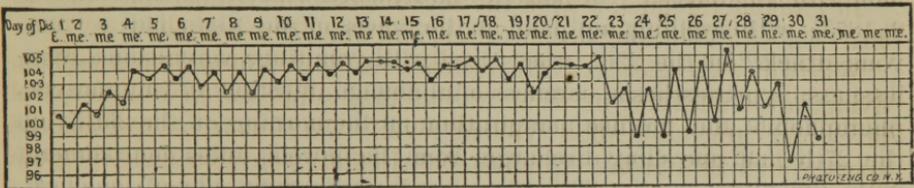


FIG. 71.—Range of temperature in a severe and prolonged case of enteric fever—*m. e.* morning and evening temperature (Wunderlich from Aitken Pract. Med. i, p. 530).

In light cases it is probable that the characteristic curves would show less similarities, as there are decided intermissions in such cases of trichinosis in place of the usual morning remission. Fig. 72 shows the fever curve for a mild case of trichinosis.

In one case reported by Wunderlich (Arch. der Heilkunde, ii, 3, 1861, page 269) the fever was of an irregular remittent type. There was oppression and bloody sputa, which continued for some time with no corresponding pathological condition discoverable by auscultation or percussion.

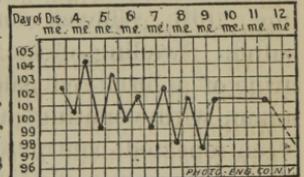


FIG. 72.—Fever curve of a mild case of trichinosis (Maurer, Ziemssen, iii, 632).

In one of the sailors from the Valparaiso vessel, dying at Hamburg, there was no œdema. Trichinæ were not looked for. At the autopsy broncho-pneumonia and ulcers of the intestines were found. See “Mr. Power,” mentioned by Dr. Bradbury, 48th An. Meeting Brit. Md., April, 2d day. “Parasites resembling trichinæ in the voluntary muscles of typhoid fever patients.” (N. Y. Med. Record, vol. xviii, p. 353.)

From the appellation “nervous fever,” used to designate the epidemic at Planen, and diagnostication of one case as such in Gratzungen, reported by Grasenick (Thür. Corr. Bl., iii, 9, September 15, 1874, p. 170), there is still further evidence of a tendency to confound trichinosis with typhoid fever, in these instances with the abortive form. (See Niemeyer, Pract. Med., N. Y., 1875, vol. ii, p. 591.)

The staring condition of the eyes reported by Kittle in Libau might provoke a suspicion of some nervous disorder. Ring (*l. c.*) reports the case of a cooper in whom the disease was very threatening at first. On

account of the stiffness and contractions of the muscles it was thought to be tetanus. Œdema was very slight; there was fever, but no pain in the abdomen, and no difficulty in breathing. The patient was better in one month, but too weak to work at the expiration of two months.

Cerebro-spinal meningitis might under some circumstances be suspected from the headache and pain in the nape of the neck, opisthotonus, trismus, etc. But in that disease the pupils are contracted, the belly sunk in, and the bowels obstinately constipated, and although there may be vomiting, it is followed sooner by other characteristic symptoms, and coma soon supervenes. (Niemeyer, Pract. Med., ii, 221, 222.)

A case of cerebro-spinal meningitis reported by Dr. F. C. Clark (Bost. Med. Surg. Journal, January 8, 1880, p. 37) had many symptoms in common with trichinosis. The patient was attacked with rheumatism March 8, 1873; with swelling and pain in the knees on the 21st; had a "nervous attack" on the 22d; was seized with vomiting, convulsions, restlessness, hyperæsthesia, soreness of abdomen, injection of conjunctivæ, photophobia, and profuse perspiration on the morning of the 25th; on the 27th had one slimy discharge from the bowels, takes nourishment with difficulty; on the 28th rales heard on the right side of the chest, a trifling dullness on percussion, cough, and a slight bloody expectoration; April 1, eyelids somewhat swollen, abdomen tumid, but not tender, gurgling in the right iliac region; April 3, sore throat, difficulty of swallowing; April 8, great prostration returned, profuse sweating; 10th, relieved constipation with calomel, followed by magnes. sulph. Swelling of the face again on the 12th; disappears on the 13th; urine of a brick-red color; gave another purge; swelling of the face again, with vomiting and purging. The opisthotonus and epistaxis often repeated, contracted pupil. The course of the symptoms, etc., preclude a diagnosis of trichinosis, while most of the other symptoms, the condition of the bowels, and especially the condition of the abdomen, considering the age of the patient (æ. 12 years), would lead to a diagnosis of trichinosis in an epidemic of that disease.

PECULIAR CASES.

In one of Boehler's cases, previously referred to, the patient was sick five weeks, and it was thought that the disease was the result of a cold taken during menstruation. The patient had had swelling of the feet for seven days, had passed lumbricoides and a few fragments of tænia. This case was diagnosed "rheumatic fever," and on the third day after admission the symptoms assumed a light typhoid character; on the twenty-second day there was an abundant effusion into the left pleura. The hair fell off, but commenced to grow again before she left the hospital (Kestner, p. 35; Scoutetten, p. 54, *op. cit.*).

In Plauen in 1863 (Behrens) the general characteristics of the disease were those of a gastro-rheumatic fever; in most cases constipation was a prominent symptom. The whole course of the disease was very be-

nign, lasting on an average about three weeks. A few complained of pain and tension in the fingers, and one had small ecchymoses under the nails. Palpebral œdema occurred in every case, but general œdema was not present in any. The palpebral œdema was so constant and characteristic a symptom that the people were in the habit of calling those afflicted "swelled heads" (*grosses tetes, Dickkopf*).

Rupprecht so frankly states the source of his error (previously referred to) that I have inserted that portion of his remarks describing the symptoms of his epidemic to show when failures may occur. He says (*Die Trichinen Krankheit, etc., p. 1, 2*):

"In the latter part of October, 1863, there occurred suddenly several peculiar cases of vomiting and diarrhœa. The sickness began generally in the night without apparent cause, and did not yield as usual to opiates, sinapism, etc. Besides unusual weakness, there was more or less restlessness, anxiety, nausea, cardialgia, and meteorism. The evacuations were greenish, thin and slimy, and painless. There was loss of appetite, increase of thirst, sleep troubled or failed entirely, and a more or less febrile condition was developed. In another series there was nausea without vomiting, with great oppression and restlessness, neuralgic pains in the vicinity of the cœliac, mesenteric, hypogastric, and sacral plexures; also a greenish, slimy, or clay-like diarrhœa, without tenesmus. In still other cases there was constipation with dysuria; there was also exhaustion, decrease of appetite, great thirst, sleeplessness, with the appearance of gastric fever, without severe headache, dizziness, delirium, appreciable elevation of temperature, or enlargement of the spleen. The unusually warm weather in the early part of October—32° R. (40° C., 104° F.) at noon, and 13° R. (16.25° C., 61¼° F.) at midnight—seemed to have had an etiological relation to the disease. I was induced to believe that it was an epidemic of acute gastric catarrh, and treated it accordingly. At the end of the first week there was developed suddenly in the cases first attacked an œdematous swelling of the eyelids, with catarrh of the conjunctivæ and simultaneous muscular pains, difficult motion of the somewhat swollen limbs, and a tendency to profuse diaphoresis."

In the case of the soldier at Quedlinburg before mentioned, there was absence of œdema of the lids. œdema of the feet appeared only in the fourth week. The respiratory symptoms resembled those described by Wunderlich, hæmoptysis, with no appreciable affection of the heart or lungs, but which he referred to anæmia, and was attributed by Behrens in a great measure to general debility, which persisted a long time after recovery from the disease.

"In December, 1860, Professor Wunderlich met with a case of prolonged fever, which did not correspond in its course with any of the well-known specific fevers. The patient was a butcher. He eventually got well, and so far negatived the diagnosis of *acute tuberculosis* which had been made. This was undoubtedly a case of trichinosis." (*Aitken, op. cit., i, 158.*)

A case in Würzburg (Kölliker, Würzburger med. Zeitung, ii, 1861, p. 12) died of general purulent bronchitis.

Otto (Memorabilien, No. 10) reports a case of trichinosis which simulated pleurisy. All other symptoms of trichinosis present. The diagnosis was made by means of a "harpoon." The autopsy revealed old adhesions in the left lung. Pleura contained effusion of bloody serum. There was hypostasis. The pyramids of the right kidney and its pelvis contained a purulent effusion.

Wood's case (1835, *l. c.*) showed pneumonia in the first stage, and extensive pericarditis. The symptoms were attributed to a cold.

In Hettstadt, of four miners, three had pneumonic complications after the third or fourth week; the other died of pneumonia on the fifth day.

In Bovenden (Kraemer, D. Klinik, 30, 31, 1872) there was an endemic of twenty-eight cases, the first one of which was diagnosed catarrhal rheumatic affection, with angina. There soon occurred another case in which a trichinous infection seemed probable, and on examination of the remains of the food eaten, trichinæ were found in great numbers. Most of the patients showed the first symptoms at the end of the second or the beginning of the third week after eating the infected meat. Bronchitis and hoarseness occurred only in the severest cases.

In Neugersdorf (Lond. Lancet, vol. ii, 1877) the usual symptoms recurred after twenty-five days. Forty-five cases occurred. The butcher was imprisoned for selling infected meat.

In two cases in Cheektowaga, N. Y., reported by Dr. Kronbein (*l. c.*), were diagnosed "at first to be acute muscular rheumatism of a peculiar type."

In one case reported by Baring (Zeitscht. f. prakt. Heilk, 2, 1864) was diagnosed erysipelas. No desquamation followed.

In the epidemic in Neustadt in 1874 (Munzel, *l. c.*) the first symptoms—muscular pains, with œdema of the face concurrent or following in a few days—occurred on the fourteenth to the twentieth day. The cases were mostly lighter as the first symptoms were postponed.

Hun (Trans. N. Y. State Med. Soc. 1869, p. 157) reports that in one case puffiness of the face was noticed first; this was followed by vomiting and general gastric disturbances; soon after the arms and legs became tender and sensitive to the touch, muscular movements difficult and painful; about the same time diarrhœa came on; about the end of the second week the patient walked on tiptoe, other symptoms increased; cough was apparent after thirty days. This patient was first seen by Dr. H. six weeks after the first symptoms appeared. He was then lying on his back, complaining when moved or touched; face puffy, considerable œdema of legs and feet, tongue red and inclined to be dry; considerable thirst and little or no desire for food; bowels tympanitic, but not remarkably tender; frequent soft, green stools; urine normal; constant cough, with expectoration of a thick, tenacious mucus, sometimes streaked with blood, at others resembling the rusty sputa of pneu-

monia; loud mucous rales on both sides of the thorax, with bronchial respiration and slight crepitation, and dullness on percussion.

Martinsville, N. J., Dr. E. J. Bergen (communication to the Surgeon-General M. H. S.) reports four cases of trichinosis. The symptoms, as reported by the physician who first saw them, were those of cholera. Dr. B. saw them two weeks after the attack, when all but the father of the family were better. He (the father) was suffering with symptoms similar to those of arsenical poisoning, viz:

Fœtid state of the mouth; sensation of the teeth being on edge; hicough; burning pain in præcordia; inflammation of the lips (see Kratz, case No. 51); irritable stomach; vomiting of matters brown in color; black, fœtid stool; small, frequent, and irregular pulse; partial suppression of urine; livid spots over the abdomen; delirium; great prostration of strength; profuse perspiration; inability to move without great pain in the voluntary muscles; œdema in the arms and legs. The patient was better on the second day of my treatment (salycilic acid in ten-grain doses), and on the third day he died while being helped from the bed. Trichinæ encysted and free were found in a piece of muscle taken from the deltoid twenty-four hours after death. Fifty were counted in a space, perhaps, of one-half an inch square.

The following cases were reported by C. Frommann (Virch. Arch., Vol. 53, p. 501):

On the 21st of December, 1865, I was called to see Theresa M., aged 22, who lived in Weimar, suffering from an œdematous swelling of the eyelids, and also, but to a less degree, of the cheeks, a painful feeling in the limbs. The œdema had lasted eight days, but weakness was felt only in the last three days. She felt exhausted and restless. These symptoms, as well as a pain in the back, had been very much increased by hard work. There were no disturbances of digestion, and the bowels and appetite were normal. The patient had an anæmic appearance, moist skin, temperature to the touch slightly increased, pulse quick and small. Examination of the chest, except a few coarse rales, was negative; voice unchanged; upper and lower lid somewhat œdematous, less towards the back part of the cheek; conjunctivæ not markedly reddened but were slightly swollen. When lying tranquil the patient complained only of headache, a feeling of stiffness in the neck and pains in the back; on the other hand motion caused pains in the limbs, viz, in the calves of the legs, the flexors of the fore-arm and legs, notwithstanding which she would not lie still in bed, and complained of a feeling of great discomfort and restlessness, which made it necessary to change her position often. She could neither walk nor stand alone because she felt so undone (so caput.); pinching the above-mentioned muscles increased the pain besides developing pain in other muscles previously free from it, even on motion. Acute and sometimes reflex pains were occasionally called forth by pinching the serratus ant. maj., coracobrachialis, deltoid, flexors of the hand and fingers, the small

muscles of the ball of the thumb and little finger, rectus and obliquus abdominis, the flexors of the legs, gastrocnemius, &c.

R., gr. $\frac{1}{2}$ morphia in aqua laur. every three hours.

On the 22d pain in the muscles markedly decreased; on the 23d complained of loss of sleep, from pain in the nape of the neck; her head can be turned only slightly, slowly, and painfully on account of stiffness and pain in neck; muscular pains and sensibility increased; the flexors of the hands and fingers are tense; the skin about the elbow joint is œdematous as well as on the back of the hand; œdema of the eyelids increased; pulse 100, small; skin moist. On the 25th a piece of muscle was taken from the forearm; it contained neither trichinæ nor degenerated muscle fasciculi, but was œdematous. On the 26th œdema of the eyelids and pain in the muscles considerably decreased, but complaint of pain in the region of the diaphragm on taking a deep breath or on yawning; skin moist; 27th, the wound in the forearm has suppurated a great deal; the tension of the flexors and œdema of the skin of the forearm has abated. January 1, 1866, patient much better; 6th, pain only in the calves of the legs on walking or being pinched, wound on forearm healed, pulse 88, some cough during the whole of the disease. No disturbance of the appetite or digestion; the skin was moist, but no sweating appeared. The infection dated from the 26th of November, 1865, when she had eaten some cracker sausages, some of which she gave to her brother Bernard M., who in turn shared his part with Franz H.

“Bernard M. was taken sick about the 25th of December; slight trouble in swallowing, reddening and swelling of the mucous membrane of the mouth and pharynx. These symptoms improved rapidly and gave place to those characteristic of trichinosis. I first saw the patient on the 28th of December. He was complaining of great weakness and exhaustion, and was unusually quiet. The patient was somewhat small of his age, and undeveloped. He had suffered with frontal headache since the 26th, with pain in the back and nape of the neck, shoulders, flexors, and calves of the legs, increased by pinching; the muscles were elastic and tense; neither œdema of the face or eyelids present; appetite and digestion undisturbed; skin moist; temperature to the touch seemed somewhat raised; pulse, 120, small; considerable sweating during the night. Ordered morphia, &c., as before. January 1, 1866, pulse 116. January 6, œdema of the upper third of the forearm and lower third of the leg, some œdema of the cheeks, contractions in right arm.

“*Third case.*—Franz H., who ate a small part of the brother's share of the meat above mentioned, showed, on the 22d of December, a slight œdema of the eyelids, weakness and exhaustion, pain and stiffness in the limbs and neck, pain in the region of the diaphragm on deep inspiration. The œdema disappeared after two days, and after a week the patient resumed his work.

“The first two cases offer symptoms of a light form of trichinosis, viz, pain in a great number of muscles, œdema of the skin, increased frequency of the pulse, &c., while gastric symptoms were absent. Muscular pain commenced in the first case (Theresa M.) on the twenty-second, and in the second (Franz M.) on the thirty-first day after infection, and in the first case five days after the appearance of œdema. In the first case the pain lasted twenty-three days, and in the second it lasted thirty-two days. Excessive sweating was absent in the first and noticed only once in the second case. With the former it was not the extensiveness and severity of the muscular pain which aroused the suspicion of trichinous infection, but the œdematous swelling of the eyelids. In the second case there could be no doubt in regard to the diagnosis, as the muscular pains so often noticed in the fourth week were present, besides the weakness and the difficulty of motion in the limbs, &c. Mollendorf (Berliner Klin. Wochenschrift i, 37) relates a case in which, a few days after the œdema of the eyelids appeared, there was a sensation as if electric shocks were passing through the body, followed by some pain in the loins and calves of the legs, and later by intense contraction of the muscles of the left leg. This condition was observed in Bernard M. The absence of trichinæ in the specimens of flesh examined is not surprising, as I found them only once in four cases examined in the epidemic of Weimar, in which 100 cases occurred.”

In a case reported by Professor Navrateil (Pester med.-chir. Presse xi, 19, 1875, p. 295) there was paralysis of the left side of the larynx, for which no cause could be assigned during the life of the patient. Post mortem, trichinæ were found in the muscles and in the heart (?).

Dr. I. Hirschberg (Deutsche Zeitschr. f. prakt. Med. 49, 1875, p. 421) reports a case of what was supposed to be trichinæ or other nematode in the eye.

Dr. Boull (Virch. Arch. 65, 1875, p. 421) reports a similar case in a raven. Referred by Virchow (see Reimer, Schmidt's Jahrbücher, No. 178, 1878, p. 180) to “*filaria sanguinis hominis*” of Lewis (see Cobbold, l. c., p. 180, F. Bancrofti (Fig. 87).

A case is reported in the Galveston Medical Journal, 1866 (?), of trichinæ having been found in the eye of a horse.

In large epidemics or small ones in families, even if not more than two persons are affected, and especially when similar symptoms appear in several persons after partaking of the same meal, particularly when pork has been eaten, suspicion of trichinosis should be entertained early, and as many cases of sudden diarrhœa depend on offensive matters in the intestines, the desirability of an immediate administration of a non-irritating cathartic, as calomel, will present itself.

In reviewing symptoms and cases in reference to the diagnosis of trichinosis particular stress has been laid on those cases which might mislead by certain prominent symptoms, and on light ones, in which mistakes will be most liable to occur. Every case, therefore, of cholera morbus

may be looked upon with suspicion, only to be removed by a negative result of a thorough examination of the food eaten or the short duration of the symptoms. It has been seen that the symptoms of trichinosis are not so uniform, but that if the disease is suspected, the physician will be warranted in searching for trichinæ, although Leuckart (*Untersuch.*, etc., p. 81) says "as long as muscular pains fail with other connecting circumstances, exclude trichinosis." This symptom, however, may fail (as in 6 cases in Hedersleben and 17 doubtful ones). "Besides the earlier gastric symptoms" (which do not always occur), "the microscopic examination of the vomited food and the diarrhœal discharge will assist in the diagnosis." Many cases are on record where trichinæ have been found in the stools. (Pagenstecher, *op. cit.*, pp. 41, 42, also p. 39; Rupprecht, *Rdbl.*, p. 30, two cases after a purge of calomel in the third week; Gerlach, *Die Trichinen*, p. 10; Virchow, *op. cit.*, p. 59; Leuckart, p. 90.) But in many other cases where examinations have been made, no trichinæ were found, and therefore it would not be safe to exclude trichinosis because they could not be discovered. Dr. E. Wagner (*Arch. der Heilkunde*, ii, 1864) found no trichinæ in the intestines in two cases, dying respectively on the twenty-third and twenty-sixth days, "after hours of careful search." Gerlach (*Die Trichinen*, p. 10) says "the more severe the diarrhœa, and the more mucus contained in the evacuations, the more trichinæ will be found, and the most in cases where the mucus is tinged with blood. Later, in doubtful cases, the examination of a piece of muscle taken from the arm by incision or by means of a harpoon, is recommended by Mitteldorf and Kuchenmeister. This is recommended by most authors, but with varying amount of reliance in its diagnostic value." Frommann (*Virch. Arch.*, No. 53, p. 508) says "the absence of trichinæ in the muscles of the arm is no evidence against trichinosis, even in severe cases, as was shown in Weimar." Kratz says (*op. cit.*, p. 106), "by this means only a positive result is obtained, never a negative certainty"; and Leuckart (*Mensch. Par.*, ii., 3, p. 590) "a positive result is not always attainable, because in the doubtful cases the trichinæ are only sparsely distributed in the muscles." Even up to the fourth week Kratz (*l. c.*) found the microscopic examination of the muscles to give a negative result; and P. Niemeyer says (*Catachismus*, etc.), "There is nothing peculiar in the muscles in the first three weeks, but in the fourth there is an appearance of whitish streaks in the red muscular tissue."

The œdema of the face and eyelids without albuminuria, one of the characteristic symptoms of trichinosis which may be occasionally absent, may occur in other diseases.

"Neither Pagenstecher's method of examining portions of the gums for trichinæ, nor Welcker's of examining the under sides of the tongue near the frænum with a magnifying glass has been found to be reliable, and up to this time there is no way of determining with certainty the presence of trichinæ in animals during life" (*Scoutetten, op. cit.*, p. 75).

One great difficulty in the way of recognizing the presence of trichinosis is the assumption that it is a disease without variable symptoms. Wagner (*Arch. der Heilk.*, ii, 1866), after mentioning several cases, says: "The symptoms of trichinosis are so well marked that there is no necessity for using the harpoon or trochar." It was because Rupprecht relied on these "well-marked" symptoms that he failed to recognize the disease. He found a whole epidemic in which the symptoms were *not* well marked according to the type given in the first case recorded as such. [To assume that this was the first case that occurred would be to assume that Professor Zenker was the first one to make a mistake in his diagnosis. He had called it by the name of the disease which most closely resembled it in its symptoms, but it seems he was not satisfied. There was something beyond the usual symptoms of the diseases with which he was familiar; a comparison had failed to explain the case, so he resorted to investigation to learn what was beyond the existing knowledge, and happily for the world he found it.]* Tanner (*Pract. Med.*, 1875, p. 173) says the diagnosis is not difficult, especially if the symptoms occur after eating raw pork. Kratz, after the observation of 280 cases, says (*op. cit.*, p. 57), "The first symptoms occur in so many widely different ways that one is led to suspect totally different causes for them." I have thus given at some length the opinions of observers to show the probability of errors in diagnosis from erroneous notions in regard to the symptoms or course of trichinosis, particularly as one gentleman—of whom I had made inquiries regarding some cases, etc.—wrote me "I do not see how trichinosis could become epidemic." "Friedrich distinguished a case of trichinosis among 12 cases of typhoid" (Rupprecht).

7.—PROGNOSIS.

"The mortality in different epidemics of trichinosis is widely different, and depends on the degree of infection and severity of the disease, but children suffer less than adults."

Of 67 children under 14 years attacked in Hedersleben (Kratz, pp. 53, 54) 1 died—1.5 per cent.; of 100 women 17 died, 17 per cent.; of 170 men 83 died, 48.8 per cent., or nearly 30 per cent. of all cases. In Plauen in 1862 the mortality was 6 per cent.; in Calbe, 20 per cent.; in Burg, 22 per cent. In Hedersleben (Kratz *l. c.* and Cohnheim *Virch. Arch.*, 136, 1866, p. 161, etc.) the mortality was very irregular in the different periods. Two died during the first week, a few in the second. The mortality increased towards the third week, and three-fourths of the deaths occurred during the fourth, fifth, and sixth weeks, after which the death rate decreased and none died after the tenth week. Of 8 fatal cases in Plauen 1 died on the fourth, eighth, fourteenth and forty-second day, and 4 on the twenty-first day. Rupprecht, *Rundblick*, p. 10.

* NOTE.—Cobbold states that the first person in England to observe, recognize, and treat the trichina disorder, in the living subject, was Dr. W. Lindow Dickinson in 1870.

In Hettstadt (Rupprecht, Rundblick, etc., p. 26, *Die Trich.*, p. 20), "The greatest mortality occurred in the fourth and fifth weeks, *i. e.*, during the time that myositis was most severe. A few died earlier, some later, the last through marasmus, in consequence of a purulent breaking up of atelectatic nuclei or from follicular disease of the intestines, or from muscular atrophy." Also, p. 27: "The more extensive an endemic the more intense will be the disease. The earlier the disease supervenes on the infection and the more complete and severe the symptoms are developed—swelling and tension of the muscles, formication, prone position, stiffness of the body, trismus, dysphagia, severe diarrhœa, temperature 41° C., pulse over 120, respiration over 32, dyspnœa, embolism of the lung—the more unfavorable the prognosis."

Renz (*op. cit.*, p. 98) says: "The first cases of an endemic are usually the most severe."

Schenck, of Halle (*l. c.*), divides the symptoms into three sets for prognosis. "1st. Where there was severe diarrhœa after one or two days, lasting several weeks, the prognosis is most favorable. 2d. Where there was a slight diarrhœa after six or eight days, with sudden cessation, the patient most frequently dies. 3d. The lightest cases are those in which the symptoms appeared after two or three weeks. According to Meissner (Schmidt's *Jahrbücher*, No. 138, p. 92), these observations were not confirmed in the Hedersleben epidemic, for severe stomach symptoms appeared early in some cases, later in others, and in another set not at all, without influencing the prognosis." One of the last category was, in Hedersleben, very severe. Death occurs most frequently in the fourth or sixth week after infection. Implication of the muscles of respiration is the most frequent cause of death, but it seldom reaches a fatal condition before the fourth week, or comes on later than the fifth. In the gravest cases typhoid symptoms set in during the fourth week (Jackson, *l. c.*). In some cases in Hedersleben, as in Hettstadt (Kratz *l. c.*), there would occur an entire remission of symptoms, which might be followed by a sudden significant exacerbation, speedily ending in death. Sometimes death follows from gastro-enteritis before any signs of peritonitis or migrating trichinæ were observed (Kratz, *l. c.*, und Berl. Klin. Wochenschrift; see other cases quoted under diagnosis).

"A good appetite, undisturbed sleep, easy respiration in the third week, late appearance of first symptoms, favorable age of the patient, escape in the first eight weeks, are indications for a favorable prognosis" (Meissner, *l. c.*). According to Virchow (*op. cit.*, p. 41) diarrhœa is more favorable than constipation.

"In regard to the organs of respiration the hoarseness and intense dyspnœa are due to the presence of trichinæ in the larynx and muscles of respiration in the early weeks, which not seldom is the cause of death without the early symptoms of the disease having been noticed."

"Pneumonia is a complication of extreme gravity, while pleurisy is only exceptionally followed by serious consequences. In Hettstadt, of

27 fatal cases, 8 succumbed to a typhoid form of the disease, 5 died from paralysis of the lungs, 3 from pressure caused by a serous infiltration of the cellular tissue of the muscles of the neck (and in one case œdema of the glottis), 6 died of embolic pneumonia, 1 from effusion into the peritoneum from puerperal peritonitis; other cases, more chronic, from colliquative diarrhœa, marasmus, etc. (Kestner, *l. c.*, p. 46).

Meissner (*l. c.*) says: "There were constant signs of tuberculosis in cases after $4\frac{1}{2}$ months."

Other complications affecting the prognosis in some cases: Abortion, Klob. (*l. c.*), Kronbien (*l. c.*); precocious menstruation (Rupprecht-Bochler); thirty-three cases in Hedersleben had trouble in menstruation (Kratz, 1); one case of suppression of milk (Ring, *l. c.*); intermittent palpitation of the heart (Rupprecht); œdema of the larynx, Kestner (Rupprecht); hæmoptysis with phthisis (Meissner); bloody diarrhœa (Meissner, Kratz, Renz, Dithusen, Krabbe, in *Jahresbericht*, etc., 1878, p. 195); anæmia, hydræmia, and leucocythæmia (Meissner).

"Most patients can resume their work on the eighth week" (Leuckart, p. 87), but after lung complications not until the tenth week, and sometimes a painful sensation in the soles of the feet prevents the patient from walking for one or two weeks after convalescence. There is abundant desquamation, and the epidermis may be detached in large flakes, and the hair, and even the nails, may fall off.

The pupils remain inert and dilated for a long time. The catarrh of the palpebral conjunctivæ and more or less difficulty in accommodation remain generally until the eighth or tenth week.

8. SEQUELÆ. •

It has been remarked that convalescents from trichinosis have a very pronounced tendency to obesity. This is due to a fatty transformation which commences in the interior of the primitive fasciculi, and plays an important role during the destruction of the fibrillæ. It extends to the extremities of the capsules and to the intermuscular connective tissue. The weight increases more rapidly than the strength (Kestner, *op. cit.*, pp. 67, 68).

