CHINA.

IMPERIAL MARITIME CUSTOMS.

II.—SPECIAL SERIES: No. 2.

MEDICAL REPORTS,

FOR THE HALF-YEAR ENDED 30TH SEPTEMBER 1885.

30th Issue.

PUBLISHED BY ORDER OF

The Inspector General of Customs.

SHANGHAI:

PUBLISHED AT THE STATISTICAL DEPARTMENT OF THE INSPECTORATE GENERAL OF CUSTOMS,

AND SOLD BY

KELLY & WALSH, LIMITED: SHANGHAI, YOKOHAMA, AND HONGKONG.

LONDON: P. S. KING & SON, CANADA BUILDING, KING STREET, WESTMINSTER, S.W.

1886.

National Oceanic and Atmospheric Administration

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INSPECTOR GENERAL'S CIRCULAR No. 19 OF 1870.

INSPECTORATE GENERAL OF CUSTOMS,

PEKING, 31*st December* 1870.

SIR,

1.—IT has been suggested to me that it would be well to take advantage of the circumstances in which the Customs Establishment is placed, to procure information with regard to disease amongst foreigners and natives in China; and I have, in consequence, come to the resolution of publishing half-yearly in collected form all that may be obtainable. If carried out to the extent hoped for, the scheme may prove highly useful to the medical profession both in China and at home, and to the public generally. I therefore look with confidence to the co-operation of the Customs Medical Officer at your port, and rely on his assisting me in this matter by framing a half-yearly report containing the result of his observations at.....upon the local peculiarities of disease, and upon diseases rarely or never encountered out of China. The facts brought forward and the opinions expressed will be arranged and published either with or without the name of the physician responsible for them, just as he may desire.

2.—The suggestions of the Customs Medical Officers at the various ports as to the points which it would be well to have especially elucidated, will be of great value in the framing of a form which will save trouble to those members of the medical profession, whether connected with the Customs or not, who will join in carrying out the plan proposed. Meanwhile I would particularly invite attention to—

a.—The general health of.....during the period reported on; the death rate amongst foreigners; and, as far as possible, a classification of the causes of death.

b.—Diseases prevalent at.....

c.—General type of disease; peculiarities and complications encountered; special treatment demanded.

d.—Relation of disease to { Season. / Alteration in local conditions—such as drainage, etc. / Alteration in climatic conditions. }

e.—Peculiar diseases; especially leprosy.

f.—Epidemics { Absence or presence. / Causes. / Course and treatment. / Fatality. }

Other points, of a general or special kind, will naturally suggest themselves to medical men; what I have above called attention to will serve to fix the general scope of the undertaking. I have committed to Dr. ALEX. JAMIESON, of Shanghai, the charge of arranging the Reports for publication, so that they may be made available in a convenient form.

3.—Considering the number of places at which the Customs Inspectorate has established offices, the thousands of miles north and south and east and west over which these offices are scattered, the varieties of climate, and the peculiar conditions to which, under such different circumstances, life and health are subjected, I believe the Inspectorate, aided by its Medical Officers, can do good service in the general interest in the direction indicated; and, as already stated, I rely with confidence on the support and assistance of the Medical Officer at each port in the furtherance and perfecting of this scheme. You will hand a copy of this Circular to Dr. ....., and request him, in my name, to hand to you in future, for transmission to myself, half-yearly Reports of the kind required, for the half-years ending 31st March and 30th September—that is, for the Winter and Summer seasons.

4.— * * * * *

I am, etc.,

(Signed) ROBERT HART,
I. G.

THE COMMISSIONERS OF CUSTOMS,—*Newchwang*, *Ningpo*, *Tientsin*, *Foochow*, *Chefoo*, *Tamsui*, *Hankow*, *Takow*, *Kiukiang*, *Amoy*, *Chinkiang*, *Swatow*, and *Shanghai*, *Canton*.

SHANGHAI, *2nd April 1886.*

SIR,

IN accordance with the directions of your Despatch No. 6 *A* (Returns Series) of the 24th June 1871, I now forward to the Statistical Department of the Inspectorate General of Customs, the following documents:—

Report on the Health of Chefoo, p. 1;

Report on the Health of Amoy, pp. 6, 7;

Report on the Health of Ichang, pp. 8, 9;

Report on the Health of Pakhoi, p. 10;

Report on the Health of Shanghai, pp. 11–16; each of these referring to the half-year ended 30th September 1885.

Report on the Health of Foochow for the year ended 30th September 1885, pp. 2–5.

Report on the Health of Seoul (Corea), pp. 17–30.

An Appendix containing a translation of a paper dealing with the force and mode of action of the Muscles which produce "Bearing-down," pp. 31–51.

I have the honour to be,

SIR,

Your obedient Servant,

R. ALEX. JAMIESON.

THE INSPECTOR GENERAL OF CUSTOMS,
PEKING.

The Contributors to this Volume are:—

W. A. HENDERSON, L.R.C.S.Ed., L.R.C.P.Ed. ..... Chefoo.

T. RENNIE, M.D., CH.M. ..... Foochow.

B. S. RINGER, M.R.C.S., L.S.A. ..... Amoy.

A. HENRY, M.A., L.R.C.P.Ed. ..... Ichang.

J. H. LOWRY, L.R.C.P.Ed., L.R.C.S.Ed. ..... Pakhoi.

R. A. JAMIESON, M.A., M.D., M.R.C.S. ..... Shanghai.

Dr. H. N. ALLEN ..... Seoul (Corea).

For everything enclosed within square brackets [ ], the compiler is responsible.

DR. W. A. HENDERSON'S REPORT ON THE HEALTH OF CHEFOO

For the Half-year ended 30th September 1885.

DURING the past hot season, amongst residents and visitors the only form of contagious disease that appeared was scarlatina, and that limited in the Settlement to one family of which the four children were attacked. In connexion with this circumstance it is interesting to note that their mother who nursed them was attacked a month afterwards with erysipelas within six hours after having given birth to a child, though antiseptic precautions had been taken. The child then born was cyanotic and lived a month.

The mortality amongst the residents and visitors consisted of two cases of cirrhosis and one of sprue,—the last being four years in duration.

From the French fleet which visited this port 27 cases were sent to hospital. These cases consisted of one of atrophy of the liver, two of fever, which were brought on shore in a state of stupor from which they never emerged, and the remainder for the most part were of dysentery, which yielded to treatment.

In one of the dysenteric patients an abscess in the epigastric region of the liver was demonstrated by the hypodermic syringe. Owing to its small size and the character of the situation, operative interference was suspended in the hope that it would disappear, which it eventually did, the patient recovering both from his intestinal and hepatic disorder.

The result was in no small measure due to the sedulous care of a lady who devoted herself to the sick during their stay in hospital.

The mean maximum and minimum thermometric observations for the four months, June, July, August and September, are as follows:—

	JUNE.	JULY.	AUGUST.	SEPTEMBER.
Minimum . . .	70°	74°	76°	65°
Maximum . .	75°	77°	82°	75°

DR. T. RENNIE'S REPORT ON THE HEALTH OF FOOCHOW

For the Year ended 30th September 1885.

DURING the earlier part of the period reported upon the health of the foreign community was good. The winter was exceptionally cold. On many nights in January and February there were slight frosts, and on several occasions the higher surrounding hills were capped with snow. With the early spring rains, which were very abundant, came a few cases of malarial fever.

During the summer months climatic affections, such as rheumatism, malarial fevers diarrhœa, hepatic disorders, and dysentery—generally of a mild nature and affecting the younger members of the community,—were markedly prevalent. Although the summer could not on the whole be considered unusually warm, it was characterised throughout by marked changes of temperature, which may have had considerable influence in determining the amount of sickness. Thunderstorms and windstorms were very frequent early in the season, and towards the end of August a typhoon of great violence passed over the Settlement.

During the year, among foreign residents there were four births and two deaths, the latter being caused by typhoid fever and cholera respectively.

The following are the notes of the fatal case of typhoid fever:—

Deceased, a male, aged 42 years, had resided in China upwards of 20 years, and had always been a free liver. On the afternoon of 30th June I was called to see him at his office. He said he was suffering severely from muscular pains all over his body; had been out of sorts for about a week; that three nights previously he had taken a dose of purging pills, and on the following morning a dose of Friedrichshall; and that ever since he took the medicine his bowels had been very loose. Temperature in mouth, 103°. Being very busy he reluctantly complied with my request to go home to bed. At bedtime he took 10 grains of quinine and 10 grains of DOVER'S powder.

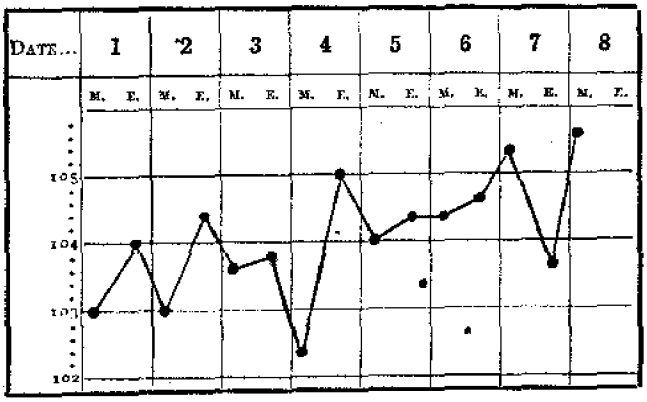
1st July, morning.—Had passed a very restless night; was much prostrated and felt that he must remain in bed. Tongue moist, slight white fur; had three loose motions during the night. Abdomen somewhat tumid, ileo-cæcal gurgling, and slight tenderness on pressure in the right iliac fossa. Area of splenic dulness increased. Pulse, 92; heart and lungs normal. No albumen in urine. Skin moist; temperature in axilla, 103°. Up to the evening of 4th July, beyond increasing prostration, there was but little change in the condition. The nights were restless. Daily, from three to six loose motions were passed. The pulse ranged from 88 to 96, full and strong. Since the morning of 1st July the temperature had been carefully taken in the axilla almost every two hours during the day, and sometimes when awake at night the temperature was also recorded. From these records it was observed that the morning remission was of very short duration. The temperature began to remit at 7.30 A.M., and the daily exacerbations commenced at 9 A.M., reaching the highest point early in the afternoon. With but slight variations the temperature remained high till the following morning. At 6 P.M. on 2nd July temperature was 105°; pulse, 100. At 7 A.M. on 3rd July temperature was 104°.3. On 4th July a few rose spots scattered over the epigastrium were noticed.

5th July, morning.—Muttered and talked a good deal in his sleep. Intellect seems cloudy, and he is very deaf. Has no headache, but says scalp all over is tender to touch. Has no desire for fluid, but when given drinks greedily. Tongue, thick fur in centre. During night passed two loose, peasoup and very fœtid stools. Abdomen all over tender. Area of splenic dulness much increased upwards. A number of rose spots were seen over the chest and upper surface of abdomen. Had a slight cough, with mucous expectoration. Pulse weak, small, 120. In this condition patient remained till the morning of 7th July, when he was completely prostrated and lay in an unconscious state, from which he was with great difficulty aroused. After repeated pressing he was induced to show his tongue, which was dry and brown, and the teeth were covered with sordes. Loose motions containing a little blood, and urine had been passed in bed. Abdomen distended with gas. Pulse, 120, weak, soft, double. The dependent portions of lung were dull on percussion. A gradually cooled bath greatly ameliorated his condition, so that he was able to speak and intelligibly answer questions; but he quickly relapsed into a semi-conscious state, and, except when roused to take food or to be bathed, so remained till 3 P.M. on the afternoon of 8th July, when he died.

From the morning of 1st July the patient had daily consumed as food and drink 4 pints of milk, to each draught of which an equal quantity of either soda-water or Apollinaris had been added. Towards the end of his illness he had to be roused to take his food, but when roused drank as quickly as his parched tongue would permit. Up to the morning of 6th July 30 grains of quinine, in divided doses, commencing the administration with the morning remission, had daily been given. Up till the evening of 4th July the patient's body had, every four hours, been sponged with water; afterwards the gradually cooled bath was substituted for sponging. On the morning of 5th July the administration of alcoholic stimulants, in small and frequently repeated doses, was commenced, but never had any beneficial influence over the course of the illness. From the first an ice cap had been worn, and, to control diarrhœa, small doses of DOVER'S powder had been used from time to time.

Postmortem, 5 Hours after Death.—Only the abdomen was examined. The temperature in the recto-vesical pouch was 108°. In the ileum the characteristic lesions of enteric fever were found in a very aggravated form. PEYER'S glands were extensively disorganised, and many of them, almost separated from the surrounding portions of bowel, were on the point of sloughing. The mesenteric glands were greatly enlarged. The spleen was four times its natural size.

The accompanying chart shows the fever curve. The temperature was taken in the axilla at 8.30 A.M. and 7.30 P.M.



About the same time that the fatal case of typhoid fever occurred, three other foreign residents, occupants of the same house, were affected with this disease, which ran a mild course and ended in recovery.

It is very likely that the disease was communicated by milk contaminated with polluted water. For some time those affected had been getting their milk supply from the same native dairy. *Some months previous to the outbreak of the fever I had, at the request of the head of* the house in which the three cases occurred, examined the milk ordinarily supplied, and found that at the very least the sample had been diluted to the extent of one quarter.

The death from cholera occurred on the 25th August.

On 15th August deceased was taken ill with acute dysentery, which most satisfactorily yielded to the usual treatment by large doses of ipecacuanha. Since 22nd August he had felt quite well; formed stools had been regularly passed; and he had been attending to his duties. At 10 P.M. on the evening of 24th August, when he retired to rest, he was perfectly well, and slept well till 4.30 A.M., when he was suddenly seized with profuse vomiting and purging. Extreme prostration quickly followed; severe collapse set in early; and death occurred at 2 P.M. The usual treatment, together with hypodermic injections of morphine and ether had no beneficial effect.

On the following day, at 2 P.M., the servant of deceased was suddenly attacked with cholera, and after an illness of five hours' duration, died.

In November a non-resident foreigner died of hypertrophic cirrhosis of the liver.

The deceased gentleman, who was 59 years of age, had always been a careful liver, but had never enjoyed robust health. Thirty years ago, after residing in Foochow for four years, failing health compelled him to return to his home in America. There he was speedily restored, and although occasional slight dyspeptic troubles occurred, he was able, until a short time before death, to pursue with vigour his professional calling. About midsummer 1884, being in weak health, and an opportunity of revisiting the East having presented itself, he, thinking that a sea voyage would improve his condition, sailed for China. His journey across the Pacific did not have the desired effect, and during a sojourn in Japan and North China serious derangement of the digestive functions set in. By 16th September the stomach retained nothing but fluid food, and there was slight jaundice. Towards the middle of October but little fluid food was retained by the stomach; jaundice had greatly increased; and hepatic pains became troublesome. On 6th November he reached Foochow. Failure of digestion and nutrition had by this time caused much exhaustion and emaciation; icterus was intense; and at times he complained of much pain in the hepatic region. The area of liver dulness was uniformly excessively increased. In the nipple line absolute dulness on percussion extended from the nipple to a point 3 inches below the margin of the ribs. In the middle line of the body the liver reached the navel. The surface of the liver where not covered by the ribs was found to be perfectly smooth; no fluctuating or soft spot could anywhere be detected, and the lower margin was firm, smooth and well defined. The spleen was much enlarged. There was slight ascites. The physical signs of heart and lungs were normal. The urine was stained to almost the colour of porter by bile pigments. Sometimes in the evening there was slight fever.

During the first week of his residence in Foochow careful feeding by the mouth and by the rectum, with rest in bed in a warm room, caused slight improvement; but after the first week he gradually sank till 22nd November, when he died.

At a postmortem examination held some hours after death the liver was found to be enormously enlarged, weighing 150½ ounces. It presented a smooth surface, was exceedingly firm and tough, and when laid on a table did not alter in shape. The cut surfaces were of a greyish-green colour and had a mottled, granular appearance. A little bile and five small gall-stones were found in the gall bladder. In the large bile channels no obstruction could be found. The spleen was three times its natural size, and the head of the pancreas was very large and of fibroma-like consistence.

Among natives during the year there was no epidemic.

The occurrence of small-pox during the winter months has in recent years been extensively modified in its extent. Vaccination, for some years gratuitously provided by the native authorities, has been eagerly sought after.

In summer several severe and fatal cases of typhoid fever were observed among the Chinese.

Towards the end of August and in September a few sporadic cases of cholera were encountered. After a few hours' illness, characterised by the most marked manifestations of malignant cholera, death usually occurred. In July some deaths, ashore and afloat, caused by cholera were reported from Sharp Peak. The disease was next heard of among the floating population on the river off the foreign settlement, and after this a few cases came to light in the villages around us.

From the middle of July up to the end of September 30 cases of beri-beri were admitted into the Foochow Native Hospital. As far as admissions into hospital went, the disease was confined to soldiers, and with the exception of one case in a soldier from Swatow, the remaining 29 cases occurred among soldiers who had during the previous autumn come overland from Honan. No cases in natives of this province were met with, and hitherto I had not seen the disease. Annually during the past six years about 5,000 new out-door and in-door patients have been treated by Dr. ADAM and myself at the Foochow Native Hospital, and until this summer we had not met with a case of beri-beri, neither could I find any record of this disease at the other native hospitals in Foochow.

DR. B. S. RINGER'S REPORT ON THE HEALTH OF AMOY

For the Half-year ended 30th September 1885.

THE *half-year just terminated has been one of the most unhealthy periods noted for* many years past in Amoy; dysentery, diarrhœa, typho-malarial and enteric fevers, and hepatic congestions being amongst the most serious cases treated.

Three deaths have to be reported: one from acute dysentery, one from apoplectic coma and one from enteric fever.

There were four births.

The patient who died with apoplectic coma was brought into the Kulangsu Sailors' Hospital from a light station in a state of complete insensibility, and died without recovering consciousness. The history *of the case was not very clear, but it appeared there had been some exposure to the sun.*

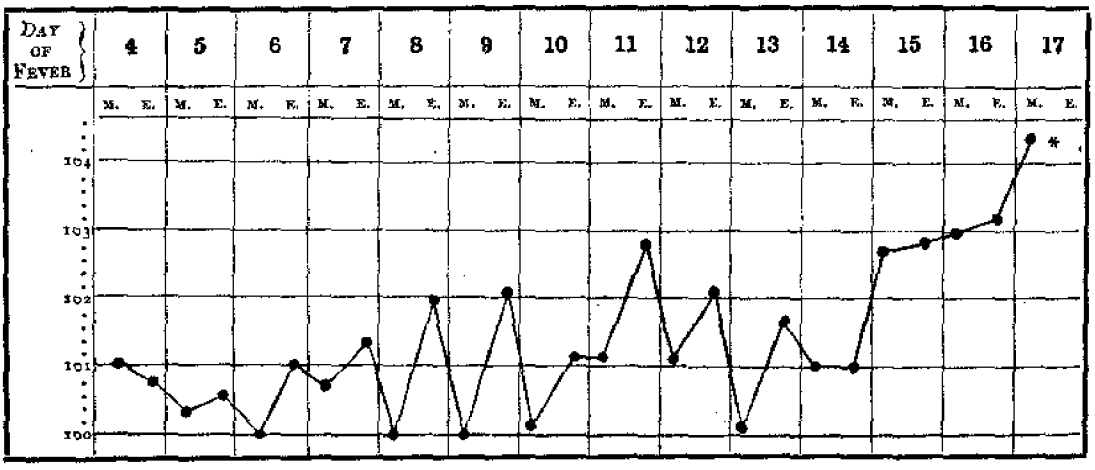
At a postmortem examination the dura mater was found partly adherent at the posterior portion of the vertex, both to the skull and pia mater, which was generally congested; there was also considerable congestion of the choroid plexus. On section of the brain, numerous blood puncta were visible, disseminated throughout the cerebral matter.

A severe case of typhoid fever occurred in July, which terminated fatally before the middle of the third week.

There was no characteristic eruption in this case. From the following chart it will be seen that a *very high temperature was reached towards the end of the disease, the thermometer registering 108°.2* Fahr. in the axilla shortly before death.

A rapid accession of heat took place on the last day, the temperature rising without interruption from 104°.5 in the early morning till it reached the maximum recorded.

ENTERIC FEVER.



* Temperature at 1.15 P.M., 108°.2; death took place at 1.37 P.M.

Great mental confusion existed from early in the case, and it was very difficult to persuade the patient that he was seriously ill, as he did not suffer any severe pain.

The bowels were generally loose, but there was no grave diarrhœa.

On the 14th day of the fever a copious evacuation of offensive, dark-coloured liquid and broken-down blood clot took place early in the morning, and was repeated, to a less extent, later in the day, but never afterwards; and from that day forward, it will be seen by the chart, the temperature gradually rose without remission until the time of death.

At a postmortem examination, on opening the peritoneum there was an escape of fœtid gas; the abdomen, however, contained no free fluid, nor was the appearance of the peritoneum notably altered. Towards the right iliac region deep congestion and matting of tissues were so pronounced as to render the removal of the cæcum a matter of difficulty. A continuous portion, consisting of about 2 feet of small intestine and half a foot of colon, was removed for examination; on being opened it was found to contain a small quantity of disintegrated, treacly blood of very fœtid character. In the neighbourhood of the ileo-cæcal valve and for a few inches above that spot there were characteristic ulcerated PEYER'S patches; the ileum above the valve was sacculated, and in the sac was found a large, ill-defined sloughing ulcer perforating the wall; the margin seemed normal. Three-fourths of the circumference of the cæcum immediately below the valve was found to be a sloughing, ulcerated mass, with the wall perforated in one part, forming an opening sufficiently large to admit the forefinger, the perforation being, however, protected by adhesions. Extending along the colon downwards for 9 inches were found a number of typical ulcerated PEYER'S glands; at this spot a large sloughing, non-perforating ulcer, the size of a florin, was found, the corresponding peritoneal surface of which was deeply congested but not adherent. The contents of the colon were small in quantity and of the same colour and consistence as that of the small intestine, and the bowel was distended throughout with fœtid gas.

