1935-1937 年
第 3 卷第 1,3 期,
第 4 卷第 1-2 期

東吳學報

第三卷　第一期

生物專號

蘇州東吳大學文理學院

東吳學報社

目　錄

月蛾生活史初步研究報告

尤大壽

(1)導言

蘇州附近田野之區，人民多以種植五穀菓食爲生，每年收入亦可驚人，爾來農村破產，五穀不豐，樹木之被害者亦不少。雖大半由於土壤不肥，水分不足，然亦多被蟲蛾幼蟲嚙傷而死者，偶入田間，每見樹上結繭纍纍，農民無知，視爲常事，不知留意，輒待冬春之交，幼蟲化蛹後，售於賣鳥店中，爲鳥類之食料。

去冬本校生物材料處購得大批月蛾繭子，欲待其化出，作者鑒於該蛾侵害樹木，損失殊大，故着手研究其生活史，裨爲農民除害之借鏡焉。

(2)研究之方法及時期

作者研究月蛾之材料多由本校生物材料處供給，先向本地城內玄妙觀賣鳥店中，購得蛾蛹數十頭，俟其化出，交配後，不久生卵，排列成塊，閱數日，幼蟲孵出，蠕蠕而動，乃將每頭幼蟲分編號碼，僅十七頭，飼育於二公厘（mm.）口徑之玻璃瓶中，上蓋紗布，每日喂以楊柳數葉，後幼蟲漸長，小瓶不敷應用，乃遷入較大之玻璃瓶中，覆以紗布，使通空氣，每日喂楊柳二三次不等，分上午，下午，夜間各一次，每次楊柳二三葉，至幼蟲將化蛹時，體積甚大，乃移入鐵管內，一端封沒，一端覆以紗布，四面流通，越數日，幼蟲成熟而化蛹，藏於繭中，待天氣漸熱，成蟲先後破繭而出，乃將雌雄各一，置於交配箱中而視其交配及產卵。

(3)月蛾在分類學上之位置

鱗翅目 Lepidoptera

天蠶蛾科 Saturnüdae

學名 Actias selene Hb.

(4)食料之試驗

飼育幼蟲，食料最爲要緊，作者遍聚本校植物之嫩葉飼之，如桑葉，桃葉，楊柳，櫸樹，靑菜等數十種，經試驗後，楊柳咀嚼最烈，櫸樹次之，其餘數種均非其所好。作者乃分幼蟲爲二份，一喂以楊柳，一以櫸樹，其結果前者幼蟲體質肥大，每齡生長甚速，後者則反是，瘦弱異常，至第三齡時，強弱益顯，乃改喂楊柳，不數日，體復長大。

(5)生活習性及外部形態

A. 卵(圖1)

1.卵塊之形態——卵塊形狀不一，有呈圓形者，有呈不正圓形或長圓形者。

圖 1

2.卵色形狀及大小——卵略呈扁圓形或蛋形，當卵初產出之一秒鐘時，呈灰色且頗柔輭，須臾則變白色而漸硬化，待幼蟲將孵化時，卵呈黃色，其大小爲直徑二公厘左右。

3.卵之排列法——卵之排列不齊，有高有低，或成一直線或成一曲線但無一相疊者。

B. 幼蟲(圖2)

幼蟲孵化後，凡脫皮五次，末次在蛹化前行之，每次脫皮，其體積必膨大一次，膨大時體色與平時略異，至等三齡後，體色不變，全身呈靑綠色，直至化蛹，茲將幼蟲孵化及脫皮之方法，體色，形態，歷時，體積，食慾，以及死亡率等分別述之於后：

圖 2

(1)孵化之方法——卵內之胚胎成熟後，幼蟲破殼而出。法以大顎將卵頂端之壳嚙破，呈一不規則之圓形，繼則頭部徐徐而出，至全體脫殼而止。

(2)幼蟲脫皮之方法——當幼蟲脫皮時，先將在頭胸部之皮，用大顎嚙破，然後舊口器脫落，易以黃色之新口器，於是幼蟲伸出舊皮，頭部略向下灣曲，似頗用力，若幼蟲在玻璃面上脫皮，則幼蟲須吐出絲液，縈繞全身，使其不易脫落。各齡脫皮之方法，無大差別。頭部至腹部第四五節，脫皮較易，故費時亦少，以下脫皮頗難，幼蟲每因不能完全脫落而死者，其亦天然淘汰之一法歟。

(3)各齡幼蟲色澤及形態之變化。

(a) 第一齡

幼蟲初孵化時，頭部爲灰黑色，胸腹細長，徧身生黑毛，長約7公厘，胸腹辨別不清，胸起三對呈黑色，驟視之，僅黑色三點而已。腹部第三至第六節及末節各具僞足一對，氣孔不甚明顯。

(b) 第二齡

色澤與第一齡幼蟲大異，全身呈黃色，胸腹背上有黑色斑點甚密，因前胸中胸發育較後胸爲速，故高出頭部與腹部成一直線，胸足與腹足呈黑色，背側兩部之細毛長於其他各部且呈淡白色。

(c) 第三齡

幼蟲初脫皮時，全身呈白色，不數分鐘，色澤較深，在中胸後胸二節上各具二杆狀物 (tubercle) 凸起，無黑圈環繞其底端，僞足呈白色，其下端爲紅色。

久之，全身變爲青綠色，並有黃色斑點，口器漸次發達，中胸後胸上之杆狀物繞以黑圈，全身生黑毛，長而且細，該毛

爲幼蟲之防禦器，能分泌液汁，觸之頗覺不適，氣孔隱約可見，但不甚明顯耳。

(d) 第四齡

兩大顎辨別甚明，口器各部亦可分清，前胸如前，色青綠，中胸後胸背上之杆狀物呈黃色，有黑色圈環縈繞其底端，其上生有一長黑毛及八至十根之短毛。在其側面有四處高起(projections)排列成二行，亦生有細毛，氣孔甚顯。

腹部第一節至第八節兩側各具氣孔一個，背上有二排杆狀物惟不及胸背之甚，底端紅色，上有三四根短針 (spine) 與一長毛 (hair)，排列不齊，第八節背上中央僅有一杆聳起，上生黑針，下繞青環，側面有二白線，恰在氣孔之下。白線之下，生有杆狀物一排底橙黃色，每杆上有長針二，短針三。白線之上，有短杆狀物一排，針之排列法如前。僞足之尖端呈紫紅色，如寄生蟲之吸盤，用以攀援樹枝，末節背上有杆狀物四，排列成二行，底部橙黃色，其針之排法與前同。凡在背上之細毛皆呈白色，腹下之細毛，則呈黑色。

(e) 第五齡

前胸帶有四球黑毛，中胸後胸如前，胸足黑色略長，腹部體積甚大，僞足上有黑毛，頂端之吸器內層爲紅色，外層爲紫色，側面二白線，自腹部第一至第八節甚清楚，末一節背上及足上均有紅色塊各一。

(4)各齡幼蟲體積之大小 (表1)

由第一齡至第五齡在預備化蛹時其體積竟增加二十倍，自第四齡至第五齡，增加尤速，茲將各齡之長闊列表以明之。

各齡幼蟲體大表

表 1.