According to Leuckart (*Mensch., Parasiten*, ii, 3, p. 584), Davaine, and others, after the trichinæ have become encysted there is no further trouble from them; but Simon, quoted by Kestner (*op. cit.*, p. 73), mentions the probability of encysted trichinæ affecting the general health of the patient and becoming the cause of muscular weakness, and the latter says, "In robust persons there is little to fear from this cause, but to persons of advanced age, and those of feeble health, it may be a source of future trouble. Grave cases show a tendency to become chronic."

All cases of profuse perspiration, if attended with nauseating or strong odor, or more or less œdema after slight exertion, dating from a given sickness, or often recurring peculiar pains or weakness, might be

looked on with suspicion. Muscular pains occurred in the Dresden case operated on by Langenbeck, in the case infected in Davenport in 1856 (Timm, Virch., Arch., 30, p. 447), in a butcher reported by Rupprecht, also a case by Groth (Virch. Arch., vol. 29, 1864, p. 604). Besides these cases, Dr. Wendt (Am. Jour. Med. Sciences, April, 1878, p. 434) reports several cases in New York where muscular pains occurred five years after recovery from trichinosis. He says, "These attacks do not depend on changes in the weather. There are painful spots commencing suddenly at all times of the year, and disappearing as suddenly, or sometimes declining gradually, the latter the most frequent; or it may develop slowly as an irksome tension, like 'growing pains.'"

Disorders of hearing may also result from an attack of trichinosis, as the auditory muscles are often affected (Henle, Coupland, Kestner, Meissner, and others).

From the large number of cases of trichinosis reported as showing lung or pleural complications, and the large number of cases where evidences of lung troubles appear post mortem in those showing trichinæ in the muscular tissue, there is reason for connecting the two conditions, and for the suspicion that some, if not many cases of lung disease of a chronic character may have their origin in a light form of trichinous infection, or may be the remains of a somewhat severe case of trichinosis. Virchow says (*op. cit.*, p. 34): "In a few cases I have examined the bodies of those said to have died of consumption, and found, besides marked lung disease, extensive trichinization and extreme emaciation. Harrison's cases showed (three out of six) lung disease, also Bowditch's, and Coupland's cases died of an acute bronchitis added to a chronic phthisis, and Wood's case had chest troubles.

9.—PATHOLOGY.

The pathological conditions and changes in the different parts of the body are known by well-marked changes in the symptoms. The latter, according to Rupprecht, follow in three distinct stages (see Section I, 2 Symptoms), 1. Stadium ingressionis; 2. Stadium digressionis; 3. Stadium regressionis.

Delpech (*op. cit.*, p. 27) asserts that "the first symptoms appear when the birth of the young trichinæ commences;" and according to Kestner (*op. cit.*, p. 59) "the symptoms of the first stage are declared as soon as the females have commenced to deposit their young." This could hardly be possible, as it has been seen that the embryos are not deposited before the fourth or sixth day. The first as well as the earliest case seen is where Hun (*l. c.*) saw a female give birth to young on the fourth day; but the first symptoms may commence in a few hours after the ingestion of trichinised meat. Kratz (*op. cit.*, p. 107) mentions "a few hours to forty-three days" as the "period of incubation." Gerlach (*l. c.*) says: "Nausea and anorexia occur after twelve hours, when infection is severe, with diarrhœa and vomiting." Sutton's cases commenced in a few hours

after infection. In one case in Hedersleben the first symptoms commenced after two hours, and in two others—one in Calbe (Renz, p. 29) and one in Hedersleben (Kratz, p. 4)—the patient died on the fifth day; and further (p. 8, *et seq.*), it will be seen that of the 280 cases reported in Hedersleben, 12 showed the first symptoms on the day of infection, of which 7 had diarrhoea alone, 3 had vomiting, and 2 had both; 22 were attacked on the day following, and 20 on the third day. Whatever else might have been the cause of these early symptoms, it could not have been the presence of a brood of embryos. In the above epidemic there were 26 cases commencing on the fourth, fifth, sixth, and seventh days, and 11 others were attacked on the eighth. Unfortunately, the date of the first appearance of symptoms is not given in hours in the first 12 cases. The appearance of the early symptoms in these cases would perhaps correspond more nearly to the liberation of the muscle trichinæ by the digestion of the surrounding muscle and capsule, which, according to Flint (who gives the time required for the digestion of albuminous substances at $1\frac{1}{2}$ to $5\frac{1}{4}$ hours, raw pork taking 3 hours—Text Book of Physiol., p. 250), would be completed in that time, and have also time for the commencement of the irritation in the intestines produced by their motion. Renz (*op. cit.*, p. 27) considers it probable that the muscle trichinæ are liberated in 4 or 5 hours after reaching the stomach. Virchow (*op. cit.*, p. 43) found the trichinæ free, in 6 hours after feeding. After they are set free the muscle trichinæ increase in size very rapidly, and in a mouse fed by Leuckart (p. 39) they had increased one-half of their former size in 24 hours. Virchow found intestinal trichinæ completely developed in $3\frac{1}{2}$ days. Leuckart (pp. 20, 21) found intestinal trichinæ full of eggs and embryos on the fourth day after feeding, but no free larval trichinæ. Gerlach (Die Trichinen, p. 29) says:

“The first symptoms are caused by the liberated muscle trichinæ. The irritation increases the secretion and peristaltic motion of the intestines, and may even amount to an inflammation of its walls. In 24 hours after feeding large quantities of trichinosed meat, I have found irritation of the upper part of the small intestine, and later, of the whole intestinal wall. In young dogs I have found the greatest degree of irritation in the rectum. This irritation begins with the liberation of the muscle trichinæ, and reaches its highest grade as sexual maturity of the worms is reached, and lasts until after a majority of the embryos have left the intestines. From the fact that the highest grade of irritation does not always coincide with the passage of the greatest number of trichinæ through the intestinal walls, it follows that the early symptoms are not due to migration of the embryos, or at least not to that alone.”

It will thus appear that the first gastro-intestinal symptoms can undoubtedly be referred to the irritation produced by the liberated trichinæ rather than to the presence of the new brood in the intestines, and later by their passage through the intestinal walls. Friedrich (Deutsche Arch. für. Klin. Med., Bd. ix, p. 459) reports a case in which œdema of

the face, hands, and feet occurred on the first day. He does not consider this early œdema as collateral, but as due to blood-poisoning on account of the setting free by the capsule, after solution of its walls, of its poisonous contents, probably the secretion of the animal from which the trichinosed meat was obtained. (See, also, Meissner, *op. cit.*, No. 165, 1875, p. 285, and Jahresbericht, etc., i, 1872, p. 257.) Renz says (*op. cit.*, p. 163):

“The question as to the cause of early death in trichinosis has been answered, although hypothetically, yet in a manner worthy of consideration, by Fürstenburg (Wochenblatt, etc., du. K. P. Staaten, 1865, p. 191), who says ‘the inflammation in some animals dying in consequence of migration [of trichinæ] is often not so well marked that it can be said that they died of inflammation. It seems more probable that there is some other cause of death. It is not improbable that substances may be absorbed by the lymphatics of the intestinal wall, pass into the blood, and thus cause death.’ I am glad to see my opinion of a toxic substance vindicated, although in a later time and on different grounds.”

The muscle symptoms noticed by Kratz, as a feeling of lameness or soreness of the muscles, occurred very early, and in some cases was one of the first, and in one (No. 35) the only, symptom noticed. “It appears before the young brood could possibly reach the muscles, and was constant in the Hedersleben cases. I have considered this as a sympathetic affection of the muscles.” (Kratz, *op. cit.*, p. 763.) Wolff also (*l. c.*) reports a case in which these muscle symptoms appeared a few days after infection, and it is said to be the first one in which this symptom had been observed before the young brood could possibly have reached the muscles. Renz (*op. cit.*, p. 92) says:

“If we cannot accord to the trichina a peculiar muscle poison which, during their rapid development to sexual maturity, is distributed by means of the intestinal secretion and blood to the muscles, there is no other way of explaining these muscle phenomena than by calling them reflex.” According to Leuckart (Untersuch, etc., p. 87), “the muscular weakness is due to blood poison, and perhaps to certain changes in the liver, as lately shown by Cohnheim.”

“The second stage is ushered in with œdema. The explanation of the genesis of œdema varies according to different authors. Those who, as Virchow, regard the act of generation accomplished in a week, explain the tumefaction of the cellular tissues by the presence of the parasites in the muscles of the face; the observations of Leuckart, who found them in the muscles of rabbits on the seventh day, have confirmed this opinion. Pagenstecher has found trichinæ in the diaphragm in rabbits after 7 or 8 days, also in the diaphragm and tongue of a pig after 9 days. Fiedler wrongly thought that the embryos did not quit the intestine until the tenth day. Kestner has found larvæ trichinæ in the muscles of the larynx and jaws on the seventh day. He has made in this connection the judicious remark, ‘according to all probability a

few of the experiments in which œdema appears late, have been made with larvæ which have not attained the degree of maturity necessary to a rapid development which may be followed by copulation.' It will be understood by this that they must pass through the different stages in the intestine that otherwise they would have experienced in the muscles." (Delpech, *op. cit.*, p. 28.)

Krämer (Deutsche, Klinitz, 30, 31, 1872) looks upon the myositis as a direct consequence of the irritation produced by the pressure of the trichinæ. E. T. Bruen (Phil. Med. Times, Dec. 20, 1879, p. 37) considers œdema (not especially of trichinosis) the symptoms of deficient vasomotor tone, and with this view in mind it might appear likely that the reflex—or perhaps direct—disturbance of the vasomotor centers caused by the movements of the trichinæ through the muscular tissue will account for the œdema present in trichinosis (for the effect of traumatism on the vasomotor centers and nerves; see Vaulais and Marius in Compt. Rend. Cong. Sciences Médicale, Bruxelles, 1875). Schaun (Thier de Paris, 168, May 17, 1872) says, "The eminent professor, Jaecund, has, on several occasions, dwelt on the law of Stokes, which is as follows:"

"The muscles adjacent to inflamed serous or mucous tissue are rapidly affected with inertia. 'There is at first,' says Stokes, 'an augmentation of the muscular innervation, which is shown by the pain and spasmodic movements; to this condition a state of more or less complete paralysis succeeds.' I go further than Stokes, and say that the reciprocal is also true; that serous, mucous, or subcutaneous tissue in the vicinity of inflamed muscles are, on account of their proximity, themselves the seat of inflammatory processes."

Renz (p. 93, *op. cit.*), "The œdema is at first collateral, similar to that of phlegmatia alba dolens, and does not retain the impressions made with the fingers; later, it takes on the character of an anæmic hydropsy, in which the finger marks remain."

"Myositis coincides with the œdema in most cases. Appearing in the beginning of the second week, it increases with the migrations of the trichinæ and until their encapsulation has commenced, which takes place towards the fourth week. Thus, during the second, third, and part of the fourth week the symptoms of muscular traumatism supersede all others. (Kestner, p. 65.) This condition—inability to move the muscles without pain—depends on the number of trichinæ in the muscles. It is often absent in light cases."

"A certain degree of trismus indicates invasion of the masseter." (Delpech, *op. cit.*, p. 31.) "Dyspnœa and hiccough are due to invasion of the intercostal muscles. Loss of voice is due to invasion of those of the larynx." (Kestner, p. 31.)

"The destruction of the muscular tissue is not merely anatomical; it is also chemical. The muscles and blood are overladen with the products of disintegration, which interferes more or less with their normal function. (Colberg found that the muscle of a recently trichi-

nosed animal gave an alkaline reaction, and Neubauer found the creatin very much increased after 14 days, with only an insignificant decrease of the sarcine.) It is probably on this account that many cases show such great similarity to certain typhoid conditions." (Leuckart, *Mensch. Parasiten*, ii, 3, pp. 583, 584.)

"Trichinosis lasts only during the continuation of irritation and destruction of the muscular tissue produced by the motion of the parasite. As motion is impossible after the commencement of encapsulation the cause of this condition no longer exists. The changes then are the same as those occurring in a wound which interfered with the integrity of the parts." (Leuckart, *op. cit.*, p. 584.) "From the encapsulation of the last trichina, and the repair of the last fasciculus, the cure commences, and in spite of the large number of trichinæ (in some cases over 30,000,000), the patient will return to his former health." (Leuckart, *Untersuch.*, etc., p. 84 and *l. c.* 1.)

"The muscle convalescence commences with fatty degeneration and absorption of the detritus of the primitive bundles; the cure is in almost all cases complete, although it may last through many months." (Rupprecht, *Rundblick*, etc., p. 27. See prognosis.)

"The severe sweating cannot be explained by the relaxation of respiratory activity caused by the painful state of the thoracic muscles, neither by the diminished secretion of urine, which is more likely an effect than a cause. The true cause of the perspiration and the œdema is the inflammatory irritation of the peripheric muscles, which determines a hyperæmia of the sudorific glands in their neighborhood. Local manifestations are due to circumscribed areas of infection." (Kestner, *op. cit.*, p. 64.)

The irregularity of the appearance and duration of the disease (see Kratz, pp. 78, 79) is probably due to the irregularity in the duration of the productiveness of the female intestinal trichinæ, which, according to Virchow (*l. c.*), is four to six weeks. Renz (p. 31), from the fifth or eighth day until the twelfth week, or even longer. One case in Pankow (Mendel, *l. c.*): in the fourth week the intestinal trichinæ contained numerous eggs and embryos, showing that emigration was not yet complete. "In Hedersleben living intestinal trichinæ were found in the seventh week. I found them in the twelfth week after feeding." (Leuckart, *Untermelung*, etc., p. 62.) Wagner (*l. c.*) "reports two cases dying on the twenty-fifth and twenty-sixth days, respectively, in which no intestinal trichinæ were found," showing that the disease is not always kept up by the presence of living trichinæ in the intestines, which might be inferred from Leuckart, who says: "As soon as the number of intestinal trichinæ has notably decreased, causing a reduction in the number of migrating worms, there is a minimum of the symptoms."

"The presence of trichinæ in the pus of a furuncle (Friedrich, *Virch. Arch.*, xxv, 1862, p. 397) confirms the fact already mentioned by Käl-

liker that trichinæ may stray into the subcutaneous cellular tissue, provoking pustular inflammation, which may end in a partial mortification or gangrene of the skin." (Kestner, *op. cit.*, p. 28. See, also, Virch., *l. c.*)

The occurrence of pericarditis in Wood's case is not surprising when it is considered that one of the most common causes of cardiac inflammation, and even of pleurisy and lung diseases, is the presence of deleterious substances in the blood, as in Bright's disease, etc.

"The origin of the pneumonia of trichinosis, which must be considered embolic, is to be sought for in the muscles invaded by the parasites. The capillary vessels are destroyed in part. The detritus of the fibrillæ furnishes the first elements of a thrombus, of which the volume is augmented under the influences of the inflammatory processes. The thrombus forms then a prominence in the lumen of a large capillary; it then softens and is washed into the current of the blood, which carries it from vein to vein, and, reaching the right ventricle through the vena cava, is propelled into the smaller capillaries of the pulmonary artery, where on its arrest by the small size of the vessel it becomes the nucleus of an infection." (Rupprecht, *l. c.*)

The clay-colored stools mentioned by authors indicate that the function of the liver is interfered with, the beginning of fatty degeneration.

Œdema of the meninges—as also of the glottis and pharynx—when it occurs, is produced, according to Rupprecht, by an extensive immigration into the superficial and deep muscles of the neck causing pressure on the veins (Kestner, *op. cit.*, p. 63).

10.—TREATMENT.

"The therapeutics of trichinosis deserves no great praise. Means by which the muscle or intestinal trichinæ can be destroyed have not, after the most careful search, been found. Calomel has been prescribed to evacuate the intestines by way of the rectum. I would recommend a one-half per cent. solution of chloride of sodium, at 37° C. A blood-warm solution of salicylic acid would probably serve a better purpose" (Falek, *Das Fleisch*, Marburg, 1880, p. 518).

Pagenstecher says (*op. cit.*, p. 78): "In the first period give calomel and jalap p. āā 1.0 to 1.5 grams, and, later, oleaginous emulsions and sulphur made into pills with glycyrrhiza radix."

Virchow says (*op. cit.*, pp. 53, 54): "As a rule, when there is a probability of infection, powerful evacuants, with or without previous anthelmintics, are indicated."

Rupprecht (*op. cit.*, p. 95) recommends calomel, "not only because of unirritating qualities, but also on account of its parasiticidal qualities as demonstrated in its effect on the anchylostomum duodenale in Africa. Other anthelmintics are of little use. Castor oil is less energetic than calomel as a cathartic;" further, p. 98, "one of the best informed practitioners of our province has expressed the opinion that in case he was called to treat trichinosis he would commence with inunctions of mercu-

rial ointment and keep them up every hour until salivation was produced. But the trichinæ, when brought into contact with particles of mercury, do not seem to be affected. And the weakening influence of severe salivation, with the accompanying fever, is greatly to be feared in some cases and in light ones would not be necessary." Yet it would seem that a fair trial would be desirable.

Kratz says (*op. cit.*, p. 116): "Rupprecht warmly recommends scruple doses of calomel, and, as long as we have no real anthelmintic against trichinæ, I look upon it as a very useful remedy on account of its beneficial action on the mucous membrane of the alimentary canal. I have occasionally combined it with santonine. I have, however, seen salivation follow after the use of one scruple of calomel; certainly a very unfortunate complication in such a disease (see Nos. 174, 262). The anthelmintic effect of calomel is, to say the least, very doubtful."

Infusion of quassia, so destructive to ascarides, might on trial be found to destroy the trichinæ in the intestine. The solid extract would be the best form, administered in pills and perhaps combined with sulphur.

Tanner (*Pract. Med.* vol. ii, 1875) suggests the use of sulpho-carbolate of soda.

Drs. Ritter and Von Brenner (Meissner, *op. cit.*, 130) used R. Cupri acet., ʒi; aqua cinnamoni, mucil. gum arabic, āā ʒi; aqua font., ʒvj, in teaspoonful doses, and found it very useful in connection with salt-water baths.

Dr. Dirke (*Inaug. Dissert.* Berlin, 1874, p. 31) found the hydrarg. cum creta recommended by Traube to have the best effect as an anthelmintic and antiphlogistic in the cases treated in charity hospitals.

Rohde (*Berlin Klin., Wochenschrift*, No. 43, 1878) found morphia and ergotine useful antipyretics, but according to Levy (*Ann. d'hygiène* Dec. '79, p. 504) ergotine has not been sufficiently tested to warrant an opinion. The use of salicylic acid seemed to make the patient restless.

Friedrich (*Virch. Arch.*, 25, 1862, p. 399) used picro-nitrate of potash with good results, while Fiedler (*ibid.*, No. 26, p. 573) found the picro-nitrate of potash and soda entirely useless.

"One case in Plauen" (Kestner, *op. cit.*, p. 33) "treated with iron got well rapidly."

Veh. (*St. Petersburg Med. Wochenschrift, Jarz.* ii, 1874) says: "Iron was useless against the œdema of the lower extremities, but digitalis and increased diaphoresis by means of hot bottles did good service, as also did cold sea baths. Warm baths did little good."

Kramer (*l. c.*) found that warm baths decreased the pain.

Mosler (*Helminthologische Studiren, etc.*, pp. 27, 28) concludes that the lack of any symptoms of trichinosis during life or of intestinal trichinæ after death in a steer fed by him was due to the use of benzine, as a calf that had been fed by Leuckart with trichinous meat died of *enteritis trichinosa*. Ad. v. Dirke (*l. c.*) found benzine (Mosler), picro-

nitrate of soda (Friedrich), oil of turpentine (Behrens), ext. felix mas. æth. (Küchenmeister), of little use.

Flogel (Weiner Med. Presse, xv, 21, p. 490, 1874) used turpentine. Owing to its known irritating effect on the stomach and kidneys, gives, it in small doses often repeated, rubs it on the swollen parts, and administers it by inhalation. He treated successfully a filaria in the eye of a horse with turpentine.

“Benzine was administered by Kratz to the extent of one fluid dram daily with no other effect than that fewer trichinæ were found after death in the intestines than after the use of opium.” (Because it did not have the same constipating effect?) Meissner (Sch. Jhr. 138, p. 96) recommends thalium or lithium carbonate with sulphur præcipitatum.

Behrens (*l. c.*) suggests the salts of lime to favor calcification. (See, also, Hanen, Berl. Klin. Wochenschrift, vii, 25, 1870.) In cases where patients drop off suddenly while apparently feeling well, as in Maddren or Bergen’s cases, artificial respiration should be resorted to. The effects of amyl-nitritis and electricity should be tried.

“There were several cases in Hettstadt in males who drank notable quantities of brandy and escaped infection, while their families, partaking of the same meat, became seriously ill. Another man who drank two bottles of red wine experienced no inconvenience after eating trichinosed meat. Alcohol, according to Rupprecht, kills trichinæ in a few hours.” (Kestner, *op. cit.*, p. 74.)

Schonenberg (Vierteljahreschrift für Gericht, etc.) reports the infection of three in one family, viz, a man, his wife, and wife’s mother; the two women died; the husband, who drank freely of whisky (Korntrautwein) during several days after infection, recovered. But in Bovender (Krämer, *l. c.*), several who had been drinking had about the same symptoms as the others (Schmidt’s Jahrbucher., 165, 1875), “and one of Friedrich’s cases had been drinking hard, so that his sickness was at first considered the result of his debauch.” Virchow (*op. cit.*, p. 55) says “stimulants give no security against infection, and much less a promise of a cure.”

“In conclusion (Delpech, *op. cit.*, p. 102), it may be said that there are no medical preventives, *i. e.*, medicines, which protect against trichinosis when trichinosed meat has been eaten. Anything thus recommended is based on charlatanism or personal illusion. It may be that in a great many cases such or such a remedy might apparently have prevented the development of the disease, or rendered it insignificant. In such cases the meat has contained but few trichinæ, or the subject had a strong constitution. If there is a substance which will kill the parasite in the stomach or intestines it has not been found yet. If such an agent can be found, of which there can be no doubt, it certainly will not be an ordinary remedy, as wine or brandy, spices, etc., but a true medical substance. Such a remedy can never be used as a prophylactic.”

SECTION E.—TRICHINOSIS IN ANIMALS.

The symptoms of trichinosis in animals have never been studied under the conditions natural to epidemics. It has been seen that there are certain circumstances under which human beings—and there is no reason why the same should not apply to animals—are not usually infected after the ingestion of trichinosed meat. Among these are the small quantity of meat eaten and the lack of susceptibility of the patient to any quantity as well as a high state of that irritability which is excited by the presence of deleterious substances in the alimentary canal, and which may result in the immediate expulsion of the parasites, as in one case in Kratz's table (No. 131); also cases cited by Leuckart (Untersuch, p. 3 a) and others. In other cases this irritability is at a minimum, and small quantities of trichinosed meat produce no symptoms (see Leuckart, *op. cit.*, p. 62, *et seq.*), but undergo the same changes as larger quantities, the number of trichinæ being so small that no great disturbance is produced, as is remarked by Leuckart (*op. cit.*, note 3, p. 63), who says, "It will thus appear, as has also been confirmed by other later observers, that neither in all cases nor in all hogs are such marked symptoms observed as in my first case," and (p. 70) "single cases are found where a complete immunity exists, but whether due to age, sex, or race is not known"; (p. 73) "because we have a negative result after feeding in a single case, it does not follow that in that class of animals there is immunity to trichinosis." Some of these negative results may be due to the use, in feeding, of unripe trichinæ, which, according to Leuckart and others (see section B), are not susceptible to further development in the alimentary canal.

The symptoms of trichinosis in hogs, as given by Gerlach (Die Trichinosis, Hanover, 1873, p. 35, *et seq.*) in 40 cases, after feeding, 12 of which were under his own observation, were very light or imperceptible in about 41.5 per cent.

"These were mostly over six months of age. Pigs from three to six months old became infected more readily and completely than older ones. The symptoms in the light cases had nothing characteristic; they consisted merely in slight gastric disturbances, which appear generally on the third or fourth day, seldom later, and in a few days entirely disappear. There is diminished appetite, lessened vivacity, drooping of the tail, and a tendency to constantly lie at rest.

"The more complete and severe cases present, as in man, two different stages (?), as the gastro-intestinal or muscular symptoms are most prominent.

"1. Symptoms of intestinal irritation and inflammation. In a few or several days—five to ten as a rule—the following symptoms appear: The appetite is lessened or disappears entirely, sometimes vomiting (one case observed by Fürstenberg and one by myself); vivacity destroyed, back hollowed, tail hangs loose and limp, constant lying down,

posterior portion of body stretched out, often bodily pain shown by restlessness and pawing with fore feet. Diarrhœa appears soon, and, with irregular exacerbations, may last a few days or longer and even several weeks. Fever appears with the diarrhœa, or may come on at first; weakness, erection of the bristles, pale skin, irregularly distributed, and diminished cutaneous temperature.

“The termination of this intestinal affection differs greatly in different cases; sometimes it disappears in six to eight days, sometimes a few days later, or within this time may end in death. In my researches death resulted from the intestinal affection only in young pigs, which were always weaker, and would lie on their belly because they had not strength to stand up.

“2. The symptoms of the muscular affection begin gradually, at the earliest (in one case) on the eleventh day after feeding, but later as a rule; but never later than the third week after feeding. As a rule they commence about the time that the intestinal symptoms are disappearing; the fever comes on with the muscular affection. If the intestinal irritation is inconsiderable, or the muscle symptoms appear late, the second stage begins with the development of the fever. The symptoms of the muscular affection form gradually and appear different according to the particular group of muscles involved.

“*a.* The animals show a certain restlessness; lie down a great deal; get up often to change their position; walk with an unsteady gait; are stiff or tottering; irresolute and appear troubled, or even suffer pain. These symptoms appear less prominent when the patient has suffered with weakness during the first stage—while the difficulty of motion and stiffness become more apparent if the animal presents but few of these in the stage of intestinal irritation; in severe cases the animal lies flat on the side with the fore legs stretched backwards; rising from this position is always difficult and often requires help.

“*b.* A second group of symptoms previously but little observed, is presented in the disturbances of muscles of mastication and deglutition. The animal shows appetite, but eating is very difficult, and in spite of the hunger they turn away from their food. Motion of the jaws is interfered with, and it may even amount to lockjaw, and in severe cases a complete inflammatory trismus may be found. I have seen one case in which the mouth could be opened scarcely one-fourth of an inch. At the same time motion of the lips and tongue is interfered with. The animal dips his snout deep in the fluid food (milk), but can only with difficulty take a small quantity, so that they are in danger of starving unless fluid food is furnished. The act of deglutition is very much interfered with, but as a rule can be accomplished; milk cautiously administered was swallowed even in cases of trismus. In the milder cases, especially in old hogs, this symptom was not present.

“*c.* Besides the above symptoms, difficulty in breathing is often present. The inspiration is troublesome, and there is more or less wheezing and

panting. The voice changes—it becomes weak and may even disappear, so that the animal does not even try to squeal when disturbed.

“*d.* Redness and œdema. Redness of the conjunctiva occurs in the beginning, but gradually disappears; the eyes water sometimes, but œdema of the eyelids, as it occurs in man, has not been observed. With difficulty in taking food, there is found a somewhat swollen condition of the tongue, and at the same time a slight swelling of the under lip and cheek; sometimes there is a light swelling of the root of the neck, the shoulders, and even the œdema of the fore feet and of the sheath. This œdematous swelling occurs only in cases of the severest type, and even then is not always found in all the parts mentioned.

“The above-mentioned symptoms, with rapid and well-marked emaciation, form a characteristic group. The falling off commences with the well-marked intestinal affection, and is apparent through the course of the muscle affection. In one case an 8-week pig lost over one-fourth its weight before it died. These symptoms pass away, except in fatal cases, by the fourth or sixth week. In very severe cases the emaciation may last somewhat longer.

“The further development and fattening of the animal does not seem to have been interfered with by the disease.

“Of the 23 severe cases 12 died, viz: 2 on the fourth day, and 1 each on the sixth, ninth, eleventh, fifteenth, sixteenth, seventeenth, nineteenth, thirty-fifth, forty-second, and forty-ninth day after feeding.