The fatal case of dysentery was seen only a few days before the termination of the disease. It seems to have supervened after a severe attack of neglected diarrhœa, during which the patient injudiciously indulged daily in quantities of pineapples and other fruit.

The attack was very acute, tenesmus and constant action of the bowels being marked symptoms; these were, however, to a certain extent modified by large doses of ipecacuanha, which were well borne, but the patient was too far gone to recover.

At a postmortem the whole of the interior of the rectum and a considerable portion of the colon was one mass of ulceration, the mucous membrane of these parts having entirely disappeared.

Of the four births, three labours were natural.

In the fourth case the pelvis, though of normal shape, was unusually small; and on two previous occasions the mother, after prolonged suffering, was delivered instrumentally of dead children at the full time, on each occasion the child being fully developed and of large size, death resulting from the necessary surgical proceedings. It was therefore considered advisable on the last occasion to induce premature labour, which was accordingly done a month before the expected time, in the manner recommended by BARNES, and after some delay in the production of uterine action, the patient was safely delivered by forceps of a living female child. Both progressed favourably without an untoward symptom.

DR. A. HENRY'S REPORT ON THE HEALTH OF ICHANG

For the Half-year ended 30th September 1885.

THE weather during the past summer was fine and dry, and there was an absence of serious illness among the population. Malarial fever I scarcely heard of, and in this district no cases of cholera occurred in the period under review. But from Shashih and other low-lying places between this and Hankow there were reports of an epidemic disease which from the descriptions seemed to be cholera. As some cases of this nature have lately occurred in Ichang, I shall defer any further mention of the disease until my next Report.

The health of the Customs staff was very satisfactory; and as a residence Ichang seems to be one of the healthy ports, especially as regards immunity of foreigners from malarial disease. Of the poorer natives I saw a considerable number as patients, but their maladies were generally of a trifling character. One exceptional class must be noticed, however, namely, cases of syphilis. In Ichang this disease is very rife, and the symptoms are much more severe than I have seen in England. Secondary eruptions assume always a pustular or psoriasis-like character, and in a short time perforation of the palate is liable to come on. Treatment with PLUMMER'S pill seems to do very well, and I find mercury in this form is generally well borne.

The following case is perhaps worthy of note:—

A child, 18 months old, was brought to me, which, it was alleged, had swallowed a pea-nut seven days previously. It had suffered since then from repeated paroxysms of coughing; its breathing was always laboured, and any attempt to take solid food brought on a fit of coughing. When I saw the child these symptoms still existed; and on making an examination with the finger I fancied I detected a foreign substance in the back of the pharynx, but it was not so hard as a pea-nut might be supposed to be. However, on withdrawing the finger the child was noticeably better; it breathed easily, and on its trying to take a lump of sugar, the swallowing was easy and followed by no fit of coughing. Apparently, the offending mass had been sent down the gullet by the finger, and the child left perfectly cured.

In cases of ophthalmia where the cornea is implicated I find calomel flicked into the eye the most ready and efficient remedy, and it has as marked an effect on the conjunctival inflammation as on the corneal ulceration.

I append a meteorological table for the summer months; it is abstracted from observations (except the barometrical readings for April, May and June) taken with new and corrected instruments.

Meteorological Table.

Month.	Thermometer (Fahr.).				Barometer.		Rain.	
	Highest.	Lowest.	Average Highest.	Average Lowest.	Highest.	Lowest.	Fall.	No. of Days.
1885.	°	°	°	°	*Inches.*	*Inches.*	*Inches.*	
April	93.70	38.80	66.64	53.36	30.30	29.63	2.43	12
May	92.30	57.60	78.58	64.89	30.12	29.71	4.78	17
June	95.50	62.20	84.40	70.30	30.15	29.68	5.77	15
July	101.90	68.40	91.13	74.43	29.84	29.44	7.80	10
August	103.20	70.80	97.00	76.64	29.86	29.49	2.92	11
September	96.50	60.80	88.31	65.29	30.16	29.75	1.25	5

DR. J. H. LOWRY'S REPORT ON THE HEALTH OF PAKHOI

For the Half-year ended 30th September 1885.

THE health of the foreign community during the period under review has, on the whole, been good.

The summer has been hotter than usual, and the rainfall has been in excess of previous years; during August it was very great.

Two births have to be reported, the first since the opening of the port. A case of dysentery occurred in a missionary after return from a tour in the interior, and gave way to treatment. A case of liver inflammation and one of phthisis fill up the list of serious cases that have required treatment.

Luen-tzŭ (鼠疫) *or Bubonic Plague.*—Not a single case has occurred here this year, but a few cases were reported at the prefectural city of Lienchou.

I append my own meteorological observations taken here (latitude, 21° 29′ N.; longitude, 109° 6′ E.), supplemented by the Harbour Master's register of the rainfall for six months.

METEOROLOGICAL TABLE.

MONTH.	THERMOMETER.						RAIN.		REMARKS.
	Highest by Day.	Lowest by Day.	Highest by Night.	Lowest by Night.	Average Day.	Average Night.	No. of Days.	Fall.	
1885.	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*	° *F.*		*Inches.*	
April	86	60	79	59	78	70	6	2.60	Several severe thunderstorms occurred.
May	90	73	86	72	85	77	6	6.40	
June	89	74	85	72	84	76	13	24.50	
July	88	75	87	76	84	80	9	15.40	
August	88	72	85	73	83	76	21	47.70	
September	87	73	85	73	83	76	10	12.10	

DR. ALEXANDER JAMIESON'S REPORT ON THE HEALTH OF SHANGHAI

For the Half-year ended 30th September 1885.

ABSTRACT of METEOROLOGICAL OBSERVATIONS taken at the Observatory of the Jesuit Mission at Zikawei, for the Six Months ended 30th September 1885. Latitude, 31° 12′ 30″ N.; Longitude E. of Greenwich, 8h. 5m. 45s. *

DATE.	Barometer at 32° F.	THERMOMETER. Diurnal Mean Temperature in Shade.	THERMOMETER. Extreme Temperature in Shade.	Amount of Vapour in the Air per Cubic Foot.	Humidity, 0–100.	Ozone, 0–21.	Velocity of Wind per Hour.	Mean Direction of Wind.	Total Evaporation during Month.	Total Rainfall during Month.	REMARKS.
1885.	*Inch.*	° *F.*	° *F.*				*Miles.*		*Inch.*	*Inch.*	
April ... Max...	30.296 (8)	69.1 (27)	83.8 (27)	.01677 (28)	94 (5)	18 (6)	40.4 (29)	N. 78° E.	3.122	5.372	Fourteen rainy days. Thunderstorms on 7th, 13th and 26th.
Mean	30.032	53.4	...	.01074	78	13	13.6				
Min....	29.574 (28)	41.0 (5)	26.4 (22)	.00708 (9)	59(29)	6 (27)	Calm				
Range	0.722	28.1	57.4	.00969	..	...	...				
May..... Max...	30.209 (2)	72.7 (8)	86.0 (8)	.02281 (31)	88(16)	15 (15)	39.2 (15)	S. 76° E.	3.825	4.209	Fourteen rainy days. Thunderstorms on 4th, 8th, 30th and 31st. Magnetic disturbances on 10th, 14th, 26th, 29th and 30th.
Mean	29.875	65.7	...	.01639	76	11	13.2				
Min....	29.575 (26)	56.8 (1)	46.0 (1)	.00981 (2)	62 (2)	7 (11)	0.6 (25)				
Range	0.634	15.9	40.0	.01300	...	...	...				
June.... Max...	30.103 (4)	78.3 (19)	87.1 (19)	.02896 (25)	94(14)	15 (30)	32.3 (10)	S. 70° E.	2.673	11.437	Twenty rainy days. Thunderstorms on 9th, 19th, 20th and 25th.
Mean	29.749	72.2	...	.02258	82	11	11.9				
Min....	29.514 (16)	64.4 (4)	51.8 (4)	.01101 (5)	56 (5)	7 (5)	2.0 (1)				
Range	0.589	13.9	35.3	.01795	...	...	...				
July .... Max...	29.959 (12)	85.5 (16)	94.8 (16)	.03401 (27)	97 (8)	16 (9)	34.8 (29)	S. 49° E.	4.244	3.576	Twelve rainy days. On the 11th first chirp of the grasshopper (*Cicada*). Thunderstorm on the 21st.
Mean	29.705	78.6	...	.02836	84	10	15.9				
Min....	29.493 (3)	70.5 (2)	64.2 (6)	.02204 (6)	72(15)	6 (17)	1.2 (10)				
Range	0.466	15.0	30.6	.01197	...	...	...				
August Max...	29.882 (13)	89.4 (21)	100.2 (21)	.03876 (29)	95 (3)	12 (30)	60.3 (3)	S. 50° E.	4.738	2.083	Six rainy days. On the 3rd–4th typhoon between Shanghai and Ningpo, running westwardly. Thunderstorms on 18th, 21st and 29th. Whirlwind on the 21st, afternoon, over Huangp'u.
Mean	29.715	83.3	...	.03215	81	6	16.5				
Min....	29.164 (4)	78.1 (31)	68.4 (31)	.02677 (8)	74(19)	0 (24)	0.5 (8)				
Range	0.718	11.3	31.8	.01199	...	...	...				
Sept. ... Max...	30.189 (30)	82.9 (12)	92.1 (8)	.03307 (12)	95(22)	11 (22)	22.3 (23)	N. 45° E.	3.061	5.616	Twelve rainy days. Thunderstorms on 1st, 2nd and 5th.
Mean	29.891	74.1	...	.02332	81	8	10.8				
Min....	29.575 (6)	66.2 (25)	56.7 (28)	.01650 (26)	71(18)	6 (12)	Calm				
Range	0.614	16.7	35.4	.01657	...	...	...				

* Position of British Consulate-General, Shanghai :—Latitude, 31° 14′ 41″ N.; longitude, 121° 28′ 55″ E. of Greenwich.

NOTE.—The figures in parentheses indicate the days on which the observations to which they are appended were made. Under the headings "Diurnal Mean Temperature in Shade," "Humidity," and "Ozone" they indicate the days on which the *mean readings* were respectively highest and lowest.

For the above abstract I am indebted to the Rev. Superintendent of the Zikawei Observatory. Frequency of thunderstorms, large amount of rainfall, and generally moderate degree of temperature were the notes of last summer as they struck the ordinary resident. The highest temperature registered at Zikawei was 100°.2, on the 21st August. In the Settlement 95.°4 was the highest reading of a NEGRETTI and ZAMBRA standard, hung about 30 feet from the ground and carefully sheltered from radiation. This maximum was reached on two consecutive days—the 20th and 21st August. Night temperatures were reasonably low all through the summer, the highest minimum occurring on the night of the 20th August, when 82° was registered. On the 15th September the night temperature fell to 58°, and after this date there was no notable rise.

The diseases usually prevalent during the summer months presented this year little worthy of special remark. Enteric fever, malarial affections, including neuralgia and orchitis, catarrhal sore throat (starting chiefly as tonsillitis), muscular rheumatism in its various forms, hepatic congestion, diarrhœa and dysentery, including the acute inflammatory diarrhœa of children, contributed most largely to the monthly sick lists. So-called typhus, probably in most instances neglected remittent fever, proved fatal to a large number of natives. Conjunctivitis of a severe grade was frequently observed among foreigners. Two cases of pernicious fever with choleraic symptoms, in children, occurred in my practice between the 23rd and 25th August, but yielded to general treatment and quinine in large doses. A third case, also in a child, of which I am informed, terminated fatally on the 23rd August; but this was probably cholera. There was a very remarkable outburst of dysentery and inflammatory diarrhœa during the first half of August, affecting persons exposed to the most various conditions, and irrespective of age or sex. At this time the weather was dry, the temperature ranging between 72° and 90°. In the middle of May, when the weather suddenly became cold and wet, there was also a short period marked by rapid increase in the number of cases of fever and diarrhœa and by the temporary going wrong of patients already convalescent from climatic troubles. Yet a precisely similar burst of wintry weather at the end of May was attended by no such alteration in health conditions.

Towards the close of June a very high mortality among the Chinese was reported. Persons in excellent health were said to be seized with fever accompanied by diarrhœa, which carried them off with great rapidity. Children specially suffered. I saw no cases. A month later cholera had fully established itself among the natives.

The crew of the French gun-boat *Aspic* were among the earliest foreign sufferers from cholera. The following memorandum of their experiences was kindly supplied by Dr. CAUQUIL of the French navy:—

During the first half of August a certain number of men, varying between 12 and 15, daily presented themselves at the morning visit, complaining of diarrhœa. About 30 in all were attacked, out of a total strength of 90. The affection was usually trivial, and yielded readily within four or five days to treatment with bismuth, diascordium and laudanum. A few cases, however, were less amenable, the flux lasting for 10 days or so. The discharges were generally serous, devoid of bile and extremely liquid. Things were in this condition when at 9 A.M. on the 13th August a lad aged 17, who had not been among the sufferers from diarrhœa, complained of a sudden dizziness which had attacked him a few minutes before when going to stool. He had been picked up almost insensible and carried to the sick-bay.

The skin was pale, damp and cold; pulse, small, weak, 95; pain in lumbar region, fugitive cramps in the calves, occasional violent griping; tongue dry. He was ordered a cup of tea with rum, and a spoonful halfhourly of a mixture containing sulphuric ether and laudanum. Two hours later the colic and the cramps in the legs had become violent and almost continuous. Prostration extreme, face earthy, eyes sunken, pulse fallen in frequency (80) but almost imperceptible. Every half hour there was a gush of blackish fluid from the bowels. The medicine was continued, 6 grammes of acetate of ammonia was administered in a single dose, and champagne was ordered. Everything swallowed was, however, rapidly rejected by vomiting. The patient was meanwhile wrapped in blankets. No effect was produced by treatment, and death occurred at 2 P.M., cyanosis being then general. The rectal temperature taken after death was 40°.3 C. Rigidity set in about 1½ hour later.

Meanwhile the *Aspic* had started for Hongkong at noon on the 13th. Three fresh cases occurred during the night of the 13th–14th.

One of the patients, who was attacked at 1 A.M., presented identically the same symptoms as those noted in the first case. Treatment with large doses of extract of opium, along with acetate of ammonia and champagne, was immediately instituted, but medication was rendered inoperative by uncontrollable vomiting. We were at sea, and without the help which ice would have afforded in calming the gastric irritability. The patient died about 10 A.M.

The symptoms were less acute in the other two cases, who were torpid and indifferent.

The lad first attacked had not been on shore for a fortnight. The second had landed frequently and had paid several visits to the native city.

On the evening of the 14th a fourth man came under treatment, raising the number of cases actually on board to 3. The treatment for all alike was as follows:—

Champagne every hour.

One spoonful hourly of a mixture containing—

Extract of opium	0.20 gramme.
Sulphuric ether	20 drops.
Acetate of ammonia	8 grammes.
Peppermint water	25 „
Water	100 „

Cold rice water and barley water were given as drinks. An enema of carbolic acid was administered morning and evening.

The *Aspic* had now put back to Woosung. During the forenoon of the 15th a fifth case occurred. Every case of diarrhœa, however slight, was sent to the General Hospital, and I landed at Woosung the four men who were too ill to be sent to Shanghai. The ship was carefully disinfected with sulphurous acid gas, and scoured with carbolic acid and permanganate of potash in solution. Chloride of lime was also freely used.

On the 16th I sent one of the men to hospital who had been attacked during the night of the 13th–14th. A sixth case occurred on this day, whom I kept at Woosung.

On the 17th a case (the seventh) clearly of cholera, but which I thought could bear the journey to Shanghai, was sent to the General hospital.

The fourth case, in order of seizure, died on the afternoon of the 17th. There had been some appearance of recovery. Reaction had set in on the 16th, with fever. I administered 40 centigrammes of quinine, but in the evening typhoid symptoms manifested themselves. Vomiting had ceased, diarrhœa had greatly diminished in frequency; cerebral disturbance, however, began to dominate the scene. He became prostrate, somnolent, half insensible, betraying only fear of light. Thirst continued. I ceased the administration of opium, and applied dry cups beneath the clavicles, and sinapisms to the legs. The feet were rolled in flannel wrung out of hot water. At the same time extract of cinchona was given in a 2-gramme dose. Cold milk as food. In spite of this treatment the patient went from bad to worse, and finally died.

The treatment adopted at the temporary hospital at Woosung was nearly the same in all cases. The only differences consisted in the quantities of food and medicine administered and in the intervals

between the doses, in correspondence with the idiosyncrasy of each patient, his tolerance, and his proneness to vomit. Cold weak tea was given as a drink, and iced champagne to arrest vomiting, which but rarely failed of success. To meet the torpor, and the depression of the circulation, acetate of ammonia was administered in combination with large doses of ether, in peppermint or balm water. When vomiting was urgent I gave this mixture iced. I endeavoured to combat the diarrhœa by antiseptic enemata of carbolic and boric acids, with opium in minute pills, which were easily borne. As soon as gastric irritability had somewhat diminished, and vomiting became less urgent, I gave iced milk in small quantity frequently. Energetic friction with a piece of flannel dipped in camphorated spirit was generally useful in diminishing painful muscular cramps. A broad flannel band was rolled round the abdomen of each patient.

On the 21st I sent all the men under treatment at Woosung to Shanghai, where convalescence proceeded without interruption.

To sum up. We had 8 cases of grave and unmistakable cholera, with 3 deaths. With regard to treatment, most benefit was derived from champagne and acetate of ammonia. Under their influence vascular tension was maintained, and was raised when it had already fallen. Ice proved extremely useful in controlling vomiting.

The first fatal case of cholera on shore in Shanghai occurred on the 23rd August in a non-resident, an old resident dying the same day.*

Cholera made its appearance among foreigners at Kobé during the last days of August. For some weeks it had prevailed among the native population at this place and at Nagasaki, where it was officially announced on the 22nd August. At Takashima cholera was not reported among the miners until the 10th September, but the mortality speedily became so great that during one night 125 corpses were burned. The U.S.S. *Ossipee*, which had left Shanghai early in August, lost 5 men at Kobé, diarrhœa having prevailed among the crew for nearly a month previous to the cholera outbreak. The first man seized (28th August) had not been on shore for six days, and some of the others (seven in all) had not landed since the ship's arrival in Japan. Coal had been taken in at Nagasaki on the 20th August, but, to say nothing of the discrepancy between the dates, no fireman suffered during the epidemic, which renders it unlikely that the coal was the vehicle of contagion. The *Trenton*, moreover, coaled at Nagasaki after the *Ossipee*, but had no cases of cholera.

An epidemic, mild as regards numbers, broke out in Yokohama on the 5th September. Only 54 cases were reported up to the 20th October, but of these 75 per cent. died. The cases were scattered all over the native quarters, and one was rarely followed by another in the same house or neighbourhood. The average number attacked in a single day was 4, and never rose above 10. The Japanese Government, acting chiefly under skilled foreign advice, took very active measures to restrict the spread of the disease, and was remarkably successful in limiting it, in spite of the malignity of the form assumed by individual cases. *The greater number of those seized died after one or two stools or attacks of vomiting, too early* to exhibit dyspnœa or even the withering of ordinary cholera. During September and October hæmorrhagic evacuations were the rule.† Premonitory diarrhœa was seldom present. No treatment appeared to have the least effect. But one foreigner was attacked, and he was one of the only two asphyxial cases observed.

A fatal case of cholera in a foreigner occurred at Kiukiang on the 13th September.

* The last fatal case for the year occurred on the 28th October, in the person of a sailor. The number of deaths from cholera in October was 12. Of these, one only was a resident,—a colporteur, and therefore much exposed to unhealthy conditions.

† Compare with first case on board the *Aspic*.

Towards the end of August a curious and fortunately brief epidemic was reported as proving extremely fatal among the natives in Shanghai and the suburbs. Children were specially the victims. An individual would go to bed at night apparently well; but in the early morning he would be found sweating profusely and perfectly cold, death occurring in less than an hour. I verified this account as far as it could be verified by means of Chinese agents, but I saw no cases myself.

The subjoined return of burials in the foreign cemetery is compiled from the municipal registers and from the sexton's books, the latter kindly placed at my service by Mr. OLSEN.

BURIAL RETURN of FOREIGNERS for the Half-year ended 30th September 1885.*

CAUSE OF DEATH.	APRIL.	MAY.	JUNE.	JULY.	AUGUST.	SEPTEMBER.	TOTAL.
Measles	...	...	*f* 1†‡	...	...	...	1
Pernicious malarious fever	...	...	...	...	*f* 1‡	...	1
Enteric fever	...	...	...	...	1§‖	...	1
Cholera	...	...	...	...	1 2§ *f* 1	3 2§ 1‖ *f* 1‡	11
Diphtheria	...	...	*f* 1	...	...	...	1
Infantile marasmus	...	...	...	...	*f* 1‡	...	1
Rheumatism (chronic)	...	1‖	...	...	...	...	1
Tubercular peritonitis	...	...	...	...	...	*f* 1‡	1
Tubercular meningitis	...	*f* 1‡	...	...	*f* 1‡§	...	2
Alcoholism (chronic)	...	...	1	...	...	2	3
Heat apoplexy	...	...	...	...	1	...	1
Cerebral hæmorrhage	...	...	...	...	...	*f* 1¶	1
Phthisis	*f* 1	2	...	...	1§‖	...	4
Pneumonia	...	...	...	1§	...	...	1
Umbilical hæmorrhage	*f* 1‡	...	...	...	...	...	1
Diarrhœa (chronic)	...	*f* 1	...	...	1§	*f* 1‖	3
Dysentery	...	...	...	...	...	1§	1
Hepatic abscess	...	...	1	...	...	1	2
Nephritis (chronic)	...	...	1	1	...	1	3
Premature birth	...	...	1‡	...	...	...	1
Fracture of spine	1§	...	...	...	...	...	1
Fracture of skull	1§	...	...	...	...	...	1
Drowned	...	...	...	...	1§	1§	2
Uncertified or with non-medical certificate	...	1 *f* 1‡ *f* 1‡‖	...	...	1§	2‖ *f* 1 1§ *f* 1‡‖	9
TOTAL	4	8	6	2	13	21	54

* Not including deaths (if any) among the Catholic religious bodies, among Eurasians or Japanese; exclusive also of still-births.