幼蟲號碼	第一齡		第二齡		第三齡		第四齡		第五齡	
	長	闊	長	闊	長	闊	長	闊	長	闊
I.	0.70*	0.12	1.2	0.17	2.3	0.32	4.5	0.60	7.0	1.5
II.	0.72	0.12								
III.	0.75	0.13	1.4	0.2	2.5	0.40	4.2	0.70	7.2	1.7
IV.	0.69	0.10	1.3	0.18	2.4	0.35	4.0	0.60	7.3	1.6
V.	0.72	0.10	1.2	0.17	2.3	0.33	die			
VI.	0.76	0.12	1.3	0.17	2.4	0.36	4.2	0.70	7.0	1.5
VII.	0.73	0.10	1.4	0.20	2.5	0.40	4.1	0.50	7.3	1.7
VIII.	0.77	0.13	1.5	0.21	2.5	0.39	4.3	0.65	7.5	1.8
IX.	0.71	0.12	1.2	0.17	2.2	0.38	3.9	0.60	7.2	1.5
X.	0.68	0.10	1.3	0.16						
XI.	0.68	0.09	1.2	0.18	2.4	0.32	3.8	0.60	7.0	1.4
XII.	0.69	0.10	1.1	0.17	2.5	0.34	3.8	0.60	6.8	1.2
XIII.	0.70	0.11	1.3	0.19	2.4	0.35	4.2	0.62	7.2	1.5
XIV.	0.70	0.12	1.2	0.18	2.3	0.36	4.2	0.70	7.3	1.3
XV.	0.72	0.12	1.3	0.19	2.5	0.34	4.0	0.70	7.3	1.4
XVI.	0.71	0.12	1.2	0.17	2.5	0.35	4.0	0.70	7.0	1.4
XVII.	0.69	0.10	1.3	0.18	2.4	0.32	4.0	0.55	6.8	1.3
平均	0.74	0.11	1.3	1.7	2.4	0.35	4.1	0.63	7.2	1.5

* 作者以公分計算

(5)各齡幼蟲之食慾。

初孵出之幼蟲，每日嚙楊柳頗少，並擇其最嫩端食之，成不規則之鋸形狀。俟幼蟲漸長至第二三齡時，第次喂以新鮮楊柳時輒見其已食去一半。至第四齡時，食量大增，在每喂飼時，見幼蟲嚙嚼

嫩莖，樹葉已殆盡。至第五齡時，每日非喂三次不可，每次一二小枝，小莖亦能咀嚼，以致全部將盡歸烏有。幼蟲初脫皮時，口器青嫩，不食約數分至數十分鐘之久，俟口器變黑後，乃咀嚼如舊。

(9)各齡幼蟲之死亡率

此次作者初步研究，取蟲僅十七，爲數甚少，其中因疾病或脫皮而死者爲百分之十七。在第一二齡時，幼蟲易罹此病。至第四五齡死亡率較底，關於脫皮不成者作者曾見二只，咸因舊皮在腹部下端不能脫下，其一經用手術後始得恢復，另一則因不及救治而亡。

C. 蛹

(1)變蛹之方法

成熟之幼蟲身長約7公分(C.M.)闊1.3公分，身重13克，若伸長後可9公分許，高一公分，每節長7公分。

當幼蟲變蛹時，作者曾見第十二號幼蟲變法，其法先將外皮變爲褐色，同時幼蟲須排出二粒如黃豆大之糞，並有綠色之浠液汁同時流出，然後開始織繭。背上之杆狀物，除胸部外，完全變爲橘橙色，其在腹部第八節上者，底端爲橙黃色，繞以黑圈，尖端爲褐色，側面二白線甚顯明。在腹部中央第一至第八節有青線一條。當幼蟲結繭時，先將樹葉拖近身邊，幼蟲藏匿其中，如擾亂之，則幼蟲以全力抗禦至成繭爲止。初變蛹時，觸角，複眼及僞足均顯明。兩三星期後，腹部漸漸蛹化惟觸角複眼如舊。

(2)結繭之位置及大小

繭之位置每在飼育器之一角成直立或橫立狀，惟前者居多。每繭平均長5—5.5公分闊2.5—3公分。

(3)蛹之體色

初蛹化時頭胸腹各部均爲青褐色，數日後，微帶淡棕色，以後逐日增深，至將羽化時則爲極深之赭色，其表皮內爲淡白色即他日

成蟲之翅。

(4.)蛹之形狀及大小 (圖3)

蛹橢圖形，頭部鈍形，至尾則漸尖，小複眼及翅均顯著，而足及觸角均可辨，從背面視之，腹部爲十節，在腹面視之，則爲七節，由第二節至第八兩側各具氣孔一個，共七對，成黑色小點，在第九節上氣孔不甚顯明，體長爲4—5公分闊1.5公分。

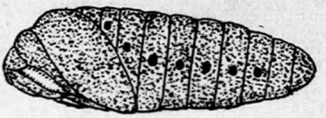


圖 3

C. 成蟲 (圖4)

體長平均3.5公分，展翅通常11公分，靜止時翅呈屋脊狀，胸腹兩部有白毛簇起，觸角爲羽狀，翅呈綠色，脈紋顯明，兩前翅肩部各具棕色之線板一條，後翅尾端引長成筆杆狀，前後兩翅之側面各具一不正圓形之小點，該點分前後兩部，前部分黃褐兩色，後部爲白色，雌蛾腹部較闊，胸足較雌蛾粗而紅，其餘無甚差異。