“The 5 deaths occurring before the eleventh day were caused by intestinal trichinæ, the remaining 7 by muscle trichinæ. In those dying on the fifteenth to seventeenth day the intestinal irritation might have played an important part. Among the first 5 dying from intestinal inflammation, there were 2 pigs, one æt. 7 months, which had eaten 1½ pounds of trichinosed meat, the other, æt. 1¼ years, which had eaten 103 gm. of highly trichinosed meat (in the latter case there was a high grade of intestinal irritation, and after death occurring very unexpectedly on the fourth day, an inguinal hernia was discovered, Kühn), and a sow, æ. 1½ years, that was fed with 2 pounds of trichinosed meat (Berlin, Müller). The unusually severe infection accounts for the early fatal result in the older hogs, while in that of an ordinary grade only the young pigs succumb during the stage of intestinal irritation. The case dying on the fifteenth day was a 2 months' old pig which was taken sick 5 days after feeding. In this case there was no intestinal irritation found post mortem, but there was a somewhat clear serum found in the peritoneal and pericardial cavities, and in the loose connective tissue, between the cervical muscles, great infiltration of the muscles and the usual changes in the fasciculi tolerably well marked. There were embryos in the serum and in the muscles, and in the latter half-developed muscle trichinæ were found. Those dying on the sixteenth and seventeenth days were respectively 9 weeks and 8 months old; the first had received intestinal trichinæ, and showed intestinal and undeveloped muscle trichinæ; the lat-

ter had devoured a trichinosed rat, which was estimated to contain 3,000,000 trichinæ, and was attacked with a severe, persistent diarrhœa on the third day, and at the autopsy showed numerous intestinal trichinæ in the small and large intestines, and embryonal muscle trichinæ. In both cases the mucous membrane of the intestine was in a condition of inflammatory irritation (Kühn). The 8 weeks old pig before mentioned died on the nineteenth day. The one dying on the thirty-fifth day was a young hog, age not given. A 5 months old pig died on the forty-second day apparently from paralysis of the lungs. (Claus, Mag. von Guslt und Hertwig, Bd. 31, Heft., 1, 2).

"A yearling boar died on the forty-ninth day, not having been able to stand up for the last fourteen days, and presenting emaciation in the highest degree (Berlin).

Some reporters speak of a typhoid disease as the cause of death. I have not found this view confirmed, and therefore believe that an error has arisen on account of a diffuse reddening of the skin presented by the cadaver; but this reddening of the skin is merely a hypostasis, and is always present in the bodies of hogs dying of disease and is apparent if the skin is not pigmented.

According to my observations, trichinization was always moderate after a light sickness; on an average 2 to 10 trichinæ were found in 5 preparations. In severe cases I found in those recovering 15 to 20 trichinæ in every preparation of less than one-quarter of a grain. Thus, a recovered hog may have 15,000 to 20,000 trichinæ in every half ounce of muscle. Hogs may become highly trichinosed with small and repeated feedings, and may not show marked symptoms of disease. The absence of severe diarrhœa, which as a rule follows after feeding of a considerable amount of highly trichinosed meat, seems to promote the reception of muscle trichinæ, which, after successive movements, are more readily tolerated. Of this, one of Kuben's cases furnishes the strongest proof. A six weeks'-old pig was fed daily for 4 days with 20 grams of highly-trichinosed meat, then after 4 days more the same was repeated, and in the course of 15 feedings about 10 ounces of this meat were taken. There was no important sickness noticed, but finally a high degree of emaciation appeared. The pig was killed, and in 60 preparations 3,052 trichinæ were found, viz: 1,021 in 15 from the diaphragm, 787 in 15 from the larynx, 474 in 15 from the shoulder, 770 in 15 from the psoas; an unusually large number, which never could have been reached by one feeding. In one case, dying during the migration of the trichinæ in the muscles, after strong trichinization by a single feeding, I did not find half so many.

The difference in susceptibility does not depend on sex or race; only age was not without influence, although not to such a degree as in other parasites which leave the intestinal canal to penetrate other organs.

Early age seems to favor the migration of the embryos. This is most apparent in dogs, but is noticeable in other animals. In hogs there is a

lessened disposition in the second year. The researches in the second year of life in the veterinary school in Berlin, and by Kühn in Halle, with 2 yearling hogs, one hog of $1\frac{1}{4}$ years and one $1\frac{1}{2}$ years old, showed no decrease of susceptibility, while my own investigations with 2 hogs of 2 and $2\frac{1}{2}$ years showed it distinctly.

“A two-year-old hog (which had been trichinosed in early life, and showed numerous encapsulated trichinæ when weighing 10 pounds, but showed very few when reaching 200 pounds) was fed with a dressed rabbit tolerably trichinosed, so that in every preparation some trichinæ at least were found. From the eighth to the eleventh day there was slight indisposition, fever, temperature of 38° to 40° C.; disturbed appetite, moderate diarrhœa; vomiting on the ninth day, and no sickness after the twelfth day. On the fortieth day he was killed, and after a careful search only a few from the last feeding could be found, and in most preparations none were present.

“A further confirmation is found in the result of feeding a $2\frac{1}{2}$ -year-old sow. She received one pound of moderately trichinosed hog’s muscle. On the third day there was a feverish condition present; from the eighth to the eleventh there was decided sickness; the appetite decreased, bristles erected; unequal distribution of heat; one ear hot and the other cold. The fæces were soft and pulpy; the animal laid mostly on its side, and resented disturbance. From the eleventh again appeared well; from the nineteenth to the twenty-third light febrile attacks, inactivity, lying down most of the time, then again entirely well.

“After $1\frac{1}{2}$ months this sow was fed with the carcass of a rabbit which had died of trichinosis, and whose body contained numerous trichinæ about 28 days old. Diarrhœa appeared on the third day, which continued actively until the eighth day, and gradually disappeared by the thirteenth day. At the same time there was a well-defined fever, almost entire loss of appetite, and appreciable emaciation. After this the animal recovered and ate its food, but on the sixteenth day began again to appear sick; motion weak and uncertain; lying a great deal, and sometimes flat on the side; could hardly stand without support; urinated freely, and became emaciated. On the twentieth day the animal commenced to appear lively, and was then killed. There was found only a few muscle trichinæ from either feeding, so that in the muscles usually most infested (diaphragm, masticating, and shoulder muscles) there was on an average in each preparation scarcely 2 from the first and still less from the second feeding. In both experiments the animals had received an unusually large number of trichinæ, in consequence of which the intestinal symptoms were tolerably severe. It will be apparent that the small number of muscle trichinæ would cause very slight muscular symptoms. * * *

“Trichinization does not depend on age in any other class of animals or in man to such a degree, as is shown by the occurrence of the disease in old persons and by many researches with animals. In order to de-

termine whether very old animals could be successfully trichinosed, I fed an old horse (aged 25 to 30 years) from time to time with a quantity amounting in the aggregate to $2\frac{1}{2}$ pounds of tolerably trichinosed meat. He was killed after six weeks. Trichinæ were found in all muscles more numerous than in the hogs above.

RÉSUMÉ—(Gerlach).

“1. About two-fifths of the hogs fed were either not affected or only slightly disturbed; the remainder, three-fifths, became sick.

“2. The light cases offered nothing characteristic, as is the case in many other diseases of hogs. The severe ones, on the contrary, are characteristic enough to enable us to recognize trichinosis, at least when the scalpel and microscope are used to determine the presence of trichinæ in the muscles.

“3. After an attack of trichinosis the hog becomes again sound and can be raised, and will become as fat or even fatter than other hogs.

“4. In cases where no symptoms appear or the health is only slightly disturbed after feeding, the infection is sufficient to render the meat a dangerous article of food. After severe sickness the infection in recovered cases is always considerable, so that a small quantity, $\frac{1}{2}$ ounce or less, of the meat may cause infection in man.

“5. In early age hogs are most susceptible to trichinosis; after 2 years they will bear a considerable number, and even after eating a large quantity of highly trichinosed meat they show a comparatively small number of muscle trichinæ.

“6. Death follows in hogs in over one-half of the completely developed cases.

“7. Death occurs through intestinal irritation as well as through myositis; 41 per cent. die in the former stage and 59 per cent. die from myositis,” etc.

From the description of the disease by Gerlach, as given above, it would seem that the symptoms in a true animal epidemic of trichinosis should present the same variations as in man; but a majority of the earlier writers on trichinosis do not seem to think the symptoms in animals are sufficiently well marked to depend on their absence as an evidence of the absence of trichinosis. Leuchart says (*Untersuchungen*, etc., p. 103):

“The first case observed by me (p. 32 *op. cit.*) showed the same symptoms as in man; the next two showed no particular symptoms to distinguish trichinosis. Also Haubner, Gürll, and Kühn report cases in which the symptoms would not warrant a diagnosis of trichinosis. In most of my 12 cases in hogs the symptoms commenced, in 5 to 8 days after feeding, with a feverish diarrhœa, to which after a few days the other symptoms were added. In one case the animal died after 12 days with inflammation of the intestines. Gürll also reported cases in which the animal died.”

Referring to the case mentioned above, he says :

“The next day after feeding a young hog with the intestines and contents of a trichinosed dog, which was eaten greedily, there was loss of appetite, drooping of the head and tail, grinding of the teeth, and contraction of the abdominal muscles, showing colicky pains. The next day the symptoms increased so much that the animal maintained the recumbent position; the head was hot and quite feverish. He recovered his appetite on the eighth day, but there was an insecurity of motion, particularly when the hind legs were brought into play. This was increased on the ninth day, and on the nineteenth amounted to complete paralysis. On the twenty-fifth day the animal was stiff, cold, and extended; motion caused pain; there was involuntary evacuation of the bladder and bowels. The voice, becoming hoarse in the first week, now lost all resemblance to a squeal, and sounded like the bleat of a sheep. In spite of all this the vegetative (trophic) functions seemed normal, and the appetite was very little disturbed. Although I could entertain no doubt as to the cause of the sickness in this animal, yet at the onset I was disposed to consider the suffering as due to an affection of the central nervous system, and hourly expected to see him die. But, with unremitting care, keeping him in a warm place, with milk diet, he rapidly recovered and was soon able to stand up.”

Haubner (Bericht über das Veterinärwesen im K. Sachsen, 1862-'63, p. 117) fed a young hog with trichinosed meat on the 26th of May, and again after 27 days (July 22). The last time the animal ate in addition the intestines of a trichinosed hog. For four days he was feverish and presented the appearance of erysipelas (Rothlauf), but was found free from trichinæ on the 27th of December (158 days), while others fed at the same time had many trichinæ. The above hog was constipated during the sickness, so that there was no ground for the opinion that the trichinæ were passed off in the excreta.

Other observers have presented their views in regard to the symptoms of trichinosis in animals. But a majority of them, while giving individual cases in which the symptoms are severe (Leuckart, Virchow, Pagenstecher) and some in which the animals have died in various stages of the disease, say that there are no characteristic symptoms (Fürstenberg, Kühn, Scoutetten, pp. 80, 81, Virchow, p. 30). Gerlach has shown that there is a vast difference between cases in which the hogs were fed small quantities of trichinosed meat and those in which large quantities have been ingested. The latter always have “characteristic” symptoms and show numerous trichinæ in the muscles, while the former, with slight symptoms, always show a small number, but he has also proved that the results of one feeding may be added to those of another, and after numerous light infections the animal may become intensely trichinosed without showing any characteristic symptoms unless the observers were looking for this disease. In an epidemic of trichinosis in hogs, if they ever occur, it seems very probable that some cases would present the

symptoms in such intensity that there could be no mistake in the diagnosis. It is possible that the small number of observations made by each investigator will account for the lack of conclusiveness in regard to animals, but the whole number taken together by Gerlach have given a different result. The Vienna committee (Bericht des zur Erforschung der Trichinenkrankheit von der K. K. Gesellschaft der *Ärzte* ernannter Comité's, &c., Wien, 1867) report, while giving the symptoms observed by others after artificial infection, that there are no symptoms characteristic of the disease, while they show that the symptoms, as in man, are more or less complete, according to the amount of trichinosed meat consumed.

"In the first case (p. 10), after feeding with a small quantity of trichinosed meat, there occurred very insignificant disturbance of the health, shown by decrease of appetite, soft stools, often hoarseness; later, staggering, weakness of the posterior portions of the body, symptoms which disappeared after the fifth or sixth week, while a larger quantity of the same meat or often repeated feeding of small quantities was followed, as reported by Gerlach above, by severe symptoms or even death. But these symptoms had nothing characteristic, and no one not knowing that trichinosis had been produced would have the least excuse for saying that the animals were suffering from that disease.

"In the first case there was a hoarse cough after 6 days, decrease of appetite on the 7th, lasting until the 14th day; there was occasional diarrhœa and a disposition by the hog to rub himself over the whole body; great emaciation, but absence of staggering or weakness. No trichinæ were found in the stools. After 2 months the animal had recovered, but showed traces of hoarseness. Numerous encapsulated trichinæ were found, especially in the diaphragm.

"The second case showed only a hoarse cough, itching of the surface, decrease of appetite, and continuing emaciation after the ingestion of 6 ounces of trichinosed meat, taken at several feedings during a period of 3 months.

"In the third case the pig ate about 4 ounces of trichinosed meat at intervals during a period of 2 months; there was hoarseness, itching, decrease of appetite, and finally emaciation ensued.

"In the fourth case the symptoms were the same as in the other cases. In none of these cases, however, was there diarrhœa, pain in the bowels, nor weakness, much less a paralysis of the lumbar muscles.

"With a moderate amount of trichinosed meat the animal seemed to increase in fat, but when it was fed repeatedly there was always a progressive emaciation. The hoarseness and cough occurring with every motion, especially on eating, raises a suspicion of trichinosis, but even that symptom may be explained on other grounds. The itching of the skin is due to the irritation of the cutaneous nerves by the migration of the trichinæ in the cutaneous muscles and neighboring connective tissues."

Emaciation, which seems to have been pretty uniformly present in the above cases, as also in those mentioned by Gerlach, may occur in other diseases, but unless otherwise explained should lead to investigation.

In some cases muscular weakness (Sten. Bericht, etc., Berlin, 1865), loss of appetite, dragging of the hind legs constitute the principal symptoms. Of 4 cases fed all became sick and 2 died. Scoutetten says (p. 81): "When hogs show symptoms they resemble more or less those of a rheumatic affection; * * * œdema which is common in man has never been observed in hogs." This may be due to the thick covering of fat, but is contrary to Gerlach's observations.

The above symptoms, though not uniform, as reported by different observers, are perhaps as much so as the same number of cases in man would be under the same circumstances. While Gerlach's description of the disease in hogs corresponds to cases of human infection, the dragging of the hind legs (Berlin), its absence, but the peculiar hoarseness and itching of the skin (Vienna), and the rheumatic symptoms (Scoutetten) point to varieties of the disease due perhaps to the amount of trichinosed meat ingested, the condition of health, or other peculiarities of the animal, which may be determined by future observations, and if the symptoms in a possible epidemic, if following any of the above varieties, are not such as to lead a person who is entirely unfamiliar with trichinosis to suspect that disease, they would be sufficient to one who was familiar with them, or had read them, to lead to the use of more certain and conclusive means of diagnosis, *i. e.* the use of the microscope.

The symptoms of epidemic diseases occurring in droves of hogs are often so similar to those of trichinosis that it would seem very possible that in many of such cases they might be due to trichinous infection. In the Agricultural Report for 1863, p. 205, is found a description of the symptoms of hog cholera prepared by Dr. George Sutton, of Aurora, Ind., and furnished to the Medico-Chirurgical Review, as follows:

"The hog at first appears weak; his head droops, and sometimes in a few hours after these symptoms diarrhœa commences; there is frequently vomiting. In some cases the discharges were serous and clay-colored, sometimes dark, also bloody and mucous, resembling those of dysentery. The urine at first was generally small in quantity and high colored, but as the animal recovered it became abundant and clear. This was one of the symptoms by which the men attending the hogs at the distillery ascertained that they were recovering. In a large number of cases the respiratory organs appeared to be principally affected, and there was coughing, wheezing, and difficult respiration. In some instances the animal lost the power of squealing, and the larynx was diseased. There was frequently swelling of the tongue and bleeding from the nose. In those cases where the respiratory organs were the principal seat of the disease there was generally no diarrhœa or dysentery. In many instances the ear or the side of the head were very much inflamed, the ear swollen to twice its usual thickness. This inflammation

would spread along the skin, sometimes over the eye, producing complete blindness. Sometimes one or more legs were inflamed and swollen, and the inflammation also extended along the body. The skin where it was inflamed was red and swollen. Some had large sores on their flanks or sides from 3 to 6 inches in diameter. In one instance the foot became ulcerated and sloughed off, and the animal recovered. Some appeared delirious, as if there was inflammation of the brain. Sudden changes of the weather, particularly from warm to cold, appeared to increase the fatality of the disease."

And on page 207 of the same report the disease is described as follows :

"The first thing to be noticed in the diseased hog is weakness in the eyes, the water flowing from them, together with the forming of dark spots under the eyes. In the second stage there is discoverable a slight shrinkage of the shoulders, something like that of the shoulder of a horse in case of swinney, connected with slight coughing. In the third stage there is great thirst, a drawing up of the hind quarters, a sign of great weakness, and a refusal of food."

In the latter case there is sufficient similarity to the above symptoms of trichinosis, as developed by experiment, to warrant a suspicion of that disease. The former outline presented by Dr. Sutton, the diarrhœa, vomiting, clay-colored stools, the decreased diuresis, its augmentation as convalescence progresses, cough, wheezing, and loss of voice, &c., show a more marked similarity to the symptoms as they occurred in Leuckart's first case, given above, and as they occur in man.

The descriptions of hog cholera, as quoted in the Agricultural Report for 1877 from that of 1861, as also the exhaustive article by Professor Law, give some symptoms in common, and others which, although not so common in trichinosis, yet do occasionally occur, as Haubner's case, where the skin assumes the appearance of erysipelas, and in one of Veh's cases, where there were bluish saggillations under the skin. On page 386 of the same report will be found other series of symptoms which correspond in many respects to those of trichinosis.

In thus presenting these similarities and comparing so closely the symptoms of trichinosis with those of well-established and defined diseases, it is not my intention to try to prove that such diseases are due to the presence of trichinæ. It has been thought that hog cholera was due to trichinous infection, but Dr. Sutton has proved that it is not. While the opinions of observers on this subject cannot be called into question, and accepting as fully proven that what is called hog cholera is not trichinosis, it will at the same time be found just as easy to prove that rheumatism, gastric fever, typhoid fever, &c., are not produced by trichinæ, yet the presence of this parasite in large numbers has given rise to a diagnosis of those diseases by observers well able to distinguish any known disease, and it is just as possible that cases of trichinosis in animals have been pronounced hog cholera, especially as the diagnosis

of diseases in animals is often left to those who have no knowledge of disease, and it seems very probable that one or more of the prominent symptoms may have given an erroneous idea of a whole epidemic in animals as in man.

I have tried to show by these remarks that among epidemics of what is called hog cholera, trichinæ may possibly in some cases be the cause of the symptoms, and when such epidemics occur, trichinæ should always be searched for.

Further, in those places where epidemic diseases have appeared among hogs, particular attention should be given to the examination of rats as well as of hogs that have suffered during the epidemic, and if any trichinæ are found, a more general search should be made.

SECTION F.—PROPHYLAXIS, ETC.

Prophylaxis may be directed (1) to the prevention of infection from the use of trichinosed meat; (2) to the prevention of the use of trichinosed meat; (3) against the production of trichinosed hogs; (4) to the eradication of trichinæ from hogs and other natural bearers.

Leuckart says (Untersuch., etc., p. 91):

“It has been clearly determined that trichinæ possess a very unusual power of resistance. Not only may they remain alive in their cyst for many years, and during putrefaction of the meat containing them” (see section C), “but they show a high state of indifference to the effects of changes of temperature. I succeeded in producing a high degree of infection when trichinosed meat had been kept for 3 days at a temperature of -16° to -20° R. Similar observations have been made by Rupprecht, Fiedler, and Kühn, yet Fiedler believes that the trichinæ expire at a temperature of 11° —R. Kühn found the trichinæ from frozen meat which had been kept in an ice-house $1\frac{1}{2}$ months capable of infection, but after 2 months the trichinæ were all dead, pale, and motionless. They also undergo a temperature of 40° to 42° R. without showing much change. Raising the heat to 45° R. seemed to affect them, but not until it reached 50° to 55° R. did it seem to produce a change in them (Fiedler, Haubner), when the albuminous substances became coagulated. Then the dead trichinæ presented, under the microscope, a uniformly clear, almost opalescent, appearance, as I had observed in undeveloped trichinæ found dead in the alimentary canal (*op. cit.*, p. 61). In order to be secure against trichinous infection by means of boiling or roasting, it is necessary that the whole mass of meat be subjected to a temperature of at least 51° to 55° R. (65° to 70° C.). Meat may be subjected to a high temperature, yet not be cooked unless time be given for the whole mass to become heated (Rupprecht, Küchenmeister). Further, meat may be cooked, but underdone, and trichinosis be caused by its consumption (Rupprecht), so that cooking is no guaranty that the trichinæ are all dead. Salt will kill trichinæ, but not all salted meat is innocuous (Fürst-

enburg, Fiedler, Rupprecht, Leuckart), but the same meat may be made innocuous by sufficient cooking (Kühn). A temperature of 52° R. will prevent infection (Haubner). Kühn found that hams were innocuous after 31 days' pickling.

Gerlach (*Die Fleischkost*, etc., p. 68) says: "It is a matter of fact that man, wherever trichinæ are found, without particular care is liable to an infection every time he eats pork. Hogs appear sick only after severe infection; they recover and appear well, and even become fat," and thus present no signs during life by which the presence of trichinæ may be suspected. Falck (*Das Fleisch*, p. 520) says: "The best way is not to eat pork; but, if you must eat it, do not eat raw pork." Cobbold (*op. cit.*, 173): "There is no need to be in the slightest degree nervous about flesh food, provided it is properly cooked." This is the opinion of all authorities on the subject, and the experimental question of the exact amount of heat necessary to destroy the vitality of trichinæ is of less importance. Thorough cooking implies that the meat shall be done entirely through—down to the bone; and that there shall be no appearance of blood; as Niemeyer (*Catechismus*, etc., p. 5) says, "Meat must be cooked until gray." According to Kestner (*op. cit.*, p. 55): "The vital substance of the trichinæ succumbs to heat that coagulates albumen and boils water." Besides the above witnesses there is further evidence in the effect of heat in the case in Halberstadt (*Schmidt's Jahrbücher* 138, p. 101), where highly-trichinosed pork was well cooked and afterwards eaten with safety; also in Marion, Iowa, the meat from the same hog which produced the infection was eaten without bad result after thorough cooking. Falck (*l. c.*) says that drying meat destroys the vitality of the contained trichinæ. Thorough salting or smoking, or both, will destroy trichinæ. Virchow deplors the modern dishonest way of sprinkling hams, bacon, etc., with creosote or pyroligneous acid, instead of curing them after the old-fashioned method of smoking. According to the Agricultural Report for 1863, salt does not penetrate pork from hogs fed in distilleries, because the meat is softer. Perhaps this may account for cases in which the effects of the preservative measures are found only on the surface of the hams, etc.

The use of trichinosed meat can only be prevented by a thorough microscopic examination of all pork offered for sale as well as that slaughtered for private use. A judicious use of the knowledge thus obtained, and the destruction of all trichinæ thus found by means that will admit no doubt as to their efficiency—*e. g.*, by boiling or burning the infected carcass—will, by preventing the distribution of the contained trichinæ, lessen the cause of infection and thus the number of trichinosed hogs. The fourth proposition can only be carried out by a thorough examination of the sources of infection, and thus perhaps determine the original bearers, or at least the most dangerous source of infection in hogs. "It is of great interest (*Bericht*, etc., Wien, Co., p. 5) in a scientific as well as a sanitary point to know what animals contain

trichinæ, and from whence hogs derive their infection." As has been seen in Section C of this report the rat has had a large share of attention in this respect, and while large numbers of rats have been examined in Europe, very meager notices of such investigations have appeared in American medical literature.

According to the report above mentioned (p. 29)—

"Large centers of infection have been found among rats, and in some places, as Klederling, where the rats were found infected, trichinosed hogs, not previously observed, were found, and in Brünn, after the occurrence of a case of trichinosis in man, the infecting pork was found, and trichinosed rats were found in the houses as well as in the neighboring flayers' establishments. Another remarkable circumstance is that trichinosed foxes are not seldom found in lower Austria, and it is not improbable that a series of animals may be discovered in the course of time in which a reciprocal infection occurs. * * * If we accept the proposition that hogs get trichinæ from rats, then the first and most important thing will be to investigate the subject in that connection, and in places where rats are found to be infected, to make a special search for trichinæ in hogs."

In addition to the scientific interest and sanitary necessity of a thorough investigation of the subject of trichinosis in the United States, its importance in a commercial point cannot be overrated. In 1862, 1863, and 1864 the exportation of American pork products to Bremen, Hamburg, and the German Zollverein amounted to over four millions of dollars. Since the figures have been given for a few observations in places in the United States where trichinosed hogs had been found in large numbers, a feeling of distrust has grown up in regard to American pork, ham, bacon, etc., and no doubt exaggerated reports have arisen in regard to the danger of infection from salted and smoked pork, etc., from the United States (and various laws have been made in many parts of Europe relating especially to the importation and sale of such meats), which, as the home products are very much higher in price, it is to the interest of dealers to magnify. The best way to allay these fears and suspicions is to provide that no meat shall be allowed to leave our ports without a guaranty that it is fit for human food; and this can only be done by a thorough and systematic microscopic inspection in our own country, made by microscopists who can have no interest in shirking their work or in giving false or sensational results, and when ham, bacon, and pork sides are put up for export, they should, for a time at least, be so marked by the inspector who makes the examination that they may be easily recognized by him as having passed through his hands, and authority should be given if any shall be found unsound in foreign ports to have them returned immediately.

It is possible that something more may be learned from the artificial infection of animals, but Pagenstecher, Leuckart, Virchow, and others have apparently exhausted this subject, and have arrived at nearly uniform

conclusions. Our first object should be to find out where they already exist. The able discussion by Leuckart (*Untersuchungen, etc.*, p. 96) of the origin of trichinous infection gives a key to the direction the investigations ought to take in this country. The question is not now in what animals can trichinæ be propagated, but where do they occur naturally. To this end extensive investigations should be made, particularly as to the surroundings and habits of hogs kept together in large numbers, as in the West. What we wish to know, after it has been determined where trichinæ are oftenest found in the United States, is what can be done to prevent their propagation and extension, the procedure which will in time exterminate or at least lessen their areas of infection. Where they originally came from is of remoter interest. We should learn first if they occur in any wild animals. Do they exist in the rat here in as large numbers as in Germany? Do they extend along our water courses, or only over land, and what influences their extension? Have we trichinæ centers?

Then let all pork be carefully examined, and by this means trace the parasite to its original infection center, if such exist; determine the average of trichinosed animals among large numbers of hogs, and if possible find out where the infected animal was born and raised, and the various conditions under which he was kept and fed, the kind of food used, and especially trace the formation of droves which are made up in remote places. Also it should be ascertained if the hogs have been allowed to run loose or were kept in pens, and in all cases to learn if there has been any possible access to carcasses of any kind. Special attention should also be directed to animals raised in villages, particularly when they are allowed to roam at will and become public scavengers—and often the only ones for large areas.

The known habit of hogs to root in their own excrement makes it extremely likely that if one hog in a drove becomes infected the rest will (at least in part) become so sooner or later, and any small drove might thus be thoroughly trichinosed in the course of a year or two, and when added to a large one in picking up a drove in different places by collectors or buyers, might constitute all the diseased animals in that drove. Animals may be sick in a drove without being noticed by an ordinary observer. The droves should thus be carefully and regularly inspected by persons competent to judge of any change from the normal. That trichinæ may pass with the excreta of hogs there can be no doubt, as it has been observed by Pagenstecher (p. 41, 2 *op. cit.*), Rupprecht (*Trichinenkrankheit, etc.*, Rundblick, 30), Cohnheim (Pagenstecher, p. 39), Gerlach (*Die Tr.*, p. 10), Virch. (*op. cit.*, p. 59), Leuckart (*Note*, p. 90, *Untersuch.*, etc.). That trichinæ may spread from hog to hog, and that their pens may become infested sufficiently to propagate trichinosed hogs, is shown by Warfwinge, quoted by Riemer (*Schmidt's Jahrbücher*, 178, 1878, p. 205), who found two infected hogs in the same pen twice, and in one case he found 3; in another, 4 trichinosed hogs in the same

pen, and one man brought trichinosed hogs in a drove who, the previous year, had sold a drove in which many infected animals were found; the infection of the first mentioned dating from the killing of the latter, and probably caused by the excreta from the first. (This author does not think it probable that hogs are infected by rats; 1st, because they are not quick enough to catch them; 2d, hogs do not often have access to dead rats. See also Heller in Ziemssen, iii, p. 653.)