† Macao parentage (1).
‡ Infants of any nationality (12, of whom 11 were females).
§ Non-resident (16).
‖ Manila (9).
¶ Aged 74.

We are first, at a cursory glance, struck by the facts that no European died of enteric fever during the period under review; that but 2 deaths occurred in July; that September, as usual, furnishes the largest contingent of mortality; and that, with one exception, all the infants that died were females. I may further note, though this does not appear from the table, that no deaths occurred between the 1st and the 21st June. Infant mortality was very high, forming 22.22 per cent. of the total, and is not to be explained by neglect, as out of the 12 children whose deaths were registered 1 only was of Macao and 2 of Manila parentage. The case of diphtheria occurred in a girl of 12, and is counted with the adult mortality. The case of infantile marasmus was directly due to artificial feeding, the child dying of diarrhœa at the age of 9

months. The immediate cause of death in the case of tubercular peritonitis fatal in September (child 1 year old) was total obstruction of the jejunum by the pressure of a mass of caseous mesenteric glands, around which plastic effusion had taken place.

The number of uncertified deaths (16.66 per cent.) or, what comes to much the same thing, of deaths certified by persons who are practically irresponsible, demands public attention. Unless the Municipal Council becomes less lax in permitting burials without reliable certificates, serious crime will sooner or later find convenient shelter under the polite facility with which permits for burial are now granted.

There was no case of suicide.

Subtracting from the total of 54 deaths, 2 cases of drowning, 2 of accident and 1 of premature birth, there remain 49 deaths attributable to disease. To this number young children contributed 11. The foreign adult mortality from disease was thus 38 (31 males and 7 females), against 27 (24 males and 3 females) during the corresponding period of 1884. The following tables present a full analysis of the figures :—

CAUSES of DEATH from DISEASE among RESIDENT EUROPEAN ADULTS.

Cholera	5 (1 female).	Phthisis	3 (1 female).
Diphtheria	1 (female).	Chronic diarrhœa	1 (female).
Alcoholism	3	Hepatic abscess	2
Heat apoplexy	1	Chronic nephritis	3
Cerebral hæmorrhage	1 (female).	Uncertified	2 (1 female).

16 males and 6 females, the numbers for the last previous corresponding period having been 10 males and 2 females.

CAUSES of DEATH from DISEASE among the CHILDREN of RESIDENT EUROPEANS.

Pernicious fever	1 (female).	Tubercular meningitis	1 (female).
Cholera	1 („).	Umbilical hæmorrhage	1 („).
Infantile marasmus	1 („).	Uncertified	1 („).
Tubercular peritonitis	1 („).		

7 females, against 4 males and 2 females during the summer six months of 1884.

CAUSES of DEATH from DISEASE among NON-RESIDENT EUROPEAN ADULTS.

Cholera	4	*Dysentery*	1
Pneumonia	1	Uncertified	2
Chronic diarrhœa	1		

9 males, as against 11 males and 1 female during the corresponding period of 1884.

CAUSE of DEATH from DISEASE of a CHILD of NON-RESIDENT EUROPEAN.

Tubercular meningitis . . . 1 (female).

CAUSES of DEATH from DISEASE among RESIDENT NON-EUROPEAN ADULT FOREIGNERS.

Cholera	1 (Manila).	*Diarrhœa*	1 (Manila, female).
Rheumatism	1 („).	Uncertified	2 (Manila).

4 males and 1 female (all natives of Manila), as against 3 males in the last corresponding period.

CAUSES of DEATH from DISEASE among NON-EUROPEAN FOREIGN CHILDREN.

Measles	1 (Macao, female).	Uncertified	2 (Manila, females).

3 females. 1 Malay female child died during the corresponding period of 1884.

One non-resident Manilaman died of enteric fever, and one of phthisis.

DR. H. N. ALLEN'S REPORT ON THE HEALTH OF SEOUL (COREA).

SEOUL, the capital of Corea, is a walled city of some 150,000 inhabitants, with upwards of the same number living just outside the walls, in the extensive suburbs. The city is located in latitude 37° 31′ N., longitude 124° 30′ E. (Paris). It is about 30 miles from the sea by road, and 80 miles by the Han or Seoul River, near which it is situated and with which it is connected by some 3 miles of suburbs.

The river is navigable by schooners up to the Seoul landing-mapoo. The tide is felt up to this place, and the water there is a little brackish at the highest tides.

The city is built in a well-drained basin formed by a high mountain on the north and one on the south, these being connected by high ridges, along the top of which the city wall is built. The city gates are located in breaks in this ridge, where the wall comes down to the basin level. The city side of the south mountain is covered with pines and is a refreshing resort for a hot day, while its green shows well through the winter snows. The break in the ridge of hills on the south-west side of the city allows full sweep to the prevailing winds, and as the majority of the foreigners live near the wall on this side, they are constantly supplied with pure country air. So far the foreigners live in native houses altered to suit their tastes, and in fact they make very pretty homes, with their large sodded compounds and abundance of trees, bushes and flowery terraces. The Japanese Legation building, which was burned last winter during the *émeute*, would have shown very well in a foreign city; it was a fine modern building in every detail. A similar building on a much smaller scale is now being erected for the use of the Japanese representatives at their new site on the south mountain.

The native house is built by laying isolated foundations of pounded stone, in which are set large stone uprights. These occur at every 8 feet—the unit of measure in building. The framework of unnecessarily large timbers is then built up upon these several foundations, and the tile roof is put on much as in China. The framework of the sides of the houses, after being divided into divisions 4 feet square, is filled in with a network of sticks tied together; this is plastered over first with mud and afterwards with mortar. If it is to be a stone house, stones are tied in this mud to the network within, having the smooth side out; tiles nicely cut are used in finishing up the work, and when the interstices are all filled in with white mortar the effect is very good. The house is built around a court, with perhaps another set of buildings, entirely secluded, for the female members of the family. The living rooms, which are to be heated, are usually 8 feet square, with sliding doors, so that several rooms may be thrown into one. The large reception rooms, which are not expected to be warmed, have board floors of a neat pattern, well oiled, and have windows over the whole of one side, so that they can be thrown up and the room made open to the court.

The small rooms are warmed by the very ingenious and fuel-saving *kang*. This is made by building a system of shallow flues where the floor is to be. These flues begin at a large

fireplace, and end in a deep trench at the other end of the house, into which the soot falls. This trench is connected with a chimney, which may be in tile running up the wall, a board trough, or a handsome tall chimney of fancifully cut brick, situated some 10 feet from the house and connected with the *kang* by a continuation underground of the above-mentioned trench. The flues are covered with large flat slabs of limestone from 2 to 4 inches in thickness. These are in turn evenly covered over with mortar, upon which is placed the very superior oiled paper, which forms a good substitute for European oilcloth, and answers its purpose better. The rooms are neatly papered inside with white or coloured paper, and when perfect no smoke should enter the room. The fireplace is so arranged that the family cooking may be done thereon, and the smoke and heat from the necessary cooking fire, made morning and evening, heats these large stones well, so that they remain warm till the time for the next fire. The heat is dry and comfortable. In a properly arranged house there should be no draughts, and the people do not seem to be greatly troubled with colds.

The foreigners use stoves largely in addition to the *kang*. One great objection to the use of the latter is the high price of wood, so that coal from Japan is cheaper than the native fuel. Of course the natives are not so lavish with their fuel as are the foreigners; they use very small rooms, and make a small fire often of grass or dried dung.

The food of the foreign population is mostly imported; beef, fowl, fish, game, rice, beans, a very few inferior vegetables, and some fruit in season making up the list of what the native market affords. They have pork, but it is too vile to eat. One great objection to the use of beef is that a sort of septicæmic disease is endemic here among the cattle, and the diseased and worn-out animals are taken for food. At times this trouble becomes violent and rapidly fatal to the beast, as also to man after eating the flesh.

The climate can hardly be discussed, as it has been tested but a couple of years by foreigners. Aside from the rainy season, however, it seems to be delightfully dry and equable, which has led to its being recommended as a temporary resort for persons suffering from throat and lung troubles. The cold weather begins in September by the nights growing cooler; by the last of the month fires are necessary in the evening, while the midday is quite hot. It continues in this way, the end of each week a little colder than the end of the preceding week, the change being scarcely noticeable from day to day, till about the middle or latter part of December, when cold weather may be said to have come in force. The river is frozen over, so that large carts loaded with tons of goods and drawn by two or three bulls may pass over on the ice. From this time the thermometer (at Seoul) does not vary much, but remains from 8° to 12° Fahr. for some two months or two months and a half. The 1st March is ushered in by the slight thaws of February becoming more extensive; strong south-westerly winds take the place of the north-easters, and snow and ice begin to disappear. The passage over the frozen river becomes dangerous, and a canal is cut through the ice for ferry-boats.

Spring comes in, as did autumn, in a gradual manner. The proverbial showers of April follow the winds of March in most perfect order, after which come two months of very dry weather, growing hotter each week till in the middle of June it seems about as hot as it

can get. When showers begin, they increase till about the middle of July, when the rainy season is well established, and the water comes down very hard and very steadily for two or three days and nights, stops a little and comes again, but not quite so heavily. This decreasing scale is kept up till about the 1st September, when fair weather sets in again. During the rainy season all drainage seems inadequate. The little stream which winds through the city, within its banks of masonry and under the numerous stone bridges, becomes a raging torrent, sweeping away the masses of filth that have been poured upon its dry sandy bed during the whole year, and occasionally it carries away one of the large embankment stones, whereupon a huge rent is made by the wash in the sandy soil. Not a few houses are destroyed in this way. The streets running down to this stream become themselves swift streams, in which, if one must venture out, it is necessary to wade carefully with the water up to the horse's belly.

The soil being mostly of clay, or the porous granite sand washed down from the mountains, these deluges of course leave the streets in a very bad condition, as the sand is washed out from the clay, leaving the stones. Some people are killed every year by houses falling upon their sleeping inmates. These houses are usually thatched huts, however; a tiled house would have a proper foundation.

At present the drainage of the city is in a very bad condition. When the place was first laid out, its founders had good ideas, and left the streets of fair width, being from 20 to 200 feet wide. Along either side an open drain was left, with sufficient fall to allow of the carrying away of water and filth to the before-mentioned stream, which acts as a main sewer. There were also some very large covered stone drains, 3 feet high by 4 feet wide, only a few of which remain in good condition at present. This arrangement allowed the proper sluicing of the city whenever Nature's flood-gates were opened with a sufficiently heavy rain. At present, however, the streets are badly encumbered with thatched shops placed in front of the main line of tiled stone houses. These booths usually cover the drain and more or less encroach upon it, and in many places a house with foundations is built out into the street, damaging the appearance and causing the drain to make a bend. In these and many other ways the sewers are obstructed, so that the filth from the houses, after being shoved through a hole in the house wall, lies and rots, unless eaten by the dogs or pigs or carried away by the very few gardeners who go about as scavengers.

The wells of the city are placed along the streets, probably in a nook taken from two adjoining compounds. The drain runs along just above and very near, so that it is almost certain that the water from the overloaded drain finds easy access to the well. There are springs of good water upon the mountain sides, within the walls, and men make a business of supplying water, supposed to be from these springs, to their customers. Samples have, however, been sent to me, together with other samples from the nearest well; it is hardly necessary to say that I found them identically the same. Foreigners use largely water taken from wells within their own compounds, and great care is used in boiling and filtering the water.

With this introduction, the health of the foreign community may be intelligently considered.

With one exception, there has been no serious illness among Europeans. The exception was in the case of one who through great exposure during the troubles of last winter, and a strong predisposition to pulmonary disease contracted phthisis. He has, however, been able not only to hold his own during the severe rainy season and the period when beef could not be eaten because of the cattle plague, but has gained flesh, so that his weight is greater than ever before. One lung is completely disabled, and he has had to endure the drain of a profuse expectoration of the diseased matters.

Several cases of intermittent fever have occurred, but have yielded to treatment. Diarrhœas were common during and just after the wet season, owing doubtless to the fact that floors, walls and roofs were saturated and mouldy from the dampness. One case of chronic dysentery of long standing has been treated. A few specific ailments, one case of writers' cramp, and slight cases of bronchitis among the children, make up the list. During the winter there is scarcely any trouble among the foreigners as regards health.

The health of Chemulpoo has been much the same as that of Seoul. Malaria plays an important part in the causation of disease there as here. At low tide there are miles of mud-flats exposed to the glare of a hot sun; also the necessary turning over of earth which occurs in forming any new settlement adds to the malarial influence. I have only been called to that port three times during the past year. The foreigners there are under the efficient care of Dr. TANAKA of the Japanese Consulate.

From a partial report of the Government Hospital, which has been open but six months, some idea of the diseases affecting this people may be gained.

The people suffer from about the same diseases as do other peoples, modified somewhat by their peculiar surroundings. The style of house they live in has been mentioned. The only thing with which I think the house is directly chargeable is the number of serious cases of hæmorrhoids and great burrowing gluteal abscesses which constantly present themselves, and may be caused by the habit of sitting on the hot floors with only a thin mat as protection.

Their habits are uncleanly. I have found their bodies invariably dirty. Bathing is very uncommon except among the poor, who take a bath in summer to cool off. Bath tubs are unknown.

The dress is fantastic, and with the clean white, blue or highly coloured outside robes, looks pretty, but one can see at a glance that the people are devoid of energy; their dress will not admit of energetic action. It is eminently suited for the sitting posture which this people are accustomed to. The coat is like a European lady's very loose wrapper; the trousers are large bags, the white stockings and the end of the trousers being tightly tied around the ankle, shutting off the circulation to a large extent. The under coats are smaller than the outer ones. In winter time these cotton or silk garments are wadded with cotton, and are put on one above the other till the wearer is warmly clad.

The hair is worn upon the top of the head in a neat little coil. Down the back of the head the hair is shaved off from a space, but the surrounding hair is made to cover over this place. A very tight silk band of open work is bound around the forehead and head, and at first causes a great deal of headache. This is put on at puberty, when the boy becomes a man and is betrothed. The hat is simply for ornament, being in shape somewhat like an

American "stove pipe" hat, with a wide brim and sloping crown. It is of horsehair and silk, woven in a fine open network, which shields the eyes from the sun to a slight degree, but offers no other protection.

The women dress much after European style, with loose gowns and a waist. They are carefully secluded, have but little exercise in the open air, suffer greatly from nervousness, venereal troubles, rheumatism and confinement. The children of the upper classes are usually pasty, scrofulous little creatures, with delicate features, long eyelashes and clammy hands. Some of the nobility seem to appreciate the fact that by marriage with the secluded daughters of their own rank their families are becoming continually weaker, and their second wives or concubines are usually taken from more robust classes. These sons of second wives, though not entitled to full power, are said to be the strongest men in the Government service.

The native food is rice, beans, vegetables and a little meat for the poor. The better classes eat a great deal of meat—beef, pork, fowl, game, dog; and fish. Dogs are used commonly by all classes; at certain seasons they are consumed medicinally, the period corresponding to our dog days being a great time for eating dogs' flesh. They also eat a great many hot peppers; as their food is often taken cold, these and other condiments add much to the palatableness. They are enormous eaters, and eat very fast, not masticating any more than is absolutely necessary, and often seeming to crowd down the bolus with a gulp.

Their food and manner of eating are largely accountable for many of the most common ailments, as, for instance, a sort of dyspeptic colic, which they graphically describe as a snake which lies at the bottom of the abdomen but sometimes starts up and twists around till it gets up into the throat, to the great agony of the patient. The other symptoms of indigestion are common enough, as enormous flatulent distension of the abdomen, "a stone" in the stomach, etc. Tapeworm is so common as to be frequently seen in the stools along the street. It does not alarm the possessor. Round worms are so widely distributed that they are seldom complained of, and patients seem surprised at being asked if they have them. From the filthy condition of the pork used, trichinæ must be prevalent, and may be the cause of a great deal of irregular rheumatism resembling acute rheumatism without the fever.

The drink of the people is water; they have but little tea, which is used as a medicine. Their alcoholic drinks are much stronger than those commonly used in China, and they get very drunk at times, quite after the European fashion. Their wine is made from rice; in the process of making it a weak milky liquor is formed, which is consumed in vast quantities by the coolies. From barley they make a clear, very strong spirit. They do not seem to understand the use of grapes in the manufacture of wine. Their grapes are but few and very costly, usually to be obtained only as presents. The bunches are often a foot in length and a foot through the greatest diameter. They resemble the catawbas, and are more delicate than the Peking grapes.

As a result of their drinking, a number of cases of genuine delirium tremens have presented themselves, and the affection seems to be well known. Two cases of paralysis, with a history of syphilis, have occurred in which the attack was precipitated by hard drinking. The water, and the consumption of a highly seasoned cabbage, turnip and pepper mixture which has been allowed to ferment and become sour, are largely chargeable for the prevalence of

diarrhœa. They seem to know but little about dieting, and unless considerably scared, seem unwilling to obey instructions and stop eating this indigestible pickle while sick.

No cases of sprue have been diagnosed. The usual habit is looseness of the bowels, though a few cases of obstinate constipation have occurred. In one case obstruction was feared, but it yielded to treatment. No cases of impaction have occurred. Prolapse of the bowel has been treated in about a dozen cases.

Venery is greatly indulged in. The people are married early, and plural marriage is the common rule. Concubinage is recognised, and a class of "dancing girl" prostitutes exists and is largely blamed for the spread of syphilitic affections and gonorrhœa. Many cases of chancroidal ulcers about the anus and fissures of the scrotum, as well as the prevalence of large gummata of the anus and buttocks, occurring in boys led to the discovery of an unnatural system of sexual gratification, the details of which will hardly be appropriate for insertion in a general article of this nature.

Gonorrhœa seems as inevitable as ague, and does not alarm the patient. The people distinguish between the various venereal troubles, and have separate names for gonorrhœa, syphilis (secondary and tertiary) and the primary sore. I have not been able to learn whether they distinguish between chancre and chancroid as a primary sore. The discharge of pus and painful urination in gonorrhœa is all that they wish treatment for; the presence of gleet seems a matter of little concern to them.

Victims of sexual excess have frequently presented themselves, and they seemed to know that their troubles were due to their own irregularities, yet they would not acknowledge that their imprudence amounted to what would be considered over-indulgence from a European standpoint. It is possible that these people have become somewhat exhausted and cannot endure very much; in the absence of reliable information, however, this must remain a mere conjecture.

Chancres in all stages are frequently seen; chancroids more often. Syphilis proper (secondary and tertiary) is known to them as "the Chinese disease," and is almost a constant factor. It must be considered in making up nearly every diagnosis. Many of the cases of paralysis yield to iodide of potassium, as also do some of the cases of iritis and keratitis. Large patches of tubercular syphilides are seen on the face, and some of the most gratifying results of treatment have been the dispersing of these blotches by anti-syphilitic remedies. In the worst cases the frontal bone becomes carious, and the nose is eaten away. The diagnosis in these nose cases is, however, often difficult, and the question as to whether the disease is leprosy or syphilis has to be left to treatment. Sores, large and small, upon the genital organs and other parts of the body commonly occur, and the disease is known to be the cause of the frequent abortions. The children that survive have very often ugly, notched teeth, and strumous affections are constantly encountered.

A peculiar affection of the lymphatic glands occurs in which the glands beneath the chin from ear to ear are chronically enlarged. It occurs just in the line of the hatband, and it is possible that there is irritation enough from the silk or linen band, or string of beads, as the rank may demand, to cause this chronic enlargement in persons otherwise predisposed to strumous troubles.

Tumours of all kinds are common, more so than in European countries, because of the fact that they have been so long unmolested. One form of tumour, though seen in European practice, cannot but strike the attention of a foreign physician. It is a huge black growth, often upon the face, in which case I have seen it covering all but one cheek. It is usually covered with a heavy growth of hair. Some half-dozen of these cases presented themselves, but as nothing could be done for them they seem to have spread the report, and no others have come for assistance.

Leprosy is abundant, occurring in all its forms. Anæsthesia may or may not be associated with the fawn-coloured spots. Many of the patients who present themselves are beggars and have lost fingers or toes by the disease, which can be seen in a dirty, scaly incrustation on the spots affected, with indolent, scabby ulcers on the face and body. These outcasts are not well posted in regard to their family history, but from the disconnected account obtained it is probable that the affection is hereditary. Two cases have occurred in high life, and in each case it was very hard to convince the patient that nothing could be done. As leprosy and syphilis are often co-existent among these poor wretches, they have been put on iodide of potassium and iron, which has worked quite a change up to a certain extent. This has given rise to a report that foreign medicines will cure leprosy, and as a result victims come from distant provinces with large certificates bearing the stamp of the various governors through whose territory they have passed, to the effect that the patient is worthy, etc.

Blind people are met continually in the street. Their trouble is frequently caused by cataract; more often they are blind from small-pox, the eye sometimes being sunken, at others covered with a dense opacity. Opacities are not seldom due to entropion, which, with cataract, affords the most frequent of operations. Two cases of detachment of the retina have occurred; in one, the reclining posture and iodide of potassium nearly effected a cure.

Insanity is known and recognised; six patients have been seen altogether. In only one case were there violent demonstrations. If the patient is poor and harmless he is allowed to wander about the streets, to the great amusement of the children. One of the cases seen was that of the son of a wealthy man, who wanted him cured "regardless of expense." This man was married and living with his wife.

Epilepsy is surprisingly common; the worst case yet seen, however, had seizures only twice daily. The disease is considered no bar to matrimony, which may account for its prevalence. Bromide of potassium has already become very popular, and one patient wished to buy 30 lb. of the salt.