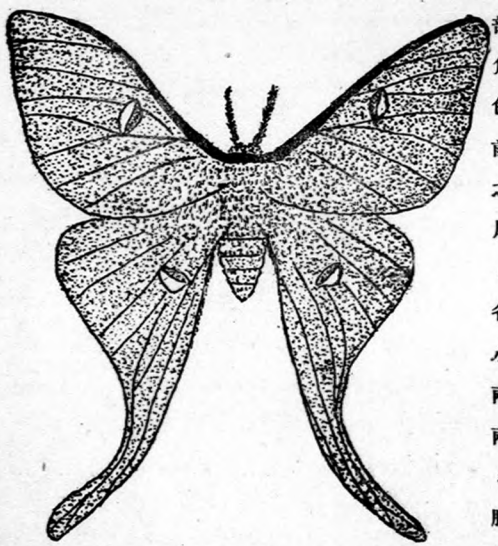


圖 4

各齡幼蟲及成蟲歷時脫皮記載表

表 2.

	卵之孵化日	第一齡之日數	第一次脫皮日	第一次脫皮所歷日	第二齡之日數	第二次脫皮日	第二次脫皮所歷日	第三齡之日數	第三次脫皮日	第三次脫皮所歷日	第四齡之日數	第四次脫皮日	第四次脫皮所歷日	第五齡之日數	蛹化期	羽化期	死亡日	雌雄之別	生活日數
1.	5月 12日	7日	5月 19日 上午	5月 18日 至 19日	5日	5月 24日 上午	5月 23日 至 24日	5日	5月 29日 上午	5月 28日 至 29日	7日	6月 5日 上午	6月 3日 至 5日	12日	6月 17日	7月 8日	7月 17日	♀	9日
2.	5月 11日	7日	18日 上午	17日 至 18日		21日 死													
3.	11日	6日	17日 下午	16日 至 17日	4日	21日	20日 至 21日	5日	26日 上午	25日 至 26日	5日	5月 31日 下午	5月 30日 至 31日	8日	8日 上午	6月 27日	7月 3日	♂	7日
4.	12日	7日	19日 下午	18日 至 19日	6日	25日 上午	22日 至 25日	3日	28日 上午	26日 至 28日	8日	6月 5日	6月 2日 至 5日	9日	14日 上午	7月 2日	6日	♂	4日
5.	11日	7日	18日 上午	17日 至 18日	5日	23日 下午	22日 至 23日	5日	28日 上午	27日 至 28日		死							
6.	12日	6日	18日 上午	17日 至 18日	5日	23日 下午	22日 至 23日	6日	29日 上午	27日 至 29日	7日	6月 5日 上午	3日 至 5日	12日	17日 下午	7月 10日	19日	♀	9日
7.	11日	7日	18日 下午	17日 至 18日	4日	22日 下午	21日 至 22日	6日	28日 上午	26日 至 28日	6日	3日 上午	5月 31日 至 6月 3日	9日	12日 下午	7月 3日	13日	♂	10日
8.	11日	6日	17日 上午	16日 至 17日	4日	21日 下午	20日 至 21日	5日	26日 上午	25日 至 28日	7日	2日 上午	5月 31日 至 6月 2日	8日	10日 下午	6月 30日	7日	♀	8日
9.	12日	7日	19日 下午	18日 至 19日	4日	23日 下午	22日 至 23日	5日	28日 上午	26日 至 28日	7日	4日 下午	6月 2日 至 4日	13日	17日 上午	7月 8日	12日	♀	4日
10.	12日	5日	17日 下午	17日 至 18日	5日	23日 上午	死												
11.	12日	6日	18日 上午	17日 至 18日	5日	23日 下午	22日 至 23日	6日	29日 下午	28日 至 29日	9日	7日 上午	5日 至 7日	14日	21日 下午	15日	20日	♀	5日
12.	12日	7日	19日 上午	18日 至 19日	6日	25日 下午	23日 至 25日	5日	30日 下午	29日 至 30日	9日	5日 上午	4日 至 5日	11日	16日 上午	18日	22日	♀	4日
13.	12日	7日	19日 下午	18日 至 19日	5日	24日 下午	23日 至 24日	6日	30日 上午	29日 至 30日	6日	5日 上午	2日 至 5日	10日	15日 上午	6日	15日	♀	9日
14.	11日	7日	18日 下午	17日 至 18日	4日	22日 下午	21日 至 22日	5日	27日 上午	26日 至 27日	7日	3日 下午	2日 至 3日	11日	14日 上午	13日	17日	♂	5日
15.	11日	7日	18日 下午	17日 至 18日	5日	23日 下午	22日 至 23日	5日	28日 下午	27日 至 28日	7日	4日 上午	2日 至 4日	8日	12日 上午	1日	4日	♂	3日
16.	12日	6日	18日 上午	17日 至 18日	5日	23日 下午	22日 至 23日	7日	30日 下午	29日 至 30日	6日	5日 上午	3日 至 5日		殺				
17.	11日	8日	19日 上午	17日 至 19日	3日	22日 下午	21日 至 22日	6日	28日 上午	27日 至 28日	8日	5日 上午	3日 至 5日	16日	21日 上午	12日	18日	♂	6日

十二指腸蟲對於宿主關係在生物學上底研究

J. Allen Scott 原著
王志清譯

緒言

最近的二十餘年，大家都注意到一種寄生蟲，就是十二指腸蟲 Hookworm，寄生於人和其他動物體內。他主要的原因，是因爲他在公衆衛生上佔一重要的地位，後來經過多次的實驗，又成爲生物學上有興味的材料。當然他的自由生活時代和寄生生活時代，都有研究的價值，但本篇祇就他的寄生時代討論之。本篇的主要意義是歸納犬和貓體內的十二指腸蟲，就實驗上已得的許多事實，而加以推論。因這等犬和貓體上的品種，是實驗最便利的材料。這等品種雖和人體上的品種關係很密切，然而從實驗方面，可以知道所得的理論，不能一概應用於人體寄生的十二指腸蟲。

I. 十二指腸蟲的特殊寄生性

Specificity of Hookworms

我們先須明瞭犬貓十二指腸蟲，人體十二指腸蟲和他種動物的十二指腸蟲的相互關係。一般十二指腸蟲，都有特殊寄生性，就是一個品種，往往祇寄生於一種的宿主內。但是也有很少數的例外，能寄生於一種以上的宿主，多種十二指腸蟲往往又能在他宿主的相近種類體內尋得。形態上的異種以外，又有形態全同而生理性質相異的品種，各有他特殊的宿主。