Schuchardt (Thuring. Corresp. Bl. Par. vi, 9, 1877, p. 232) remarks that there is more trichinous meat found in the cities than in the country. Levy (Ann. d'hygiène, December, 1879, p. 506) thinks that this is due to less care in the examinations in the country.

Eulenberg (Vrtljrscht. f. ger. Med., etc., Bd. 28, 1878, p. 149) thinks that the occurrence of relatively large numbers of trichinosed hogs in Bromberg is because they are allowed to roam over the wild lands, and thus have an opportunity to get the bodies of dead animals. This, however, is contrary to the statistics given in section C, which show that hogs raised in cities give the largest per cent. of infection; but for all this the original infection may have come from the wildest possible places, and the more rapid spread of the parasites in the city be due to the special surroundings.

That legislation with appropriations will be necessary to determine these points must be apparent, because the disease if it does exist in this country to such an extent as would seem possible after a careful examination of the facts presented in sections C and D, is not sufficiently recognized to arouse the fears of the people, and as the expense is considerable, and the subject one that interests commerce, it should be commenced by the government, under direction of the Commissioner of Agriculture.

The question may arise, can a law be made to govern the examination and sale of meats which will be beneficial in proportion to the inconvenience it entails?

Even if the action of such a law must of necessity be continuous, the protection to life and health would more than compensate for the expense and trouble, which latter at first no doubt would be considerable, and perhaps cause some annoyance, but if there is a possibility of eradicating, in a few years, the disease from our midst it should be attempted at any price. At first this examination should be made a general one, and the fact concerning the existence of trichinæ be fully settled for the whole country, while the systematic examination of all pork should be commenced as early as possible. Heller says (Ziemssen, iii, p. 654): "The experience of several cities shows that the difficulties of a thorough microscopic inspection are by no means insurmountable." "The microscopic examination of hogs has been practiced in the Duchy of Brunswick since 1863 with excellent results, and it has resulted similarly in other localities" (*op. cit.*, p. 655). Muller (Jahresbericht, etc., i, 1870) says: "As a result of microscopic examinations of pork, trichinæ are not

so often found, and consequently trichinosis does not so often occur in Prussia." The statistics of other places show that there are fewer trichinæ found than formerly, perhaps on account of the removal by destruction of all trichinæ in slaughtered hogs of one of the sources of infection. Zenker in Dresden, Wagner, Fiedler, and others (see section C) found over three per cent. of cadavers to contain trichinæ in the early part of the seventh decade of this century. In examinations of over 4,000 cadavers in Dresden and Erlangen by Zenker for the ten years ending in 1872 there was only 0.95 per cent. found in Dresden and 0.11 per cent. in Erlangen. Whether this is also due to prevention by the official examinations is a question which although possible seems less likely when we consider the probability, as before mentioned, of human infection lasting through a period of years by small accretions.

There are those, however, who seem to be opposed to the general microscopic examination of pork, or do not believe in its efficiency. Dr. Liman (*Vierteljahrsschrift f. gericht. Med. N. S. Bd. xvii, p. 281*) says: "The use of the microscope in the examination of pork does not establish a certainty against, but lessens the danger of, infection." Meissner (*op. cit.*, 138, p. 101) says: "In spite of the optional examination of pork since 1862, Simon reports three home epidemics in Calbe." Berkan (*Virch. Arch., No. 42, p. 354, 355*) says: "Trichinosed hogs have infected persons, yet only after the most careful examinations could a single trichina be found. There may, therefore, be light cases of trichinosis without trichinæ being found in the hog of which the patient partook," and "it is not safe to say after an examination that there are no trichinæ, but that none were found in the specimens examined, as they may occur in other parts of the body" (P. Niemeyer, *op. cit.*, p. 12).

Such experience should not be brought forward to discourage the examination of pork, but should rather lead to a more thorough search. Dr. Eulenberg (*Vierteljahrsschrift für ger. Med., etc., 1878, p. 149*), to show the necessity of great thoroughness in examinations, mentions that in three of the trichinosed hogs found in Prussia in 1876 one showed only 40 trichinæ in 30 preparations, another showed 40 in 35, and a third only one trichina in 40 preparations.

The editor of the journal last mentioned, in commenting on cases of trichinosis in Magdeburg, says "by the eating of raw pork there will always be cases of trichinosis in spite of microscopic examinations."

Wasserfuhr (*Deutsche Vtljr. f. öff. Gesndhtspf. ix, 4, 1877, p. 825*) does not believe in the microscopic examination of pork as a general measure, as the largest proportion of trichinosed hogs are raised and consumed by their proprietors. He thinks it sufficient to give a careful examination with the naked eye, by which means not only trichinosis but other diseases may be discovered, and thinks it better to get the people to understand the danger of eating pork not thoroughly cooked. P. Niemeyer (*op. cit.*, p. 5) says that "raw meat should not be eaten even if free from trichinæ, as there will be danger from *cysticercus*."

The opinion of Wasserfuhr is not sustained by the evidence given by all observers, viz, that trichinæ if present would be visible to the naked eye. If pork has been found free from trichinæ after microscopic examination, any cysticerci present will have been seen, and on that account the meat declared unfit for food (see Gerlach quoted later on this subject).

Even admitting that the microscopic examination of hogs or pork will not be a perfect protection against trichinous infection, as asserted above, it will be apparent that the intelligent use of the results of such examinations, if carefully followed to the source of the trichinæ whenever possible, will have a tendency to prevent the spread of infection to other swine, and thus lessen the number of infected hogs and assist in the more general work which should be instituted immediately by the national government.

The necessity of early action in this direction will be apparent if we accept the opinion of Dr. Röper (*Deutsche Vrtlhrschr.*, etc., f. öff. Ges. vi 2, 1874, p. 280), who estimates that a drove of 10,000 hogs may become trichinosed through the addition of one trichinosed hog. He says:

“When it is considered that one trichinosed hog may infect two others—even if only one occurs in every 10,000—through his dejections, we have as a result of geometrical progression 2 in the second year, 4 in the third, 8 in the fourth, etc.; so that after fifteen years 16,384 trichinosed hogs will result, and in this manner, by a continuation of the feeding with offal from trichinosed hogs there is a certainty that in a few years all the hogs in America will become infected. The necessity for microscopic inspection of American pork increases every year, for in the American slaughter-houses there is apparently a system for propagation of trichinæ scarcely less effective in its consequences than if it had been instituted by design.”

This extreme view would seem to be corroborated by a comparison of the results of examinations in Chicago in 1866 and those of 1878. In the former series only 2 per cent. were found trichinosed, in the latter 8 per cent. of trichinosed hogs were found. (See *Chicago Med. Examiner*, April, 1866, and *Report Health Dept. Chicago*, 1878.)

Kraemer and Fuge (quoted by Röper, *l. c.*) found 3 per cent. of American pork trichinosed. Fuge claims to have found sugar-cured hams (*Roberzuckerschinken*) infected oftener than others—5 per cent. of the former and only 2½ per cent. of the latter. This could be true only (1) on the assumption that the method of curing increases the number of trichinæ, the absurdity of which must be apparent to the most superficial observer, or (2) that in places where trichinæ are most abundant in hogs that method of preservation is practiced.

This paper is quoted in the *Medical Times and Gazette* (Lond., Dec. 12, 1874, p. 667), with a warning against American pork. Petri (*Virch. Arch.*, B. 57, p. 296) in Rostock found 12 out of 622 (2 per cent.) American hams infected. Jacobi (*Vierteljrsch f. ger. Med.*, etc.) found 5 per

cent. in Ebling (21 in 415 pieces). A. Key (Jahresbericht, etc., I, 1875, p. 650) found 18 out of 800 pork sides (half hogs), or 2.25 per cent., infected; also 9 samples in Cassel were found infected; no statement given as to the number examined. Christiania, Sweden, 24 out of 1,000 pork sides were found trichinosed (consular letter, June 6, 1879).

Gerlach (Die Fleischkost, p. 76) gives the following results of examinations of "American" pork, etc.:

"In the municipality of Cassel, Hafgeismar, Marburg, Eschwege, and other places in three years 140 pork sides were found trichinosed.

"In Hildesheim in 1872, '73, '74, many trichinosed hams were found; three trichinosed hams were found in Göttingen.

"In Hanover in 1872 trichinæ were found many times in American pork; in 1873-'74 they were found in 54 sides and hams.

"In Erfurt, 1873, trichinæ found in American pork.

"In Magdeburg and Aschersleben in American hams, 1874.

"In Stettin, 1874, trichinæ found in American pork.

"In Danzig, 1872, trichinæ found in American pork.

"In Solden, in Brandenburg, 1872, trichinæ found in American pork.

"In Leignitz, in Silesia, 1872, trichinæ found in American pork.

"Trichinæ were also found in American pork in Westphalia.

"Also in Hamburg, according to a verbal report by Professor Köhne, trichinæ have been found several times in American pork."

Warfvinge (Nord. Med. Ark., vii, 3, Nov. 18, 1875) reports: "Of 112 Bavarian hams 3 were trichinosed; of 800 American pork sides (see A. Key, above) 18 were infected, and in Galeburg 8 in 210 (3.8 per cent.) were trichinosed." Reimer, quoting this article in Schmidt's Jahrbucher, No. 178, 1878, p. 204-5, notices the remarkable number of American hams found infested, but says nothing of the 3 per cent. in Bavarian hams; and Levy (annalis d'hygiene public, Dec., 1879) fails to say anything about the large per cent. found among the European samples, while he remarks particularly in regard to the infected samples from the United States.

Dr. Wallpert, V. S., Mayence, examined 80 specimens of American pork and found no trichinæ, and the American consul-general at Frankfurt (see consular letter, March 15, 1879) says:

"Well-authenticated cases have come to my knowledge of rumors of the finding of trichinæ in American pork, resulting on examination in proving that the infected meat was not American but German."

* * * Further, "I made inquiries of experts and veterinarians if trichinæ had been discovered in American pork imported into Frankfurt. The responses were unanimous and emphatic in the negative. One of them, a well-known veterinarian, who is commissioned by the army contractor to examine American ham and bacon, declared that he had never in the course of a long experience of this kind found trichinæ in American pork, and that he had not heard of such discovery."

It has been thought by several of the American consular officers that

the laws which had been made concerning the examination of meats in various places, viz, Rome, Manheim, Vienna, Berlin, Frankfort, Christiania, Hanover, Lisbon, Barmen, discriminated unjustly against American swine products, and examples are cited which give color to such an opinion; *e. g.*, "in Mayence the butchers requested the burgomaster to caution the people against the use of American refined lard, and asked that active duty be levied on the same. In Manheim the law in regard to examinations refers only to American hams, &c.; other meats are sold without examination." In Freiburg (consular letter ——) the city papers reported cases of trichinosis occurring from the use of American ham. Several children were taken ill, but it could not be ascertained what was the cause of the disease. Forty soldiers were taken sick in Mayence with what was reported as trichinosis, and although some of them died, there was no positive evidence of trichinosis, as no trichinæ could be found. The consul at Freiburg further states: "In this district cases of trichinosis occur, sometimes resulting in death, yet after close inquiry and investigation in no case can I find that death or even sickness could be traced to American meat. * * * Great exaggerations have been accepted as authorized statements." Rumors of the prevalence of trichinosis in American hogs having reached Portugal, were rife in Lisbon, and the introduction, storage, and sale of American pork products were forbidden "so long as said disease continued." (Consular letter, April 21, 1879.) This order was afterwards so modified as to allow the sale of such pork, after due inspection, as was in stock. Not only the authorities and dealers, but the press has been accused of unjust assaults on the American pork interest. Of course the press of any country would neglect its duty if it did not warn the people of what might be considered a great public danger; but the question arises, How much of private interest exists as the cause of these reports? Even scientific men have been led carelessly to make statements which are not founded on observation, and are not corroborated by facts. For example:

"Professor Heschl, of Vienna, wrote a very authoritative statement to the Wiener Med. Wochenschrift, June 8, 1878, to the effect that there was great danger from the use of American hams, etc.; that one hog in every 5 or 10 in America was infected; that several epidemics of trichinosis had occurred, probably from the use of American hams, and warning the people against the further use of the same. [This was telegraphed to the London Times, and has been quoted by the European press generally, and has been accepted by the American medical press as a matter of fact.] The city council of Vienna requested the government to prohibit the sale of American pork in Austria. * * * The professor was requested to state the reports on which his statement was based. He referred to the article by Dr. Roeper and that by Dr. Jacobi [already mentioned in this report], and declared that he had no personal knowledge of the subject, * * * and had never seen an American

ham. After the examination of some American hams he said there were certainly no trichinæ in them, and that they were sound and good."

The consul, Mr. Post, blames the professor for giving the weight of his name to a statement not founded on personal observation. The article appeared in the London *Lancet* (vol. i, 1878). The impression made by it is probably stronger and more lasting than any retraction or denial could possibly be, and will be noticed quicker, and still the American pork interest has no way of denying such statements, however exaggerated they may be.

The government correspondents have been strongly impressed with the idea that facts have been greatly exaggerated and used against the sale of American swine products, and it may, perhaps, be considered somewhat significant that the reports concerning the occurrence of trichinæ in American products have been mostly made by men who seem to have been very thorough in their work, while the official examinations in Germany are often made by persons who are careless or incompetent. Even under ordinary circumstances mistakes may be made, as competent authorities assert. Scoutetten (*op. cit.*, p. 85) says, "Some discover trichinæ where they do not exist, and others fail to find them where they do exist." Dr. Thorn, of Königsberg (*Virch. Arch.*, No. 50, p. 461), sent what he asserted were the charred remains of calcified trichinæ—over which there had been some discussion—to Professor Virchow, who pronounced them accidental foreign bodies. In two cases the *anguillula aceti* (vinegar eels) (*Jahresbericht*, etc., i, 1878, p. 514) from the acetic acid used in making the preparations was mistaken for trichinæ (Fig. —). Delpech (*op. cit.*, p. 53) says, "Many mistakes are made in regard to trichinæ; other nematodes or their larvæ being mistaken for them." (See section C.)

The comparative statements in regard to trichinous hogs in America and Germany have always favored the latter country, partly because all the examinations on which they were based were made there. The numbers given for American pork are the more readily accepted, because the isolated examinations in this country having been made in places where a higher degree of infection might be expected, large numbers of trichinosed hogs have been found. On the other hand it is more than probable that many cases in German hogs have been overlooked through lack of thoroughness, or from pure carelessness. For example, in the municipality of Erfurt (*Riemer Sch. Jrbr.* 178, 1878, p. 195) Dr. Krahmer, the physician having charge of the examination of hogs, was in the habit of marking "sound" on each line of a whole page in the book kept for records, *before the examinations were made*. Cases of trichinosis having occurred from eating pork that had passed through his hands, he was prosecuted and condemned to 6 months' confinement. Other cases are on record where trichinosis has occurred when it was discovered that the butcher did not submit all his pork to inspection. Meissner says (*op. cit.* 152, p. 24), "although the examination of hogs is

obligatory in Saxony, not over one-half of the hogs are examined." He also refers (*op. cit.*, 138, p. 101) to the occurrence of cases in Calbe showing that the optional examination as practiced there is not thorough enough. Also an instance near Hanover where 400 cases occurred, 50 of which were fatal. (*Brit. Med. Journal*, ii, 1875, p. 75); and at Diedenhofen where 121 soldiers were attacked (*B. M. J.*, i, 1877, p. 820); in Neugersdorf 45 cases; butcher was imprisoned one month (*Lond. Lancet*, ii, 1877); and Magdeburg there were 100 cases where the victims had all patronized the same butcher (*B. M. Journal*, i, 1873, p. 316); 9 cases in Hanelbach; several children in Rüpendorf; 5 cases in Lissa (*B. M. Jour.*, i, 1874, p. 494.) Berlin several cases, one fatal, in Chemnitz Hospital; cases at Gratzungen, Bleidengen, Trebra, Etzalsroda, Pulzlingen, Grors-Nechsungen, Forstham, Königsthal, and 45 cases in Nordhausen (*Brit. Med. Journ.*, ii, 1874, p. 182). The trichinosed hogs causing these epidemics were not included in the statistics, and they would increase the percentages considerably if added to the number already reported.

Numerous laws have been framed and put in force to protect the people against the sale of bad or diseased meats. Such laws stipulate that the butcher shall use due diligence, but can hardly be effective against the sale of trichinous meat, as there is no way known at present by which trichinæ in meat can be recognized except by the use of the microscope. Prosecutions are not rarely commenced against butchers on account of the sale of meat which has proven to be infected. Cases of this kind have occurred within the past year, one in Brooklyn, N. Y., and one in Newark, N. J. In Germany there have been three instances of such prosecutions. In one case Professor Küchenmeister was called to testify as an expert, and gave as his opinion (*Oertel, Zeitschr. f. prakt. Heilk.*, xix, 48, 49, Nov. and Dec., 1873) that the butcher could not be in a position to know whether the meat in question contained trichinæ, as he was unfamiliar with the microscope and the appearance of trichinæ; and, further, as long as there was not a cheap and general obligatory inspection of meats, any laws, such as the one under which this butcher was prosecuted, would be an illusion. (Also see Dr. Maeder in *Thur. Corr. Bd.*, iii, 9, 15, September, 1874, and *Berlin Klin. Wochenschrift*, xi, 22, 1874.)

The necessity of microscopic inspection of meats, is recognized by all prominent investigators. Meissner—often quoted in this report—who has given a great deal of attention to the subject of trichinosis, etc., for many years (see *Zeitschr. für rationelle Med.*, 1855, and *Schmidt's Jahrbücher*, 1868 to 1875), speaking of the epidemics reported by Schauenberg in the Harz, Grasenick in Gratzungen, and Kraemer in Bovenden, says (*op. cit.*, 165, 1875, p. 285): "These epidemics show again the necessity for a thorough meat inspection. In Gottingen, where there has been an obligatory examination of meat for the last 6½ years, seven trichinosed hogs have been found. No cases have occurred in man."

Professor Gerlach, of Berlin, whose authority on this subject cannot be doubted, says (*Die Fleischkost*, pp. 69, 70):

“The microscopic examination of hogs after killing in connection with other means of protection is always a necessity, especially in all places where trichinæ have been previously found. The experience of ten years proves its usefulness, its security, and the possibility of its execution. All the earlier objections have been refuted by the success of the practice. Yet the objection that it is very difficult to find trichinæ when they exist in small numbers still retains its force. But the usefulness of such investigations loses nothing on this account, because when the examination is skillfully performed no fears of trichinous infection need be entertained after a negative result. Isolated trichinæ do not produce disease, and when the meat is sufficiently infected to produce even light cases of trichinosis the trichinæ will be readily discovered in the regular examinations. Thus far only one instance has come to my knowledge in which trichinosis occurred after microscopic examination had been instituted. In this instance (in Hanover) it was ascertained that the butcher had not submitted all his hogs to the inspector;” and further (p. 79), “during eleven years 744 hogs were found infected, and of this number there was only a small number determined after the development of trichinosis among the people, and we can assume that more than 600 trichinosed swine have been withdrawn from consumption by microscopic examination, and when we consider that one hog may be the cause of hundreds of cases of disease, especially in the cities, it must be plain that many thousands of cases of trichinosis have been averted by such examinations. No measure for the protection of the public health can show a more brilliant success. Let us take, for instance, the city of Hanover.

“Previous to the microscopic inspection of hogs in this city there occurred (in 1864-’65) three epidemics, in which over 300 persons were infected. Since its introduction in 1866 until now (1875) only one epidemic, with 54 cases, has occurred, and these cases were all traced to the meat of one butcher, who, according to his own confession, had killed a hog in the beginning of the year 1870—at which time the epidemic occurred—and sold the meat without its having been subjected to microscopic examination. How often the city of Hanover might have been visited by epidemics of trichinosis is shown by the fact that in the intervening 9 years trichinæ have been found in 9 hogs. In Linden (a suburb of Hanover, with an independent city government), where the inspection was introduced at the same time that it was ordained in Hanover and shortly afterwards given up, an epidemic occurred in 1874, in which 400 persons were infected and 40 died of trichinosis.

“The application of the microscope is not at all difficult, and only in large cities where large numbers of hogs are slaughtered is there any inconvenience encountered, and this can be readily overcome by the employment of men and women without any special knowledge of the medical sciences. The greatest difficulty is to bring all hogs under control;

and to this end it will be necessary in large cities that all hogs be killed in public abattoirs, and of those found infected nothing but the lard should be used, and that only after sufficient boiling. The meat should be burned or otherwise destroyed, or deeply buried. [As trichinæ will withstand so many changes and even putrefaction of the meat (see section B) burying should not be thought of until after boiling at a high temperature. This will secure the destruction of the trichinæ.] Rejection should not depend on the number of trichinæ found to be present, but the discovery of a single worm should be sufficient ground for declaring the whole hog unfit for food, because if one muscle trichina is present, one female trichina—capable of giving birth to 1 to 2,000 embryos—may be set free in the intestine, although from a sanitary point of view it cannot be said that trichinosis will occur from the presence of a solitary intestinal trichina.

“Trichinæ belong to that dangerous class of parasites which always increase in numbers, and thus afford increasing danger, unless all possible measures are used against them. While measures are taken, at great expense, against the parasites which destroy our forests, vineyards, and vegetables, the destruction of trichinæ, which may infect our bodies and even destroy our lives, should be the objects of particular attention. Of the means to attain this end the microscopic examination of all slaughtered hogs in trichinæ districts, and in places where even a trace of infection is suspected is the groundwork. When all hogs are subjected to inspection, when rats are kept from places where trichinosis occurs in man or trichinæ are found in hogs, and when the carcasses of trichinosed rats, etc., are rendered harmless to pigs by burning, then will there be a prospect of exterminating trichinæ. On the other hand, if measures are not taken against them the danger of infection from trichinæ will increase from day to day.”

On the subject of sanitation and prophylaxis, in connection with trichinæ, etc., Professor Virchow says (*Lehre, etc., p. 64, et seq.*):

“As the infection of hogs comes through the food, especial care is necessary to prevent the consumption of suspicious animal substances. Of these we have on one hand trichinous meat, on the other the excreta of trichinosed animals, and especially of man. Clean food and clean stables give the greatest security. Rats and mice should be caught and destroyed; * * * but trichinosed hogs are found where—as at Schönrade, in East Prussia—no trichinosed rats and mice are found, so that the hogs should be kept as much as possible from the excreta of men and dogs. * * * Thus far most of the epidemics of trichinosis have occurred in the Saxon districts where stable-feeding is the rule, * * * where, according to my own investigations, the poorer classes make the pigs eat human excreta.

“*The endemic centers must be carefully determined and watched. I have previously explained my views concerning the existence of such centers, of which there can scarcely be a doubt entertained. Private individuals*

cannot control the sale and transfer of trichinosed meat and animals. *The public authorities should therefore, first of all, make registers of all places where trichinæ occur or have been found, and publish them at proper times.* By this means special care could be given to animals from such places; but public preservation should not be limited to this alone. In small places (and this should be especially observed in breeders and breeding places) all pigs living during the occurrence of an epidemic among the people should be marked, and should not be allowed to be sold, and when killed should be thoroughly inspected. Finally, associations should be formed to insure against individual losses, with a participation by the district or even of the government—such as already exists in Brunswick. [In some places, Nordhausen, Mühlhausen, etc., in Prussia, premiums are paid for the discovery of trichinosed hogs. Eulenberg, Vierteljahreschrift f. gerichtl. Med., etc., 1878, p. 149.] This is more especially necessary in the interest of many poor people who raise hogs. * * * The sooner such measures are undertaken the sooner will the propagation of trichinæ and the occurrence of trichinosis be brought within narrow limits. *This subject is of sufficient importance for special legislation, without which such regulations cannot be enforced.*

“As there are no certain signs by which trichinous infection can be discovered, and as the capsules cannot be seen with the unassisted eye unless calcified, a microscopic examination of the meat becomes essential. * * * In every place where such examinations have been practiced for even a short time, the results have been eminently practical. In Altenburg, where it was ordained December 22, 1865, a trichinosed hog was found on the 2d day of January, 1866, showing that it is only necessary to introduce it in order to test its efficacy.”

Thus it will be seen that the only way to insure success in the eradication of trichinæ is to establish complete methods, and then make them thorough in their execution. This, according to Gerlach, can only be accomplished by the establishment of public abattoirs. I have taken the liberty to quote complete (from *Die Flieschkost*, p. 134, *et seq.*) his remarks on the subject, and although they are so worded in some parts as to apply particularly to Germany, they may be equally applied to any other country. Exceptions might be taken in regard to the large establishments already in running order in several American cities, where many other precautions are no doubt observed, and which may only need the addition of the trichinæ inspector. The object of his remarks, it will be apparent, is to bring the smaller dealers under control.

PUBLIC SLAUGHTER-HOUSES, AND OBLIGATORY USE OF THEM, UNDER CONTROL OF VETERINARY SURGEONS.

HISTORICAL.

“The ancient Romans built slaughter-houses—*Laniæ*—and market-places—*Macelli*—which in size and luxury were not surpassed by other public buildings, baths, arenas, etc. There were also in the larger cities

common places for the slaughter of animals, in the middle ages—*e. g.*, one in Breslau in the fifteenth century (Brandes), and in many European cities, viz, in Germany, particularly in the seventeenth and eighteenth centuries, the so-called Kuttelhöfe and Kuttelhäuser. Abattoirs were erected in Berlin during the past century, which were demolished in 1811 and 1842 (Feit).

“The ancient abattoirs were often demolished and rebuilt as they failed to answer to the necessities of the changed ideas and increased population. They were not properly arranged; were situated within the cities and annoyed the people who lived near them, and finally, becoming inadequate to the wants of the increasing population, private slaughter-houses had to be allowed. These public slaughter-houses were not looked upon as a sanitary necessity. Such a necessity could not be recognized, because the butchers as well as the public in general looked upon the meat from sick animals with horror; but in later times, on the contrary, it came to be considered harmless. In early times the people without exception rejected meat from sick animals, and no butcher even thought of killing one that was diseased. But this prejudice was somewhat overcome at the first development of veterinary science in the second half of the eighteenth century without discriminating between those which were dangerous and those which were harmless. As the crude empiric veterinary science of that time proved only that harmless meat was sometimes excluded, some authors assumed that all meat was harmless. It was thus that a ground was laid for a carelessness in the slaughtering of animals which has now increased to such an overwhelming magnitude.

“The modern slaughter-house, which answers to all the demands of the times—in which butchering is done in the most careful way, where the greatest cleanliness is observed, and which is under veterinary supervision—first appeared in the early part of the present century in France. Napoleon I, in 1810, ordered that all private slaughter-houses be demolished and the erection of public establishments in all the medium sized and large cities in France. The first five were opened in Paris in 1818. At the present time there are about twelve abattoirs in Paris, which have become the models of all establishments of the kind. This proclamation of Napoleon should be adopted by every civilized nation. According to the imperial decree of October 15, 1810, and the royal ordinance of January 14, 1815, and April 15, 1838, the slaughter-houses in France belonged to the first class of those establishments which were called ‘dangerous, unwholesome, or inconvenient, and not to be erected in the vicinity of dwelling-houses.’ The last ordinance (1833, article 2) provides that after the opening of the public slaughter-houses all private ones in the vicinity shall be closed.

“The impulse thus originating in France was next shown in Belgium, where at the present time slaughter-houses exist in all the large cities (Brussels, Ghent, Antwerp, Louvain, Mechlin) and some of the smaller ones.

“In 1850 the Austrian Government ordered that each community should build abattoirs, and since that time in nearly all of the large and middling-sized cities such buildings have been erected. In 1872 a slaughter-house was built at Pesth, which is the best one on the continent.

“South Germany also excels in the number and completeness of the arrangement of her slaughter-houses. The arrangements of the meat markets in Baden and Bavaria are considered the best. In North Germany, on the contrary, these establishments are very much neglected. They exist only in Hamburg, Rostock, Güstrow, and Wismar, but under deficient control.