Eunuchs are very commonly met, this being the capital. They are prepared for service in the palace, yet they usually have their own homes and women. A eunuch's compound is known by its only having one gate, instead of the usual gate for men and another for women. This is said to be a necessary precaution for keeping the women in, as they do not like their masters and are apt to run away. One case of gonorrhœa has presented itself in the person of a eunuch. The operation of castration usually consists in ablation of the testes, but in some cases I am told all the appendages are removed.

Labour here is attended by ignorant midwives, as in China. Two cases have called for assistance; in one the patient was dead before I could reach her, and the other might as well

have been, for I found her very weak and almost pulseless. She had been delivered of a living child, and for four days and nights a company of midwives had been tugging at the cord of a retained placenta. I found an old straw shoe attached to the cord, and on making inquiries found that it was so fixed to facilitate the walking out of the after-birth. CREDÉ'S and other methods proving of no avail, I introduced my hand into the uterus, but the woman *was too far gone, and died before anything could be done.*

Medicine is often asked for to prevent impending miscarriages.

Hernia is common among men and children; no cases have been seen among women, nor have any strangulated cases occurred.

Children seldom escape the full complement of the diseases of their period; measles, whooping-cough, mumps, chicken-pox, small-pox, and five cases of cancrum oris have been seen. In two, most of the cheek was ulcerated through, leaving a deep black offensive hole, filled with a brown *medicine.*

Small-pox is universal. Children who do not take it under 2 years are inoculated by placing the virus from another patient in the nose. The results are frequently very serious, one or both eyes being destroyed or covered with dense opacities. The ear is often invaded, and the tympanic membrane ulcerated through, causing permanent deafness. In other cases huge cicatrices with bridge-like connexions are left to mar the features. No treatment is asked for small-pox unless the eye is becoming seriously affected. The little patients are carried about the streets on the backs of their nurses with great unconcern.

Epidemics of cholera are well known; the last serious one occurred four years ago, when hundreds of people died in and about the capital. Local conditions are always ripe for cholera, and the only wonder is that the disease is not endemic. The filth of the city, the bad water and indigestible food keep up a constant state of diarrhœa with occasional cholera morbus; and the habit that coolies and country people have of sleeping on the ground without covering, even when the nights are growing cold, would help in inducing cholera.

I can find no history of yellow fever.

Typhoid ought to be common, as all the conditions are favourable to its existence; as yet, however, no cases have presented themselves. One case of typhus occurred in a man who had just landed from a Japanese steamer. The disease was running the usual course when he was taken away by his friends. Typhus could hardly fail to prevail among the poorer classes. The males and females usually occupy different apartments, and to save fuel they crowd into rooms 8 feet square, often filled with smoke from the leaky *kang*, and always thick with tobacco smoke, for men, women and children smoke constantly. In such a room six or eight persons will pack themselves on the floor, head to foot, so that not a bit of standing room is left. The dense, confined atmosphere becomes further charged with their breath and the emanations from their dirty bodies as they slowly "cook" over the hot stones. A more perfect typhus incubator could not well be imagined.

It would hardly seem probable that malaria should exert itself greatly in such a fine climate as this; yet, with the exception of the northern provinces, the whole country has been

represented by ague patients. It occurs in all its forms. Remittent has been seen and treated; intermittent occurs as tertian, quartan and quotidian. At Seoul tertian and quartan are about of equal occurrence, but in the southern districts quartan is by far the more common and possesses a separate name. As in other countries, the especial paroxysm seems to have disappeared in some cases after having worn itself out; in these persons we have a periodic cough, diarrhœa, or neuralgia of the bowels, and other existing troubles are complicated by this condition. Several cases of double quartan have occurred, and double quotidian is not uncommon; in fact, the patients seem so over-charged with the poison that they only come out of one paroxysm to go into another. It also occurs in masked forms, as brow ague, and an affection of children called "baby's ague," in which irregular chills occur and a swelling is complained of over the region of the spleen. Syphilis and malaria sometimes join forces, and the pains occur every other night, in which case quinine should be united with the iodide. The cases of ague form a large per-centage of the numbers now presenting themselves for treatment.

Beri-beri or kakké is well known here by its Japanese name, which is pronounced like "kahkey." Quite a number of patients have presented themselves with symptoms referred to this trouble, and the disease has been diagnosed in about a dozen cases. They come mostly from the south-western province of Chula-do, and, with one exception, the cases have all been chronic, or kakké, for the acute disease goes by another name. The chronic cases complain of shortness of breath and inability to climb the hills, and the legs are said to be "asleep," as though they had been sat on. The pain in the calves I have only found in one case; the knee seems to be the usual locality for pain. The feet are usually œdematous, the lips and palpebral conjunctivæ pale, the expression anxious, and the heart tumultuous. I have not been able to get the vertebral pain by twitching the neck. As the hospital contains only 40 beds, and these are occupied almost continuously by surgical cases, it has been impossible to accommodate these patients. They have been quartered outside, however, and fed on bromide of potassium, LUGOL'S solution, and strychnine, with an occasional dose of quinine. Nearly all improved more or less. One died.

It has seemed strange that while dysentery is very common no cases of liver abscess should have presented themselves, though they have been carefully looked for. Hydatids have been diagnosed in two cases, in one of which the abdomen was greatly enlarged by the tumours.

Cirrhosis of the liver has been seen in two cases of hard drinkers. The nodules could be easily felt externally, the patients were jaundiced, had no appetite, circulation feeble, and in one case there was marked ascites.

Jaundice is a common ailment; in some cases the whole body is very yellow, even for an Oriental. Dropsy, usually ascites, occurs often. Tapping relieves, but after it is done six to ten times patient and doctor become discouraged.

One case of long standing presented itself in which the liver was greatly enlarged, but no sign of an abscess could be made out. He had a persistent diarrhœa. The organ could be felt overlapping the median line and extending to below the umbilicus. There was some general œdema and high fever, ending in death in two weeks after the onset of acute symptoms.

I am inclined to believe that this was a case of distoma hepaticum, and regret that a post-mortem could not be obtained.

Bright's disease has been found in two adults and one child. One of the adults was the first man admitted to the wards of the hospital. He was put on a mixture of buchu, potash and digitalis, and the assistant was given very careful directions as to its use. The first night and second day he made marked improvement, but on the second night he decided to hasten matters, and got the bottle of medicine, which he drank down at once and died promptly.

Palpitation is rather common; mitral insufficiency has been diagnosed in several cases. One marked case of exophthalmic goitre has occurred.

Diseases of the lungs are frequently seen. Pleuritis has been treated, but no pneumonia has been recognised. Phthisis is abundant, with destruction of the lung substance, and all the attendant symptoms.

Bronchitis is prevalent in all its stages, from a common cold down to the deep-seated disease, with, in some cases, purulent expectoration.

Asthma is the burden of life with many Coreans, and they beg for medicine that will stop the cough and give them sleep. There are many cases of chronic blood-spitting, not connected with the physical signs of lung destruction. These cases, which are treated with dilute sulphuric acid and alum, seem to be of the same nature as the distoma pulmonale, discovered recently, and said to have been found in the person of a Corean official resident for a short time at Tokio. Of course, postmortems are as yet out of the question here; and as a microscope has not until very recently been at hand, it has been impossible to say positively what the trouble is by examining the sputa.

Cases of elephantiasis have occurred, and it is the intention to look soon for filaria.

Skin diseases revel in unmolested glory, those of a parasitic nature being in the ascendant.

The system of medicine used in Corea is the same that is used in China. Ginseng is the great panacea for all ills, and it must be conceded that it has its powers, and is not as inert as the American article is said to be. I have tried it on natives and foreigners, and found it to be "heating," like iron, and to have active aphrodisiac properties. It is a good carminative, and is used as a tonic as well as for every other purpose. Acupuncture and the actual cautery rank next to ginseng as curative agents, and are used for everything. The puncture *often causes serious inflammation, as when the eye is punctured, as is often done;* and nearly every person, male and female, carries the circular scars made by the red hot cash used as a cautery.

The Coreans really excel in the manufacture of eye-glasses. I have been ashamed when trying to fit a superior lens, from a good trial case of glasses, in place of a stone lens already worn. *I could not do it; the Corean lens was the better. They are made of transparent* stone, finely ground, and are expensive, costing in the neighbourhood of $100. Some Chinese or Japanese traders are making money by fitting foreign lenses to native bows and selling them as stone lenses. As yet I have seen no concave lenses; they have all been convex.

As this is the first official report given by a medical officer on Corea, an account of the medical side of last winter's troubles may not be out of place. I will quote extracts from an article which appeared in the New York *Medical Record* for 13th June 1885.

——— was cut with a sharp sword on the night of 4th December 1885 in seven places. The principal wound was made by a vertical, somewhat slanting blow. The cut commenced on the temple, midway between the external canthus of the right eye and the ear of the same side. The temporal artery was divided; the ear split longitudinally and cleanly, one-half lying back on the hair of the head, the other upon the face. Extending downward along the course of the sternocleidomastoid, the external jugular was laid bare but uninjured. Lifting the platysma myoides for about half its breadth, the wound continued down the back to a point on a level with the lower angle of the scapula, and midway between it and the spinal column, ending with a curved point, where the sharp instrument left the flesh. The cut was 2 inches deep in the muscles of the back, but the only severe hæmorrhage was from the divided temporal artery. The other wounds were upon the scalp, the mastoid, arms and thigh.

I tied the temporal artery, cleansed all the wounds with carbolic solution 1–40, dressed them with iodoform and put in 22 silk and 5 silver sutures. Having to be moved about from place to place for safety, the wounds began to gape, and suppuration took place in all but the wound of the ear. The temperature ranged between 101° and 103°, with occasional chills, until 1st January, when it fell to 100°, and did not rise so high again.

The dressings were cotton wool soaked in carbolic solution 1–20, and were changed daily because of the discharge, excepting only those of the ear and the scalp, which were not removed till the wounds had healed.

Some peculiar things occurred during the treatment. One was the dosing of the patient with strong infusions of ginseng—the native panacea. This was done without my knowledge, and I only discovered it in trying to ascertain the cause of a rise of temperature that was not accounted for by any fresh inflammation.

Another thing was his great persistence in taking soup made from dogs' flesh and dogs' heads. This was done also without my sanction. I was not much surprised, however, at the finding of segments of tapeworm in his stools, but became surprised at his unconcern regarding it. It was with difficulty that I induced him to take the turpentine and castor oil that eventually cured him.

Aside from the common and ever-present syphilis, which came in as a complication, as it does in almost all disease among Coreans, the only other thing of importance was the development of marked facial paralysis of the wounded side. It came on a few days after the injury, leading me to suppose it to be due to consequent inflammation and swelling, rather than to division of the nerve. I was strengthened in this belief by the fact that the paralysis came on in sections, so to speak; the temporo-facial branch seemed unaffected till late, as I could see no tendency in the eye of that side to remain open until about 30 days after the injury, when it became painfully and obstinately open. At the same time I found swelling over the parotid gland, which eventually broke down into pus and necessitated an external opening, the affection of the eye decreasing therewith. The tongue never deviated perceptibly, though there was abundant swelling about the stylomastoid foramen, and it would seem difficult for the lingual branch to escape being pressed upon. His recovery has been good.

Among the Chinese soldiers there were gunshot wounds of thigh, two; groin, one; foot, one; fore-arm, three; abdomen, three; hand, two; eye, one; and gluteus, one: bayonet wound of abdomen, one: wounds from explosion of powder-mine—of leg, two; of hand, one; one sword cut of calf, and a bayonet wound of neck.

There were three cases for amputation, one of the hand, two of the fore-arm, but in no case would they allow me to use the knife. In one case, however, that of a clean shot in the eye, I performed excision

without asking permission, and he has made a good recovery, with no sympathetic trouble. I did not see the above-named cases of wounds to the abdomen until three days after the injury; in no case was there marked peritonitis. The only death was one of the cases of wounds to the fore-arm, where amputation was not permitted. He died of tetanus on the 8th day after the injury, the 3rd of the spasm. All the rest of the cases recovered either completely or sufficiently to be removed to their men-of-war. These cases well illustrate the powers of endurance among Orientals, and especially is this a fact in two cases which I wish to mention more fully.

In the gunshot wound of the groin the ball entered just below POUPART'S ligament, and about an inch outside of the external ring, on the left side; it came out at about the centre of the buttock on the same side, and must have pierced the bone without much splitting. When I first saw him, 24 hours after the accident, he had the skin of a dog, freshly killed, on both wound of entrance and exit. As it made an excellent poultice I left it on for the first day, and then poulticed it for three days with hot rice, after which I applied small bags of pulverised yellow clay, simply as an absorbent and disinfectant, being without anything better. The man went on rapidly to recovery, with no untoward symptoms, until on the 20th day from the receipt of the injury he was walking about. He now rides a horse and attends to his duties as a colonel in the Chinese army.

The bayonet wound of the neck was ugly indeed. The Japanese have a large sword toothed bayonet; one of these had been thrust through this man's neck, entering just below the angle of the jaw, on the right side, and coming out at the back, almost piercing the ligamentum nuchæ. When the weapon was withdrawn it tore away a piece of flesh three inches by two and a half. I thoroughly cleansed the track of the wound with carbolic solution 1–40, and applied pressure; the raw surfaces were dusted with iodoform, and the whole covered with cotton wool soaked in carbolic acid. To my great surprise this man improved almost daily, and at the end of six weeks had only a small cicatrix left over both wound of entrance and exit. Morphia was given liberally in all these cases, and as their pain was relieved and they had enough to eat, probably the resulting state of contentment had much to do with their speedy recovery.

These cases were seen by several medical gentlemen during treatment. Dr. KAINOSA of the Japanese Legation saw ——— and assisted at the second dressing. All were seen at different times by Dr. WHEELER of the British navy, and Drs. PRICE and RUSSELL of the U.S. navy. . . . . .

The treatment of the above-mentioned cases, with many others, caused by the promiscuous firing during the excitement of last winter, was such an introduction that the one representative of Western medical science found it necessary to make more adequate preparations to meet the increasing demand for medical and surgical help. Consequently, on the 22nd January last the U.S. Chargé d'Affaires kindly forwarded to the Government a scheme for the opening of a hospital. It was accepted, and a large compound of buildings was granted, with money for equipment and running expenses, and as one medical man was deemed insufficient for the work, consent was given that another should be called from America. Dr. J. U. HERON was applied for and sent out by the Presbyterian Mission Board, reaching here 24th June.

The hospital was opened 14th April. It speedily became popular, and prior to the heavy rains the number of out-patients treated daily was from 60 to 100. They fell off during the rainy season, and have not since reached the former high average.

A report of the diseases and number of out-patients treated during the six months from 14th April to 14th October is added, that a proper idea of the diseases of the country may be gained. Explanations might clear up certain matters, but as this is not the hospital report proper, such explanations will be left till some future time.

REPORT of DISEASES and NUMBER of OUT-PATIENTS treated from 14th April to 14th October.

Abortion	9	Dislocation, shoulder	1	Ichthyosis	2
Acne rosacea	36	„ knee-joint	1	Impetigo	6
Albuminuria	2	Distoma hepaticum?	1	Impotence	24
Algid penis	1	Dropsy	24	Indigestion	467
Amaurosis	12	Dysentery	160	Ingrowing toe-nail	2
Amenorrhœa	7	Dysmenorrhœa	3	Inguinal fistula	4
Anæmia	24	Dyspnœa	12	Insanity	6
Ankylosis, knee-joint	1	Earache	21	Intestinal catarrh	48
Aneurism, finger	1	Ecthyma	7	Iritis	6
„ popliteal	1	Eczema	98	Jaundice	42
Anorexia	2	Elephantiasis	4	Kakké (beri-beri)	12
Aphonia	13	Emphysema, lung	2	Keratitis	36
Arteritis	1	Enlarged cervical glands	176	Leprosy	24
Ascaris lumbricoides	48	Entropion	102	Leucorrhœa	24
Asthma	121	Ephelis	12	Lichen	20
Aural abscess	17	Epilepsy	184	Locomotor ataxia	12
Blepharitis marginalis	48	Epistaxis	12	Lumbago	52
Blepharospasm	1	Epithelioma, face	3	Lumbar abscess	2
Bright's disease	3	„ penis (cauliflower)	3	Malaria :—	
Bronchitis	70	Erysipelas, face	6	Quotidian intermittent	143
Bronchorrhœa	38	„ general	1	Tertian „	140
Bubo	37	Exostosis, superior maxillary	1	Quartan „	380
Burns (common)	12	Facial paralysis	24	Pernicious „	1
„ (gunpowder)	5	Favus	39	Remittent fever	14
Cancrum oris (child)	5	Felon	4	Ague cake (hypertrophy of spleen)	60
Carbuncle (anthrax)	3	Fissure of anus	21	Marasmus	2
Cataract	31	Fistula in ano	72	Mastitis	4
Cervical (glands) abscess	24	Fracture, wrist (COLLES's)	1	Necrosis, frontal bone	6
Chancre	131	„ femur (gunshot)	1	„ knee-joint	1
Chancroid	200	Frostbite	2	„ femur	5
Chlorosis	2	Gleet	47	„ ribs	1
Chorea	2	Goitre	2	„ lumbar vertebra	1
Cirrhosis liver	3	Gonorrhœa	196	„ metacarpal bones	1
Colic (children)	12	Gunshot wounds	14	„ metatarsal bones	2
Conjunctivitis (ophthalmia)	132	Hæmoptysis	81	Neuralgia	12
Constipation	24	Hæmorrhoids	91	Nocturnal pains	50
Corneal ulcer	48	Hare-lip	29	Occlusion, mouth	2
„ opacity	72	Hemiplegia	36	„ nostrils	1
Corns	10	Hepatitis	2	Onychia	4
Curvature of spine	10	Hernia	24	Orchitis	5
Deafness	97	Herpes labialis	3	Osteosarcoma	1
Delirium tremens	12	„ præputialis	2	Otorrhœa	28
Dental abscess	2	„ circinatus	1	Ozœna	7
„ caries	52	Hydatids, liver	2	Painful hemiplegia	1
Detachment of retina	2	Hydrocele	3	Panophthalmitis	2
Diarrhœa	294	Hysteria	28		

Paralysis, arm	6
„ foot	1
„ agitans	12
„ *general*	36
Parametritis	1
Paraplegia	12
Parturition	2
Pediculus capitis	67
„ pubis	21
Pemphigus	4
Perforating ulcer, foot	2
Perineal fistula	14
Pertussis	29
Phimosis	7
Phthisis	39
Pityriasis	13
Pleuritis	5
Polypus (nasal)	24
Prolapsus uteri	1
„ bowel	12
Prospective red nose	1
Psoas abscess	2
Psoriasis	13
Prurigo	12
Pterygium	7
Ptosis	3
Pyrosis	60
Rachitis	2
Ranula	1
Recto-vaginal fistula	1
Retained placenta	1
Rheumatism	60
Rheumatoid arthritis	2
Rupia	9
Scabies	96
Sciatica	10
Scrofula	161
Sexual excess	21
Small-pox (complicated)	7
Snake-bite	2
Snoring in sleep	1
Sprain of foot	12
Staphyloma	5
Stomatitis	37
Strabismus	2
Strangulated piles	3
Strangury	2
Supra-clavicular abscess	3
Swollen ankle	6
Symblepharon	5
Synechia	3
Syphilis (secondary and tertiary)	460
„ with eruption	24
„ „ leprosy	48
Syphilitic dermatitis	13
„ gumma (anus)	76
„ periostitis	96
„ *tubercle (face)*	11
Tænia solium	84
Tinea circinata	13
Tinnitus aurium	30
Toothache	12
Tumours	172
Tympanites	4
Typhus	1
Ulcer, foot	10
„ leg	24
Ulcerated throat	60
Urethral stricture	14
Urticaria	11
Wounds (not counted)	24
Unclassified	269
TOTAL	7,234

APPENDIX.

ON THE FORCE AND MODE OF ACTION OF THE MUSCLES WHICH PRODUCE "BEARING-DOWN."

AN ANATOMICAL INVESTIGATION.

By Dr. A. LAWRENTJEFF, of St. Petersburg.

(Virchow's Archiv, 1885, ii, 459.*)*

AN inquiry into the force and mode of action of the muscles concerned in the act of "Bearing-down," or, in other words, into the direction in which compressive force is exerted, is of especial importance to obstetricians, as dealing with the secondary expulsive element which notably comes into play during the middle stage of labour. Obstetrical literature accordingly contains most minute descriptions of the manner in which bearing-down acts, but unfortunately these descriptions are founded either on clinical observation or on theoretical views, and offer no tangible principles for discussion. So SCHATZ* when describing bearing-down as a secondary expulsive force in labour makes no attempt to solve the question of its amount, and confines himself to indicating its direction, in regard to which he bases his opinion partly on theoretical grounds and partly on clinical investigations.

SCANZONI† regards bearing-down as a purely reflex accompaniment of the activity of the uterine contractions, especially towards the close of expulsion; and yet he ascribes to it not only an important direct share in the process, but the power of stimulating the uterus to contraction. LAHS shares this opinion, making the force of bearing-down dependent on the uterine contractions, to which it is directly proportional.

KEHRER‡ likewise regards bearing-down contractions as reflex, and involuntary at the acme of the expulsive stage, and describes the particular groups of skeletal muscles which contribute to the activity of the "pains," without, however, mentioning the effect of bearing-down as a whole. He devotes only a couple of pages to the matter.

KÜNEKE§ in his chapter on the dynamics of bearing-down, ascribes to this latter an important expulsive influence, but assigns an altogether subordinate rôle to it in actual expulsion, and does not support his opinion by figures.

On the whole, obstetricians, although they certainly admit the expulsive energy of bearing-down, especially when there is any serious pelvic obstruction, give up but little space to its description in text-books of midwifery. This is the case with SCHRÖDER, SPIEGELBERG and others, the greater number of whom mix it up with other expulsive elements, and acknowledge, as LAZAREWITSCH‖ also does, that this question is as yet very imperfectly worked out.