這種人體的寄生蟲，從何而來，現在還是一個未解決的問題。1927 年 Cameron 主張可以有二個來源：(1)人體寄生的一種十二指腸蟲，叫做人體十二指腸蟲 Ancylostoma duodenale, 有從食肉獸類得來的可能。這種品

種雖和寄生於食肉獸的完全不同。但是間或能在貓和犬科的動物體內發見。而他同屬的十二指腸蟲，像犬十二指腸蟲 Ancylostoma caninum 和 Ancylostoma braziliense 普通寄生在犬貓等獸體，而間或又在人體內發見。根據了這等事實，我們可以猜想，人類獲得這個寄生蟲，大概不在人類以前的時代而在自有人類以後的初期，因和食肉獸相處一地的緣故。(2)這種十二指腸蟲，可以從人類以前的時代遺傳得來。就是十二指腸蟲的祖先，早已寄生於人類的祖先，因此遺傳下來的。這種可能性，是指着人體十二指腸蟲的另一種，叫做人體美洲十二指腸蟲 Necator americanus 說的。這種十二指腸蟲的同屬，並不能在犬貓一類和人類相處一地的動物中檢得，而能在最近人類祖先的高等靈長類 Primate 發見。這一個品種，從沒有在食肉獸體內發見過，而猿猴類和草食獸就有偶然發生這蟲的事實。且這種十二指腸蟲的病害，比較前一種是輕，根據這一點，以爲他寄生於人的時期比較長久些，大概在人類以前的時代已經開始。

兩種十二指腸蟲是值得特別注意的，因爲實驗上常常應用他，並且和人體寄生的品種發生關係，現在分述在下面：(1)犬十二指腸蟲 Ancylostoma caninum 是世界各處犬體內的普通十二指腸蟲。又常在貓體內發見，而後者大約爲一生理上的變種，當在後節再討論。這個品種又偶然在貓科犬科和他動物體內尋得。且又有發見於人體的報告。(2)犬十二指腸蟲的另一種 Ancylostoma braziliense 現都主張和 Ancylostoma ceylanicum 是同種而異名。寄生於世界各處的貓和犬體，散布很廣，沒有什麼變種發見。這個品種，也在貓科和犬科的他種動物體內發見，間或又發見於人體內，不過數目是很少的 (Sarles 1929)。這一屬的他種品種，常發見於各種動物，而以食肉性動物最爲普通。

另有幾個品種，和人體的美洲十二指腸蟲相關。兩種在靈長類，一種在家豬體內。後面的一種叫做 Necator suillus, 和人體的美洲十二指腸蟲，很相類似，是否有什麼區別，現在還是一問題，不過至少在其特殊寄生性上已

經顯然不同。同科的他屬動物中，另有 Uncinaria stenocephala 一種十二指腸蟲，是歐洲犬體內的普通十二指腸蟲，也是美洲狐體內的普通十二指腸蟲。這個品種又常供實驗應用。

討論這等寄生蟲實驗結果以前，我們先略述他們生命循環的要點，或者比較容易了解一些。十二指腸蟲的卵混在糞便內，由宿主排出，倘遇適宜的溫度，水濕和土壤，就在泥土中發育。數日後孵化出幼蟲，地面倘有足夠的水濕，幼蟲就向地表面移動，靜候侵入宿主底機會，一星期中不失他的傳染力。倘遇一機會和宿主的皮膚接觸，數分鐘後就能鑽入皮膚而達於血管。隨着血循環經過心臟到肺。在肺的微血管內，又穿入肺胞，經過支氣管而逆行於氣管到咽頭，於是就嚥下，最後在腸內成長。

實驗上和自然感染上，也可以從口傳入而感染，特別有幾種是更加容易。他在腸內生長時，要脫皮兩次。第一次脫皮後生成一初期的口囊 Primitive mouth capsule, 第二次脫皮後生成一永久的口囊 Definitive mouth capsule。靠着口囊和內面的齒，吸着於腸黏膜，吸收宿主的血液和組織爲養料。成熟後就交尾，雌蟲產生多量的卵，經過一長久的時期。

Ⅱ. 侵入宿主的方法

Entrance into the Host

十二指腸蟲對於宿主關係在生物學上的第一點研究，當然是他侵入宿主的方法。Looss (1911) 所發見而詳細記載的皮膚侵入法 Skin penetration 大約是最普通的一法，對於人類的被侵入更加適合。先天的或遺傳的傳染 Prenatal infection 大概起因於母體的皮膚沾染幼蟲，乃侵入子宮內的胎兒。口腔傳入法 Mouth infection, 可以發生於任何動物，像犬舐食地上的食物時就易侵入，不過這種方法並不普遍。實驗室內常應用口腔傳入法，因爲侵入的幼蟲數目，比較的容易確定。作者的實驗室內，常以幼蟲放入膠質囊內，可以防止未達胃前的侵潰作用。應用這法，可以減少皮膚和肺內幼蟲的遺失。Sarles (1929) 實驗小犬的結果，由皮膚侵入的幼蟲，達腸內發育者祇有百分

之九，而同一組幼蟲，由口腔侵入者約可百分之五十。

幼蟲由皮膚侵入動物體後，雖然還有許多困難，但是這個方法，比較上還是最便利。倘就人類而說，人類取食沾有幼蟲食物的機會很少，所以皮膚侵入法，是適應生活最優良的一法。這種特異的適應法，幼蟲顯示某種一定的趨向性，引起很多的研究 (Brumpt, 1921; Fülleborn, 1924) 。幼蟲有趨向溫熱的性質，和趨向體組織的性質 Histotropism, 所以能被吸引而侵入體組織。實際上幼蟲侵入皮膚，須從泥土裏面推進而來。固着於皮膚的溜泥可以完全適應這種侵入法。皮膚的厚薄和乾濕，對於侵入的難易，大概有相當影響。例如實驗上已經證明皮膚經洗浴摩擦後，幼蟲很易侵入。自然現象中，幼蟲大概常能遇着他適宜的情况。