“In Hanover the necessity for an abattoir became urgent more than ten years ago, but against the strenuous opposition of the corporate butchers, the medical society, the often-appointed commissioners, the indefatigable exertions of the medical counselor Dr. Brandes, even with the knowledge that there were 300 stricken men and women and 40 corpses, have not succeeded in attaining this end. In Magdeburg the same opposition occurs. But in Berlin the best example of the obstinacy of butchers is shown. Under the patronage of Stromberg a company has built a large slaughter-house, with stables attached, at an expense of about 1,000,000 thalers (\$400,000), but only a few of the 780 butchers have availed themselves of its privileges. By this is proven that nothing can be expected from the free will of the butchers; that without compulsory laws nothing can be done, for they seek and find profit in that on which the necessity of a strenuous control is founded.

“A laudable exception is the corporate Butchers' Association of Dresden, which built an excellent abattoir in 1872.

“THE NECESSITY AND USEFULNESS OF PUBLIC ABATTOIRS.

“The necessity can no longer be disputed. This arises first from the possibility of infection of meat used for human food; and, secondly, the butchers have not the necessary knowledge, and much less the good-will, to consider the health of the people against a possible increase of profits. Butchers as a rule do not believe in the danger from diseased meats. They do not wish to believe it, and therefore cannot be convinced of what is so clear to us concerning trichinæ. In spite of direct proof—the many sick and dead—they for the most part persevere in their opposition without scruple.

“The necessity has become greater of late on account of the abolition of the butchers' tax, which, as it was levied *per capita* on the species and was not affected by the weight and discriminated only between calves and full-grown cattle, caused the butchers to look out for the heavy weights, as light lean cattle thus paid a higher tariff per pound. But now this restriction has disappeared with the duty which thus prevented the slaughter of sick, lean cattle.

“The compulsory slaughtering in public abattoirs offers other advan-

tages which in themselves are sufficient to make it desirable, as follows:

“(1) *It will put an end to the driving of cattle through the streets of our larger cities.* This inconvenience is overcome in Berlin, where according to the street regulations, cattle moved in the day-time must be transported in closed wagons. But in other cities no such law exists, and it has been repeatedly and vainly proposed by the police authorities in Hanover.

“(2) *Prevention of cruelty in butchering.* It is not necessary to prove how much cruelty *may* be practiced in the slaughter of animals. In private slaughter-houses it is not seldom in consequence of insufficient room, deficient arrangements for holding the victim firmly, and especially in consequence of lack of firmness in handling the instrument of death, which can alter the best methods of killing animals to a system of torture. In the large abattoirs the work is divided; every man attains the greatest possible dexterity in his particular work, and thus only can the greatest possible certainty of a rapid death be secured. The international congress for the prevention of cruelty to animals, held in Zurich in 1869, saw correctly, in the erection of abattoirs, an effective expedient to prevent unnecessary pain to animals.

“(3) *Greater cleanliness on account of the more judicious arrangements and cleansing with water.* The most careful cleanliness in private slaughter-houses cannot compete with the properly arranged abattoirs, because the space, especially in the larger cities, is always very limited, but even in ordinary cases is generally insufficient, and filth is the rule; and it only exceptionally occurs that the accumulations do not become unbearable. In public slaughter-houses the care for the best possible state of cleanliness is increased by its publicity.

“(4) *With the closing of private slaughter-houses in cities abundant sources of air poisoning are removed.* Those living in the vicinity of slaughter-houses know best how often in summer the air becomes foul, particularly near open water courses. The question here not only concerns the foulness and unpleasantness of the air, but from the putrefaction of blood very often arise peculiarly dangerous substances, which are directly infectious, and therefore in densely populated cities the greatest care should be taken to prevent such decomposition. This is recognized in the ordinance concerning the trades.

“(5) * * * * *

“(6) *Real progress in the control and extermination of infectious and contagious diseases among domestic animals.* It is a fact that the public in general is inclined to hide contagious diseases, and on this account it is very difficult to check and especially to exterminate them. Obligatory inspections of slaughtering is by far the surest means of accomplishing this end. The discovery of contagious diseases in the abattoirs is so important that for this reason alone the compulsory use of the public building should be inaugurated in every city. When the enormity of the danger to the public health on account of the diseases of our do-

mestic animals in the present conditions of commercial intercourse is considered, and when it is seen that we can seldom prevent their introduction by isolation, but that our efforts must be directed to a rapid destruction—that we can do little to prevent but must act to repress—it may be safely said that a successful exercise of the duties of the veterinary police without legal control of the slaughter-houses can by no means be accomplished.

“With all these great advantages to the States and cities the butchers will lose nothing. On the contrary, they have the greater advantage in the expenses, that butchering together is handier and cheaper, and the scraps and offal can be more readily utilized. In former times the slaughter-houses, as the bakeries, were erected solely for the profit to the trade. No supervision was necessary in those days. The butchers know this very well, and when they (as in North Germany) nevertheless oppose the obligatory use of public slaughter-houses by bringing forward all possible difficulties and the cost, they must have some ulterior object—which probably is that they do not wish to be interfered with in their business, which indicates still more the necessity of supervision. The profits made must certainly be great when the butchers reject the very apparent advantages and conveniences of public slaughter-houses.

“It may thus be seen that in the most cultivated cities in Europe the necessity of compulsory use of public abattoirs has become apparent, but it seems inexplicable that such measures have not succeeded in North Germany, where the consumption of meat is greatest, and where pork and beef are often eaten in a raw or half-cooked condition, and where therefore the danger of infection is much greater than in other countries.

“STABLING IN CONNECTION WITH SLAUGHTER-HOUSES.

“In order that these abattoirs may attain completely the object in view there should be sufficient space left for stabling and the storage of hay. To keep the cattle, etc., near the place of killing is necessary for the following reasons :

“(1) The cattle can be bought at any time and killed when needed. The butchers, etc., can thus become independent of the brokers.

“(2) The animals should be well rested before slaughter, as only after a long bodily rest can animals furnish normal and healthy meat. Muscular activity changes the blood and muscle. Nourishment is disturbed during exercise or labor. There is a consumption of the elements of nutrition, the products of which accumulate in the muscles and blood in proportion to the amount of activity, which in extreme cases may become fatal. Fat cattle may easily be driven to death, and fat hogs succumb much more readily. Even work animals can be brought to a fatal exhaustion, and wild animals may be chased to death.

“According to my experiments on horses, the blood after muscular activity becomes at first of a bright red, but changes after a time to a dark red, and after extraordinary exertion becomes of a blackish red color,

and loses its coagulability. Animals killed under such circumstances bleed little. The muscular tissue contains more blood than usual; is moister and softer; the secretion is acid instead of alkaline; it breaks down easily, and putrefaction rapidly supervenes. After the highest degree of muscular labor the muscular tissue, especially in those parts of the body where the muscles were subjected to the highest degree of activity for a long time, appeared soft, more or less discolored, and under the microscope showed a more or less complete granular degeneration of the transverse striæ.

“There is a decided loss on account of muscular labor before killing, which is augmented by the rapidly occurring putrefaction, and, as before remarked (*Fleischkost*, etc., p. 12), the meat itself may become dangerous to life. A rest of at least 12 hours after even the lightest exercise, and twice or four times as long after severe exertion, is necessary before the animal will be fit to be slaughtered for human food.

“The present way of transporting cattle affects the animals as much as driving. After long journeys by rail they arrive in a feverish and nearly exhausted condition, and need a rest of several days.

“VETERINARY SUPERVISION OF PUBLIC ABATTOIRS.

“Such a supervision should be exercised both before and after slaughter. An examination of the live animals requires a rapid glance as to the quality in general (or individual), of which a closer examination after killing will be necessary. A general ambulatory inspection of cattle in large establishments is not sufficient to properly bring the health of the animals under control, yet through the necessary observation of animals before killing it is possible to determine the condition of the health in general. It is not necessary that every animal should undergo a special and methodical examination. A general but thorough inspection, followed by a thorough examination in doubtful cases, will be sufficient.

“The examination of slaughtered animals must necessarily, on account of the large numbers to be examined, be executed in a rapid and practical manner. The thoracic and abdominal organs especially should be examined, as also the meat independent of trichinæ and cysticerci. The intestines should be glanced at, and the portions that have a suspicious appearance should always be subjected to a closer examination. In regard to the cysticercus the examination becomes comparatively easy, as they usually occur under the tongue and in the muscular substance of the heart. The difficulty in regard to the microscopic examination of pork for trichinæ is that it takes so much time. A veterinary surgeon can supervise the microscopic examinations in a large establishment. About 20 hogs can be reckoned daily for each inspector, for which a special room should be provided. Non-professional persons may be instructed, and with practice will be able to do this work.”

For small towns where there is no veterinary surgeon, persons should be instructed by official veterinary surgeons, to whom all doubtful questions should be referred.

SECTION G.—MICROSCOPIC EXAMINATION OF MEAT.

“The recognition of trichinæ in swine during life is of grave importance. The symptoms in many cases, after artificial infection, are not characteristic, but this cannot be said of all cases. The appearance of trichinæ capsules has been pointed out as a diagnostic sign, but even if present their color is not so distinct from the surrounding tissues as to make them appreciable unless calcified;” but “if the muscle is unusually red, look out for trichinæ” (Leuckart, *Untersuch.*, etc., p. 104 and note).

Only a few cases of calcified trichinæ capsules in hogs have been observed (see Section B of this report—Calcification).

“The use of the microscope is the only means by which we can determine the presence of trichinæ without a doubt. During life the investigation may be made by cutting a piece of muscle, or, better, by withdrawing a piece of muscle by means of the harpoon, but such measures would not be fitting to animals unless infection were suspected, as in the healing of the wound a sore might be left or an abscess might form, and besides it might prove very unsatisfactory unless often repeated; but this, according to Kühn, can be done at the pleasure of the operator without inconvenience or danger to the animal. He sometimes operated 16 times at one sitting without inconvenience to the animal. Caution must be used not to pierce the periosteum, while the puncture must be deep enough to pass through the layers of fat which lie under the skin. The regions of the neck and shoulders and fore limbs have the preference. Kühn not only determined the presence of trichinæ, but their relative abundance.” (Leuckart, *op. cit.*, p. 105.)

“However, the examination of the slaughtered animals, when either the harpoon or scalpel or both may be resorted to, is the most certain, as all parts are thus exposed, and especially the diaphragm, which, according to Leuckart, should, in the earlier stages, contain the trichinæ in the greatest abundance; but the youngest embryos will be found first between the layers of the mesentery.”

In 741 specimens taken from 15 different places, Kühn found 1,628 trichinæ. Of these 25.3 per cent. were found in the diaphragm; 7 per cent. in flexors of hind legs; 14 per cent. in scapular muscles; 4.5 per cent. in muscles of neck; 11.3 per cent. in lumbar muscles; 4.7 per cent. in muscles of tongue; 8.5 per cent. in laryngeal muscles; 4.4 per cent. in masseters; 3.6 per cent. in orbital and abdominal muscles; 3.1 per cent. in extensors of fore leg; 1.7 per cent. in intercostals; 0.3 per cent. in dorsal muscles.

These figures varied somewhat with the degree of infection. From this table it will be seen that the diaphragm, as well as the muscles of the shoulders and loins, are particularly liable to infection (Kühn), with the pectoral and those of the neck (Leuckart). The orbital muscles are less infected than those of the latter. Kestner (*op. cit.*) found the tri-

chinæ most numerous in the masseter, temporal, and pharyngeal muscles of a rabbit fed by him.

Delpech (*op. cit.*, p. 51) says :

“Professor Gerlach informs me that in Hanover the meat inspectors choose the diaphragm, the intercostals, and the masseters. Professor Müller, of Berlin, who has carefully studied the subject of distribution of trichinæ, has given us a table of results obtained by him by the following method. He raised at the point of examination a sufficient amount of muscular tissue to weigh exactly a grain, and then carefully counted the number of trichinæ contained therein, with the following results :

“	From the	psoas muscle	one grain of tissue contained	....	161	trichinæ.
“	“	diaphragm	“ “ “ “	....	129	“
“	“	laryngeal muscles	one grain of tissue contained	.	126	“
“	“	lingual	“ “ “ “	“	105	“
“	“	orbital	“ “ “ “	“	64	“
“	“	abdominal	“ “ “ “	“	54	“
“	“	masseter	“ “ “ “	“	45	“
“	“	lips near the snout	“ “ “ “	“	43	“
“	“	serratus magnus	“ “ “ “	“	39	“
“	“	pectoralis major	“ “ “ “	“	33	“
“	“	oesophagus in front of the diaphragm, one grain contained	.....	.....	31	“
“	“	oesophagus close to the stomach, one grain contained	.....	.....	1	“
“	“	pelvi-femoral muscle, one grain contained	.....	.....	26	“
“	“	tibial muscle, one grain contained	.....	.....	26	“
“	“	longissimus dorsi muscle, one grain contained	..	..	20	“
“	“	scapulo-humeral muscle, one grain contained	..	..	18	“
“	“	radio ulnar muscle, one grain contained	.....	.....	17	“
“	“	metatarsal muscle, one grain contained	.....	.....	9	“
“	“	intercostal muscle, one grain contained	.....	.....	8	“
“	“	small muscles of the ear one grain contained	..	..	2	“
“	“	“ “ of the tail	“ “ “ “	“	1	“

“Neither the heart nor muscular tissue of the stomach contained trichinæ.

“From the above table it would appear that the psoas, the diaphragm, the larynx, and tongue can be the most usefully reached in cases where the infection is light.

“The official instructions published at Magdeburg order inspection of the muscular portion of the diaphragm, the muscles of the eyes, of the jaws, of the neck, and the intercostals. This does not accord with the results we have given, in which the intercostals do not have an important place.

“The above figures have reference to an animal in which the trichinæ have their usual distribution. It is very certain that if a recently trichinosed hog were examined in which the embryos were still in the stage

of migration the results obtained would be very different. While the diaphragm and the neighboring muscles would contain a large quantity, those of the other parts would show very few."

Krämer (Deutsch Klinik, 30, 31, July, August, 1872) obtained results different from those quoted above. He examined one gram (gr. xv) of muscular tissue from various muscles, with the following results:

In one gram (gr. xv) of muscle from the	biceps	420
" " " " "	masseter	213
" " " " "	genioglossus	188
" " " " "	gastrocnemius	186
" " " " "	sternomastoid	171
" " " " "	pectoral	148
" " " " "	diaphragm	129
" " " " "	cricothyroid	124
" " " " "	intercostals	113
" " " " "	rectus abdominis	106
" " " " "	psoas	105
" " " " "	tongue	58
" " " " "	laryngeal	21

A consideration of the above results will show how uncertain it is to depend on any one set of muscles as showing conclusively whether a body contains trichinæ. Meissner (*op. cit.*, No. 138, p. 101) gives a case where "no trichinæ were found in the extremities of a hog; a later examination showed none in the extremities or spinal muscles; a few were found about the shoulder, but a large number of trichinæ were found in the intercostals." (See also Simon, *Virch. Arch. Bd. 34, p. 624.*)

"When an animal is highly infected the muscles of the posterior extremities will be found to contain trichinæ, as well as the anterior portions of the body; but when after repeated observations there are none found in the anterior, the result will also be negative for the posterior portions" (Kuntz, *Trichinenkunde Stuttgart, 1876*). But P. Niemeyer states that "even after examination in 30 places it cannot be said positively that the animal is free from trichinæ."

Trichinæ are found at the extremities of the muscles at their insertions into bones and tendons in greater abundance than in the central portions, and consequently these parts should be chosen for examination.

MICROSCOPIC EXAMINATION.

"Lay bare the fibers by separating from the surrounding connective tissue, or make an incision in the direction of the fasciculi; take up a small portion (1^{mm} to 2^{mm} in width) with forceps and separate—in the direction of the fibers—with a pair of scissors curved on the flat, a portion of the muscular tissue not over one millimeter in thickness (many authors say less, Ruffert 0.25^{mm} to 0.35^{mm}) and 20^{mm} to 30^{mm} in length, avoiding the vicinity of the blood vessels and nerve filaments, remembering that the trichinæ are most abundant in the portion of the muscle nearest the tendons—some of the deeper muscles may more

easily be reached by the harpoon. Place the specimen on a glass slide

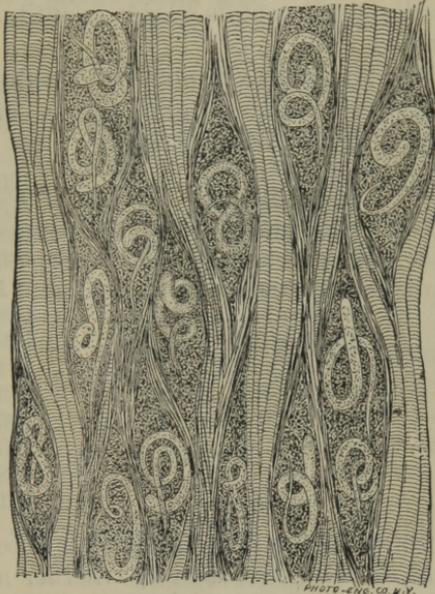


FIG. 73.—Preparation from a corpse in Hadersleben; trichinæ about 7 weeks old, and with few exceptions are completely developed; no trace of capsule (Leuckart).

5^{cm} long and 2.5^{cm} to 3^{cm} wide" (the ordinary glass slide, 2.5^{cm} wide and 7.5^{cm} long, will answer). Flitner (Aubeitung, etc., für Fleischbuschauer Lippstadt, 1877, p. 17) recommends the use of a glass plate 10^{cm} long, 4^{cm} wide, of clear, colorless glass 2^{mm} to 3^{mm} in thickness, and a cover somewhat smaller 0.5^{mm} in thickness (thick covers interfere, especially under the higher powers, with the sharpness of the outline), "and with mounted needles spread out to double its width." Ruffert (Mik. Fleischbeschau. Leipzig, 1880, p. 45) recommends that at least 50 preparations be taken from every sample to be examined, placing several on the same object-holder and using one cover for the whole, thus saving much time in mounting. "Moisten the slip of muscle with a solution of caustic potash, 1 to 8 (or acetic acid, Vogel); after a few moments, when the muscle becomes clear, lay on a cover made of thin window glass about 25^{mm} square, and press down to flatten out the sample and remove air bubbles. By holding the specimen towards the light, trichinæ capsules, if present, will appear as small clear specks to the naked eye—more readily seen, however, by the myopic than by the presbyopic."

Use an objective of 40 to 50 diameters, which should, by means of a nose-piece, be connected with another one of twice the power (100 diameters), so that any doubt may be cleared up by a ready resort to a higher power. Speaking of the necessity of a good microscope, Dr. Long (Das Wissenwercheste, &c., der Trichinæ Spiralis, Breslau, 1878, p. 12) says there is no doubt that trichinæ if encapsulated may be seen by means of a

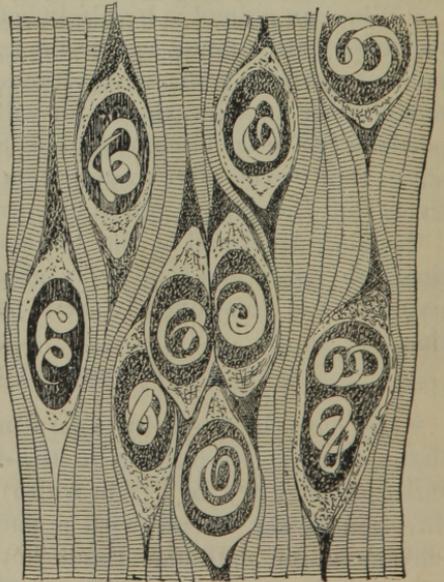


FIG. 74.—Muscle trichinæ from a hog three months after infection. The capsules are complete, but no trace of calcification is seen. The connective tissue accumulations are seen at the poles (Leuckart).

simple lens. Hilton even saw the calcified trichinæ with the naked eye without searching for them; but a simple magnifying glass would be useless in searching for trichinæ on account of their small size.

“The absence of trichinæ in single specimens cannot be relied on as evidence, as they may not be found unless the infection is of a high grade.” Besides the cases quoted above, Leuckart in some instances found trichinæ only after the tenth or twelfth trial; he thinks that if none are found after a careful trial of 12 to 16 specimens it may be considered that none are present; but Kühn found numerous trichinæ in every specimen after 40 had been examined with negative results. Virchow (*op. cit.*, p. 45) speaking of cases—mostly light, but some

very severe—which resulted from the use of lightly infected meat in Ueslitz in Rügen, says: “From my examination of the meat I conclude that in a superficial investigation it might easily be said that there were no trichinæ present.” Falck says (*op. cit.*, p. 519), “it should not be forgotten that the inspectors, even with the greatest of care, may overlook trichinæ if they occur in small quantity.” Berkan (*Virch. Arch.* 42, p. 354) says, “in cases where one or a few trichinæ are found, the muscles of the loins should be examined, as the greatest number will always be found there.”

In Mosseburg (*Allgemein med. Central Zeitung*, 1879) the meat of a hog was eaten raw, after having been pronounced free from trichinæ by ten persons and one regular inspector, and trichinosis followed. Later examinations showed that trichinæ were present, and that the *failure* to find trichinæ in

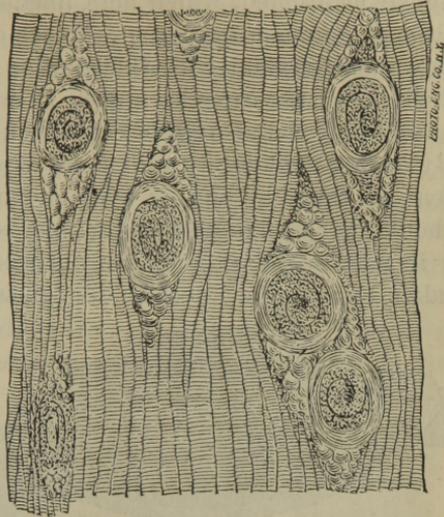


FIG. 75.—Preparation from a ham from Illinois; calcified trichinæ capsules of a form seldom seen in hogs; capsules mostly spherical, and show accumulations of fat cells at their poles (Leuckart).

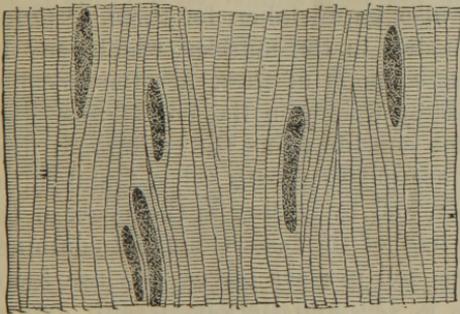


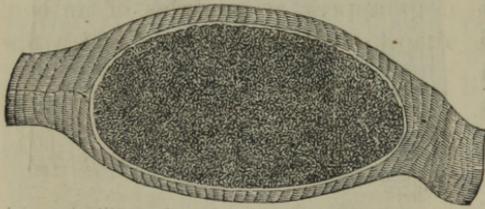
FIG. 76.—Psorosperms; Rainey's podus synchytrium micherianum ⁴/_p (Leuckart).

the first instances was due to the use of a magnifying power entirely too high.

“The appearance of trichinæ will differ according to their age and the degree of development (Figs. 73, 74, 75). When the capsules are calcified they can be plainly seen with the naked eye as small whitish

points in the more or less red muscle. It is more difficult to distinguish them before calcification, but when treated with the caustic solution above mentioned, which acts unequally on the capsules and muscle, they become more apparent. Place a piece of muscle, 1^{mm} in thickness, in a watch crystal with the solution; now if the glass be held over a dark object the capsules appear as whitish specks. The solution will, after a time, act also on the capsules and a homogeneous mass will result. By drying moderately thin slices of muscle the capsules become apparent as small oblong or oval elevations. But all such observations should be corroborated by the microscope."

In microscopic examinations of suspected meat great care should be taken to have the object-holder (glass slips above described) and covers



No. 77.



No. 78.

FIG. 77.—Single psorosperm, showing the unchanged muscle fasciculi on its periphery (Virchow).

FIG. 78.—Reniform sausage and irregular granules (navicular) from the sac of the psorosperm (Virchow).

perfectly free from foreign substances. Dr. Thom (Virch. Arch., No. 50, p. 451) sent a specimen of what he called calcified and charred trichinæ capsules, over which, it seems, there had been some discussion, to Professor Virchow for examination, who wrote that he found no such bodies, and thought that Dr. T. saw some accidental foreign bodies. Fibers of linen, cotton, or silk from the cloths used to wipe the slips might be mistaken by those unfamiliar with the microscope for trichinæ; detached muscle fasciculi might also be mistaken for them. "Other objects may be seen, as foreign bodies in the muscles, which may be mistaken for trichinæ. The most common of these are the so-called psorosperms" (Fig. 76), discovered by Rainey in the hog (Trans. Phil. Soc., 1857, p. 114), and at one time considered as the embryonal form of the *cysticercus cellulosa*; they are identical with those found in the muscles of the mouse by Miescher, and by Huling in the heart of the sheep, ox, and deer. Nearly one-half of the hogs examined contained them in greater or less quantities, and in some places they are found in nearly every hog (see Gerlach, p. 450, and Berkan, p. 451, Jahresbericht, etc., 1866). They have been found in the muscles of the sheep, and Kühn found them in the hen (see Kuchenmeister, *Die Parasiten des Menschen*, 2d, Aufl., Leipzig Lief., 1, p. 10, and Davaine, *op. cit.*, p. 261; Rupprecht Rundbleck, etc., p. 39, 40):

"The psorosperm (Fig. 77) is a more or less elongated body of a granular nature 0.3^{mm} to almost 1.0^{mm} in length, slender, or worm-like. Ten or fifteen may be found in a small slip of muscle, and they give it a

striped appearance. The stripes lie in the direction of the fasciculi, and are of a dirty-white color, and might almost be taken for trichinæ capsules if not too slender. The microscope reveals that, like the trichinæ capsules, they lie within the sarcolemma, but that the normal appearance of the muscle substance is not changed, as the transverse striæ can be seen in the periphery.

"The granular contents (Fig. 78) of the sac-like envelop consist of numerous reniform bodies which have a great similarity to the spores of certain fungi. The outer wall consists of a clear cuticular layer of tolerable thickness, and is pierced by numerous porous canals, at least in many cases, while in others the cuticular wall is covered with stiff bristles."

"Psorosperms found by me in dogs appear as pustules of an oval form, with a sharp contour, an almost shell-like capsule, and a few granular bodies. The granular substance was collected into a mass, which did not by any means fill the capsule. The remaining contents consisted of a clear albuminous substance, which was sometimes drawn together in a stringy or sausage-like mass, so that I was reminded of the egg of a nematode.

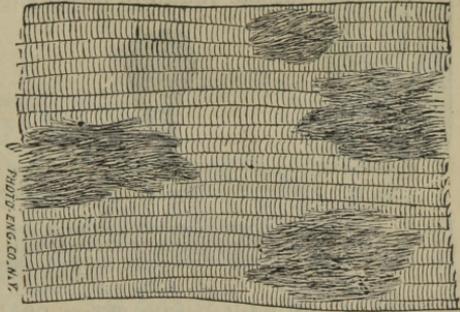


FIG. 79.—Tyrosin crystals in ham from Westphalia (Leuckart).

[Berkan (Virch. Arch. 35, p. 1), says: "Psorosperms are found in all hogs, but in smaller number in summer, owing perhaps to green food being plentiful at that season. In some cases where hogs were fed on milk he found immense numbers."]

"Although these bodies are often found in animals, the subject does not seem to be inconvenienced by their presence. Eating of the flesh in which they are found does not cause disease in man or other animals." (See, also, Gerlach, *op. cit.*, p. 84.)

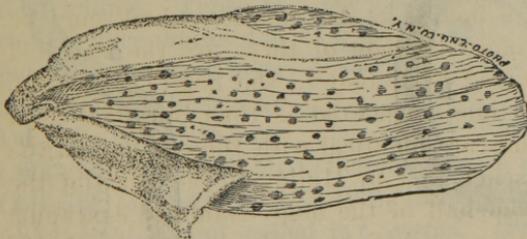


FIG. 80.—Calcified granules (cysticeri?) from hog's muscle; also streaked with fat (Virchow).

The occurrence in smoked hams of microscopic crystals of tyrosin (Fig. 79), which appear as whitish flakes with uneven borders or roundish or oval masses of needle-shaped crystals, scattered more or less thickly through the muscle, might without further investigation be taken for trichinæ. They disappear without effervescence on the addition of hydrochloric acid.