In contrast with the authors just named, HAUGHTON¶ in 1873 published a work, in the course of which he discussed on mathematical grounds the action of the muscles engaged in the act of bearing-down. He assigns to them an extremely important part in the second stage of labour, and estimates their force as nearly ten times that of the uterus itself.

* F. SCHATZ, *Der Geburtsmechanismus der Kopfendlagen*, S. 27. Leipzig, 1868.
† SCANZONI, *Lehrbuch der Geburtshülfe*, 3. Aufl., S. 176 fg.
‡ KEHRER, *Beitr. zur vergl. und experiment. Geburtsk*, H. ii, S. 51, 52. 1867.
§ KÜNEKE, *Die vier Factoren der Geburt.* Berlin, 1869.
‖ LAZAREWITSCH, *Utschebnick Akooshershi* [Handbook for Midwives].
¶ HAUGHTON, *Principles of Animal Mechanics*, p. 159, etc. London, 1873.

The diversity of opinion, and the absence from obstetrical literature of any complete examination of this point based on actual figures, caused me to accept with particular satisfaction Professor LESSHAFT's suggestion that I should determine the force of the muscles concerned in bearing-down, and the direction of their action.

Before I pass on to describe the methods employed, it is necessary to define what is meant by bearing-down.

SCHATZ describes it as a mechanism designed to diminish the size of the abdominal cavity, and consisting of two parts, namely, the abdominal and lumbar muscles which take the spinal column as their fixed point, and the diaphragm which forms a dome over this cavity and is supported by the expiratory muscles.

HAUGHTON in his description of the force and lines of action of the abdominal muscles, confines himself to the muscles of the anterior wall, taking no account of the other elements which enter into bearing-down. The anatomists, such as HYRTL, LUSCHKA, SAPPEY, HENLE and others, omit any consideration of the process in its entirety, and are not even unanimous as regards its anatomical elements. Thus HENLE* counts the quadratus lumborum among the muscles of the lower extremity, and attributes to it a very moderate share in the movements of the spinal column; while LUSCHKA† calls it "rectus abdominis posticus," and makes it exclusively an abdominal muscle.

In this paper I shall adopt Professor LESSHAFT's opinion, and consider bearing-down as the result of a constrictive mechanism applied to a closed cavity possessed of muscular walls.

It is produced by 16 muscles surrounding the abdomen, some diminishing the size of the cavity, the remainder providing points of fixation for the former group. Under the first I enumerate the external and internal obliques, transversales, recti, pyramidales, quadrati lumborum, diaphragm and levator ani. To the second group belong the erectores spinæ.

The abdominal parietes are formed on either side by three muscles arranged one over the other, externally the external oblique, internally the transversalis, and between these the internal oblique. The tendinous portions of all these muscles meet in the linea alba, and enclose between their layers the two pairs of straight abdominal muscles, namely, the recti and pyramidales, which form the anterior wall of the cavity.

The muscular portion of the posterior wall consists of the two quadrati lumborum, lying one at either side of the lumbar spine, the action of which muscles is aided by the erectores spinæ placed posteriorly to them.

The roof is the dome formed by the diaphragm. Inferiorly the cavity is closed in by the levator ani, which may be regarded as the pelvic diaphragm. The external oblique usually takes its origin from the seven or eight lower ribs by the same number of slips which interdigitate with the slips of the serratus magnus. The highest slip, which arises from the lower border of the 5th rib, is the shortest, and passes almost horizontally forwards, partly covering the outer edge of the rectus. The slips next in order arise from the outer surface and lower borders of the ribs, their origins gradually becoming more distant from the cartilages until the 9th rib is reached. From this rib downwards, however, they approach the cartilages, the slip corresponding to the 10th rib touching the cartilage and that corresponding to the 11th arising from the external surface of the rib and of the entire cartilage. The last slip often arises from the aponeurosis of the transversalis.‡ The fibres of the external oblique, covering one another in part, pass first forwards; others, increasing in length, run forwards and downwards, and the fibres corresponding to the lowest slips run almost perpendicularly downwards.

* HENLE, *Handb. d. syst. Anatomie d. Mensch.*, Bd. I, Abth. iii, S. 256.

† LUSCHKA, *Anatomie*, Bd. II, Abth. i, S. 100.

‡ SÖMMERING, *Lehre von den Muskeln und Gefässen des menschlichen Körpers.* Umgearbeitet von F. W. THEILE. Abth. i. Leipzig, 1841.

The fibres from the first four or five slips pass into a long and broad aponeurosis, which enters into the formation of the anterior layer of the sheath of the corresponding rectus, and unites in the linea alba with the aponeurosis of the opposite side. Below, this aponeurosis is continuous with POUPART's ligament, and shares in the formation of the external ring. The lower groups of fibres, directed downwards, are inserted into the anterior third of the outer lip of the crest of the ilium, while the posterior unattached border of the muscle, stretched between the 12th rib and the iliac crest, is for the most part covered by the latissimus dorsi.

The internal oblique arises from the upper portion of POUPART's ligament, from the anterior superior spine and anterior half of the crest of the ilium, and by means of the external layer of the lumbo-dorsal fascia,* from the posterior portion of the crest of the ilium and the spinous processes of the first piece of the sacrum and lower four lumbar vertebræ. THEILE asserts that the fibres situated between the ilium and the ribs arise from the aponeurosis of the transversalis, which is equivalent to denying the existence of an independent posterior aponeurosis. The fibres which arise from POUPART's ligament pass forwards and downwards, those from the iliac spine stretch horizontally forwards, those from the iliac crest pass gradually more and more forwards and upwards, and those arising from the lumbo-dorsal fascia run almost vertically upwards. The muscle as a whole is thus fan-shaped. Its posterior fibres are inserted into the extremity of the 12th rib and the inferior border of the 10th and 11th costal cartilages, being in close relation with the intercostal muscles. The remaining fibres terminate in a curved line, and are lost in an aponeurosis which almost immediately divides into two lamellæ. Of these the anterior unites with the aponeurosis of the external oblique and blends at the linea alba with the corresponding lamella from the opposite side. The posterior lamella soon becomes one with the aponeurosis of the transversalis, passes behind the rectus, entering into the formation of the posterior portion of its sheath, and terminates in the linea alba. This lamella reaches but a little way below the umbilicus, as far as the linea semicircularis of DOUGLAS; more inferiorly the aponeurosis of the internal oblique is seen to pass undivided [in front of the rectus]. Tendinous intersections are often found in the muscle, starting from the extremities of the 10th and 11th ribs, and frequently reaching the edge of the rectus. †

The transversalis arises from the inner surface of the last six costal cartilages, from the lumbo-costal ligament,‡ from the transverse processes of all the lumbar vertebræ§ through the intermediary of the middle layer of the lumbo-dorsal fascia, from the anterior two-thirds of the crest of the ilium, and from the upper half of POUPART's ligament, where the fibres of this muscle unite with those of the internal oblique. The remaining fibres follow an almost horizontal direction directly forwards, and terminate in a broad aponeurosis, forming a curve, the linea semicircularis of SPIGELIUS, at their insertion. Superiorly they are attached to the xiphoid cartilage. The aponeurosis of the transversalis soon blends with the posterior lamella from the internal oblique, and shares in the formation of the posterior incomplete portion of the sheath of the rectus, uniting with the corresponding structure from the opposite side. More inferiorly some tendinous fibres of the aponeurosis pass into the anterior layer of the internal oblique aponeurosis, aiding in the formation of the anterior part of the rectus sheath; others are attached to the linea alba, or independently to the upper border of the pubic symphysis.‖

The rectus is placed on the anterior abdominal wall, and arises by its narrow extremity from the pubic bone. It is usually inserted by three slips into the 5th, 6th, and 7th ribs.¶ The outer, longer

* SAPPEY, *Traité d'anatomie descriptive*, tome ii. 1876.

† In my nine subjects I found these intersections six times. They were thrice present on both sides. Thrice also two intersections, starting from the 10th and 11th ribs, almost reached the border of the rectus.

‡ SAPPEY, HENLE.

§ THEILE.

‖ LUSCHKA, *Anatomie*, Bd. ii, "Der Bauch."

¶ SAPPEY, LUSCHKA, THEILE and others assume that the rectus takes origin by its narrow extremity and is inserted by its broad, upper extremity. HYRTL, HENLE and others are of the converse opinion.

slip reaches the upper border of the 5th costal cartilage, the middle slip is inserted into the outer surface of the 6th cartilage, and the shortest and innermost is attached to the outer surface and inner border of the 7th cartilage, and to the costo-xiphoid ligament. Inferiorly the rectus arises by two heads, of which the smaller, situated towards the middle line, is attached to the anterior surface of the symphysis, while the longer and external head arises from the pubic spine. A few fibres, moreover, arise from the linea alba.* The muscle is flat and triangular, broader above than below, and marked across its length by tendinous intersections. Three or four of these intersections are to be observed between the muscular bundles, curvilinear in form, or zig-zag or perpendicular.† The highest is generally on a level with the costal cartilages, the second midway between the first and the umbilicus, while the third corresponds to the umbilicus. When a fourth intersection is present, it lies below the umbilicus, does not extend through the entire breadth of the muscle, and is merely superficial. It is but rarely that the fibres are uninterrupted throughout their whole length; they are usually intersected, so as to give the appearance of the muscle being divided into separate segments. The rectus is enclosed in a special sheath formed from the aponeurosis of the broad abdominal muscles. The anterior layer of this sheath is inseparably united with the tendinous intersections. The posterior layer is incomplete and terminates below the umbilicus in a thin, crescentic edge known as the linea semicircularis of DOUGLAS; above, this layer reaches the lower border of the ribs. Higher up, the rectus lies immediately on the ribs.

The pyramidalis arises from the pubic bone somewhat in front of the origin of the rectus, and passing upwards is attached to the linea alba. Its inner fibres follow a vertical course, the outer fibres are oblique; the entire muscle resembling a right-angled scalene triangle. It is often absent from one side, oftener still from both,‡ in which case the lower part of the rectus is thicker.

The quadratus lumborum arises by a broad attachment from the posterior part of the crest of the ilium, and from the ilio-lumbar ligament. Fibres from the transverse processes of the lumbar vertebræ run to join it, and thus form a flat muscle, which is inserted into the 12th rib.§ Posteriorly it is intimately united with the lumbo-costal ligament, anteriorly it is enclosed in the fibrous arch to which the lateral fibres of the lumbar portion of the diaphragm are attached. Its posterior surface is covered by the middle lamella of the lumbo-dorsal fascia, anteriorly it is enclosed in the inferior and excessively thin layer of the same fascia. Its outer border is free, its inner border is partly covered by the edge of the psoas magnus.

The erector spinæ is situated behind the quadratus lumborum, and arises from the posterior surface of the sacrum, the posterior portion of the crest and posterior superior spine of the ilium, and from the spinous processes of the lumbar vertebræ. At the level of the last rib this muscular mass divides into two parts—the sacro-lumbalis and longissimus dorsi,—which are inserted into all the 12 ribs, the former into their angles, the latter into their tuberosities. The erector spinæ is separated from the quadratus lumborum by the middle layer of the lumbo-dorsal fascia, while its outer surface is covered by the upper layer of the same structure.

* LUSCHKA, *op. cit.*, S. 97.

† HENLE admits three or four, LUSCHKA two to four, HYRTL three to five intersections. Among my nine observations, in four there were three intersections, and in the other five cases a fourth presented the appearance of a small, tendinous surface.

‡ Among my subjects it was present three times in eight bodies, once on the left side only, and twice on both sides: in each of the last cases the subjects were women.

§ Anatomists are divided in their opinions about this muscle. LUSCHKA regards it as the analogue of the rectus, and does not hesitate to call it the rectus abdominis posticus. On the ground of comparative anatomy he divides it into three portions—ilio-costal, lumbo-costal, and ilio-lumbar,—arising [respectively] from the posterior part of the inner lip of the ilium, from the transverse processes of the 3rd and 4th lumbar vertebræ, and from the ilio-lumbar ligament, and inserted into the 12th rib. On the other hand, HENLE counts this muscle among those of the lower extremity, regarding it as the superior segment of the iliacus. He considers the 12th rib as its point of origin, and the iliac crest as its insertion. Flat muscular bundles pass from the tips of the transverse processes of the lumbar vertebræ to the body of the muscle, and intersect similar ascending bundles. Other authors, *e.g.*, SAPPEY, place the origin at the ilio-lumbar ligament and iliac crest, and the insertion at the 12th rib and transverse processes of the lumbar vertebræ to which it is attached by five bundles.

The diaphragm is divided into a lumbar and a costal portion. The lumbar portion arises by two pair of slips, the inner pair taking origin from the 3rd and 4th lumbar vertebræ and the intervertebral cartilage. The right slip is generally thicker and longer than the left. They unite and run upwards, forming an arch beneath which the aorta descends. They then again separate, passing in part from one side to the other, and after forming a cleft for the passage of the œsophagus, are attached to the posterior border of the tendinous centre. The outer pair of slips are more slender than the other, arise from the sides of the first and second lumbar vertebræ, and, like the inner pair, pass upwards. Other fibres entering into the lumbar portion arise from the fibrous arch which surrounds the quadratus lumborum *(ligament cintré du diaphragme*)*. Bundles belonging to the lumbar portion pass upwards and forwards and are inserted into the lower, concave border of the tendinous centre, usually leaving a triangular space uncovered by muscle between their external edge and the costal portion of the muscle, corresponding to the lumbo-costal ligament.

The costal portion of the diaphragm is divided into the costal portion proper and the sternal portion.

The costal portion arises from the lower borders of the last six ribs by a series of slips which interlace with the insertions of the transversalis, and passing upwards and inwards are attached to the convex edge of the tendinous centre. Fibres arising from the lumbo-costal ligament frequently join them, and in that case there is no free, triangular space between the lumbar and costal portion of the diaphragm. The sternal portion commonly arises by two fascicles, sometimes united into one, from the xiphoid appendix, and is inserted into the most prominent point of the anterior convex border of the tendinous centre. It is, however, often absent, or present on one side only.†

The levator ani arises from the lower portion of the body and of the horizontal ramus of the pubes, from the spine of the ischium and from the fibrous arch* uniting the pubic bone with the ischial spine. It is connected by a few small bundles with the pelvic fascia.‡ Its fibres run obliquely inwards and backwards, passing over the sphincter ani, and unite with those of the opposite side, forming a raphe behind the rectum, which is attached to the point of the coccyx. The lateral fibres, in close relation with the coccygeus, are attached directly to the same point.

Beneath the levator ani, and surrounding the orifice of the rectum, the sphincter ani is found, the concentrically arranged fibres of which arise from the apex of the coccyx and are lost in the skin of the scrotum. Posteriorly the pelvic outlet is closed by the coccygeus, which, arising from the spine of the ischium and lesser sacro-sciatic ligament, is inserted into the lower segment of the sacrum and lateral border of the coccyx, and is in relation by its edge with the levator ani.

Having thus briefly described the muscles concerned in "bearing-down," we pass on to the question which mainly interests us, namely, the determination of their force.

Many papers have been written (by BORELLI, the brothers WEBER, FICK, LESSHAFT, WARAWIN and others) on the force exerted by individual muscles of the human body, and especially by the muscles of the extremities, but existing literature contains very little as to the determination of the force of the trunk muscles, and less still about that of the muscles which produce bearing-down. The only work in which this question is discussed from its mechanical side and with the aid of calculation is HAUGHTON'S treatise,§ but in this, as I have already stated, the anterior abdominal wall is alone considered. Moreover, in consequence of the imperfection of his method and the theoretical character of his mathematical calculations, HAUGHTON'S estimate of the anterior muscles is too high and is refuted peremptorily by everyday clinical observation. Hence we must regard the question of the force exerted by the abdominal muscles as hitherto practically untouched.

* SAPPEY.

† Among my observations the sternal portion was four times entirely absent.

‡ LUSCHKA, *Zeitschr. f. rat. Med.*, v. HENLE u. PFEIFFER. Bd. ii, 3. Theil.

§ HAUGHTON, *Principles of Animal Mechanics*, p. 218. London, 1873.

Absolute muscular force is determined by the physiological diameter of the given muscle. The greater this is, the more force can the muscle exert. The physiological diameter of a muscle is the sum of the diameters of all its fibres. According to WEBER,* it is the ratio of the volume of the muscle to the mean length of the fibres. The muscle's volume is the ratio of its weight to the specific gravity of muscular tissue. Here, however, we encounter a difficulty, as there is no perfectly reliable estimate of the specific gravity of muscle, different authors fixing it differently. Thus WEBER gives 1.0583, KRAUSE 1.0555, VALENTIN 1.064, and so on. I have therefore abandoned this method of determining the volume, in favour of another plan already used in my laboratory, namely, the immersion of the muscle in a vessel filled with oil.

The principle of my method is fundamentally the same as that of WARAWIN'S, but, in addition, the surface and the aponeurosis of the muscle are determined. In order that my procedure may be understood I will briefly describe it.

The weight and length of the body were first noted. In order to prevent, as far as possible, drying of the muscles by evaporation, shallow vessels of water were placed round the corpse, and the prepared muscle was immediately covered with a damp cloth. As soon as the muscle was freed from skin, fat and fascia, its outline was traced with a pointed aniline pencil at its skeletal insertions and at its fusion with the aponeurosis. Isolated groups of fibres were then carefully cleared in the direction of their length, which was measured with a waxed thread. From 20 to 30 such measurements were made in the case of each muscle according to its size, so that the number of short and long fibres measured should as nearly as possible correspond to the number of short and long fibres respectively in the muscle. The superficies of the muscle and of the aponeurosis was then determined in the following manner. Thin waxed paper was so placed over the prepared and marked muscle as to fit it closely everywhere. As the surface of every muscle is irregular, it was necessary to pucker the paper into larger or smaller folds, so that it should lie smoothly on every part of the muscle and aponeurosis, and reach to the linea alba. The muscle itself and its aponeurosis were then outlined on the paper, and the folds in the latter were marked. As soon as the surface was thus registered, the muscle was divided at its aponeurotic junction, and carefully dissected up to its origin. Its surface of origin was circumscribed from within and the muscle separated from it. After its separation, its inner surface was freed from areolar tissue and fat, it was spread on a table, and the length of its fibres measured with a pair of compasses, the measurements being the same in number as those of the outer surface. These measurements were generally greater by some millimètres than those of the external fibres, a result due partly to the actually greater length of the inner fibres and partly to the fact of their being more stretched. The muscle was then weighed, all the tendinous parts having previously been as completely as possible removed, and finally it was plunged into a BENEKE beaker filled to the brim with purified oil. Its volume was determined from the quantity of oil which overflowed into a graduated cylinder. The marked surface of insertion was then again covered with waxed paper and its boundary copied off with a pointed pencil.

These processes were carried out in the case of each muscle. The outlines of the muscular surfaces, of the aponeuroses and of the insertions were transferred to paper ruled into square centimètres and millimètres, and the number of square millimètres covered was counted. This plan of measuring surfaces is preferable to all others, for instance, to the use of AMSLER'S planimeter, or to the weighing of the paper used in the measurements, for by it more exact results can be obtained. The planimeter is unsuitable for measuring the abdominal muscles, inasmuch as for its use a horizontal surface is indispensable, which can never be found on muscles in situ. Moreover, it was not suitable for the measurement of the surfaces outlined on paper, because in the cases before us the folds due to the curvature of the surface had to be calculated from each figure. Lastly, the complexity of the apparatus and its great cost were sufficient to debar me from its use. Weighing the paper that had been used for surface measurements was also

* WEBER, WAGNER'S *Handwörterbuch der Physiologie*, iii. 1846.

impracticable, for in the first place, having been in contact with the dissected muscles, fragments of fat and blood were liable to adhere to it, and secondly, one cannot place any reliance on the uniformity of waxed paper, and thus serious errors would necessarily have crept in. The method of direct counting adopted by MECH* and WARAWIN,† although extremely tedious, often demanding a lens in order to secure exact results, is very precise. Repeated countings applied to the same figure showed only very slight differences amounting perhaps to 2 or 3 millimètres.

When the surfaces of insertion were transferred to the ruled paper their extreme points were united by straight lines, and the fulcrum surface of each muscle thus determined.‡

This system of measurement was applied to five male and three female bodies, or to more than 120 muscles in all.

In the following tables the results obtained are registered. For the two sides the extreme lengths, *i.e.*, the lengths of the shortest and longest fibres, were ascertained in centimètres. The averages were obtained by dividing the sum of all the inner and outer measurements of each muscle by the number of measurements made.

The weight was estimated in grammes, the volume in cubic centimètres.

I arrived at the cross-section by dividing the volume by the average length of the fibres. The surface of each muscle was estimated separately from that of its aponeurosis, which latter is here to be considered as one arm of the lever acted on by the muscle, and serves, as will be seen later, to determine the direction in which muscular force is exerted.

The fulcrum surface was determined by the counting of every millimètre corresponding to the insertions and to the spaces included within the lines joining their extreme points. The fulcrum surface and the surface of insertion must therefore not be confused, as the latter is always much the less extensive.

The linea alba was taken as the line of application of the force exerted by the broad abdominal muscles. In the case of the others, however, their anatomical insertions were taken, upon which their force is exerted from the fixed points of the pelvis.

Passing on now to my results, I will first record the weights and lengths of the bodies employed, The estimates of age are merely approximate.

No.	Sex.	Age.	Weight.	Length.
			Kilos.	*Cm.*
1	m.	old	50.027	176.0
2	,,	,,	44.765	169.0
3	,,	middle aged	46.062	169.2
4	,,	,,	46.811	167.5
5	,,	,,	48.752	165.2
6	f.	young	36.402	162.7
7	,,	middle aged	43.841	160.9
8	,,	old	29.973	153.0
9	m.	young	51.132	172.2
		Average.....	44.196	166.2

* MECH, *Oberflächenmessungen des menschl. Körpers. Zeitschr. f. Biol.*, Bd. 15. 1879.

† WARAWIN, *Petersburg. Dissert.* 1882.

‡ *Ibid.*

MUSCULUS OBLIQUUS ABDOMINIS EXTERNUS.