皮膚侵入法常引起宿主的某種反應。現時應用犬體的犬十二指腸蟲 Ancylostoma caninum 做實驗，已經顯示宿主的皮膚反應，因年齡而不同。Sarles (1929) 實驗得小犬經過多量幼蟲侵入後，祇現暫時的紅腫。而老犬就立刻紅腫發炎，持續一星期或較多，並有液汁滲出，傷處的中心發生僵塊。這種因宿主年齡不同而起的相互關係，容後再行討論。人體皮膚應用不適合的幼蟲行實驗時，僅微腫而發癢，不數日就消退。自然傳染的一般『脚底發癢 Ground itch』往往因搔破和感受細菌作用的緣故，非常疼痛。關於皮膚反應一種有趣味的情形，普通叫做『皮下鑽爬 Creeping eruption』。依最近的實驗 (Kirby-Smith, White and Dove, 1926, 1928; White and Dove, 1928) 已能顯示這種人體皮下的直線鑽爬，都起因於另一種犬十二指腸蟲 Ancylostoma braziliense 幼蟲的侵入。這種十二指腸蟲是犬貓體上寄生的普通種類。爲什麽這種幼蟲常在人體皮膚的直下移動，而這種移動究否發生於犬，貓，猿猴等的皮下，現在還難詳悉。另一種犬十二指腸蟲叫做 Uncinaria stenocephala, 據說可以發生同樣情形 (Fülleborn 1928) 。普通犬十二指腸蟲 Ancylostoma caninum, 據說 (White and Dove, 1929) 在人體的皮下並沒有那種鑽爬現象，祇發生和人體十二指腸蟲侵入時的同樣結果罷了。

Ⅲ. 佔據寄生位置的移動

Migration to seat of Infestation

當幼蟲應用任何方法侵入宿主體內以後，仍然要解決怎樣能達到他最後終點（卽小腸）的問題。侵入皮膚後，繼續他的侵襲作用，於是就侵入血管。不論他侵入血管是從某種一定反應的結果，或只是一種偶然的機會，大部分都能侵入血管，最後循環到肺臟。當達肺臟微血管時，幼蟲就穿過他的薄膜而入肺胞。這種情形或係其偶然的侵襲動作所致，或係其發生一特種反應，以適合此作用。Looss 考查得經過支氣管和氣管時，犬十二指腸蟲 A. caninum 和人十二指腸蟲 A. duodenale 有不同的習性。據說犬十二指腸蟲常沿氣管黏膜的表面移動，而人體十二指腸蟲往往侵入氣管的管壁。他主張這種人體內的情形，或係變常(不正常)宿主 Abnormal host 內不適宜環境所致，而在正常宿主 Normal host 內就能開始發生一種新反應，以適應他的寄生生活。多量幼蟲經過喉頭的時候，常發生輕微的咳嗽。既達咽喉，就順自然的趨勢，可逕達小腸，無須再靠幼蟲的動作。

由口腔引入的幼蟲，經過胃臟後，似可立刻發育。但事實上則不盡然，侵入作用的反應，常使這等幼蟲，仍然侵入消化管壁，進入門脈循環 Portal circulation 到肝臟，再經心臟達肺臟。他種圓形動物如蛔蟲 Ascaris 和腸類圓蟲 Strongyloides 也經過這種路程，Fülleborn(1923) 和 Miyagawa(1916) 等都主張這一說。但是 1926 年 Yokogawa 經過犬體內的犬十二指腸蟲 A. caninum 試驗後，發表並無這種遷移，而逕可直接發育。Fülleborn 在同年以另一種犬十二指腸蟲 Uncinaria stenocephala 又證實這一事。著者(Scott) 在 1928 年也取 Yokogawa 所用的材料作試驗，不過應用一不相同的實驗方法，也證明幼蟲從口腔侵入後，並沒有這種遷移，而逕可直接發育。

同時 Yokogawa 又引入這問題的另一方面。根據他的實驗，以人體十二指腸蟲 A. duodenale 使寄生於犬，以犬十二指腸蟲 A. caninum 使寄生於兎，鼠和豚鼠，得一結論：——凡由口引入的幼蟲，在變常宿主內常須發

生這種遷移，而並不發生於正常的宿主體內。上述的多種實驗，1928 年著者 Scott 應用一種分離儀器 Baermann isolation apparatus 可以分離出宿主各內臟內的幼蟲（這種分離器原用於分離土壤內的幼蟲）。用這個方法，較多量的 A. caninum 幼蟲能自鼠的肝和肺分離出來，自犬分離出來的就較少。貓體對於這種十二指腸蟲是一種生理上的變常宿主。應用同法試驗，祇很少數幼蟲能從他的肺和肝析出。當鼠體內有極多量的幼蟲，由口腔引入後，大部分幼蟲都可由肺臟分離出來，同時多發生劇烈或致命的肺炎。多量幼蟲能否打破宿主的抵抗而完全他的遷移，還是祇得一定比例量能遷移，而這個數量已足以使肺發炎，因以阻止完全的遷移，而使幼蟲集積於肺，現尚未能決定。不過這種遷移，雖不發生於正常宿主的體內，而在變常宿主的體內似已成顯然的事實。但是他的相關原因，是否全係宿主的變常性，Abnormality 著者的意思以爲還難十分明瞭。

Ⅳ. 十二指腸蟲的生長

The Growth of Hookworms

十二指腸蟲在變常宿主內的發育，似乎很多阻礙。幼蟲發育，能否在變常宿主內就開始的一個問題，可以應用數種鼠類爲變常宿主，做多種試驗。1925 Hung 查悉人體十二指腸蟲的幼蟲，由皮膚侵入鼠體三日後，在鼠糞內排出生活幼蟲；他的體長似稍增加。作者曾覆做這項實驗，由口腔傳入犬十二指腸蟲 A. caninum 的幼蟲。其結果很不一律，不能得其要領，且反示有減短體長的趨向。這減短體長的趨向，如果正確，那末他唯一的解說，大約是淘汰的結果，因較大的個體，仍留剩在宿主體內。從同一動物測量幼蟲似可顯示體長的增加，不過鼠和鼠間的變異極大，所以終難證明他怎樣的正確。1297 年 Fülleborn 也得 Uncinaria stenocephala 幼蟲在鼠體內增加體長的實驗結果，但是也以爲並不十分顯明。