"Other bodies also now and then appear as small sharply defined nodules about the size of a pin's head or larger, with usually a compact connective-tissue investment, and consisting of a more or less calcified

friable substance. Similar bodies, but larger (4^{mm} in length), have been found by Drs. Wiederhold and Rupprecht in fresh meat, which contain, besides the calcareous concretions, numerous fat globules, distinct cells and cell remains, a part of the cells corresponding in their size and granular condition to pus globules. The whole has a caseous appearance, corresponding to a condition of retrograde metamorphosis." (Leuckart, Untersuch., etc., pp. 112-114. See, also, degenerated capsules, in latter part of section B of this report.)

The cysticerus cellulosa found in measly

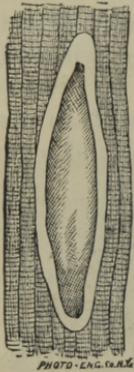


FIG. 81.



FIG. 82.

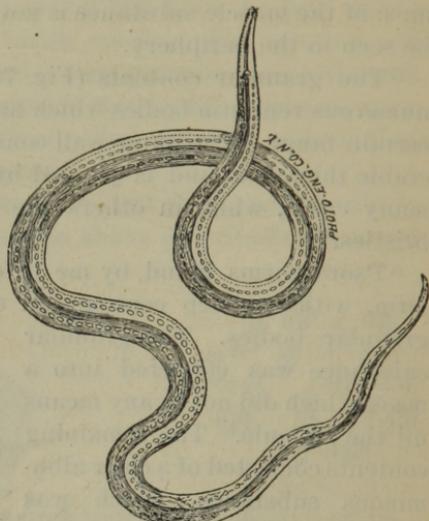


FIG. 83.

FIG. 81.—Cyst of the cysticerus cellulosa magnified 120 diameters.

FIG. 82.—Free larva of tenia solium (free cysticerus cellulosa) enlarged (Rüffert).

FIG. 83.—Vinegar eel (*anguillula aceti*) (Rüffert), sometimes mistaken for trichina spiralis.

pork are small white cysts (Figs. 80 and 81) from the size of a millet seed to that of a pea, containing the armed head of the tenia solium

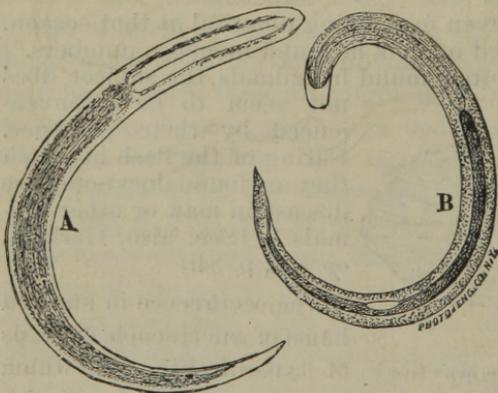


FIG. 84.

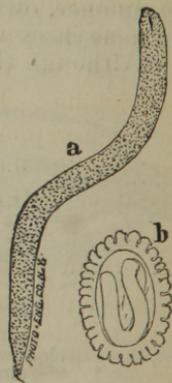


FIG. 85.

FIG. 84.—A, embryo of strongylus filaria; B, embryo of ascaris lumbricoides (Leuckart).

FIG. 85.—A, new-born embryo of ascaris lumbricoides; B, appearance in ovum just before birth (Davaine).

(Fig. 82). The cysts are mostly visible to the naked eye (Flitner *l. c.* and Rüffert *op. cit.*, p. 71).

In two cases the vinegar eel (*anguillula aceti*, Fig. 83), from the acetic acid used in making the preparation, was mistaken for the trichina.

Finally, many mistakes arise by miscalling other nematodes or their larvæ, as Dr. Merland de Chaillé and Professor Tigri found nematodes in the lungs of sheep, which, as Delpech (*op. cit.*, p. 35) demonstrates, were the young of the strongylus (Fig. A 84). He also shows that the organization of the worms found by Lebert (*Gaz. Médicale*, 1866,

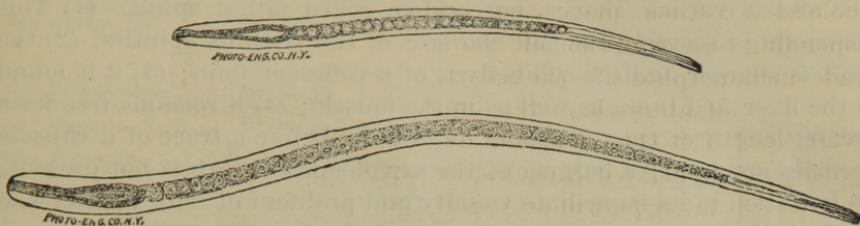


FIG. 86.—Young of trichocephalus dispar (Leuckart).

No. 19) in an abscess of the uterus of a woman dying of cancer did not correspond to larval trichinæ of the same length. The larva found in

the water newt, and called trichina spiralis, is a trichosoma (*T. tritonis*) (Pagenstecher, *op. cit.*, p. 99). The last author (p. 100) mentions also another nematode found in the intestines of hogs, having a short tail and double sexual organs. The young of the ascaris lumbricoides (Fig. 84 B and 85 A) may also be mistaken for trichinæ. Those of the trichocephalus dispar (Fig. 86) have been

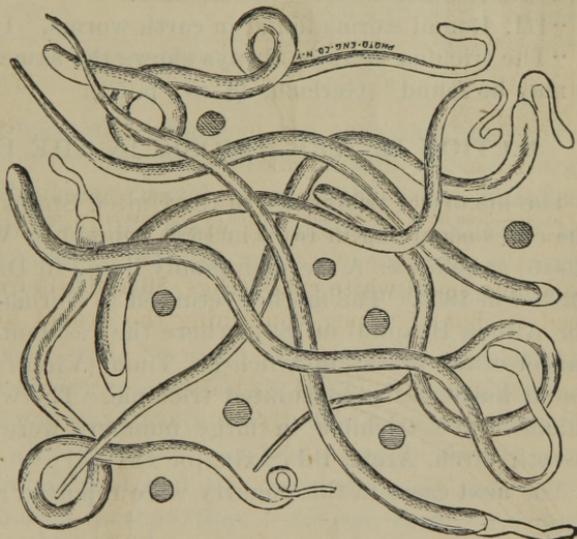


FIG. 87.—Filaria sanguinis hominis (Lewis), from Leuckart, sometimes mistaken for a form of trichina.

mistaken for them also. Dr. J. H. Salisbury

(*American Journal Med. Sciences*, 1863, p. 376) mistook, according to Cobbold (*op. cit.*, pp. 157, 198), the filaria sanguinis hominis (Fig. 87) for a trichina, and called it *t. cystici*. (See Leuckart, *Mensch. Par.*, p. 382, ii, a filaria cystica, young strongylus.) Meissner, in Schmidt's *Jahrbucher*, No. 65, 1875, p. 289, gives the following table to distinguish the above, as well as the embryo of the dracunculus, from the muscle trichinæ.

	Diameter.	Length.	Proportion of length to breadth.	Head.	Tail.	Proportionate length of tail.
	<i>Ctm.</i>	<i>Ctm.</i>				
Muscle trichinæ	0.0036	0.1008	1 to 28	Sharp.	Blunt.	.....
Dracunculus embryo	0.0025	0.0787	1 to 31	Round.	Sharp.	1 to 3½
Filaria sanguinis	0.00073	0.0338	1 to 46	... do ...	... do ...	1 to 8

(See section C, p. 104, of this report. Other worms taken for the trichina spiralis.)

"I. The so-called trichina affinis was found in nearly every mole examined by Gerlach (Die Trichinen, p. 49), and occur principally in the thick parts of the flesh as well as in the liver and brain; they are mostly free and in various shapes, but seldom rolled into a spiral. (1) This nematode is scarcely one-half the size of the trichina spiralis; (2) the head is sharper and the cell body is of a different form; (3) it is found in the liver and brain as well as in the muscle; (4) it remains free for a greater length of time, reaching its full size before a trace of a capsule becomes apparent; a bulging of the sarcolemma sheath is not present; (5) irritation in its immediate vicinity and prolifera of cells, etc., as well as the intense hyperæmia, was absent; (6) feeding gave no results.

"II. A small round worm has been found in the muscles of the frog. The delineation by Kühn (Virch. Arch., 23, p. 222) shows that they are essentially different from the trichina.

"III. Round worms found in earth worms. IV, in beets."

"The trichina spiralis always shows the same form, no matter where it may be found" (Gerlach, *op. cit.*, p. 52).

SECTION H.—TRICHINOSIS IN THE UNITED STATES.

The history of trichinosis in the United States should commence with the cases occurring in Iowa in 1856, related by Virchow (Lehr., &c., pp. 39-40) as follows: A German family living in Davenport, Iowa, was attacked in 1856. The mother returned to Germany and was admitted to the Altona Hospital in 1861, where the resident physician extirpated a cancer of the breast, in which Dr. Timm (Virch. Arch., Bd., xxx, p. 447) found numerous encapsulated trichinæ. The woman died in 1864, and calcified live trichinæ in large numbers were found in the muscles (Groth Virch. Arch., Bd., xxix, [or xxxix?])

The next cases in this country were reported as follows:

Year.	Locality.	Reporter.	Number of cases.	Number of deaths.	Reference.
1864	New York.....	Schnetter.....	4	1	Am. Med. Jour., February 20, 1864.
1864	do.....	Professor Dalton.....	1	.....	Trans. N. Y. Acad. Med., 1864, N. Y. Times.
1864	do.....	Dr. Voss.....	4	.....	Aitken Prac. Med., vol. i, p. 160.
1864	Cheektowaga, N. Y.	Dr. Kronbein.....	2	2	Buffalo Med. & Surg. Jour., June, 1864.
1864	Marilla, N. Y.....	Dr. Dwyler.....	6	2	Am. Jour. Med. Sci., July-September, 1864.
1865	Massachusetts.....	A. Sawyer.....	.....	.....	Bost. Med. & Surg. Jour., 1865, p. 16.
1865	New York (in hospital).	Dr. H. Coupland.....	1	.....	From Path. Soc., Lond., 1874; case diagnosed enteric fever
1865	Linn County.....	Dr. H. Wilson.....	6	.....	St. Louis Med. Rep., 1866, Chicago Med. Jour., 1866.
1866	Marion, Linn County, Iowa	Dr. H. Restine.....	9	5	N. Y. Med. Rec., August, 1866, Flint's Prac., p. 487.
1867	New York Hospital	Dr. E. C. Seguin.....	1	1	N. Y. Med. Jour., vol. iii, 1868, p. 116.
1867	Massachusetts.....	.....	6	.....	Med. Times, April 20, 1867, p. 431, Davaine, Cobbold, p. 169.
1869	Albany, N. Y.....	Dr. Hun.....	2	1	Trans. N. Y. State Med. Soc., 1869 p. 157.

Years.	Locality.	Reporter.	Number of cases.	Number of deaths.	Reference.
1870	Saxonville, Mass. ....	.....	?	1	Lond. Lancet, 1871, p. 515.
1870	Lowell, Mass. ....	.....	.....	.....	Do.
1870	Marengo, De Kalb County, Ill. ....	.....	8	3	N. Y. Med. Jour., xi, 1870, p. 107.
1874	Aurora, Ind.	Dr. Sutton.....	.....	.....	A report on trichinosis as observed in Dearborn County, Indiana, in 1874; reprint from Trans. Ind. State Med. Soc., 1875.
1874	Detroit, Mich.	Dr. Keifer.....	1	1	.....
1874	Port Huron, Mich.	Dr. Northup.....	4	1	Mich. Bd. Health Rep., 1875.
1879	Brooklyn, N. Y.	Dr. William Maddren	5	2	Proceedings Med. Soc., county of Kings, 1879.
1879	Martinville, N. J.	Dr. E. J. Bergen.....	4	1	Letter to Surg. General M. H. S.
1879	Milford, Ind.	E. P. Gilpin.....	5	3	American Practitioner, September, 1879, p. 135.
1880	Newark, N. J. ....	.....	4	.....	N. Y. paper.
(*)	Bridgeport, Conn.	Prof. E. L. Sanford, Yale College. ....	.....	.....	Number of cases a long time ago.
(*)	Newark, N. J.	Dr. A. Boll.....	4	.....	Epidemic in German family a long time ago.
(*)	Baltimore.	Prof. Michael.....	.....	.....	Diagnosis not confirmed by post mor- tem.
(*)	New York.....	Specimen shown to Dr. Thayer. ....	.....	.....	Microscopist. N. A. Jour. Homœop., No. viii, p. 317, N. Y. Free Press.

*Date uncertain.

In regard to the discovery of trichinæ in the cadaver, the first recorded cases are those by Dr. Bowditch in the Boston Med. & Surg. Journal, 1842-'43-'44. Professor Chazal, dean of the South Carolina Medical College at Charleston, told me in the summer of 1879 that he had seen trichinæ in the cadaver 1841-'42, while demonstrator of anatomy in South Carolina Medical College. Asking for further particulars, he wrote, March 8, 1880:

“All that I can recollect is that I noticed at least three cases at the time I was demonstrator during the session 1841-'42. I think all these were colored; one was a mulatto woman with much disorganization of the liver, the nature of which I do not recollect. I made drawings of the interesting little colonists, and had the drawings in my possession a few years ago. I state this to show that I *did* see them. At that period I only knew of Owen's article, which the late Dr. E. Geddings gave me to read after telling me what I had before my eyes. I infer from that circumstance that he himself had met them before.”

I have attempted to ascertain what had been done in the way of searching for trichinæ in the cadaver in the United States. In response to my inquiries to professors of anatomy and pathologists in colleges and hospitals I have received many letters showing that trichinæ are occasionally found in the cadaver. In some of these cases trichinæ were not searched for—in fact, there are very few in which an especial search had been made.

CONDENSED REPORTS FROM PATHOLOGISTS AND OTHERS.

NEW ENGLAND STATES.

Maine.—Prof. C. W. Bray, Portland, Me., from 100 to 120 cases examined, no trichinæ; Prof. S. H. Weeks, Brunswick, Me., knows of no cases of trichinæ in the State; H. M. Haslam, Augusta, Me., no post mortems.

New Hampshire.—Dr. J. P. Bancroft, N. H. Asylum for Insane, but few autopsies, no trichinæ.

Massachusetts.—J. G. Park, superintendent Worcester Lunatic Hospital, no trichinæ in last eight years; E. S. Boland, M. D., assistant superintendent Boston Lunatic Hospital, eighteen autopsies in last two years, no trichinæ; Professor Bowditch, of Boston, two cases, one age 36, one age 70 (Bost. Med. & Surg. Jour., vol. xxvi, 1842, pp. 117, 222); 1 case (Bost. Med. & Surg. Jour., vol. xxvii, 1842, p. 241); 1 case (Bost. Med. & Surg. Jour., vol. xxx, 1844); Prof. H. A. Beach, politeness of Professor Holmes, Boston, February 23, 1880, "in past twelve years five bodies contained trichinæ; no record except in two cases; no history sufficient to account for death."

Connecticut.—Hospital Hartford, Conn., few post mortems, no trichinæ; H. V. Stewart, Retreat for the Insane, Hartford, Conn., no trichinæ; Prof. Leonard J. Sanford, Yale College: "In the course of twenty years no trichinæ observed. About two hundred cadavers examined in that time. Some of our old doctors have known of fatal cases of trichinosis." (Letter May 31, 1880.)

MIDDLE STATES.

New York.—Prof. William Darling, M. D., LL. D., Professor of Anatomy, University of New York, New York City, and at Burlington, Vt., reports eight cases that he has met, the discovery of which were accidental. They occurred in dissecting-room subjects. Prof. Mary A. Wattles, Woman's Medical College, New York Infirmary, about 150 cadavers examined in last twelve years; two trichinæ subjects in 1870 and one in 1879. Dr. E. A. Maxwell, Charity Hospital and elsewhere, 100 to 150 autopsies annually. "Have seen trichinæ, always dead, how many times I cannot say." Prof. Corydon L. Ford, Long Island College Hospital, reports one case, and states that the number of bodies dissected in different colleges under his direction would probably amount to 1,500 to 2,000. No special attention given, but thinks he would have been notified.

Prof. Wm. Hailes, Albany Medical College: No trichinæ in cadavers in dissecting room. Found them in muscles of rat, in bacon, and in rabbits to which trichinised human flesh was fed. Cases dying in hospital. Prof. E. V. Stoddard, Rochester City (N. Y.) Hospital: No trichinæ found, but cases have occurred in the city. T. M. Franklin, New York City Lunatic Asylum, Blackwell's Island: No cases recorded. E. H.

Parker, M. D., Saint Barnabas Hospital, Poughkeepsie, N. Y.: No cases recorded. J. M. Cleaveland, superintendent Hudson River State Asylum, Poughkeepsie, N. Y.: About twelve post mortems annually; no trichinæ reported. Dr. J. R. Healy, Hart's Island Hospital: Ninety-two deaths 1879; 60 post mortems; no trichinæ. Dr. Geo. Ford, State Emigrant Refuge Hospital, Ward's Island, New York: Some post mortems; trichinæ not looked for. Professor Van Vuyer, Syracuse (N. Y.) University, both demonstrator and professor, microscopist: No trichinæ found; number of cadavers not given. Dr. C. O. McBeth, Buffalo General Hospital: Interested in the subject; no cases in hospital; was prosecutor two years in Buffalo Medical College; no cases there. Prof. Charles Cary, secretary Medical Department University, Buffalo, N. Y.: Fifteen to twenty cadavers dissected annually; no trichinæ found. Prof. J. D. Bryant: Trichinæ often observed in the dissecting room of Bellevue Hospital Medical College.

New Jersey.—Dr. A. Mercer, Saint Barnabas Hospital, Newark, N. J.; average ten post mortems a year for ten years; found one cadaver containing trichinæ. Dr. A. Boll, German Hospital, Newark, N. J.; twenty-five post mortems annually for last two years; no trichinæ found. Dr. Thomas W. Harvey, Memorial Hospital, Orange, N. J.; autopsies, five per annum; no trichinæ found in hospital or in his private practice.

Pennsylvania.—Professor Leidy, of University of Pennsylvania, of Philadelphia, in a personal letter writes that he “has seen trichinæ repeatedly, but has never kept account of them. I have repeatedly met with trichinæ spiralis at the university. One case of a woman used last winter to show the vascular system; the muscles were filled everywhere. All cases under my observation encysted, and in most cases alive. It was the observation of a case of trichinosis in the university which subsequently led me to its discovery in the hog.” (Proceedings Academy of Natural Sciences of Philadelphia, 1846, p. 107.)

Dr. Morris Longstreet, Philadelphia, Pa.: No case in hospital for thirteen or fourteen years; about that time a fatal case; found trichinæ in many specimens of flesh of man and animals sent for diagnosis; few post mortems in hospital. Dr. J. Berens, pathologist, Philadelphia Hospital: Four to five hundred autopsies for past five years; forty of them conducted in such a manner that trichinæ could not have escaped detection; found one case in University of Pennsylvania, 1878-'79. Dr. S. S. Schultz, State Hospital for Insane, Danville, Pa.: No examination for trichinæ; post mortem, one case per month; no trichinæ found at the Homœopath. Hospital, Pittsburgh, Pa.

Prof. Mary J. Scarlett Dixon, Woman's College Hospital, Philadelphia: Few deaths in hospital; no suspicion of trichinæ. Thirty-three cadavers in dissecting-room of college past two years; no trichinæ found. Dr. H. Schrapinger, Jewish Hospital, Philadelphia: Six autopsies per annum for the last three years; no trichinæ observed. Dr. G. Alder Blusner, German Hospital, Philadelphia: But few post mortems;

no trichinæ. Dr. W. Evans Cassellberry: Eight to ten autopsies annually for last three years; no trichinæ. Prof. J. G. Richardson, Philadelphia Pathological Society, May 9, 1878, found trichinæ in a man, age 40 to 50, a victim of an accident. (Philadelphia Med. Times, Aug. 31, 1878.) Dr. Stockton Hough, Philadelphia Hospital, reports 2 cases in 1867 and 2 in 1869 (Amer. Jour. Med. Sciences, ii, 1867 and 1869.) He also reports two later cases; one, Mrs. M. L. Irish, age 28, admitted for phthisis-pain; no account of œdema; another, T. McC., age 42, admitted first for rheumatism, second time for necrosis of superior maxillary, third time for chronic diarrhea.

SOUTHERN STATES.

Maryland.—Prof. J. Edson Michael, University of Maryland: Average fifty autopsies yearly in college hospital; no trichinæ found; not looked for particularly during past six years. Prof. C. F. Bevan, College of Physicians and Surgeons, Baltimore, Md.: Sixty to eighty cadavers per annum; no trichinæ found.

Virginia.—Prof. J. S. David, University of Virginia: Average about ten autopsies every winter since 1865; saw one case about seven years ago, in which the trichinæ were dead and encysted. Dr. John Clapton, Eastern Lunatic Asylum, Williamsburg, Va.: Only two post mortems in twelve years; no trichinæ.

North Carolina.—Dr. Eugene Grissom, North Carolina Insane Asylum, Raleigh: No post mortems held.

South Carolina.—Professor Parker, Medical College, State of South Carolina: Twenty cadavers annually; no Trichinæ found. He sends a brief abstract of a case reported by Dr. R. W. Gibbs, of Columbia, S. C., in Transactions of Medical Society of South Carolina, 1871, as follows: "Negro man, age 50, suddenly fell dead; numerous cellular bodies found in muscular tissue of abdominal and thoracic walls and in the heart; cysticerci in ventricular walls, one of which near the apex of the right ventricle was ruptured, and blood had exuded from the opening." Was it cysticercus?

Georgia.—Dr. John M. Niell, Georgia Infirmary, Savannah: Forty cases of autopsy per annum; trichinæ never suspected, neither looked for nor found. Dr. W. Duncan, Savannah Hospital: No trichinæ in twelve years, and not looked for.

Alabama.—O. Bryce, superintendent Alabama Insane Hospital, Tuscaloosa, Ala.: No trichinæ found.

Mississippi.—T. J. Mitchell, superintendent Lunatic Asylum, Jackson, Miss.: Post mortems not allowed.

Louisiana.—Prof. Samuel Logan, New Orleans, Feb. 22, 1880, has not had experience; is under the impression that they are rarely found there. Dr. A. W. Smyth has made a number of nice preparations of those found in the dissecting room of the University of Louisiana.

Kentucky.—Prof. J. M. Bodine, University of Louisville, Medical De-

partment: Thirty to forty post mortems a year; no trichinæ found; has heard of none in post mortems there for some years.

Tennessee.—Prof. Frank Gleason, Medical Department University of Tennessee, at Nashville: Twenty to thirty bodies dissected annually; no trichinæ found.

WESTERN STATES.

Missouri.—Prof. H. H. Mudd, Saint Louis, Mo., found trichinæ in one case in 1877; has seen others, but has only indistinct recollections of individual cases. Prof. N. B. Carson, professor of surgery, Saint Louis Hospital, has examined many bodies with trichinæ; some of them died in their hospital; found them all encapsulated; signs of life in only one. One or more found in city hospital; some from subjects in dissecting room of Saint Louis Medical College, and others were sent him from different parts of the country; all notes have been lost. N. I. N. Howard, superintendent Saint Louis Hospital: Trichinæ never searched for. T. R. H. Smith, superintendent State Lunatic Asylum, Fulton, Mo.: But few post mortems and no trichinæ.

Indiana.—Prof. W. A. Wheeler, Medical College, Evansville, Ind.: Twenty-five post mortems per annum; no trichinæ found. Prof. J. Chambers, Medical College of Indiana, Indianapolis: Thirty-five bodies per annum; trichinæ not looked for.

Illinois.—Prof. D. W. Graham, Woman's Medical College, Chicago, Ill.: Eight cadavers per annum during last six years; no trichinæ found. Prof. Chas. T. Parkes, of Rush Medical College, has seen no cadavers containing trichina spiralis in Chicago, Ill.

Michigan.—Prof. Corydon L. Ford, University of Michigan, found one case of trichinæ twenty years ago, but they had no sign of vitality.

Minnesota.—Dr. C. A. Wheaton, Saint Paul, Minnesota, Medical School, Saint Paul, Minn: In operation one year; no trichinæ found. Dr. Joseph R. Rogers, superintendent Hospital of Saint Paul, Minn.: No autopsies until 1879; trichinæ not looked for, and not found. Dr. C. K. Bartlett, Saint Peter, Minn.: Made post mortems for the last twenty years in Massachusetts and Minnesota; averaged ten per annum; trichinæ not suspected and not looked for.

Iowa.—Prof. E. M. Clapp, University of Iowa, Iowa City: Trichinæ found in one case, in which the flesh was examined for another purpose.

California.—Dr. Henry C. Kerber, German Hospital, San Francisco, Cal.: 72 post mortems since March 1, 1878; no attention given to trichinæ. He examined 13 consecutive cadavers in 1878 for trichinæ, with no result. G. Shurtleff, superintendent Insane Asylum of California, at Stockton, Cal.: Few post mortems, and not conducted so as to be apt to find trichinæ. Dr. George H. Jenks, superintendent Saint Luke's Hospital, San Francisco: But few post mortems; no trichinæ found.

Ohio.—Prof. J. M. Wheaton, Starling Medical College, Columbus, Ohio, has been connected with the college for the past fifteen years, and there has been an average of twenty-five dissections per year, and as

many post-mortem examinations in hospital, but has never seen or heard of the occurrence of trichinæ in any stage. Prof. J. F. Baldwin, Columbus Medical College for five years: Thirty cadavers per annum; no trichinæ found or looked for. Prof. Charles Van Pelt, Toledo School of Medicine: Six cadavers in past years; no trichinæ. Prof. N. W. Kitchen, Medical Department University of Wooster, Cleveland, Ohio: 16 bodies a year; no trichinæ looked for. Dr. C. A. Miller, Layview Asylum, Carthage, Ohio: Trichinæ never found.

District of Columbia.—Prof. D. L. Lamb, Medical Department Howard University: Thirty post mortems annually; no trichinæ found.

MARTINVILLE, SOMERSET COUNTY, NEW JERSEY,

April 24, 1879.

SIR: Yours of the 20th received. In reply I send you, as requested, the following:

About February 1, 1879, Mr. Low, of Bound Brook, in this State, bought in the city of New Brunswick a quantity of pork (a ham), bringing it home, and there being more than could be eaten fresh, Mrs. Low cut the meat in slices and salted it, one layer on top of the other, on an earthen dish (a common pie-plate.) The meat was bought on Saturday. The following Saturday the family were all taken sick—Mr. and Mrs. Low and their two children, aged one and three years—Mrs. Low being much the worst, while the youngest child, who had eaten but little of the meat, was but slightly affected. Before the meat was entirely consumed Mrs. Low noticed an unusual taste and smell to the meat, so much so that the last cooking was thrown away. As I get it from the physician who attended them when first taken, the symptoms were like those of cholera. When they came under my charge at the township farm, about two weeks after first taken, all but Mrs. Low were better, and have at this writing got comparatively well. Mr. Low presented the following symptoms, which it will be noticed are similar to arsenical poisoning: Fœtid state of the mouth; sensation of the teeth being on edge; hiccough; burning pain; præcordia; inflammation of lips; irritable stomach; vomiting of matters brown in color; black, fœtid stools; small, frequent, and irregular pulse; partial suppression of urine; livid spots over the abdomen; delirium; great prostration of strength; profuse perspiration; inability to move without great pain any of the voluntary muscles. On seeing him I proposed to take from him a piece of muscle and settle the question of diagnosis; but he objecting to being cut, I delayed the matter till the next day. At my visit the next day he seemed so much better that I again deferred the operation. The next day, the third of my *treatment*, Mr. Low, while being helped from the bed, suddenly died. Twenty-four hours after death I took from the left deltoid muscle a small piece. Dr. Berg, of North Branch, N. J., cut

it in thin sections, placed one under his microscope, when numerous capsules were seen. (It is said trichinæ do not become encapsulated till after some months.) On tearing the capsules apart with the point of a needle a trichina was found in each. Trichinæ were also found not encapsulated. Fifty were counted in a space perhaps half an inch square. They were in various positions, and were seen to change their position. Some were in size $\frac{1}{35}$ of an inch in length by $\frac{1}{400}$ of an inch in width or thickness.

My treatment was salicylic acid in ten-grain doses, without, however, expecting to do him any good, which proved to be so. The rest of the family took no medicine and got well.

Mr. Low had œdema of the arms and legs.

Any other information you wish will be cheerfully supplied by

Yours, respectfully,

E. J. BERGEN, M. D.

J. B. HAMILTON,

Surgeon-General, M. H. S.

Faint, illegible text, likely bleed-through from the reverse side of the page.