No.	Extreme Lengths of Muscular Fibres.		Mean Lengths of Muscular Fibres.		Weight in Grammes.		Volume in Cubic Centimètres.		Cross-section in Square Centimètres.		Surface of Muscle in Square Centimètres.		Surface of Aponeurosis in Square Centimètres.		Fulcrum Surface in Square Centimètres.		Surface of Application in Square Centimètres.	
	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.
I	5.3—19.4	3.3—19.2	12.6	11.5	106.0	85.8	103.0	83.2	8.1	7.2	...	...*	...	...	129.0	56.7	34.0	
II	2.8—22.0	6.8—23.2	13.0	14.0	85.5	89.0	84.5	87.0	6.5	6.2	312.2	271.6	314.3	278.3	101.1	87.9	32.0	
III	4.9—21.8	5.1—21.6	13.4	13.0	98.5	95.0	96.0	93.5	7.1	7.1	307.1	273.7	289.6	263.7	79.9	90.0	34.6	
IV	6.3—24.8	5.0—22.3	15.2	12.8	113.0	111.5	111.0	110.0	7.3	8.5	343.5	323.7	285.4	259.0	67.9	91.9	36.0	
V	4.2—21.3	5.4—21.8	12.4	13.7	88.0	97.0	84.2	94.0	6.7	6.9	266.2	225.7	269.5	253.7	70.9	90.8	35.6	
VI	3.4—22.0	4.1—21.7	12.2	13.4	65.0	69.5	64.0	67.0	5.2	5.0	263.8	272.0	277.8	297.0	75.3	83.2	37.5	
VII	3.6—20.3	4.4—19.8	11.9	12.4	83.0	78.0	80.0	73.0	6.7	5.9	236.8	308.7	246.0	242.5	70.7	51.8	37.2	
VIII	4.5—21.1	3.1—21.5	11.5	12.4	32.0	34.0	27.0	30.0	2.3	2.4	249.0	234.7	207.5	199.5	57.4	51.5	37.0	
Mean	4.2—21.5	4.8—21.3	12.7	12.9	83.8	82.4	81.2	79.7	6.4	6.1	283.1	272.9	270.0	256.3	81.5	75.5	35.5	
MUSCULUS OBLIQUUS ABDOMINIS INTERNUS.																		
I	3.2—13.2	3.6—12.5	10.4	8.4	71.5	63.6	70.0	62.5	6.7	7.3	...	...	...	...	18.5	17.7	34.0	
II	3.9—13.4	4.4—14.5	8.4	8.7	66.0	85.0	63.5	63.4	7.5	7.3	176.2	161.2	375.1	373.2	20.7	20.2	32.0	
III	4.4—14.0	4.0—12.8	9.1	8.0	71.5	69.8	68.5	67.5	7.5	8.4	232.6	186.9	344.9	368.0	14.1	14.4	34.6	
IV	4.0—16.2	2.7—12.7	8.7	6.3	75.5	73.5	78.0	71.0	8.9	11.2	268.3	182.0	359.8	404.8	7.7	10.1	36.0	
V	4.1—15.4	2.7—12.4	8.9	8.0	74.0	77.5	69.0	75.6	7.7	9.4	253.4	217.6	299.9	326.1	9.5	9.9	35.6	
VI	4.3—13.7	3.0—13.3	8.5	7.3	52.0	53.0	50.6	52.6	5.9	7.2	216.6	209.4	377.3	364.9	9.8	10.5	37.5	
VII	3.9—16.4	5.0—15.7	8.8	9.3	81.8	68.0	80.0	70.0	9.0	7.5	198.0	193.0	498.5	485.8	10.9	14.6	37.2	
VIII	4.1—13.5	2.7—14.0	8.7	8.4	28.3	32.0	28.0	30.0	3.2	3.5	158.6	193.0	268.8	278.3	9.9	7.1	37.0	
Mean	4.5—14.3	3.8—13.6	8.9	8.0	65.1	62.8	64.5	61.4	7.2	7.6	214.8	191.9	360.6	372.5	12.6	13.1	35.5	
MUSCULUS TRANSVERSALIS ABDOMINIS.																		
I	1.8—13.6	2.6—13.9	7.6	7.2	44.7	43.4	44.5	42.3	5.8	5.8	...	...	...	...	43.0	43.0	34.0	
II	2.6—17.0	1.4—13.6	8.0	8.6	35.7	38.0	34.5	36.0	4.3	4.1	230.8	235.3	304.9	282.6	41.0	44.0	32.0	
III	2.1—14.1	2.3—13.8	8.0	7.8	42.1	43.0	40.8	40.5	5.1	5.1	220.1	233.6	255.4	250.1	43.1	43.7	34.6	
IV	2.5—12.1	2.5—12.4	8.5	7.8	46.0	45.5	43.5	40.0	5.1	5.1	232.5	199.2	246.9	281.2	44.0	43.8	36.0	
V	2.5—13.9	2.7—14.7	7.9	8.7	42.0	45.3	41.0	44.5	5.2	5.1	197.3	266.4	214.6	202.4	44.4	44.0	35.6	
VI	2.9—11.7	1.6—11.3	7.8	7.4	22.7	23.3	23.0	26.0	2.9	3.5	184.4	195.0	310.0	286.8	43.0	42.8	37.5	
VII	3.0—10.0	3.1—10.3	7.5	7.7	39.8	37.5	40.0	40.0	5.3	5.2	214.5	260.0	260.9	267.8	43.8	43.8	37.2	
VIII	2.9—10.7	2.3—10.7	6.8	7.2	14.0	14.5	13.0	14.0	1.9	1.9	198.2	183.6	191.3	179.7	39.6	39.5	37.0	
Mean	2.5—12.9	2.3—12.6	7.6	7.8	35.9	36.3	35.0	35.4	4.6	4.5	211.1	224.7	254.9	252.7	42.7	43.0†	35.5	
MUSCULUS RECTUS ABDOMINIS.																		
I	4.0—40.1	5.0—36.7	14.2	17.0	114.0	104.3	111.5	102.1	7.8	6.0	...	...	...	...	1.7	1.7	4.4	3.8
II	3.4—39.5	4.0—40.5	10.3	10.4	114.0	105.0	116.0	103.5	11.2	9.9	174.6	155.2	233.3	220.7	8.9	7.8	7.5	13.2
III	3.9—27.9	4.0—31.3	11.8	12.1	113.7	108.5	113.0	106.0	9.5	8.7	194.5	185.9	219.6	227.9	4.3	4.1	7.1	8.7
IV	3.6—23.2	3.5—24.5	10.0	11.2	96.0	112.0	94.5	110.5	9.8	9.4	179.5	172.6	201.7	205.4	5.7	5.7	7.3	6.9
V	3.5—28.0	3.7—22.5	12.1	11.4	116.0	115.3	113.0	110.3	9.3	9.6	207.4	229.9	213.8	257.6	8.5	8.1	6.7	6.1
VI	2.8—20.0	2.4—26.7	10.2	9.2	75.7	76.0	72.5	74.0	7.1	8.0	203.1	174.0	230.5	202.4	6.2	6.2	3.1	3.1
VII	2.9—19.9	3.6—21.2	9.2	9.3	98.7	102.0	98.0	100.0	10.6	10.7	159.2	156.8	219.2	202.0	11.6	9.7	4.6	3.2
VIII	4.1—24.5	3.8—28.0	10.3	11.7	25.3	24.3	24.0	22.5	2.3	1.9	114.7	104.9	128.5	119.4	5.9	3.4	2.9	2.1
Mean	3.7—25.4	3.9—28.8	11.1	11.3	96.1	91.4	92.8	91.2	8.3	8.1	176.9	168.4	199.0	201.0	6.4	5.8	5.4	5.9
MUSCULUS PYRAMIDALIS.																		
IV	...	2.4— 6.3	...	4.4	...	1.5	...	1.8	...	0.4	...	6.1	...	...	...	0.3	...	0.4
VI	2.8— 6.9	3.1— 5.3	4.3	4.0	1.8	0.7	1.7	0.9	0.4	0.2	5.8	5.3	...	...	0.6	0.5	0.5	0.3
VIII	2.3— 7.7	5.1— 9.1	5.4	7.1	1.5	1.3	1.5	1.7	0.3	0.2	8.7	10.3	...	...	0.5	0.7	0.4	0.4
Mean	2.3— 6.9	2.8— 7.0	4.8	5.5	1.6	1.1	1.6	1.4	0.3	0.2	7.2	7.2	...	...	0.5	0.5	0.4	0.4

* In the first body the muscular surface and that of the aponeurosis were calculated together; the figures are accordingly left out of consideration.

† The fulcrum surface of the transversalis is taken to be its attachment to the ribs, the lumbo-dorsal fascia, and the crest of the ilium. It is expressed in linear centimètres.

MUSCULUS QUADRATUS LUMBORUM.

No.	Extreme Lengths of Muscular Fibres.		Mean Lengths of Muscular Fibres.		Weight in Grammes.		Volume in Cubic Centimètres.		Cross-section in Square Centimètres.		Surface of Muscle in Square Centimètres.		Fulcrum Surface in Square Centimètres.		Surface of Application in Square Centimètres.	
	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.
I	2.5—12.4	4.3—14.8	6.4	9.4	33.8	39.0	29.0	29.0	6.0	3.0	80.5	66.3	23.2	21.2	5.9	3.4
II	4.3—15.0	2.6—15.1	10.5	9.5	20.0	25.0	19.5	24.0	1.8	2.6	49.6	61.9	20.7	23.2	4.3	6.2
III	4.0—13.9	3.6—14.9	9.4	9.5	29.4	31.9	28.5	29.5	3.0	3.1	48.2	47.9	21.5	18.8	1.7	2.3
IV	4.7—15.7	4.1—15.1	11.2	10.6	29.5	29.5	30.0	29.0	2.6	2.7	37.3	29.2	21.7	17.6	0.4	0.3
V	5.0—14.0	3.8—14.5	9.7	9.4	34.5	34.2	35.0	34.0	3.6	3.6	52.7	51.2	22.1	15.9	0.6	0.5
VI	4.6—15.3	4.9—15.6	11.0	10.5	21.0	24.0	19.5	23.0	1.7	2.1	53.0	41.1	16.5	11.2	0.6	0.6
VII	3.7—15.5	4.4—15.1	10.7	9.9	33.6	32.5	34.0	32.0	3.1	3.2	51.8	51.3	12.5	11.6	1.2	0.7
VIII	3.6—12.9	3.5—13.7	8.4	7.8	15.0	14.5	15.0	13.5	1.7	1.7	51.6	50.6	10.4	9.5	0.7	0.7
Mean	4.8—14.1	4.5—14.5	9.6	9.5	27.1	28.8	27.2	26.7	2.8	2.8	53.1	49.9	18.5	16.1	1.9	1.8
MUSCULUS ERECTOR SPINÆ.																
II	4.2—22.7	5.1—22.3	12.8	15.7	273.0	277.0	260.4	266.0	20.3	16.9	...	...	...	...	...	...
III	5.7—20.3	6.2—21.5	13.6	13.1	327.5	329.0	298.0	301.0	21.9	22.9	...	...	...	...	...	...
IV	7.0—24.2	7.5—22.0	15.0	15.2	329.0	333.0	245.0	319.5	16.3	20.1	...	...	...	...	...	...
V	5.8—19.6	5.0—21.2	13.1	12.4	381.5	378.0	368.5	368.0	28.1	29.6	...	...	...	...	...	...
VI	7.7—16.5	7.4—17.0	12.7	12.6	241.5	240.0	235.0	236.0	18.5	18.7	...	...	...	...	...	...
VII	5.3—16.4	6.8—15.5	10.8	11.3	272.0	273.0	266.0	261.0	44.6	23.1	...	...	...	...	...	...
VIII	6.2—28.2	8.2—17.3	12.5	13.3	128.0	121.5	126.0	119.5	10.0	9.0	...	...	...	...	...	...
Mean	6.9—19.2	6.7—19.2	13.0	13.4	278.8	278.7	256.9	267.3	19.7	19.7	...	...	...	...	...	...
PARS LUMBALIS DIAPHRAGMATIS.																
II	12.0—14.5		13.0		40.0		38.0		2.9		...		36.5		27.0	
III	11.3—14.7		13.5		52.2		51.0		3.7		...		18.2		26.8	
IV	11.0—14.6		12.3		54.5		54.0		4.3		...		34.7		31.6	
V	9.5—16.8		13.3		62.0		61.0		4.5		...		14.7		22.0	
VI	10.1—17.2		13.3		41.0		41.5		3.1		...		6.3		22.6	
VII	5.8—12.9		9.9		56.5		56.0		5.6		...		10.8		21.1	
VIII	6.3—12.4		9.8		22.3		22.0		2.3		...		7.5		37.1	
Mean	8.8—14.6		11.7		46.9		46.2		3.8		...		18.4		26.8	

PARS COSTALIS DIAPHRAGMATIS.

No.	Extreme Lengths of Muscular Fibres.	Mean Lengths of Muscular Fibres.	Weight in Grammes.	Volume in Cubic Centimètres.	Cross-section in Square Centimètres.	Surface of Muscle in Square Centimètres.	Surface of Aponeurosis in Square Centimètres.	Fulcrum Surface in Square Centimètres.	Surface of Application in Square Centimètres.
II	7.6—21.9	14.7	167.0	163.0	11.1	821.0*	...	127.4	55.9
III	6.1—19.3	12.4	145.1	145.0	11.6	1021.8	158.1	116.4	54.3
IV	5.9—19.6	13.4	150.0	157.0	11.7	1192.9	168.1	111.0	48.5
V	4.0—16.5	11.1	119.5	116.0	10.4	1036.4	148.2	132.0	60.2
VI	4.8—16.8	11.4	64.5	62.0	5.4	949.1	133.4	118.2	46.2
VII	4.6—17.4	11.8	116.0	112.0	9.4	794.7	129.3	72.6	48.6
VIII	6.1—14.4	10.7	32.0	31.0	2.9	576.0	98.3	66.8	20.8
Mean	5.7—18.6	12.7	116.0	112.3	8.9	913.1	139.2	106.3	47.8

* In the first body the figures for the diaphragm were calculated without separating the costal and lumbar portions, and are therefore left out of consideration.

MUSCULUS LEVATOR ANI.

No.	Extreme Lengths of Muscular Fibres.	Mean Lengths of Muscular Fibres.	Weight in Grammes.	Volume in Cubic Centimètres.	Cross-section in Square Centimètres.	Surface of *Muscle* in Square Centimètres.	Surface of *Aponeurosis* in Square Centimètres.	Fulcrum Surface in Square Centimètres.	Surface of Application in Square Centimètres.
I	3.8— 8.6	5.4	38.3	37.5	6.9	...	...	53.9	6.4
II	3.1— 9.2	5.9	31.5	32.0	5.4	159.4	...	50.3	6.1
III	3.8— 8.2	5.8	36.8	36.0	6.2	120.3	...	36.6	5.8
IV	3.8— 8.1	6.0	37.0	36.9	6.0	129.0	...	50.9	5.9
V	3.5— 9.1	5.9	41.0	41.0	6.9	99.2	...	53.2	6.2
VI	3.8—10.6	6.9	55.0	54.0	7.8	137.3	...	30.2	4.6
VII	4.8— 9.8	6.9	43.0	42.5	6.1	197.4	...	27.4	5.2
VIII	5.3— 8.7	7.6	19.0	17.0	2.2	143.4	...	17.8	4.2
Mean	4.0— 9.1	6.3	37.7	36.9	5.8	140.9	...	40.0	5.6

MEANS.

Muscle.	Extreme Lengths of *Muscular Fibres.*		Mean Lengths of Muscular *Fibres.*		Weight in Grammes.		Volume in Cubic Centimètres.		Cross-section in Square Centimètres.		Surface of Muscle in Square Centimètres.		Surface of Aponeurosis in Square Centimètres.		Fulcrum Surface in Square Centimètres.		Surface of Application in Square Centimètres.	
	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.	right.	left.
M. obl. abd. ext.....	4.2—21.5	4.8—21.3	12.7	12.9	83.8	82.4	81.2	79.7	6.4	6.1	283.1	272.9	270.0	256.3	81.5	75.7	35.5	
M. obl. abd. int.....	4.5—14.3	3.8—13.6	8.9	8.0	65.1	62.8	64.5	61.4	7.2	7.6	214.8	191.9	360.6	371.5	12.6	13.1	33.5	
M. transv. abd.	2.5—12.9	2.3—12.6	7.6	7.8	35.9	36.3	35.0	35.4	4.6	4.5	211.1	224.7	254.9	252.7	42.7	43.0	33.5	
M. rectus abd.	3.7—24.5	3.9—28.8	11.1	11.3	96.1	91.4	92.8	91.1	8.3	8.1	176.1	168.4	199.0	201.0	6.4	5.8	5.4	5.9
M. pyramidal.....	2.3— 6.9	2.8— 7.0	4.8	5.5	1.6	1.1	1.6	1.4	0.3	0.2	7.2	7.2	...	...	0.5	0.5	0.4	0.4
M. quadr. lumb.....	4.8—14.1	4.5—12.5	9.6	9.5	27.1	28.8	27.2	26.7	2.8	2.8	53.1	49.9	...	...	18.5	16.1	1.9	1.3
M. erect. spinæ	6.9—12.2	6.7—19.2	13.0	13.4	278.8	278.7	256.9	267.3	19.7	19.9	...	...	...	...	...	...	...	...
Pars lumb. diaphrag.	8.8—14.6		11.7		46.9		46.2		3.8		...		...		18.4		26.8	
Pars cost. diaphrag...	5.7—18.6		12.7		116.0		112.0		8.9		913.1		139.2		106.3		47.8	
M. levator ani.....	4.6— 9.1		6.3		37.7		36.9		5.8		140.9		...		40.0		5.6	

On a closer consideration of the anatomical relations of the broad muscles of the abdomen which cover one another in a stratified arrangement, we observe that they almost completely fill the space between the costal border and the upper edge of the pelvis, and that in the anterior wall we encounter muscular masses of different degrees of thickness according to the place we select. The linea alba, which is the line of application of all the broad muscles, is alone purely aponeurotic. Thus, the external oblique aponeurosis covers the muscular fibres of the internal oblique, which lose themselves in fascia much closer to the middle line. This fascia in turn overlies the inner muscular portion of the transversalis. The *middle portion of the anterior abdominal wall on each side of the linea alba is covered by the longitudinal* fibres of the rectus. Thus the entire anterior wall of the abdomen is muscular, but of varying thickness in different parts. The greatest thickness is found in the lateral regions between the lowest ribs and the middle portion of the iliac crest, and anteriorly where the recti are placed. The fleshy wall is thinnest between these two regions, where, however, its solidity is materially enhanced by the varying directions of the fibres of the broad muscles. Thus laterally the fibres of the external and internal obliques, which constitute the largest portion of the muscular structure, are almost parallel, while farther on in their course they cross one another nearly at right angles and form a network which largely adds to the strength of this part of the abdominal wall.

In order to get a reliable estimate of the average thickness of the layer of muscles, I added together the average volumes of the broad and straight muscles, and divided the sum by the average superficies of the broad muscles *plus* the surface of the rectus.

Thus:—

	Right.	Left.
Average volume of anterior wall	275.1	269.0
„ superficies of broad muscles	246.3	229.8
Superficies of rectus	176.1	168.4

Whence $\frac{275.1}{246.3 + 176.1} = 0.65$; $\frac{269.0}{229.8 + 168.4} = 0.68$

From this we see that the average thickness of the fleshy wall of the front of the abdomen is 0.66 cm. If we compare this number with Haughton's estimate of 0.86 inch* (derived from three subjects by direct measurement), it is evident that my figures are much smaller, a difference due to the unreliable character of his method.

Similarly we arrive at the average thickness of the posterior wall, namely, on the right side 0.51, left 0.53; that of the roof 0.16, that of the floor 0.26 centimètres.

Inasmuch as the force exerted through a muscle is determined by the physiological cross-section, and the force of each muscular group by the sum of the cross-sections of all the individual muscles constituting it, attention must mainly be directed to the cross-section. All the muscles concerned in bearing-down may be divided into the following groups:—lateral, which act on both sides; median on either side of the linea alba, which act in front; posterior, placed on either side of the spinal column; superior, situated at the lower opening of the thorax; inferior, forming the pelvic diaphragm.

The lateral group is on each side formed by three muscles—the external and internal oblique, and the transversalis. The median group on each side consists of the rectus and pyramidalis. The posterior is made up by the quadratus lumborum supported by the erector spinæ. The superior is constituted by the costal and lumbar portions of the diaphragm supported by the respiratory muscles of the thorax; and the inferior group contains the levator ani and sphincter.

If, now, we add together the cross-sections of the individual muscles of each group as given above, we arrive at the following results:—

	Right.		Left.	
	Sq. cm.		*Sq. cm.*	
Lateral group	18.2		18.2	
Anterior „	8.6		8.3	
Posterior „	2.8	(19.7)	2.8	(19.9)
Superior „	12.7			
Inferior „	5.8			

We may infer from this table that the forces exerted by the muscles on both sides are almost equal, and mutually maintain equilibrium; that the force of the anterior groups is partly antagonised by that of the posterior groups, the residue being maintained in equilibrium by the unyielding spinal column; and that the force exerted by the superior notably exceeds that of the inferior group, whence the latter becomes a locus minoris resistentiæ.† This view of the action of the separate groups of muscles would be correct if the muscular substance were everywhere uniformly distributed over the surface of the abdominal wall; but in fact certain parts of the abdominal muscles are stronger than others, that is

* Haughton, *Principles of Animal Mechanics*, p. 160.