在能發育的宿主內，我們有同樣的問題，這等幼蟲究在何時何處開始發育。據 1911 年 Looss 實驗結果，人體十二指腸蟲 A. duodenale 雖能在幼

稚犬內有一相當限度的發育，但是在普通情形之下，他的發育遠較犬十二指腸蟲 A. caninum 爲遲延。當幼蟲在犬氣管的上半部時可發見幼蟲末期的口囊，但是從未在氣管的下半部發見。未達小腸以前，這幼蟲末次的脫皮終不發生。作者以犬十二指腸蟲 A. caninum 由口傳入犬體，作多次的試驗，其結果都在第三日開始發育，從未見有第二日卽發育者。貓體內的十二指腸蟲在侵入後第三日沒有什麼變化，少數的在第四日開始發育。

寄生蟲能在變常宿主體內開始發育，但是終究不能完全他的發育，這是最普通的情形。至於十二指腸蟲，有時似亦有同樣的情形，但是常有相反的情形，往往一經開始發育，多能長成。事實上常顯示宿主體內，發育爲成蟲的數量，常爲所給幼蟲數量的一定百分數，而與傳染後時間的長短無關 (Scott, 1928)。若這等寄生蟲開始發育後，而不能完全其發育者，則經過長時期後，蟲數必減少。這種估計，至早須候蟲體完全發育時，始能決定，否則就不能正確。

犬十二指腸蟲 A. caninum 發育於貓體內，似有一種特別情形 (Scott, 1929)。Scott 已發見有兩種犬十二指腸蟲，他們的生理性質不同。一種是能沾染於犬，對於貓體則沾染力極微。但是另一種是很易沾染於貓，而犬幾全不能感受。在死體解剖時，檢驗個體，知道在犬體內的幼蟲較貓體內的發育爲速。最後的大小，在貓體內的幼蟲約小於犬體內的百分之二十。在犬體內的，約 30 天後，雌蟲得最後長度爲 12 公厘 (mm.)。同時雄蟲也已達最大長度爲 9.5 公厘。在貓體內的幼蟲，就繼續發育約共 40 天，雌雄蟲各爲 9.5 和 8 公厘。易染於貓的一種犬十二指腸蟲，對於貓和犬雖有不同的沾染力，但是他們的發育情形完全相同。關於這一點，將在下文再行詳細討論。

寄生動物的生長曲線 Growth Curve，常顯示和自由生活動物的曲線相同。這種曲線多表示成蟲時期的生長，就是末次脫皮後的生長。末次脫皮以前的生長，常和脫皮後的生長有相同的速率。大約在脫皮時生長稍有間斷。宿主體內早期的怎樣發育，很難實驗。幷且各時期時間的長短，因宿主不同而

大異，就是平均數也很不可靠。

V. 十二指腸蟲底生殖

Reproduction of Hookworms

我們現今所論的寄生蟲，無論在宿主體內或體外，都不能營無性生殖，他唯一的繁殖法，祇是受精卵的發育。產生的卵子數，就生物學上而說，是保存種族的重要事項。而由他種關係觀察，也是一最有興趣的事項。如研究公共衞生者常須估計這等寄生蟲每日的產卵量。倘若能知道每一蟲產卵總數的平均數，就可以從每日產卵數的多少，估計人體受害部分的大小。這種研究很有價值，因藉此能估計患病者的輕重，病者關係於社會的危險，並估計全社會的感染率。

性的成熟，常用二法可以決定：(1)死體解剖時，檢查成對的交接者，犬十二指腸蟲 A. caninum 在侵入體內12日以前，從沒有發見過這種現象。(2)宿主糞內發見蟲卵時期的長短，是另一方法。犬十二指腸蟲 A. caninum 在感染後約 14，15日後，可發見蟲卵。據 Herrick (1928) 說寄生於老犬者，這個時期常較長。貓被犬十二指腸蟲寄生後，20 日以前從不見卵排出。平均約須 22 日 (Scott, 1929)。另一種犬十二指腸蟲 A. braziliense 寄生於小犬和小貓者平均都爲 15 日 (Sarles, 1929)。在老貓體內者平均時期較長，約爲 20 日。寄生於人體的種類，成熟時期較長，大約爲 40 日。

一定期內雌蟲產卵數的多少，常爲多種原因所混亂，而不易計算。第一卵的計數，必以一宿主內所有的蟲產出者爲根據。若能決定在這個時期體內祇有一個雌蟲存在，那末他的情形，自然大爲簡單。比較重的病症，所產的卵數 (Herrick, 1928; Sarles, 1929) 常在短時期內增加很快，後來就減少。卵數的增多，大概因蟲體的產卵量增多；而他的減少，大概是因一部份蟲體的死亡所致，下文當再表明。產卵數的變化，除因蟲體的長幼不同外，又往往因宿主的品種，大小，年歲而不同。1929 年 Sarles 表明沾染部分蟲數的多少，常影響於他的產卵數，在大傷處的蟲他的產卵數常比在小傷處的蟲少。

宿主排出糞便的多少，也足以使決定產卵數發生困難。

前已說過在公衆衞生上產卵數的估計很屬重要，因產卵數如能確定，就可反推他寄生蟲數底多少。人體美洲十二指腸蟲 Necator americanus，每日所產的數目，常在9,000到10,000之間（Stoll, 1923; Sweet, 1925; Hill, 1926）。人體普通十二指腸蟲 Ancylostoma duodenale，每日所產的卵更多，常在 20,000，到 25,000 之間（Cort, Stoll and Grant, 1926; Soper, 1927; Augustine, 1928）。這種人體寄生蟲卵的估計，都根據自然傳染的患病者平均計算，當然包含各種時期的蟲體。而在動物試驗時，蟲的年歲比較容易確定。1929年 Sarles 檢查得犬十二指腸蟲 A. caninum 在犬體上第一月內，每日產卵數可從 20,000 漸增到 25,000。但是患重症的（超過200蟲體的）平均產卵數，常不超過 10,000。過這個時期以後，產卵數就逐漸減少。Herrick（1928）在另一方面，應用同一品種使傳染於犬，作多次實驗，得平均產卵數，自 30 日到200日，自7,000增加到 17,000。這樣的差異，大概因病症的輕重不同而發生。