Faint, illegible text, likely bleed-through from the reverse side of the page.

APPENDIX.

LETTERS FROM UNITED STATES CONSULS TO THE STATE DEPARTMENT

Third Office, Constantinople, 1874
These letters are from the
The letters from the consuls to the State Department are
The letters from the consuls to the State Department are
The letters from the consuls to the State Department are

APPENDIX

The appendix contains a list of the letters from the consuls to the State Department, with a brief description of the contents of each letter. The letters are arranged in chronological order, and are numbered in the order in which they were received by the State Department. The appendix is divided into two parts, the first part containing the letters from the consuls to the State Department, and the second part containing the letters from the State Department to the consuls.

The first part of the appendix contains the letters from the consuls to the State Department, and the second part contains the letters from the State Department to the consuls. The letters are arranged in chronological order, and are numbered in the order in which they were received by the State Department. The appendix is divided into two parts, the first part containing the letters from the consuls to the State Department, and the second part containing the letters from the State Department to the consuls.

LETTERS FROM UNITED STATES CONSULS TO THE STATE
DEPARTMENT.

No. 94.]

UNITED STATES CONSULATE-GENERAL,

Vienna, June 24, 1878.

SIR: I have the honor to state that a letter from Prof. Richard Heschl, professor of anatomy at the Vienna University, was published in the Wiener Medicinische Wochenschrift, dated June 8, of which the following is a translation:

“We have received the following letter, which we recommend to the attention of the city physician:

“*To the Editor:*

“Allow me to say a few words concerning a matter of sanitary interest, which may not be undeserving a space in your paper. It is in regard to the American hams which are offered for sale in Vienna since several weeks or months, and which are recommended by the salesmen to be superior to the Westphalia hams. While of the latter out of 2,000 to 2,500 one contains trichinæ and is rejected, the American hams examined in Germany show that of every five to ten, one has trichinæ, and the probability exists that several epidemics owe their origin to this fact. The city physician should not permit the sale of American hams that have not passed examination, and the public should be warned, and if you need my name, it is at your disposition.

“Very respectfully yours,

“Prof. RICHARD HESCHL.”

In several of the Vienna morning papers of June 22 the following notice appeared:

“ABOUT THE SUPPLY OF PROVISIONS.

“The conviction having gained ground that the hams and the sausages imported from America, via Hamburg, contain for the greater part trichinæ, the proper section of the city council has concluded in its session of to-day to forward a petition to the government asking the same to issue a decree prohibiting the further import of such goods from America into Austria.”

I inclose the extract from the Medicinische Wochenschrift and the notice which appeared in the Neue Freie Presse above quoted.

Soon after Heschl's letter appeared I requested him to specify the German reports upon which his statement was founded. In comply-

ing with this request he mentioned two German works, both published in 1874, and which do not appear to have any reference to the kind of hams recently imported into Austria-Hungary. The works mentioned are:

Vierteljahrsschrift für öffentliche Gesundheitspflege von Wanentrapp, 6 Band, 2s, Hft., 1874.

Rœpper, Trichinæ der Americanischen Schinken. Published by Vieweg, Braunschweig.

2. Eulenberg, Vierteljahrsschrift für Gerichtliche Medizine, xx, Seite 103, 1874.

Zur Trichinæ frage von Dr. Jacobi. Published by Hirschwald, Berlin.

Professor Heschl declared that he had no personal knowledge of the subject to which he called public attention, that he had never seen an American ham, and that he relied upon the examinations made in Germany. He was thereupon invited to examine some American hams, and after a careful examination he said there were certainly no trichinæ in them, and that they were sound and good.

If Professor Heschl had made his examination before he wrote his letter, he might have written more definitely and satisfactorily, and would have authorized his name to be used to endorse the truth as ascertained by investigation; but it is unlikely that any such report would have been given such widespread publicity as has been given to the letter he wrote. The substance of the letter was telegraphed to the London Times, and has been quoted in the European press generally in such a manner that readers would not suspect that its author wrote it before he had seen an American ham.

It is not the facts stated nor the suggestion which Professor Heschl made which gives the letter importance. The importers of American hams would be quite willing to have the government adopt his suggestion, not only as applicable to American but also to German and all other hams offered for sale. They feel confident that such examination would prove the superiority of those imported from America. But this course would not satisfy those interested in preventing competition in the food supply, and therefore his suggestion is rejected, while his name is used to create prejudice against American products.

It is not proposed to petition the government to cause examination of all hams offered for sale, but to prohibit the importation of American hams because "the conviction is gaining ground" that they are not good. This conviction is not gaining ground among those who have used them, for they unite in warmly recommending them, and therefore the demand for them is constantly increasing. The conviction may be gaining ground among those who have never used them, and who will believe a learned theory from men equally ignorant rather than the testimony of those who know by actual experience. Ignorant theory disguised in learned phrase so often represses and defeats practical experience that it cannot be predicted how the government will decide this

question, but it is to be hoped that the competent medical authorities of Austria-Hungary will make independent investigation for themselves, uninfluenced by the German reports.

I have also received from Professor Heschl a paper herewith inclosed, which was printed at the imperial printing office, and purports to be instructions issued for the information of the sanitary council at the request of the government of Lower Austria. There are two paragraphs only concerning America, to which I direct attention, translated as follows:

Equal precaution must be observed in regard to the disposition made of the refuse of slaughtered animals since the frequency of trichina in America is principally due to the fact that hogs there are fed with the refuse of the great slaughtering houses, whereby, so to speak, trichinæ are propagated.

* * * * *

Particularly must be noted the fact that bacon and hams have recently been imported from America which contain more trichinæ than ours. In Germany one hog in 10,000 has trichinæ, while of the hams and bacon brought from America from 2½ to 5 per cent. contain trichinæ.

In calling the attention of the Department to these several statements I beg to suggest that some proper means should be taken to contradict erroneous reports concerning our products, in order that responsible men may not indorse and give currency to them as unchallenged scientific facts. The attempt to create a prejudice against exports from America by misrepresentation and to cut off that source of food supply from the consumers in Europe is an injury to the poor, a crime against humanity; but there are those who are ready to use any prejudice or report, however unfounded, to prevent such competition in the markets of Europe, and it is not only necessary to avoid furnishing material for evil reports, but to see that false reports are promptly and authoritatively contradicted.

I am, sir, your obedient servant,

PHILIP SIDNEY POST,
United States Consul-General.

Hon. F. W. SEWARD,
Assistant Secretary of State, Washington, D. C.

[Inclosures.]

1. Extract containing letter of Professor Heschl.
2. Extract from *Neue Freie Presse*.
3. Instructions at request of Government of Lower Austria.

No. 335.]

UNITED STATES CONSULATE-GENERAL,

Berlin, July 9, 1878.

SIR: I have the honor to report that it has been decided by the Prussian authorities hereafter to dispense with a microscopical examination of all American fat pork, provided the same consists of salted and cured sides of hogs without any muscles or flesh attaching.

Heretofore the import into Prussia of these products has been largely interfered with, if not altogether inhibited, by the local authorities on the ground of their being infested with trichinæ. Thorough investigations have resulted in establishing the fact that no trichinæ ever exist in the purely fat portions of pork, and that whenever any trichinæ have been discovered it has been in the meat or the muscle attaching to the fat. American pork packers and exporters will, therefore, do well to so dress their fat pork sides as to bring them within the above regulations now established for the whole Prussian monarchy, and thereby secure for themselves additional markets.

I inclose a copy of the decree published in the premises under date of the 21st ultimo, jointly by the minister of the interior and of the church and medicinal affairs, marked Inclosure 1; also a copy marked Inclosure 2 of the royal scientific commission for medical matters, upon which the ministerial decree is based.

I am, sir, your obedient servant,

H. KREISMAN,
Consul-General.

Hon. ASSISTANT SECRETARY OF STATE,

Washington, D. C.

[Inclosures.]

Copy of decree of the Prussian ministers of the interior, &c., June 21, 1878.

Copy of decree of the Prussian scientific commission for medical matters, April 24, 1878.

No. 19.]

UNITED STATES CONSULATE,

Leeds, August 20, 1878.

SIR: It is a gratifying duty to be able to send you herewith a copy of a report by the health officer of the borough of Leeds on the subject of trichinæ in American hams.

As no little detriment has been caused to the trade in this article by a wide and mischievous circulation of the idea of the prevalence of trichinæ, I respectfully suggest that the report herewith is of great importance to our exporters.

I have the honor to be, your obedient servant,

A. V. DOCKERY,
United States Consul.

Hon. ASSISTANT SECRETARY OF STATE,

Washington, D. C.

[Inclosure.]

PARASITES IN AMERICAN HAMS.

The following report by Superintendent Newhouse was read before the sanitary committee of the Leeds Town Council at a meeting held on Monday:

“I have to report that in consequence of a paragraph in the Sanitary Record and other papers, stating that a large number of the American hams imported into England were infested with a deadly parasite called trichinæ, I obtained from the wholesale merchants in Leeds ten samples of American hams and submitted the same to the borough analyst for analysis. The following is a copy of his report:

“I have carefully examined microscopically these samples for trichinæ, comparing them with trichinæ obtained elsewhere, and find that none of the samples are so infested.

“THOMAS FAIRLEY, F. R. S. E., F. I. C.”

No. 135.]

UNITED STATES CONSULATE,
Barmen, August 27, 1878.

SIR: During the past four months the notices of the discovery of trichinæ in American hams and bacons have been so very frequent that I have been inclined to consider them the result of jealousy and spite.

The consumption of American hams and bacon even here in Westphalia has increased so much that it seemed not improbable that interested parties systematically circulated these reports for the purpose of bringing American wares into discredit.

The report, however, a few days ago, that trichinæ had once more been discovered in American bacon in Dartmund, led me to address, in the interests of truth, a few lines to the circuit physician, Kreisphysikus, of that place, inquiring whether the report is true, whether he knew the bacon to be American, and whether trichinæ were found oftener in American than in German bacon.

As will be seen in the copy of his reply, herewith inclosed, it is stated that two different examiners have at various dates found trichinæ in sides of American bacon, whilst it is alleged that since the introduction of meat examination in Dortmund trichinæ have been discovered but twice in swine slaughtered here.

Now as these reports are of almost daily occurrence, and, whether true or false, by inculcating fear or suspicion of American hams and bacon are likely to be most prejudicial to one of the most important articles of the American export trade, and as the newspapers are continually warning the public of the danger they run in purchasing American hams and bacon, since they do not receive the protection of a microscopical examination, I venture to suggest that American curers, if they

desire to retain the foothold they have obtained in the German market, take such measures as will enable them to guarantee their hams and bacon to be free from trichinæ.

Many of these reports may be unfounded, but many are but too true, and this constant agitation must ultimately be injurious to the trade. Hence it cannot be too strongly impressed upon all American merchants that a uniform and unvarying excellence is the first essential to a lucrative European trade.

I am, sir, your obedient servant,

EDGAR STANTON,
United States Consul.

Hon. ASSISTANT SECRETARY OF STATE,
Washington, D. C.

[Inclosure.]

Copy of Dr. Cassall's letter to Mr. Stanton.

[Inclosure.—Translation.]

DORTMUND, *August 24, 1878.*

SIR: In reply to your esteemed favor of yesterday, I confirm the report that trichinæ were discovered in three sides of American bacon by Mr. L. Schmid, of Ostenhellirig, Dortmund, the city meat examiner, whilst another examiner but a short time ago discovered trichinæ likewise in American hams.

Their appearance has also been noticed in other districts.

Since the examination of meats was introduced into Dortmund trichinæ have been discovered but twice in swine slaughtered here.

I am, sir, respectfully, yours,

DR. CASSEL,
Circuit Physician (Kreisphysikus).

No. 80.]

UNITED STATES CONSULATE,
Manheim, February 11, 1879.

SIR: In a dispatch sent to the Department June 5, 1878, I called attention to the inclination exhibited by the local authorities of Germany to embarrass the exportation of pork in any shape from the United States.

I have now to report that the following police regulation was issued from the grand ducal district court, Manheim, December 27, 1878:

“American pork sold in the market-place, butcher-shops, or public streets, or to be used for the manufacture of sausages, must previously be microscopically examined for trichinæ; after this examination each piece must be marked by the inspector.”

This regulation only exists in regard to American pork—native pork and pork imported from any other country than America is sold without examination.

I remain, your obedient servant,

EDWARD M. SMITH,
United States Consul.

Hon. FREDERICK W. SEWARD,
Assistant Secretary of State, Washington, D. C.

No. 115.] CONSULATE-GENERAL OF THE UNITED STATES,
Rome, March 1, 1879.

SIR: I beg you will find herewith inclosed an ordinance of the Italian Government, with translation, forbidding, until further orders, the importation into Italy of swine, their meat, or any preparation or article made from their bodies, from the ports or landing places of the United States of America.

It is believed that this ordinance does injury to our commerce by its general and indiscriminate application to the whole territory of the United States, and it may be hoped that timely notice may serve to restore to uninfected districts the trade so essential to their prosperity.

I may add that the ordinance was received at the consulate-general last evening, being transmitted through our legation from the ministry of the interior of the Kingdom of Italy.

I am, sir, your obedient servant,

CHAS. McMILLAN,
Consul-General.

Hon. WM. HUNTER,
Second Assistant Secretary of State, Washington, D. C.

[Inclosure.]

1. Marine Health Order, No. 5 (with translation), dated Rome, February 20, 1879.

[Translation.]

MARINE HEALTH ORDER, No. 5.

The minister of the interior, by virtue of the law of March 20, 1865, on public health, supplement C, and the regulations of December 26, 1871, having verified the arrival within the kingdom of pork affected with trichinæ spiralis from Cincinnati and other points in the American Union, which proves the existence there of trichinæ in swine, decrees—
That until further orders the importation into the kingdom of swine

animals, their meat, and remains, whether prepared or preserved, coming from ports and landing places of the United States of America, is prohibited.

The prefects of the maritime provinces are charged with the execution of this order.

Given at Rome February 20, 1879.

For the minister.

G. B. MORANA.

[Scott & Co., commission house, and manufacturers' agents, No. 10 Pasajie de la Paz.]

BARCELONA, *March 24, 1879.*

Hon. WILLIAM M. EVARTS,

Secretary of State, Washington, D. C. :

We hand you herewith a clipping from the leading daily paper of this city relating to the existence of trichinæ in the hog products of the United States, which, if not true, should be officially denied, as else it will result in a great injury to a new and growing trade in that line with Spain and Portugal :

En vista de la propagación de la trichinæ en los ganados de cerda de los Estados Unidos de America, el gobierno portugués, de acuerdo con la junta consultiva de sanidad, ha prohibido la introduccion en el reino é islas adyacentes de las carnes y embritidos de aquella procedencia.

We have recently established an American agency here for the purpose of developing a new market for our products, and such statements uncontradicted will go far to undo all we have accomplished.

Hoping that this matter may not escape your attention, we remain, respectfully, &c.

SCOTT & CO.

[Translation.]

In view of the prevalence of trichinæ among hogs in the United States of America, the Portuguese Government, in accordance with the opinion of the board of health, has prohibited the importation into the kingdom and the adjacent islands of meat and other hog products coming from that country.

No. 128.]

UNITED STATES CONSULATE-GENERAL,

Frankfort-on-the-Main, March 31, 1879.

SIR: As a matter seriously affecting an important branch of American trade in this part of Germany, I have to advise the Department that the following official notice appeared, with others, a few days ago in the

daily newspapers of this city, * * * which may be translated as follows:

681. (Warning.)

In the course of trade a large amount of ham is imported from America at this place. As is known, the trichina pest prevails among swine in America, and therefore the purchasers of such hams should, in order to protect themselves against sickness, only use such meat in a thoroughly cooked condition, or, before use in a raw state, assure themselves beyond doubt by careful investigation and inquiry that the ham is not infected with trichinæ.

HUGENHAHN,
President of Police.

FRANKFORT-ON-THE-MAIN, *March 15, 1879.*

Immediately after this publication appeared I made explicit written inquiry of various experts and veterinarians as to whether trichinæ had at any time been discovered in American pork imported at Frankfort. The responses were unanimous and emphatic in the negative. One of the persons questioned, a well-known veterinarian, who is commissioned by the army contractor here to examine American ham and sides of bacon, declared that he had never, in the course of a long experience of this kind, found trichinæ in American pork, and that he had not heard of such discovery in such pork imported here.

The consular agent at Mayence, who at my request also made inquiry about this matter, writes as follows:

According to the official statement of Dr. Wollpert, the veterinary surgeon of this district, he examined between the 1st and 20th of January last some 80 pieces of American ham, and discovered no trichinæ in any of them, neither has he heard of trichinæ being discovered in American pork imported at any subsequent time at this place. He has, however, been informed of trichinæ being discovered in American pork—ham—in two cases at Offenbach and in two cases at Worms, all meats said to have been imported by the firm of Kiebicher & Co., at Mannheim.

The examination of American meat imported at this place was discontinued, partly on the ground that parties were unwilling to go to the expense and partly for the reason that no appropriation being made by the government for the expense, the authorities were not willing to incur the same, and as a *precautionary measure* they recommended the public to use American pork and ham only in a well-cooked condition.

To this statement of the consular agent at Mayence may be supplemented the opinion that the official notice above quoted is intended merely as a precaution, and not as a measure to injure the trade in American pork. Similar notices have been published in other places, as for instance at Freiburg, as will be seen by the following dispatch:

* * *

[Translation.]

"FREIBURG, *March 13.*

"Cases of trichinosis have occurred here also in consequence of the consumption of American hams. An examination by the police revealed the existence of many trichinæ in the American raw hams. The grand ducal authorities caution the public, through the newspapers, against the use of American pork before it has been thoroughly cooked or subjected to a microscopic examination by specialists."

I have requested the consul at Mannheim to make inquiry as to the correctness of the statement in this dispatch that trichinæ have been found in American hams at Freiburg, but as yet I have no report from him. Well-authenticated cases have come to my knowledge of rumors of the finding of trichina in American pork, resulting, upon examination, in proving that the meat infected was not American at all, but German. It is not improbable, however, that in some exceptional cases trichinæ have actually been discovered in pork imported from the United States, and of course the greatest possible use has been made of these cases by the German pork interest. There is no ordinary article of food which is so expensive in this country, or in the production and sale of which a larger profit is made, than that of meat. It is a common saying here that butchers all get rich. Meats of all kinds are so expensive that they are used very sparingly by the laboring classes. The large and growing imports of American pork and canned meats are therefore viewed by the dealers in German meats with extreme jealousy, and no pretext is unemployed for prejudicing consumers against the American article. A few days ago the butchers of Mayence requested the burgomaster of that place to caution the public against the use of American refined lard as possibly infected with trichinæ. They also asked that octroi duties be levied upon American lard admitted within the walls of the city. The burgomaster was obliged to reply that trichinæ never appeared in refined lard, and that octroi duties would be illegal, but the petition illustrated the extreme anxiety and jealousy of the butchers. Even the alleged outbreak of pleuro-pneumonia among American cattle is cited in a precautionary and alarming way.

These facts show the extreme importance that every possible precaution should be taken by American exporters against the sending of any kind of diseased or infected meats to the German market. The trade in such meats promises to be very large and very lucrative, if the quality of the articles imported and sold here can be protected against any just grounds of complaint. But one well-authenticated case of trichinated pork or diseased beef may do vast damage to the American meat-importing interest.

I have also to suggest that it might be well for the American pork trade in Germany if reliable statistics could be collected as to the actual extent to which the trichina pest prevails among American swine, and

the facts published in some legitimate way. The truth might be very useful in combatting the effect of exaggerated and pernicious rumors.

I am, sir, your obedient servant,

ALFRED E. LEE,
Consul-General.

Hon. F. W. SEWARD,
Assistant Secretary of State.

No. 48.]

CONSULATE OF THE UNITED STATES,

Lisbon, April 7, 1879.

SIR: I have the honor herewith to inclose an extract from the *Diario do Governo* of Lisbon, of March 14, with a translation of the same, containing a decree recently issued by the minister of the interior prohibiting, until further notice, the importation from the United States of all descriptions of swine's flesh in consequence of the sanitary authorities having received official information of the prevalence in that country of the disease among hogs known as trichinosis.

I am not aware of the extent of this disease in the United States, having seen nothing in the papers concerning it, and I am not aware that any other European nation has put on a similar prohibition to the importation of pork and hams from that country.

The trade in this article between our country and Portugal, while not large, has recently commenced to increase, especially in respect to hams, the quality and price making them very popular in this market. This decree is a virtual prohibition of the trade, and is enforced without inspection of the articles offered for import to ascertain whether or not they may be affected.

Within a few days two shipments, one of pork and one of hams, have been received here from America, but in both cases the importation was not only prohibited, but the consignees were obliged to reship the same to some other country for sale, of course at loss and inconvenience. I hear also of a similar case in the island of Madeira. I should like to be informed to what extent this disease prevails in the United States, if any other nations have prohibited the importation of pork and hams from the United States, and any other facts which might be useful to me in making such a representation as may bring about a revocation or modification of this order.

I am, sir, your obedient servant,

HENRY W. DIMAN, *Consul.*

Hon. F. W. SEWARD,
Assistant Secretary of State, Washington.

[Inclosure.]

Extract from *Diario do Governo* with translation.
S. Ex. 9—13

[Inclosure.—Extract from Diario do Governo.—Translation.]

SANITARY MARINE BULLETIN, No. 62.

MINISTRY OF THE INTERIOR,

Lisbon, March 14, 1879.

Having been officially informed that the *trichinose* has manifested itself in the United States of America, and, in concurrence with the report of the consulting board of public health, it is hereby decreed that from and after this date, and until further notice, the importation into this kingdom and the adjacent islands of all descriptions of swine's flesh coming from that country is prohibited.

Ministry of the interior, March 13, 1879.

LOUIS ANTONIO NOGUEIRA.

No. 252.]

LEGATION OF THE UNITED STATES,

Lisbon, April 21, 1879.

SIR: On the 14th March ultimo an official publication was made in the Diario do Governo by the minister of the interior, stating that in consequence of the existence of "trichinosis" in the United States of America, and as a measure taken in protection of the public health, all importations of the flesh of swine into Portugal and the adjacent islands had been forbidden by the "consulting board of public health." This note was followed on the 20th of the same month in the Gazeta dos Alfondegas, or custom-house journal, an official paper issued under the authority of the secretary of the treasury, by a portaria or royal order issued on the 17th, which prohibited not only the importation for consumption into Portuguese territory of such of the products of swine as are used for human food when coming from the United States, but refusing also permission for them to be warehoused or temporarily deposited on shore. I understand that several small parcels have, under this order, been transferred to vessels lying in the Tagus bound for foreign ports.

I am credibly informed also that the public health authorities have refused to allow American pork to be taken on board of vessels for consumption while lying in Portuguese waters. However, this exclusion was modified on the 5th instant by the publication of a letter from the director-general of customs, dated the 26th of March, admitting for consumption "pork lard" from the United States; and further allowing the entry of such pork as was actually in custom-house stores at the moment of the issue of the first order, and after due inspection.

No official communication whatever has been made to me of these new regulations, and I now forward them for the information of the department.

I have not seen fit to write to Mr. Corvo on the subject, because no

one here interested in the trade has brought these rules to my notice, and I do not know how far the disease prevails in the United States, and therefore do not wish to commit myself in the dark. But I think there ought to be an inspection before exclusion.

I have the honor to be, sir, your obedient servant,

BENJAMIN MORAN.

Hon. WILLIAM M. EVARTS,

Secretary of State, Washington, D. C.

[Extract from *Diario do Governo*, March 14, 1879.—Translation.]

BULLETIN OF MARITIME HEALTH, No. 62.

It being officially shown that trichinosis has appeared in the United States of America, it has been declared, in accordance with the decision of the "Consulting Board of Public Health," that after this date, and until further notice, the admission into the continent and adjacent islands of the flesh and fatty tissues of swine is forbidden.

Secretaria of State of the Interior, this 13th March, 1879.

LUIZ A. NOGUEIRA.

[Extract from *Gazeta dos Alfondegas* of March 20, 1879.—Translation.]

A prohibition having been issued in the "Bulletin of Marine Health," published in the *Diario do Governo* of the 14th instant, against the admission into the continent and adjacent islands of the flesh and fatty tissues of swine coming from the United States of America, on account of the trichinosis having appeared there, His Majesty, the King, determines that in the several maritime custom-houses no entry be permitted either for consumption or deposit to the said flesh and fatty tissues so long as said disease continues, and no order be given to the contrary.

Palace, 17th of March, 1879.

ANTONIO DE SURPA PIMNTEL.

[Extract from *Gazeta das Alfondegas* of March 20, 1879.—Translation.]

ILLUSTRIOUS, &c., SIR: To solve the doubts which the chief of the first section of the second department has raised in his representations attached to your official order of the 22d instant, I have to declare:

1st. That by the official letter of the said date it has been already communicated that "pork lard" coming from the United States of America can be admitted for consumption; and

2d. That meat and fatty tissues coming from the country aforesaid, being already warehoused in the custom-houses previously to the publication of the portaria forbidding its importation, will only obtain admis-

sion for consumption when the respective health inspector, whose duty it is to examine it, declares in writing that it is not affected with trichinosis.

JOSE DIAS DE OLIVEIRA.

To the DIRECTOR OF THE CUSTOM-HOUSE in Lisbon.

No. 86.]

UNITED STATES CONSULATE,
Mannheim, May 3, 1879.

SIR: In a dispatch dated February 11, 1879, I called attention to regulations made by the authorities of Mannheim regarding trichinæ in American hams and pork. I now report the following correspondence regarding action in the same direction at Freiburg:

[Copy of notice appearing in Freiburg papers March 12, 1879, concerning trichinæ.]

“Many trichinæ were found in a raw American ham sold in this city; it cannot be certainly stated yet whether there are in this ham trichinæ still alive. We again call the attention of people to the danger resulting in the use of American pork, ham, long and short sides, tongues, etc., and recommend, in order to be protected against such a danger, a thorough boiling of such pork or a microscopical examination by an expert.

“Grand Ducal District Court.

“DR. GROOS.”

[Copy of a reply to a letter of inquiry written March 27 to Dr. Groos by the consul a Mannheim concerning trichinæ.]

“In reply to your letter of March 27 we have the honor to inclose herewith a copy of the advertisement of this court informing you that several children of a family of this city who had eaten of such ham were affected with symptoms of illness, yet it could not be certainly stated whether they were a consequence of the use of such ham. These cases of illness had a favorable conclusion.

“DR. GROOS.”

There is an evident disposition on the part of German authorities to discredit American meats, and unless some action is taken by our government calling the attention of the Government of Germany to this fact, our importers will be subject to so many petty annoyances and extra charges that they will abandon what should be a most important trade to the United States and a general blessing to Germany.

The physical condition of the German nations is weakening for the want of meat at such prices as will enable the common people to make a daily instead of a weekly meal of it. They are a patient people, who eat their bread with little complaint, but it is observed by their own physiologists that as a nation they are growing physically weaker. They

need more strengthening food. Our extensive grazing grounds and prolific grain fields enable us to furnish meat to them at lower prices than they can possibly produce it. Nothing but ignorance and prejudice can delay their obtaining it from the United States.

A large importer in Mannheim informs me that the annoyances and hinderances are such that he shall abandon German sales and sell in England, from whence the Germans would buy the same hams and pork at a much larger price than they now pay. He has just filled a large order for hams to Westphalia, which will be sold in Germany as Westphalia hams, restrictions regarding examinations for trichinæ not being so stringent toward any other than American hams.

It is evident that trichinæ exist more or less in all hams or pork sold, consequently the only complaint we can make is that meat from the United States should be so critically examined and condemned, while that of Germany and other European nations is allowed to pass comparatively free; no complaint could be made if the pork of Germany was in a like manner treated. The least appearance of trichinæ in American meat is taken notice of, published in the newspapers by the authorities and those interested in discrediting it, warning the people against it, while the meat of Germany is sold without criticism.

In Mayence forty soldiers were taken ill after eating pork for dinner; at once the newspapers announced trichinæ as the cause. After the post mortem of some who died it was stated that no trichinæ could be found in them. Similar notices in other places could be stated. Other countries, more or less influenced by the opinions of Germany, make absurd regulations in this direction. In Venice the city authorities passed an ordinance that all American meat could be admitted for sale after it had been cooked four hours. It is thought by some of the best authorities here that the sharp salting, smoking, and drying of American pork, combined with the long voyage, usually three months between the killing and selling, make the danger of trichinæ much less than that in freshly-killed German pork. In this district cases of trichinæ occur, causing sickness and death; yet, after close inquiry and investigation, in no case can I find that death or even sickness can be traced to American meat. On the contrary, it is stated by observers that all cases that have occurred can be traced to other than that. Within a few weeks a family of four persons died at Schriesheim from trichinæ in German pork.