† Kehrer, *Vergl. u. exper. Geburtsk.*, H. i, S. 21. Giessen, 1864.

to say, their physiological cross-section is greater, and can therefore display more force. In order to solve the question how this force is distributed over the various stages of bearing-down, I ascertained the cross-section of the upper and lower halves of the anterior abdominal wall and of the anterior and posterior portions of the diaphragm respectively. With this end in view, when the skin had been removed from the 9th subject, the linea alba was marked and a perpendicular to it drawn through the umbilicus, dividing the entire anterior abdominal wall into an upper and lower half. The weight and volume of each half of each muscle were ascertained, and the latter divided by the mean length of the muscular fibres gave the cross-section of each half.

In the case of the diaphragm I assumed as the line dividing the anterior from the posterior part, one drawn from the insertion of the lumbar portion into the central tendon, across the caval opening to the 8th costo-chondral articulation on the right side and produced to a corresponding point on the left side.

The results thus obtained are tabulated below.

Muscle.	Mean Length of Fibres.		Weight. Upper Half.		Weight. Lower Half.		Volume. Upper Half.		Volume. Lower Half.		Surface. Upper Half.		Surface. Lower Half.		Cross-section. Upper Half.		Cross-section. Lower Half.	
	right.	*left.*	*right.*	*left.*	*right.*	*left.*	*right.*	*left.*	*right.*	*left.*	*right.*	*left.*	*right.*	*left.*	*right.*	*left.*	*right.*	*left.*
M. obl. ext.	12.7	12.9	57.0	52.0	33.0	31.0	54.0	49.8	32.0	29.5	270.2	236.2	108.3	112.7	4.2	3.8	2.5	2.3
M. obl. int.	8.9	8.0	20.8	20.7	31.2	30.0	22.0	19.0	30.0	29.0	92.8	70.8	177.7	145.2	2.4	2.0	3.5	3.6
M. transv.	7.6	7.8	16.0	15.8	12.0	11.0	17.0	16.0	12.0	10.0	151.6	99.3	86.5	88.5	2.2	2.0	1.5	1.2
M. rectus	11.1	11.3	44.6	37.0	34.5	33.3	39.0	37.5	31.0	34.0	134.0	121.5	96.3	77.6	3.5	3.3	2.7	3.0
M. pyramid.	4.8	5.5	...	...	2.0	1.5	...	...	2.0	1.8	...	...	10.3	7.2	...	...	0.4	0.3
Total	...	...	137.8	125.5	111.7	106.8	132.0	122.3	107.0	104.3	305.5	256.9	220.4	193.0	12.3	11.1	10.4	10.4
Diaphragm, anterior portion	12.7		31.0				29.0				272.0				2.2			
Diaphragm, posterior portion	11.7		73.0				69.0				622.2				5.8			

From this table it is manifest that the cross-section of the right and left muscles in the upper half of the anterior abdominal wall is 23.4 square centimètres, and that it exceeds that of the muscles in the lower half (= 20.8 square centimètres) by more than 2 square centimètres. The superficies is likewise greater above than below. When, moreover, the force exerted by the whole diaphragm is counted in with that of the upper half, the diaphragm in the subject examined having a cross-section of 8 square centimètres, the difference between the upper and lower half of the abdominal muscles manifests itself much more markedly in favour of the former. With respect to the cross-sections of the anterior and posterior portions of the diaphragm, the excess of the latter is evident. Hence the forces exerted by the individual groups do not neutralise one another, but, on the contrary, by acting in concert they press the abdominal contents downwards, as I shall further endeavour to prove, and thrust against the levator ani as their antagonist.

Further consideration of the tables shows that the muscular superficies was calculated exclusive of all aponeurotic portions. Thus the length and breadth of the tendinous intersections of the internal oblique and rectus were cut out from the estimate of the superficies of these muscles.

The aponeurotic surfaces were calculated from the line of insertion of the muscular fibres to the linea alba. To that of the internal oblique was added the portion of the lumbo-dorsal fascia which lies between the muscle and the spinous processes of the lumbar vertebræ, bounded above by the lower border of the 12th rib, and below by the iliac crest. Where tendinous intersections existed, their superficies, amounting on an average to 3 or 4 square centimètres, was added to that of the aponeurosis. To the aponeurosis of the transversalis was added the surface of the middle layer of the lumbo-dorsal fascia, which, bounded above by the 12th rib and below by the iliac crest, lies between the muscle and the transverse processes of the lumbar vertebræ. The tendinous centre of the diaphragm was counted as aponeurosis.

Comparing the surfaces of the muscles and of their aponeuroses, we observe that they, especially in the case of the broad muscles of the anterior abdominal wall, are nearly alike, although sometimes, as, for instance, in the case of the internal oblique, the aponeurosis is more extensive than the muscle. Thanks to this, the broad abdominal muscles possess a great range of movement, and while the force they exert is applied to a very large surface, they possess also a considerable surface of support whereby their force is appropriately augmented.

Before I pass on to describe the fulcra of the abdominal muscles, I will briefly and in general terms indicate their importance to the manifestation of muscular force. It results from Professor LESSHAFT's* investigations that the larger the surface of support or of application is, by so much can muscles exhibit greater force; as also that they are less easily fatigued, and can work for longer periods the larger their surface of support and the smaller their relative cross-section is. On the other hand, muscular force is displayed with greater definiteness and speed according as the surface of support or of application is smaller, and the point of application of force nearer to the fulcrum. Under opposing conditions muscles can put forth increased force.

As regards their physiological function, we observe that the muscles which produce bearing-down are not designed to move single members or the entire body, and that they are required to display not either precision or speed in their action, but prolonged and forcible exertion, called into maximum intensity during labour, when they provide support for the contracting uterus.

A glance at the tables shows that the abdominal muscles answer exactly to the conditions of exertion just laid down. They have a relatively small cross-section, and very large surfaces of origin and application, fitting them for prolonged and remarkably powerful contraction. WARAWIN† is of opinion that not only the sum of the skeletal insertions of a muscle should be estimated as surfaces of origin and application, but that the entire space included between the lines joining the extreme points of the insertions should be so reckoned. The estimated extent of the fulcrum surfaces must also be augmented by the surfaces of insertion into tendinous structures, as also by the lateral supports formed by the covering aponeuroses. Thus the length of POUPART'S ligament, which on an average is 15 centimètres, must be added on each side to the fulcrum of the external oblique. The fulcrum of the external oblique and of other muscles of the anterior abdominal wall is made to include all their insertions, pelvic and costal, thus altogether ignoring their functions as benders of the trunk and expiratory muscles. And this because during the complete act of bearing-down the pelvis is fixed by the lower extremities, the cage of the thorax is expanded by the air shut up in the lungs by the closure of the glottis, the entire trunk is extended by the erectores spinæ, and the force of all the muscles under consideration is concentrated on the linea alba.

The fulcrum of the internal oblique must be held to include the length of the line of attachment of the superficial layer of the lumbo-dorsal fascia to the spinous processes of the lumbar vertebræ, which on an average amounts to 23.5 centimètres; and in certain muscles the cross-section of the tendinous intersections must be added, amounting on an average in six subjects to 1.14 square centimètres. The fulcrum of the transversalis has to be increased by the length of the attachment of the middle layer of the lumbo-dorsal fascia to the transverse processes of the lumbar vertebræ, the average measurement of which is 15.1 centimètres. The fulcrum of the rectus, exclusive of the skeletal attachment, is formed by the cross-sections of all the tendinous intersections, the sum of which is 3.9 square centimètres for the right side, and 3.7 square centimètres for the left. The extent of this surface is, moreover, markedly increased by the fusing of the tendinous intersections with the sheath, and by the insertion of certain muscular fibres along the whole length of the linea alba. Finally, in some subjects it is further reinforced inferiorly by the pyramidalis.

The fulcrum of the quadratus lumborum is formed by the entire area lying between the lines joining the extreme points of the surfaces of insertion, and by the ilio-lumbar ligament and tendinous arch

* LESSHAFT, *Von dem Unterschiede der Krafttäusserung der Muskeln der oberen und der unteren Extremität.* Arbeiten des Vereins der russischen Aerzte. 1880, viii.

† WARAWIN, *Petersburger Dissert.* 1882.

of the diaphragm, and is substantially supported by the erector spinæ lying behind that arch. The latter muscle averages 19.9 square centimètres in cross-section, and its contraction affords very great lateral support.

The costal portion of the diaphragm has as fulcrum the entire surface of insertion into the ensiform cartilage, ribs, costal cartilage and transversalis fascia. To the lumbar portion are assigned the attachment of its crura to the lumbar vertebræ, the ligamenta arcuata and the aortic aperture formed by the decussation of the crura. The entire diaphragm is further notably steadied by the distended lungs and the respiratory muscles, aided especially by the external support afforded by the upper limbs.

The fulcrum of the levator ani consists in its surfaces of insertion into the pubis, spine of the ischium and border of the coccyx, augmented by the tendinous cord passing from the pubis to the ischial spine, and in part by the lesser sacro-sciatic ligament.

The surface upon which the force is applied is the same for all six broad muscles, inasmuch as all share in the formation of the sheath of the rectus, and by their contraction exert a strain on the linea alba.

When the pelvis is fixed, the rectus acts upon its costal attachments and upon the sum of the cross-sections of its tendinous intersections. When the ribs also are fixed, it puts strain on its sheath and on the linea alba, and thus increases the fulcrum surface of the broad abdominal muscles.

The surface upon which the diaphragm acts is the periphery of the tendinous centre, which measures 47.8 cm. for the costal portion, and 26.8 cm. for the lumbar portion.

The anus is the point of application of the levator ani. When the abdominal muscles are in action, this latter muscle by supporting the anus becomes in a certain sense their antagonist.* When we add together the cross-sections of all the abdominal muscles except the levator ani, we arrive at the sum of *71.6 square centimètres, representing the muscular force which from all sides concentrates itself on the* line of least resistance, that is to say, on the pelvic outlet.

Having brought the discussion of the first question that is before us to an end, by finding numerical expressions for the average length of the muscular fibres, and for the cross-sections, fulcrum surfaces and surfaces of application of the muscles concerned in bearing-down, we may pass on to determine the *direction in which these muscles act and the mechanical conditions of their action.*

Before I discuss the direction in which each muscular group acts and the resultants of all the forces concerned in producing bearing-down, it is advisable to say something about the action of bearing-down *considered in its entirety.*

The main function of the abdominal muscles is to diminish the capacity of the abdominal cavity; but inasmuch as the obliques are attached to movable ribs, they act as expiratory muscles by depressing these latter. *On further contraction the abdominal muscles, especially the straight ones, tend to bend* the trunk, but when the pelvis and thorax are simultaneously fixed, their whole energy is concentrated on compression of the abdominal cavity, the evacuation of the bladder and of the lower section of the rectum, and, *in women during* labour, on the expulsion of the fœtus through the genital canal.†

This process is aided by the contemporaneous contraction of both lateral groups, which, straining their aponeuroses, flatten the abdominal convexity; and inasmuch as the rectus is enclosed between the aponeurotic lamellæ, by increasing its fulcrum surface they favour its action. Thus the entire anterior surface becomes concave instead of convex. The dorsal wall, however, in consequence of the contraction of the posterior group, does not bulge but is flattened, and, the ribs being fixed, exactly the

* Sappey.

† Scanzoni, *Lehrb. d. Geb.*, 3. Aufl. S. 176, 1885.

same thing occurs in the case of the superior group. From the simultaneous contraction of all these muscular groups there arises a proportional diminution in the size of the abdominal cavity.

During urination and defecation but a small part of the bearing-down power is brought into action, for the obstacle to be overcome is usually very trifling and to a certain extent under the control of the will.* The sphincter vesicæ being relaxed, the detrusor fibres are chiefly concerned in micturition, and the amount of bearing-down exerted is limited to accelerating the outflow and rendering it more forcible. In defecation the motion of the fæces is due to peristalsis of the rectum, the sphincter being relaxed, and bearing-down has only the effect of imparting to the masses about to be expelled a shape corresponding to the anus. When the rectum is overfilled or the fæces unusually hard, it serves to distend the elastic anal opening.† But during labour, where the expulsive forces have to propel a full-grown fœtus through an unyielding bony ring, the function of bearing-down is far more important, and the energy put forth is proportional to the resistance. Childbirth is therefore of especial interest to us, inasmuch as during its progress the maximum of that useful force is displayed which is the expression of the resultants of all the forces exerted by the bearing-down muscles individually.

The act of bearing-down must be divided into separate stages. According to Professor LESSHAFT, the first stage is contraction of the diaphragm taking place from behind upwards and from before downwards, whereby it encroaches on the abdominal cavity and bulges the anterior abdominal wall. The second stage is contraction of the broad muscles and straining of the sheath of the rectus. The third is contraction of the straight muscles, during which their upper portion acts with greater force than the lower.

According to HENLE,‡ the action of these muscles falls into two stages. In the first the muscles tend to change their curved surfaces to planes. It is not until their fibres have approached as near to a rectilinear direction as the compressibility of the abdominal contents permits that the second stage begins. This consists in traction upon the bony points to which they are attached. As we have here to consider only the first stage, we shall omit all notice of the second.

The diaphragm, during closure of the glottis and full strain of the respiratory muscles, being capable of maintaining the force of the ventral muscles in equilibrium, when both components come into play, the resultant acts in the direction of the pelvic outlet.§

According to SAPPEY,‖ the action of the entire ventral system of muscles is reducible to two forces: one superior, tending to diminish the size of the abdominal cavity; the other inferior and far weaker, which commonly offers resistance to the former.

HAUGHTON,¶ however, is of opinion that during childbirth the levator and sphincter ani by their contraction and retraction assist the abdominal muscles to display their energy in the expulsion of the contents of the uterus and vagina.

As regards the direction in which the force is exerted, SAPPEY holds that it runs obliquely from the umbilicus to the sacro-coccygeal articulation; while SCHATZ** takes a line parallel to the spinal column as the direction of the diaphragmatic force. On account of the reciprocal counteraction of the forces exerted from the right and left sides, SCHATZ further concludes that the direction of the force of the anterior muscles is limited to one line, running nearly horizontally from before backwards. The resultant, in consequence of the equality of the forces acting vertically and horizontally, makes an angle of 45° with the horizon; its direction is from before upwards and from behind downwards, and it makes an angle of 10°, open posteriorly, with the axis of the pelvic inlet.

* FOSTER, *Lehrb. d. Physiol.*
† DONDERS, *Physiol.* Ueb. v. W. BAKST. Th. 1, S. 366. 1861.
‡ HENLE, *Handb. d. Muskellehre d. Mensch.*, Bd. i, Abth. 3, S. 75. 1871.
§ KEHRER, *Vergl. u. exper. Geburtsk.*, Heft i, S. 21. Giessen, 1864.
‖ SAPPEY, *op. cit.*, p. 271.
¶ HAUGHTON, *Principles of Animal Mechanics.*
** SCHATZ, *Der Geburtsmech.*, S. 25.

My researches render it impossible to accept SCHATZ's opinion. From the table we see that the cross-section of the posterior portion of the diaphragm is far greater than that of the anterior portion, on which account the direction of the force resulting from the action of the two portions cannot lie vertically downwards. The diagrammatic figure (Fig. 1) makes it clear that the resultant *C* of the anterior and posterior portions of the diaphragm acts in a line directed downwards and forwards, and cuts the perpendicular *A* let fall from the centre of the diaphragm, at an angle of 47°.

This resultant was arrived at thus. At the points of bisection of the chords of the arcs formed respectively by the anterior and posterior portions of the diaphragm, perpendiculars *a* and *b* were erected and produced to intersect. On these lines lengths were taken, for the anterior half 2.2 centimètres, for the posterior half 5.8 centimètres, corresponding to the cross-sections of the two halves. A parallelogram was constructed, the diagonal of which, *C*, indicates the direction of the resultant.

In like manner the direction of the force exerted by the anterior abdominal muscles is shown not to be horizontal, as SCHATZ asserts. From the table it appears that the cross-section of the upper half of these muscles is greater than that of the lower half. Accordingly, their resultant cuts the vertical line *A* (Fig. 2) at an angle of 84°.

If, now, we produce the lines representing the resultant of the diaphragm and that of the anterior muscles, to meet in a point, and lay off on them the cross-sections of the diaphragm and of the ventral muscles respectively, and construct the parallelogram, we arrive at a resultant *D*, which cuts the plane of the pelvic inlet at an angle of 89°, or, in other words, is almost parallel to the axis of the inlet.

The umbilicus is a point of maximum tension in both horizontal and vertical directions for the entire abdominal surface. It is accordingly chosen as the point of application of the resultant of all the forces exerted by the anterior wall. To determine the angle between this resultant and a horizontal line, the average inclination of the muscular fibres to the linea alba was measured. To effect this the following plan was adopted. The external oblique having been cleaned on each side of the body, the angle between the fibres of this muscle and the linea alba was measured at a certain point. In order to measure this angle, fibres were carefully dissected out from the connective tissue, and a fine waxed linen thread stretched exactly parallel to their direction, and produced from the point where the fibres passed into the aponeurosis, to intersect the linea alba. The thread was maintained in position by a rule, and the angle was measured on a scale. This process was repeated at 10 points of intersection taken on each side at intervals of 5 centimètres above and below the umbilicus; and, in addition, the angles formed at the extremities of the linea alba and at the umbilicus were measured. The average of all these angular measurements was taken as the average angle at the umbilicus. A like procedure was adopted with the fibres of the internal oblique and transversalis in turn, and the inclination of the pyramidalis to the linea alba was also measured. The results, drawn from three males and one female were as follow:—

Average angle of external oblique	38°.20*
„ „ internal oblique	127
„ „ transversalis	101
„ „ pyramidalis	10

The difference between the cross-sections of each muscle in its upper and lower half referred to the line of intersection, and the resultant of all the forces, were calculated. The resultant of the two oblique muscles made an angle of 75° with the linea alba while the general resultant of all the broad ventral muscles was inclined at an angle of 84° to the same line. (Fig. 2.)

Inasmuch as the abdominal surface everywhere presents curved areas, and the muscular fibres bleading with the aponeurosis ascend in certain curves towards the linea alba as the line of application of force, it was necessary, in order to set forth the mechanical conditions under which these muscles act, to determine the angle between these curves and the line drawn from the anterior to the posterior abdominal

* HAUGHTON (p. 219) found 35° for the angle of the external oblique.

wall. Every force acting along a curve really acts along the tangent at the point of application, and therefore the angle between this tangent and the diameter of the abdominal cavity had to be ascertained. To effect this I investigated the direction and type of the curves, and calculated the average magnitude of the abdominal curvature. Measurements of 45 living persons were made—of men, of nulliparous women and of those who had borne children, of pregnant women in different months of pregnancy, and of women in labour,—whereby I secured an accurate representation of the ventral curves.

The peculiar method of measuring the ventral curves devised by HAUGHTON* seeming to me entirely untrustworthy, I adopted the following plan, under Professor LESSHAFT'S advice. A thin strip of pure tin was taken, 1 centimètre broad and $\frac{3}{4}$ millimètre thick, very flexible without being elastic, so that it retained all the curves once imparted to it. The distance between the umbilicus and the vertebra immediately opposite to it was measured with BAUDELOQUE'S callipers, to the side-piece of which a water-level was attached, so as to secure that the two points lay in a horizontal line. The points were then marked on the skin at the umbilicus in front, and behind usually at the level of the fourth lumbar vertebra in men and nulliparous women, and at that of the fifth in pregnant women. The height of the umbilicus was taken as an index because the umbilicus is the point of maximum tension, because there least fat is found, and because it is an easily determined point for comparison.

When these opposite points were marked and their distance measured, I applied the strip of tin firmly to the abdomen and pressed it accurately into all the inequalities of the parietes. Then after a few respiratory movements, I marked on the strip during the interval between inspiration and expiration the positions of the umbilicus and spinous process. To secure the horizontal position of the strip, the water-level was attached below its lower edge by a morsel of paste. I thereupon removed the strip to a table. The interval between the marked points was once more measured with the callipers, an edge of the strip was smeared with printing ink, and the curve of the abdominal wall was transferred to a sheet of paper. Similar measurements were made on each side of the abdomen, and along the linea alba from the upper border of the symphysis pubis to the apex of the ensiform cartilage, during which the position of the umbilicus was marked, and the length of the linea alba as a right line was measured with the callipers. This plan was proved to be sufficiently accurate by the fact that repeated measurements and graphic representations of the curves in a given patient gave identical results.

All the measurements were taken in the standing position, and the least lack of symmetry between the lateral halves of the abdomen was accurately reproduced by the strip. For instance, the least degree of lumbar scoliosis, though almost imperceptible, was at once betrayed by a comparison of the two halves of the curve. When the tracings were collected their elements were determined by analytical geometry, and from each similar series the average curve was calculated.

I will briefly describe the process.

Each curve was divided into several segments, and in each segment two pairs of parallel chords were drawn. The middle points of each pair were joined by right lines which were produced to cut the curve, and to intersect. If these lines intersected within the curve, if they were equal and bisected the chords at right angles, the segment of the curve in which the chords were drawn formed part of a circle, the perpendiculars produced to meet the segment were radii and the point of intersection was the centre. When intersecting within the curve, these lines cut the chords at an oblique angle in such a manner that the chords cut by one line were parallel to the other line, the segment formed a portion of an ellipse, of which the centre lay at the intersection of the lines. When, under similar circumstances, the point of

* HAUGHTON laid the person whom he was about to measure on his back on a plank, and allowed the ventral wall to rise and sink. Taking as a standard a right line drawn from the symphysis pubis to the ensiform appendix, he determined the amplitude of this rise and fall with reference to the standard line. On the distended abdomen he measured the curves of length and breadth (?) and calculated the ventral curve from the formula

$$P = T\left(\frac{1}{p_1}+\frac{1}{p_2}\right),$$ where T represents the tension at the umbilicus.

intersection lay outside the curve, the segment formed part of a hyperbola. Finally, when the lines joining the points of bisection of every two pair of chords, so far from intersecting were parallel to one another, the segment was parabolic.

In my cases most of the horizontal semi-circumferences of the abdominal wall consisted of four segments continuous with one another. The first or lumbar segment was generally a right line, rarely it formed a segment of a circle of very large radius. The second segment was invariably circular. The third was generally elliptical, rarely parabolic and still more rarely hyperbolic. The fourth or umbilical segment was almost always parabolic or hyperbolic. (Fig. 3.)