蟲的壽命和繼續產卵期的久暫，也很難確定。大概要決定在某次實驗後，絕對沒有再發見他有感染的現象是很難的。人體十二指腸蟲的最長壽命，曾有許多的估計，但恐難於正確，因爲很難完全確定他是否沒有再感染的現象發生。大約他最高壽命當不短於三年或四年。1925年 Chandler 擬間接計算他的壽命，而他的結果，祇知一新式而講求衞生的牢獄內的居住者，當感染蟲體數月後，他排出卵的平均數，能減少 50%。他和最高壽命的關係，仍然沒有明瞭。Sarles（1929）查得犬十二指腸蟲 A. caninum 的最高壽命，相差於 43 到100星期之間。他又查得感染一月後的排出卵數已銳減。這個減少的原因，雖一部分是因生殖力減少，然大部分是起因於蟲的死亡。根據這許多結果看來，雖 Chandler 祇發見人體蟲卵數減退這樣的快，不過由此就可以推想他最高壽命，至少當在一二年以上。

Ⅳ. 十二指腸蟲對於宿主的影響

The Effect of Hookworms on their Hosts

因十二指腸蟲致病的重要，所以人體的怎樣受他的影響，已有很多的記載。現在不擬詳載其病理的症狀，但就實驗動物，記其所受的影響，以與人所受的影響作一比較。年久的十二指腸蟲病足以使人體貧血虛弱，減輕體重，而在犬體的這種影響，並不像在人體的顯明。當犬感染多數蟲後，最普通的結果，常在第十二日死亡。大概因這個時候，蟲體發育最快，也就是血液損失最多的時候。另一部分犬當感染較少的蟲，或他的抵抗力較大者，則在此時期經過數天的極度困疲後，常能很快的復原，與常犬毫無差異。大概犬既能經過蟲體發育最快的一時期，則因食料的充足，常不難抵償其所受的損害。不過若經長時期的不良狀態，那末虛弱的症象必漸顯著。這是一般獸醫所習見的。顯著的死亡現象，當然不容易爲他們所注意，并且天然的感染，幼蟲侵入係逐漸而來的，決不是驟然同時而來的。

十二指腸蟲所生傷害的估計，還沒有十分成功。數量上的多數結果，都從研究血液變化的結果而來。多種研究，都以貧血 Anemia 做根據。因貧血是十二指腸蟲病最顯著的症狀（俗稱桑葉黃病）。發生貧血的原因有三種：（1）年久的血液耗損，（2）血色素分解 Hemolysis 和血液內血球的破壞，（3）對於製造血球器官的中毒影響。

對於血液的耗損，研究者似有一致的意見，覺得這種耗損，並不足以發生顯明的影響。在患急性病時，像前述的犬，血液耗損當然是貧血的重要原因。在死體解剖時，腸多充血，黏膜現鮮紅色，腸的下部充滿凝結或半消化的血液。死亡前數天的排出物，常完全是血和黏液。(1929) Sarles 赤血球的計算，知道減少很快，大概可表明他的原因，並非由製血球器官的影響，而是血液耗損所致。這種血液耗損，在慢性十二指腸蟲病患者並不常見。1929 年 Sarles 曾顯示着患慢性病的犬內的赤血球數和血色素的衰退很顯明。人體內的變化大約也有同樣情形。人體血色素量的檢查很難經過一長時期，不過現時檢查的成績已很多。實際上實驗不甚重患者的血色素數量，都比同等

人的不患這病者爲低。對於這問題的最近研究者，有Cort, Schapiro, Sweet, Stoll 和 Riley (1929)等許多人。

其次說及骨髓或他種製造血球器官的中毒作用。但這等器官在慢性病時的病理現象，現時還沒有十分研究。再進一層說這種中毒作用，或並非起因於十二指腸蟲的本身，而係由其損傷處侵入的細菌所致，也是可能的事情。

他種血液變化多數都不顯著。白血球數常增加，但有時在久長的患者，也有比常數減少的。Eosinophiles (白血球的一種)常受十二指腸蟲的影響而生反應。1929 年 Sarles 以犬做材料，研究十二指腸蟲關於 Eosinophilia (血內 Eosinophiles 數目增加的一種病症) 的變化，要想藉以間接明瞭人體內的變化。當犬十二指腸蟲 A. caninum 傳入老犬體後，就見顯著的變化。血內的 Eosinophiles 數目往往和普通的白血球增多病 Leucocytosis 同時有很顯明的增加。有一次增加到 42%，維持片刻。但這一個升高，同時已見血流中 Eosinophiles 數的降低，所以明明是一種局部集積的情形。幼犬的同樣實驗，並沒有顯著變化。

Ⅶ. 宿主的調換關係於十二指腸蟲底變異

Biological Variations in Hookworms which are Correlated with Variations in the Host.

十二指腸蟲常因宿主的調換而生變異，這種變異的發生，常起源于一種寄生蟲，能在數種不同的宿主內發見，且和宿主的年齡發生關係。宿主的他種變動關係，知道的很少，像宿主身體大小的不同，宿主康健的程度，飲食品，以及有否他種寄生蟲的存在，和有無疾病等等。

家犬和家貓的十二指腸蟲，是一種最有興趣的變種。這變種的起源，全因宿主品種的改變。又因爲他可以任意供實驗，所以更加有興趣。在這種宿主內，通常可得十二指腸蟲屬 Ancylostoma 的二個品種：(1)A. braziliense 在世界大部分地方，常見于犬體和貓體。這種十二指腸蟲可任意變換這二種宿主，而毫無分別。(2)另一品種 A. caninum 在實驗狀況之下，其情

形大不相同。1929 年 Scott 的實驗，證明他的調換宿主，不能像上一品種的容易。感染犬體的幼蟲不易感染於貓，而感染於貓者，幾全不能使他感染於犬。這種寄生蟲的特別情形，在生物學上究竟表示什麼意義呢？最滿意的假設(Hypothesis)，似乎是這種十二指腸蟲 A. caninum, 原是犬的寄生蟲。而這一屬寄生蟲，包含有貓犬寄生的種種品種，所以可以稍些感染於貓。既有某一部分的種類，能感染於貓，則這一部分的種類，逐漸變異，反變成適合於貓寄生的習性。同時對於犬的感染力就變小，這是當然的結果，因此有兩種性質的犬十二指腸蟲 A. caninum 存在。據分佈上的研究，已確知寄生於犬體者分佈較廣於貓體者。發生於貓體者，其區域祇有少數，比較不常見。但是有數處在貓體寄生者很普通。爲數也很多。Scott (1929) 曾試驗一處的貓體十二指腸蟲，他的結果，確是表示有貓感染的特性。同時又在另一處取犬十二指腸蟲試驗，該處的十二指腸蟲，祇發見於犬而不發生於貓。這一個試驗，證明所有犬和貓的十二指腸蟲都很易感染於犬，而對於貓祇能稍些感染。這樣看來，這等變化的發生，似乎至少有兩個可能的解釋。這種十二指腸蟲，雖有犬和貓寄生的特性，但有時在他種犬科和貓科動物也偶然發見。倘若我們以其原始寄生於犬體的假設爲正確，則其偶然寄生於他動物，自屬可能。