It is the opinion of Professor Gerlach, medical counsel of Berlin, that through thorough salting, smoking, and drying, pork is rendered comparatively harmless from trichinæ, and if cooked entirely so, while the habit indulged in by some Germans of eating freshly-killed pork, especially if raw, is productive of disease to an alarming extent. No American exporter should venture to send pork abroad that is not thoroughly cured.

The recently imposed tax, raising the duty on American pork from three to twelve marks, and on American lard to ten marks on the one

hundred kilos, amounting to nearly 25 per cent. of the value of the pork, guards the interests of the few at the expense of the many.

A large proportion of imported pork is consumed by the poorer classes, who will yet continue to eat American pork if they are not deprived of it by false statements. Even with the increased tariff it can be sold, at a profit, cheaper than Germany can raise it. Lard will not be so much affected, as it is used by all classes and it is not subject to the same inspection, and at the low prices sustained in America can compete with German lard, notwithstanding the additional tariff. The difficulties of the importer are not so much with the increase of tariff as with the unjust examination and discrimination between American and other meats. That this should be changed is very important, not only for our own people, but for the poorer classes of Germans, who are already deprived of enough of what Americans consider the absolute necessities of life, without in addition depriving them of cheap food, especially cheap meat, strong good food, 40 per cent. cheaper than they can raise it.

German pork sells here for 80 pfgs. to 130 marks.

American pork sells here for 30 pfgs. to .65 marks.

It is well known to all who have investigated this subject that a small worm, born in flesh, maturing in muscles of other flesh after it has been eaten, and from there deriving life, afterwards incloses itself in a chalky sac, which sac when taken into the human stomach is dissolved, freeing the animal to make its way out through the intestines or coatings of the stomach, causing pain, sickness, and death, but it is not known to how great an extent the danger from eating pork exists. Great exaggerations have been accepted as authorized statements, and people have been prevented from eating a food that under certain conditions is harmless from disease.

Eminent acknowledged authorities state "that 2½ per cent. of American imported pork contains trichinæ, yet it is probable that trichinæ in such pork in general are dead. It is possible that they are always dead and not dangerous; at least the percentage of dangerous pork is inferior to the microscopic-examined pork infected with trichinæ."

Much has been done in scientific investigations of this subject and much is being done. In the ordinary investigation of science it is not important that facts should be immediately produced, but in this case, one of so great interest to all exporters of pork in the United States, it is important that the opinions of acknowledged authorities should be at once obtained. I would suggest that the subject should be made a matter of scientific investigation in Germany and the United States, and that an appropriation of at least \$1,000 shall be made by the United States Government to pay the expenses of such an investigation, to be made under the control of the United States Minister at Berlin, with the co-operation of the German State authorities, and that acknowledged investigators and authorities on this subject shall be asked to

give their opinion whether there is generally danger from eating American pork, and to what extent, and whether the danger from trichinæ is greater in American pork than that of any other nation; and also the best and quickest mode of inspection for large importations. I would suggest the names of Professor Pagenstecher, of Heidelberg, and Professor Virchow, of Berlin. The earlier investigations of the gentlemen named have been accepted as authority. Their later discoveries are not well known outside of scientific circles. Their opinion would be accepted throughout the world, and the German Government would not maintain the present strict regulations towards American meat alone, even if they did not modify them or discontinue them altogether.

The rapid introduction of American products in the markets of my district have not only aroused the jealousy of the authorities but alarmed the producers and manufacturers, so as to create a reaction, which for the time injures the sales of all kinds of American products. Many who first received them with favor, and know well their superiority and low cost, persist in discrediting them and buy poorer articles at a greater cost. Nothing but the fostering care of our government and the persistent sending of our best products at reasonable prices will overcome these prejudices and false statements. If they are once overcome among the *people* the trade is secure; but if our government neglects to aid in every way the exporter, not only at home but abroad, then the position already gained will be lost.

I remain your obedient servant,

EDWARD M. SMITH,
United States Consul.

Hon. FREDERICK W. SEWARD,
Assistant Secretary of State, Washington, D. C.

No. 104.]

UNITED STATES CONSULATE,
Hamburg, June 3, 1879.

SIR: I have the honor to transmit herewith copies of two letters, with translation, received at this consulate, regarding certain hams said to have been received from Messrs. Armour & Co., of Chicago, and which have been confiscated by the Hamburg authorities as containing trichinæ, with my answer thereto. Mr. F. H. Kirsten now desires to return these hams to Messrs. Armour & Co. in Chicago. The Hamburg authorities, however, will not permit this unless he first procures a certificate from the American consul giving his permission, and to the effect that the Government of the United States makes no objection to the returning of diseased meats. Mr. Kirsten was verbally informed that the consul "personally" had no objection to his making such disposition of the hams as was to his best interest; officially, however, that the consul could not give his permission to their return, or a certificate that the

Government of the United States had no objection thereto, for the reasons given in my letter in answer to that of Senator Kunhardt.

In view of the fact that frequent confiscations of American hams are now being made in Germany upon the ground of their containing trichinæ, and as in most cases of this class the parties receiving the hams desire to return the same to the United States, I would respectfully ask that instructions be given as to what action it is desired the consul should take in the premises.

A rigid and thorough microscopic inspection is now made in all parts of Germany by government inspectors of hams, pork, etc., exposed or intended for sale, and if in the least infected the same is confiscated.

In this connection I would again call the attention of our merchants and business men engaged in exporting produce, meats, etc., to Europe to the importance and necessity of sending none but the best, and in meats especially to be certain that the same is not in any manner infected. A more thorough inspection of meats of all kinds either by the government or by those engaged in that business would tend in a great measure to enhance the value of our products, increase our trade, and do away with the general distrust now prevailing in Europe against American meats, hams, etc.

I am, sir, your obedient servant,

JOHN M. WILSON,
Consul.

Hon. F. W. SEWARD,
Assistant Secretary of State, Washington, D. C.

[Inclosures.]

1. Copy of letter of H. F. Kirsten to John M. Wilson.
2. Copy of letter of Senator Kunhardt to John M. Wilson, with translation.
3. Copy of letter of John M. Wilson to Senator Kunhardt.

[Translation.]

HAMBURG, *May 21, 1879.*

To the CONSULATE OF THE UNITED STATES:

The authorities of this place confiscated up to this time all hams which had been declared to contain trichinæ; whereas now Messrs. Armour & Co., of Chicago, desire that I should return to America the hams containing trichinæ; and whereas the authorities of this place have directed me to obtain the consent of the American consul thereto, I herewith respectfully request the permission that I may send hams which have been imported here by Messrs. Armour & Co., and found here to contain trichinæ, back to the same firm.

Respectfully,

H. F. KIRSTEN.

[Translation.]

THE POLICE AUTHORITIES OF THE FREE AND HANSEATIC CITY OF
HAMBURG.

No. 2125.]

HAMBURG, *May 31, 1879.*

To the CONSULATE OF THE UNITED STATES OF AMERICA:

The merchant H. F. Kirsten, of this city, has requested the permission to return to the shipper certain meats which have been imported into this place and found to contain trichinæ.

Kirsten asserts that upon his inquiry at the consulate he received the verbal information that there was no objection to the returning of the same.

As probably other importers of such meats will ask for the same permission, the undersigned authorities deem it proper respectfully to ask whether the statement of said Kirsten, that the Government of the United States of America does not object to the returning of meats containing trichinæ, is correct.

The senator, chief of police,

T. KUNHARDT.

[Inclosure.]

UNITED STATES CONSULATE,

Hamburg, June 3, 1879.

SIR: I have the honor to acknowledge the receipt of your communication No. 2125, under date of May 31, 1879. In answer thereto I have to say:

On the 21st instant I received a letter from H. F. Kirsten, of this city, in which he informs me that certain hams imported by the firm of Armour & Co., of Chicago, had upon examination here been found to contain trichinæ, and that the same had been confiscated by the Hamburg authorities.

Second, that he desired to return these hams to the United States, and that in order to do so he must furnish the authorities of this city the official permission and consent, and a certificate to the effect of the American consul. In answer thereto Mr. Kirsten was verbally informed that "personally" the consul had no objection to his making such disposition of the hams in question as was to his best interest, but that no official certificate or permission could be given to the effect "that the Government of the United States of America does not object to the introduction of meats containing trichinæ," as the consul neither desires to place the government he represents or himself in the position of aiding the introduction into the United States of articles declared by the Hamburg authorities to be deleterious, and confiscated as being injurious to public health and safety, without first having obtained

special instructions from his government authorizing him so to do, upon receipt of which you will be duly notified.

Availing myself of this opportunity of renewing to you the assurance of my distinguished consideration,

I am, sir, your obedient servant,

JOHN M. WILSON, *Consul.*

Senator Dr. KUNHARDT,
Chief of Police, Hamburg.

No. 213.]

UNITED STATES CONSULATE,
Christiania, May 24, 1879.

SIR: With reference to my dispatch No. 212 of May 3, I have now the honor to communicate that the board of health of this city has issued a decree to the following effect:

“From the 1st of June next, and until further notice, sides, hams, and spare-ribs of pork imported over sea into this country may not be sold until after examination by officers authorized by the board of health, and having received the mark ‘free from trichinæ.’”

The above measure, called forth by the repeated discovery of trichinæ in American hams, establishes a compulsory examination of all kinds of pork imported from the United States. Importers of this article, some of whom handle up to four thousand boxes of salt pork every year, complain much of the severity of the enactment, which must raise the price of American pork through the expenses of examination, which likewise subjects them to great inconvenience.

However, American pork has gradually become an article of primary importance, and will continue to be imported here in considerable quantities.

From other cities in Norway we also receive the report that trichinæ have been found in American hams.

I am, sir, your obedient servant,

GERH. GADE, *Consul.*

Hon. F. W. SEWARD,

Assistant Secretary of State, Washington, D. C.

[Extract.]

No. 44.]

CONSULATE OF THE UNITED STATES OF AMERICA,
Bristol, May 29, 1879.

SIR: * * * I beg to direct the attention of the Department to the reply given to the inquiry of the Earl of Belmore, in yesterday's sitting of Parliament, by the Duke of Richmond.

The stock-raisers of England as well as of the Continent have circulated reports to the effect that a very large portion of the American

hams and bacon was infected with trichinosis, thus to keep people from buying American pork in preference to the native. The pork-raisers of this country became very much alarmed in consequence of the large number, which is steadily increasing, of hogs brought to Great Britain from the United States. The interpellation of the Earl of Belmore is a consequence of this. It is a well-established fact that trichinosis appears in all countries among swine, and I doubt that the American hogs are more affected from it than those of other countries. If they are, the trade in American pork would experience a severe check in all European countries.

The interest of this trade to the United States is so vast that every precaution should be taken in sending but healthy meat to this country or any other one. The shippers ought to make it their duty to have the pork before it is sent off examined whether it is free from any and every disease. The best authorities of Europe hold that swine get infected with trichinosis by not being kept in clean places and by allowing them to eat impure food. It therefore seems that our farmers have it in their own power to protect their hogs against the named disorder, which, if it is allowed to spread on, must interfere very materially with the American pork trade, as already intimated.

I am, sir, very respectfully, your obedient servant,

T. CANISIUS.

United States Consul.

Hon. F. W. SEWARD,

Assistant Secretary of State, Washington, D. C.

HOUSE OF LORDS.

The Lord Chancellor took his seat at five o'clock.

DISEASE IN SWINE.

The Earl of Belmore asked if it was true that swine landed in this country had been found affected with trichinosis, and whether the government proposed to take precautions against the introduction of the disease.

The Duke of Richmond, in consequence of reports from abroad, had caused swine brought from America to Liverpool to be subject to examination by officers of the Veterinary Department of the Privy Council, and he regretted to say the result had been to discover trichinosis in some of the animals. The investigations were being continued, and therefore he was unable to say what steps it might be necessary to take in the matter. Swine from America were slaughtered at the port of landing. The best manner of guarding against the communication of the disease to the human species was for the public to take care that their ham, pork, or bacon was well cooked.

No. 411.]

UNITED STATES CONSULATE-GENERAL,

Berlin, June 23, 1879.

SIR: The agitation in this country against American hams and pork sides (bacon) having now reached this city also, where the consumption of the same by the middle and laboring classes of the population has become so extensive as almost entirely to exclude the home article, I beg to bring the fact to the notice of the Department with a view of having impressed anew on the parties shipping these goods from the United States to Germany the necessity of sending only such as are entirely free from trichinæ. By that course alone will they be sure of avoiding all annoyance and loss.

A copy of the notice given by the royal police department here in relation to the subject, together with an English translation of the same, is herewith inclosed.

I will add that an ordinance has been agreed upon by the municipal authorities of this city and the royal police department making the microscopic inspection of all kinds of pork offered for sale obligatory. Said ordinance will, I am advised, be very shortly promulgated.

I am, sir, your obedient servant,

H. KREISMAN,
Consul-General.

Hon. ASSISTANT SECRETARY OF STATE,
Washington, D. C.

[Inclosure to No. 411.—Translation.]

Of late large quantities of American hog hams and pork sides with lean meat still remaining on the same have been brought into the market at Berlin.

As has been proved by microscopic inspections, many of these hams and pork sides have been found to contain trichinæ.

Said fact is hereby brought to the notice of the public by enjoining on the same the urgent necessity of having an assurance in purchasing this kind of meat that the same has been subjected to a microscopic inspection.

Berlin, June 16, 1879.

Royal Police Department.

VON MADAI.

No. 214.]

UNITED STATES CONSULATE,

Christiania, June 6, 1879.

SIR: In my dispatch No. 213 of May 24 I reported that a compulsory examination of all kinds of American pork was to be enforced from the 1st of June.

At the examinations made at the bureaus established by the board of health trichinæ have been found in 24 out of 1,000 pieces of American pork sides, or $2\frac{2}{5}$ per cent. The bureaus had earlier found trichinæ in about 2 per cent. of the American hams examined. The article has consequently fallen in great discredit here, and the import of hams from the United States has virtually ceased altogether.

* * * * *

I am, sir, your obedient servant,

GERH. GADE,
Consul.

Hon. F. W. SEWARD,
Assistant Secretary of State, Washington, D. C.

INDEX.

A.

	Page.
Abattoirs, public, necessity and usefulness of	157, 159
veterinary supervision of	162
America, not more subject to trichinosis than other countries.....	68
American hams, trichinæ in	69-71, 187
examination of, by committee of Leeds town council.....	70
price of	198
"infected," in some cases not American.....	70
Anatomy and physiology of trichinæ	12
Animals, irregularity of results in feeding with trichinous meat.....	24
trichinosis in	134-144
Antonio de Surpa Pimntel; Lisbon; Order against admission of American swine.....	195
Appendix	181
Austria, government of Lower, instructions at request of	185-205

B.

Badger, trichinæ in	58
Barcelona, letter of Scott & Co	190
Barmen, United States Consul Edgar Stanton	188
Bergen, Dr. E. J., letter of.....	178
Berlin, United States Consul H. Kreisman, letter of.....	186, 204
order of Royal Police Department, Von Madia.....	204
Bladder, pathological anatomy of trichinosis in.....	94
Board of Health, Chicago	15, 65, 66
Bristol, United States consul at, T. Canisius.....	202
Butchering, prevention of cruelty in	160

C.

Cadaver, trichinæ in the human	9-11, 61, 62, 64
Canisius, T., United States consul at Bristol.....	202
Capsules containing trichinæ	16
calcification of.....	49
Cassel, Dr., letter of.....	188
Cats, trichinæ in	11, 57, 64
Cerebro-spinal fever, differential diagnosis of.....	116
Chicago Board of Health	15, 65, 66
letter from.....	66
the examination of 100 hogs in, not to be taken as a guide to the percentage of trichinised hogs throughout the United States.....	65
Cholera, differential diagnosis	112
hog	143

	Page.
Christiania, United States Consul Gerh. Gade	202, 204
Cincinnati, refuse of slaughter-houses, how utilized	66
Cohnheim's case	14
Comparative number of male to female trichinæ	35
Contents, table of	5
Crow, trichinæ in the	58
D.	
Dalton's case	15
Description of ova	12
male	12
female	12, 13
larvæ	13
Diagnosis of trichinosis	101-110
Differential diagnosis	110
cerebro-spinal fever	116
influenza	110
rheumatism	110
gout	111
"sudor-Anglicus"	111
cholera	112
typhus fever	112-116
Diman, Henry W., United States consul, Lisbon, letter of	193
Discovery of trichinæ	9
history of the	9-11, 74
Dockery, A. V., United States consul, Leeds	186
Dogs, trichinæ in	57
Dortmund, letter of Dr. Cassel, written from	188
E.	
Embryo, development of the	36, 37
number of	38
rapid progress of, through body	39-41
size of	41, 42
Epidemics	65, 69, 74-80, 82-87
cause of	87-91
in Europe since 1860—list of	82-87
Etiology of epidemics of trichinæ	87-91
Europe, trichinosis in	80
F.	
Fairley, Thomas, F. R. S. E	187
Fish, trichinæ in	55
Foxes, trichinæ in	58
Frankfort-on-the-Main, Consul-General A. E. Lee, letter of	190-193
Freiburg papers, notice in, signed by Dr. Groos	196
G.	
Gade, Gerh., United States consul at Christiania	202, 204
Geese, trichinæ in	58
Geographical distribution of trichinæ	64
German pork, price of	198
Germany, map of, showing trichinæ centers	81
trichinæ always quite abundant in	65

	Page.
Germany, disposition to discredit American meats	69
Glazier, W. C. W., assistant surgeon M. H. S., transmitting report on trichinae in American pork, &c.	7, 8
Gout, differential diagnosis	111
Groos, Dr	196

H.

Hamburg, United States Consul John M. Wilson, letter of	199
Hams, American, trichinae in	69-71
certain infected, not American at all	70
American, pronounced sound by sanitary committee of Leeds town council	70
Heart, free from	14
Hen, trichinae in the	55
Heschl, Prof. Richard, letter of (Vienna)	183
Histology of trichinae	26-28, 74
History of the discovery of trichinae	9
"Hog cholera"	143
Hogs, trichinae in	11, 55, 59, 60, 61, 64, 67, 68
Horse, trichinae in the	58
Hugenhahn, president of police (Frankfort-on-the-Main)	191
Human cadaver, trichinae in the	9, 11, 61, 62, 64

I.

Importation of trichinae, conflicting opinions in regard to	65
Influenza, differential diagnosis	110
Intestinal trichinae	26, 29
size of	26
history of	26-28
Irregularity of results in feeding animals with infected trichinae meat	24
Italian marine health order, signed by G. B. Morana	189

J.

Jenkins, Professor	80
José Dias de Oliveira, to director of custom-house in Lisbon	196

K.

Kidneys, pathological anatomy of trichinosis in	94
Kirsten, H. F., letter of, to United States consul, Hamburg	200
Kreisman, H., consul-general at Berlin	186, 204
Kunhardt, T., the senator, chief of police; letter of, to consul at Hamburg ..	201

L.

Larvæ, migration and development of the	38, 40
Leeds, United States Consul A. V. Dockery	186
Lisbon, secretary of state of interior, order against admission of American swine	195
United States Consul H. W. Diman, letter of	193
List of cases in man observed prior to the year 1860	11
List of epidemics in Europe since 1860	82-87
Liver, pathological anatomy of trichinosis in	94
Longevity of trichinae	23
Louis Antonio Nogueira (ministry of the interior), Lisbon, order against admission of American swine	194, 195

	Page.
M.	
Male intestinal trichinæ	29
Mannheim, Germany, United States Consul Edward M. Smith, letter of.....	188
Map of Germany, showing great trichinæ centers.....	81
Marmot, trichinæ in.....	58
Marten, trichinæ in.....	58
McMillan, Charles, United States consul-general at Rome	189
Microscopic examination of meat	163
Mole, trichinæ in the	55
Morana, G. B., Italian decree against American swine	189
Moran, Benjamin, letter of (Lisbon)	194
N.	
Natural history of trichinæ.....	12
"Neue Freie Presse," extract from	185
Number of trichinæ (Owen's estimate).....	15
O.	
Owen's estimate of number of trichinæ	15
Origin and distribution of trichinæ	54
P.	
Pathological anatomy of trichinosis.....	91
stomach.....	93
liver.....	94
spleen	94
kidneys	94
bladder	94
peritoneum.....	94
respiratory tract.....	94-101
Pathologists in the United States, reports of, relative to trichinæ	174-178
Pathology of trichinosis.....	126-131
Peculiar cases of trichinosis	116-123
Polecat, trichinæ in	58
Post, Philip Sidney, United States consul-general (Vienna), letter of.....	185
Private slaughter-houses in cities	160
Prognosis of trichinosis.....	123-125
Propagation of trichinæ	72
Prophylaxis for trichinosis.....	144-157
Proportion of trichinæ in cities and in the country	67
Public abattoirs.....	157, 159
Putrid meat infected with trichinæ	23
Pork products, adverse legislation in regard to, no proof of inferiority.....	71
R.	
Rabbit, trichinæ in	57
Raccoon, trichinæ in	58
Rats, trichinæ in	59, 62-64, 67
Rats as carriers of infection	67
Recapitulation of progress and development of trichinæ.....	51
Reports, condensed, from pathologists and others in the United States.....	174-178
Reproduction of trichinæ	26
Respiratory tract, pathological anatomy of trichinosis in	94-101

	Page.
Rheumatism, differential diagnosis.....	110
Rome, United States Consul Charles McMillan, letter of.....	189
Rome, Italian health decree against admission of American swine.....	189

S.

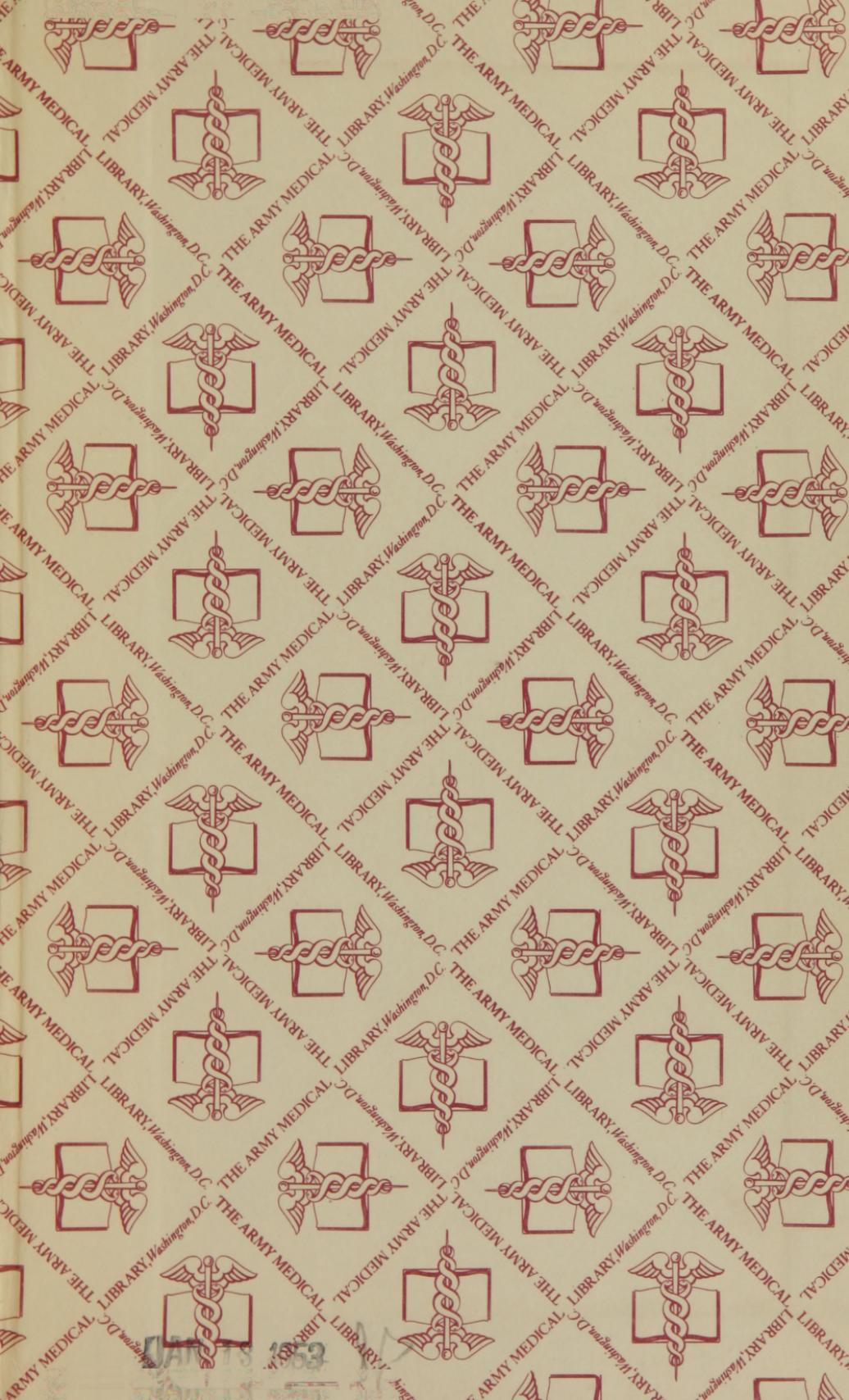
Scott & Co. (Barcelona), letter of.....	190
Secretary of the Treasury, transmitting copies of all documents relating to trichinæ.....	3
Secretary of the Treasury, transmitting report of Assistant Surgeon Glazier, made under direction of Surgeon-General M. H. S.....	3
Secretary of state of the interior (Lisbon) decree against American swine....	195
Sequelæ of trichinosis.....	125
Size of trichina capsules.....	17
Slaughter-houses (abattoirs), obligatory use of.....	157, 159
private.....	160
stabling in connection with.....	161
Spleen, pathological anatomy of trichinosis in.....	94
Stanton, Edgar, United States consul at Barmen.....	188
Sudor-Anglicus, differential diagnosis.....	111
Surgeon-General M. H. S., order directing preparation of report.....	7

T.

Table of contents.....	5
Time required for the liberation of trichinæ after ingestion.....	24
Trichinæ affinis.....	55
spiralis.....	55
centers, shown by Kestner to be in "Prussia, Saxony, and recently in Hanover".....	73
centers, map of Germany showing.....	81
comparative number of males to females.....	35
description of male.....	12
description of female.....	12, 13
description of larval.....	13
discovery of.....	9
epidemics of, in Saxony.....	65
etiology of.....	87-91
geographical distribution of.....	64
history of the discovery of.....	9
histology of.....	26-28, 74
importation of.....	65
intestinal.....	26, 29
longevity of.....	23
number of (Owen's estimate).....	15
origin and distribution of.....	54
propagation of.....	72
proportion of, in cities and in the country.....	67
reproduction of.....	26
recapitulation of progress and development of.....	51
size of.....	26, 37, 45
time required for liberation after ingestion.....	24
found in all countries where search has been made for them.....	74
in "American" hams.....	69, 70, 71
in the ape.....	58
badger.....	55

	Page.
Trichinæ found in cats	11, 57, 64
crow	58
dogs	57
fish	55
foxes	58
geese	58
hen	55
hogs	11, 55, 59-61, 64, 67, 68, 134-144
horse	58, 121, 139
human cadaver	9, 11, 61, 62, 64
marmot	58
marten	58
mice	64
mole	55
polecat	58
rabbit	57
raccoon	58
rats	59, 62-64, 67
wild boars	58
Trichinosis, diagnosis of	101-110
differential diagnosis	110
history of	74-80
in different animals, and therefore not peculiar to swine	55, 57, 58, 64, 67, 134-144
Europe	80
epidemics of, since 1860	82-84
pathology of	126-131
pathological anatomy of	91
stomach	93
liver	94
spleen	94
kidneys	94
bladder	94
peritoneum	94
peculiar cases of	116-123
prognosis of	125
sequelæ of	125
treatment of	131-133
prophylaxis for	144-157
in the United States	172
Typhus fever, differential diagnosis	112-116
U.	
United States, trichinosis in	172
trichinæ not peculiar to	68
V.	
Veterinary surgeons to control public slaughter-houses	157
W.	
Wild boars, trichinæ in	58
Wilson, John M., United States consul at Hamburg	199





NATIONAL LIBRARY OF MEDICINE



NLM 00100372 8