The vertical curve of the abdominal wall corresponding to the linea alba was generally divisible into three segments. The first, adjacent to the ensiform appendix, was always hyperbolic, with the convexity inwards; the second was most frequently hyperbolic, rarely elliptical or parabolic; while the third was almost invariably circular.

When the various arcs of the ventral curves were determined, it was necessary to find the position of the centre and magnitude of the radius in the case of the circle, and the direction and magnitude of the axes major and minor, with the positions of the foci, for the ellipse, hyperbola and parabola. The separate curvilinear elements were therefore described on the line representing the ventral curvature.

It was very easy to ascertain the elements of the circle; the centre of the hyperbola was determined by the intersection of two diameters, and the major axis by its property of bisecting all chords perpendicular to it. The minor axis was calculated from the equation

$$\frac{b}{a} = \frac{y}{\sqrt{x^2 - a^2}}$$

where a represents the semi-axis major, b the semi-axis minor, and x and y are the co-ordinates of any point on the hyperbola referred to the centre as origin and the major axis as axis of abscissæ. The above formula is a transformation of the ordinary equation to the hyperbola

$$y = \pm \frac{b}{a} \sqrt{x^2 - a^2}$$

The eccentricity was found graphically from the semi-axes a and b. It is the ratio of the hypothenuse of a right-angled triangle whose sides are a and b, to a. The position of the foci was determined along the major axis from the eccentricity, and by means of two threads whose difference in length was equal to the axis major the hyperbola was described.

In the parabola the direction of the major axis was found in the same way as in the case of the hyperbola, and the focus was discovered by taking an abscissa half the length of the corresponding ordinate. The curve was then graphically described by means of thread, rule and compasses.

In the ellipse the centre was found by drawing two diameters to intersect, and the major axis exactly as in the former cases. The minor axis was, however, either graphically determined by erecting a perpendicular to the major axis, or calculated from the equation

$$\frac{b}{a} = \frac{y}{\sqrt{a^2 - x^2}}$$

The eccentricity is the ratio of the side of a right-angled triangle whose hypothenuse represents the semi-axis major and its other side the semi-axis minor, to the semi-axis major. The foci were simultaneously determined, and the ellipse was described by the aid of a thread equal in length to the major axis.

When all the magnitudes had been determined, tangents were drawn, in accordance with the rules of analytical geometry, to the curve at the umbilicus, and the mean curves for the right and left sides and for the linea alba were described. These curves were separately constructed for pregnant women, women in labour, nulliparous women, and for men. The following was the method adopted. The average diameter of the abdomen was laid down, and at its lumbar extremity the angle was constructed which it formed with the first segment. The latter was then constructed of its average magnitude, adjacent to

the angle. The second (circular) segment was then described. Its centre was determined by means of the average radius and the average angle of its inclination to the first segment. The mean length of the chord was laid down. At the umbilical end of the diameter the mean hyperbola (4th segment) was constructed from the mean lengths of the semi-axes, the angle between the tangent and the diameter, and the mean length and direction of the radius vector. The direction of this latter was found from its mean inclination to the tangent. The eccentricity was graphically indicated by the mean lengths of the semi-axes, and the position of the focus and direction of the other radius vector were also known. The direction of the axis major was thus found, and from its average length and the direction and average length of the axis minor, the hyperbola was constructed and the mean length of its chord laid off. The third (elliptical) segment could be described by means of the average lengths of the axes or from the average eccentricity, inasmuch as the extremities of the arc, adjacent to the 2nd and 4th segments, were already known.

When constructing the average vertical curves I employed the same method, taking the mean distance between the ensiform appendix and the symphysis pubis as diameter. (Figs. 8 and 9.) When these average curves were described I found myself in possession of these categories:—those representing men and nulliparæ; those of women who had borne children, and those of women in labour and far advanced in pregnancy. (Figs. 7, 6, and 5.)

If we compare the average curves (Figs. 7 and 5) corresponding respectively to nulliparæ and to women far advanced in pregnancy, we see that the segments are more convex in the latter. During the earlier months of pregnancy there are transitions from one kind of curve to the other; the lumbar segment, however, hardly ever changes from a right line continuous with the circular segment which in pregnant women merely assumes a somewhat greater radius. The third segment, which in nulliparæ is parabolic or hyperbolic, merges in pregnant women into an ellipse of considerable eccentricity. It is mostly at the expense of this segment that the curve of pregnancy enlarges. The fourth (parabolic) segment of the curve in nulliparæ passes late in pregnancy into a hyperbolic arc, whereby the umbilicus is notably pushed forward, so that the curve of each side passes almost without interruption into that of the other.

In the average curve of pluriparæ, the two forms are united. The first and second segments become uniformly circular, which is perhaps due to expansion of the lumbar portion of the abdominal cavity during past pregnancies. In the third segment the curve again becomes parabolic. The fourth segment remains an excentric hyperbola, as the anterior abdominal wall, especially the umbilical region, is stretched to the utmost during pregnancy. Meanwhile the outline of the straight ventral muscles is lost (*ED*, Fig. 7), and the umbilicus is obliterated in consequence of the stretching of the linea alba.

If we now contrast the conditions of muscular action upon the umbilicus, assumed as the point of application of the force, under different forms of ventral curvature (Figs. 10*a* and 10*b*), we find the following to be the case. Inasmuch as the force acts, alike in the pregnant and non-pregnant, along the tangent drawn from the point of application, it works at a greater advantage the smaller the angle is between the tangent and the diameter of the abdominal cavity. To prove this, let us mark off on the tangent the sum of the cross-sections of the broad muscles and resolve this into two forces at right angles to one another. It is manifest that the forces acting from right and left perpendicular to the diameter balance one another, and there only remains the sum of the components from each side which act along the diameter. In the non-pregnant this force is directed from within outwards, and tending to obliterate the umbilical concavity its amount must be subtracted from the sum of the forces exerted by the straight muscles. (Fig. 10*b*.) During pregnancy, however, it coincides as to direction with the force exerted by the straight muscles, and augments their power. (Fig. 10*a*.) Moreover, the conditions under which these forces work during labour are rendered still more favourable by the enhanced muscular tension due to the strained abdominal wall. The conditions affecting the vertical curve remain the same in both cases. During pregnancy that curve is merely expanded, and enlarged mainly at the expense of the inferior segment of the abdomen.

From these investigations I draw the following conclusions :—

1. The sums of the cross-sections of the bearing-down muscles on the right and left sides are equal. This is likewise almost true for the broad muscles on the two sides.

2. Of the broad muscles, the internal oblique has the greatest cross-section, and therefore the greatest energy.

3. The bearing-down muscles are, thanks to the great extent of their fulcrum surfaces, fitted for prolonged exertion, whereby they gain in force, but lose in precision and rapidity.

4. The cross-sections of the ventral muscles are inversely proportional to the areas of their fulcrum surfaces.

5. Tendinous intersections augment fulcrum surfaces.

6. The cross-section of the posterior portion of the diaphragm is notably greater than that of the anterior portion, on which account the force exerted by the whole muscle is directed downwards and forwards.

7. The cross-section of the upper half of all the anterior ventral muscles is greater than that of the lower half, whence the resultant of all the muscles is directed backwards and downwards.

8. The resultant of all the bearing-down muscles is parallel to the axis of the pelvic inlet, and makes no angle with that axis, as SCHATZ asserts.

9. The principal meridians of the ventral surface are usually divisible into four segments, each of which is a curve of the second degree.

10. During pregnancy the capacity of the abdominal cavity is increased chiefly at the expense of the middle portion of the curve, which changes from the parabolic to the elliptical form.

11. The smaller the inclination of the tangent at the umbilicus to the diameter of the abdominal cavity, the more favourable are the conditions under which the broad muscles act. The latter are therefore functionally at a greater advantage during labour than when the uterus is empty.

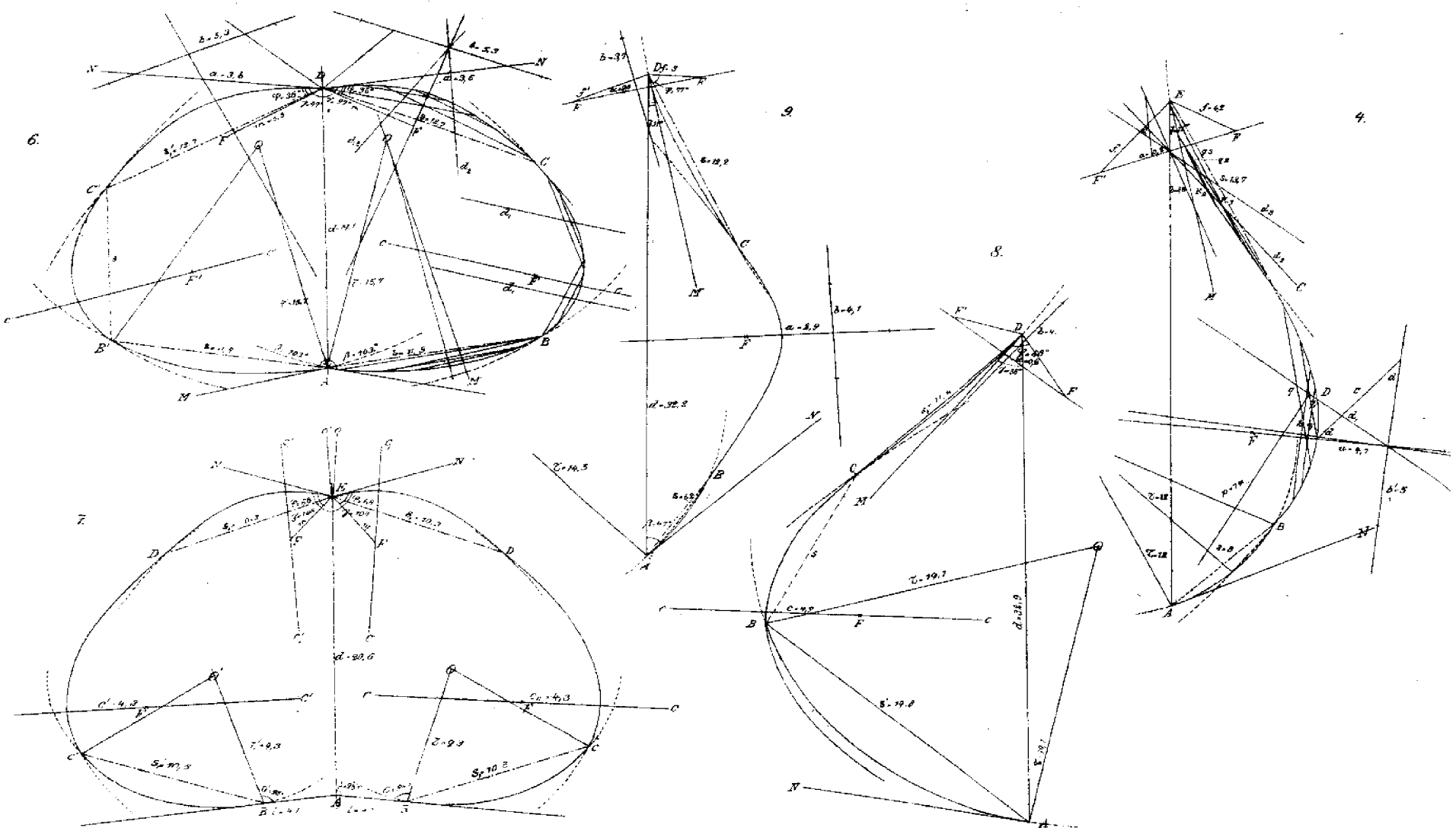


PLATE 2.

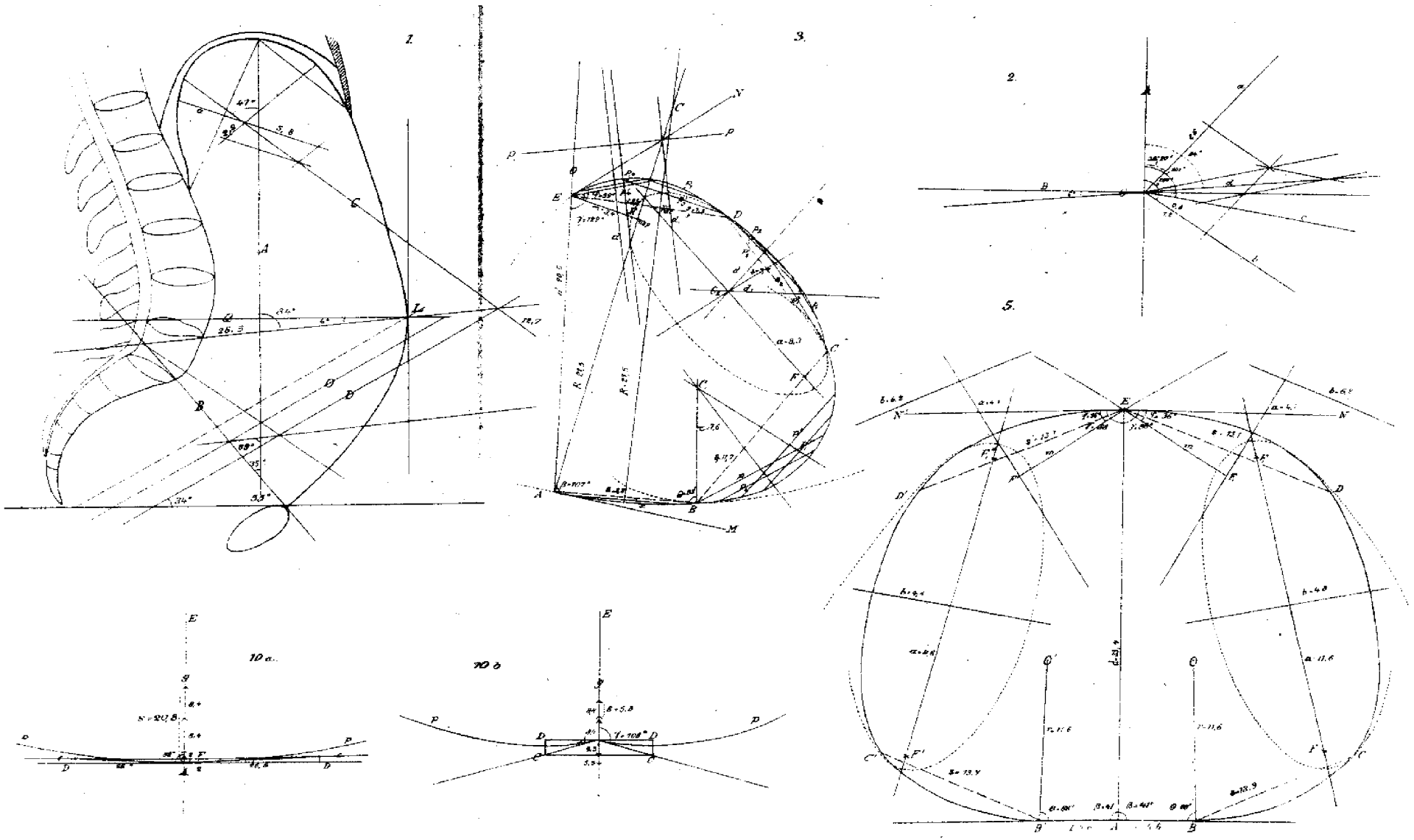


PLATE I.

EXPLANATION OF THE PLATES.

Fig. 1.—*Median, Antero-posterior Section of the Abdominal Cavity.*—*A*. Perpendicular from centre of diaphragm. *B*. Plane of pelvic inlet. *C*. Direction of resultant of *a* and *b* [the latter not printed], the diaphragmatic components. *E*. [not printed] Direction of resultant of anterior muscles. *Q*. Diameter of ventral cavity. *D*. Resultant of diaphragm and anterior muscles. *O*. Axis of pelvic inlet. *L*. Umbilicus.

Fig. 2.—*Resultant of all the broad Abdominal Muscles referred to Umbilicus.*—*A*. Linea alba. *B*. Horizontal line. *C*. Umbilicus. *a*. Mean direction of force exerted by external oblique. *b*. Mean direction for internal oblique. *c*. Mean direction for transversalis. *d*. General resultant.

Fig. 3.—*Horizontal Ventral Curve (from below) and its Determination (from a Nullipara).*—*A E*. Diameter. *A*. Spinous process of 4th lumbar vertebra. *E*. Umbilicus. *A B*. First segment, a circle of large radius. *s s*. Two parallel chords. *R*. Radius. *C*. Centre. *A M*. Tangent. β. Angle between tangent and diameter. *B C*. Second segment, a circle of less radius. *r*. Radius. C_1. Centre. $p\,p_1$ and $p'\,p'_1$. Two pair of parallel chords. δ_1. Length of curve. θ. Inclination of radius to first segment. *C D*. Third segment, an ellipse. $p_1\,p'_1$ and $p_2\,p'_2$. Two pair of parallel chords. $d\,d_1$. Two semi-diameters. C_2. Centre of the ellipse. *a* and *b*. Semi-axes major and minor. *F F'*. Foci. s_2. Length of the curve. *D E*. Fourth segment, a parabola. $p_3\,p'_3$ and $p_4\,p'_4$. Two pair of parallel chords. $d\,d_1$. Parallel diameters. *C*. Principal axis. *m*. A radius vector. s_3. Length of the curve. *N E*. Tangent at umbilicus. *O E*. Parallel to principal axis. ϕ. Angle between tangent and radius vector. γ. Angle between tangent and diameter. *p p*. Directrix.

Fig. 4.—*Vertical Curve of Nullipara.*—*A E*. Vertical diameter. *A B*. Inferior segment, circular. *r*. Radius. *N A*. Tangent. *s*. Length of curve. *B C*. Middle segment, hyperbolic. *D*. Umbilicus. $k_1\,k_1$ and $q_1\,q_1$. Two pair of parallel chords. *C*. Centre. *F*. Focus. *e*. Excentricity. *p*. Distance between symphysis and umbilicus. *C E*. Superior segment, hyperbolic (inverted). $k_2\,k_3$ and $q_2\,q_3$. Two pair of parallel chords. $d_2\,d_3$. Two diameters. F_1. Focus. e_1. Excentricity. *C*. Centre. *a*. Axis major; *b*. Axis minor. $f\,f_1$. Two radii vectores. *M E*. Tangent. *s*. Length of curve.

Fig. 5.—*Mean horizontal Curve of advanced Pregnancy and Labour.*—*A E*. Diameter. *A*. 5th lumbar vertebra. *E*. Umbilicus. *A B*. First segment, a right line. *l*. Its length. β. Its inclination to the diameter. *B C*. Second segment, circular. *r*. Radius. *O*. Centre. *s*. Length of the arc. θ. Inclination of radius to the first segment at *B*. *C D*. Third segment, elliptical. F_1 *F*. Foci. *a*. Semi-axis major; *b*. Semi-axis minor. *D E*. Fourth segment, hyperbolic. *a*. Axis major; *b*. Axis minor. F_1. Focus. *m*. Radius vector. *N E*. Tangent. s_1. Length of the arc. ϕ. Angle between tangent and radius vector. γ. Angle between tangent and diameter.

Fig. 6.—*Average Curve of Pluripara.*—*A D*. Diameter. *A*. Spinous process of 4th lumbar vertebra. *A B*. First segment, circular. *r*. Radius. β. Inclination of tangent to diameter. *M A*. Tangent. *s*. Length of arc. *B C*. Second segment, parabolic. *c c*. Principal axis. *F*. Focus. *C D*. Third segment, hyperbolic. *a*. Major axis; *b*. Minor axis. *F*. Focus. *N D*. Tangent. *D F*. Radius vector. *s*. Length of arc. γ. Inclination of tangent to diameter.

Fig. 7.—*Average Curve of Nullipara.*—*A E*. Diameter. *A*. 4th lumbar vertibra. *E*. Umbilicus. *A B*. First segment, a right line. β. Its inclination to the diameter. *B C*. Second segment, circular. *r*. Radius. θ. Its inclination to the first segment. *s*. Length of arc. *C D*. Third segment, parabolic. *C C*. Principal axis. *F*. Focus. *D E*. Fourth segment, parabolic. $C_1\,C'_1$. Principal axis. *N E*. Tangent. s_1. Length of arc. *O E*. A parallel to the principal axis. ϕ. Inclination of the tangent to the radius vector. γ. Inclination of tangent to diameter.

Fig. 8.—*Vertical Curve of Labour.*—*A D*. Vertical diameter. *A*. Symphysis pubis. *D*. Ensiform appendix. *A B*. Inferior segment, circular. *r*. Radius. *s*. Length of arc. *B C*. Middle segment, parabolic. *C*. Principal axis. *F*. Focus. *s*. Length of arc. *C D*. Superior segment, hyperbolic. *a*. Major axis; *b*. Minor axis. *M D*. Tangent. γ. Inclination of tangent to diameter.

Fig. 9.—*Vertical Curve of Pluripara.*—*A B*. Inferior segment, circular. *r*. Radius. *N A*. Tangent. β. Its inclination to the diameter. *B C*. Middle segment, hyperbolic. *a*. Axis major; *b*. Axis minor. *F*. Focus. *C D*. Superior segment, hyperbolic. *a*. Axis major; *b*. Axis minor. *M D*. Tangent. γ. Its inclination to the diameter. *s*. Length of arc.

Fig. 10.—*The Conditions of the Muscular Force referred to the Umbilicus.*—Case *a*. *Labour:*—*p p*. The curve. *A*. Umbilicus. *A C*. Tangent. *A E*. Diameter (normal to the curve). *A F*. and *A D*. Components. *A g*. Direction of force exerted by recti. *s*. Sum of forces. Case *b*. *Nullipara:*—*p p*. The curve. *A*. Umbilicus. *A C*. Tangent. *A F*. (*F*. not printed) and *A D*. Components. *A g*. Direction of force exerted by recti. *s*. Difference of the forces. *A E*. Normal.

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