淘汰說 Selection theory: 從人類飼養動物的時期起始，家犬和家貓的關係，當然比較他種動物更加密切。所以這種十二指腸蟲，自然更易發生於貓，是任何他種動物所不及的。如果一種寄生蟲生存而又繁殖於一新宿主內，經過數代後，往往有極好的適應，這是可能的一種假設。

突變說 Mutation theory: 在另一方面觀察，宿主內所見的偶然品種，或係表示特殊寄生性的突然改變的結果，亦屬可能。當這種突變種的雌雄個體，同時發生於一新宿主時，其後奇對這宿主，往往可表示一新的適應感染性。

這二說的孰是孰非，現在還沒有十分明白。Scott (1929) 又作進一層的

實驗，來試驗這二個假設，但是並沒有結果。犬十二指腸蟲 A. caninum 的兩種品種，曾引入一種不甚容易感染的宿主內，又試驗這宿主二三代後子孫的感染性。這個實驗，並沒有大規模的試驗，所以不能十分保證有確切的結論，不過大概的結果可寫在下面：易感染於犬的品種，並不因經過貓體二三代後，而變成容易感染於貓而不容易感染於犬。另一方面，易感染於貓的品種，常因經過犬體一代之後，就變成容易感染於犬而較難感染於貓。如我們所假設的這個品種原是犬的寄生蟲，而無錯誤，則變成適應于貓寄生的趨向，自然比較回復原狀的適應於犬的趨向爲難。不過這幾種實驗，仍不能解決這種變化在遺傳上的關係。所以 Scott (1929) 又試做另一種實驗，觀其遺傳上的關係。曾試用這兩種生理性質不同的個體，在犬貓體內，作雜種交配的試驗，但是還沒有成就。

現今所知的事實，顯示犬十二指腸蟲 A. caninum 的兩種不同感染遺傳性，實起因於兩種宿主的不同。寄生於貓體的十二指腸蟲的地理分佈，足以表示其起源於犬體的十二指腸蟲，不過各在不相同的地方和時期。

犬十二指腸蟲 A. caninum 的兩種品種，在生長上的性質，顯然和任何感染性的異點不生關係，而對於宿主的品種，就有密切的關係。Scott (1929) 的實驗，顯示貓體內的 A. caninum, 他發育到最後的大小和速度，總不及犬體內的大。且和品種的感染性如何不生關係。依我們的假設，這個品種原是犬的寄生蟲，所以寄生於貓時，不能似犬體內適合，他在貓體內發育的受阻礙，似有相當理由。即使其遺傳性已極適合於貓體的感染，但其阻止發育的影響，仍然存在。這一點又和我們的假設不約而同。

我們現今論及他同屬的 A. braziliense, 他的情形就大不相同。這種蟲於貓體和犬體都是常見的。且並無證據可決定他原宿主是犬還是貓。生理性質並無異點發見，不論那一種所生的幼蟲，對于兩宿主都有感染性。關於生長速率的少數實驗 (Sarles, 1929) 顯示在犬者較速，但差異很小，不能得結論。我們雖不能證明這幼蟲的起源，但覺得這個品種對於貓和犬的適應，似有

相等的程度。

另一重要的變異原因，由宿主影響及寄生蟲者，爲宿主的年齡。最顯著的影響，有叫做年齡抵抗性 Age resistance 的。A. caninum 和 A. braziliense 在犬和貓體中，都顯示着宿主的年歲如果增高，他的感受力，反示一定的退縮。從口引入的幼蟲，能完全發育的百分數，可表示這個事實。1928年 Herrick 實驗得小犬內 A. caninum 幼蟲全發育者平均爲 35%，而成長的犬內祇有 3% 發育。犬體感染性的品種，很少能感染於貓，對於成長的貓尤甚 (Scott, 1928)。貓體感染性的品種，也顯示更明瞭的異點 (1929, Scott)。平均 45% 發育於小貓，成長的貓百分數就遠少。A. braziliense 得同樣的結果。Sarles, 1929 年的報告，小貓內的發育數平均是 32%，老貓祇有 4%。同樣的情形，小犬內平均是 44%，老犬祇有 5%。至於人體這種確切的實驗，雖不能實行，但是覺得寄生於人體的品種，對於年齡並沒有這種關係。流行病研究的結果，顯示着各地兒童的患十二指腸蟲病者，較少於成人。間或也有患病的孩童數，較多於成人的，這個現象的關係，大約是因爲習慣不同。

關於宿主年歲的他種影響，現在也已經注意。犬十二指腸蟲A.caninum 幼蟲對於老犬和小犬的皮膚反應，已在前節中比較。對於這一點雖尚須繼續研究，不過似已可明瞭這個差異，確和犬的年齡相關，而並不和曾否感染過有什麼關係。在同一組試驗內 (Sarles, 1929) 老犬血內的 Eosinophiles 增加較在小犬血內者更加顯著。關于犬十二指腸蟲 A. caninum 的生長，顯示蟲體長度和宿主年齡並無關係。另一方面，關於性成熟的遲早，則不論那一種犬十二指腸蟲 A. caninum (Herrick, 1928) 和 A. braziliense (Sarles, 1929) 都是在老犬體內的成熟較晚。產卵量的多少，包含許多原因，是否和宿主年齡相關，現在很難斷定。

Ⅶ. 對於十二指腸蟲的不感受性

Immunity to Hookworms

關於寄生動物的免除性(免疫性) Immunity 和抵抗性 Resistance 等名詞，若用易感受性 Susceptibility 和不感受性 Insusceptibility 二名詞替代，著者的意見以爲比較妥當些，曾在從前表示過 (Scott, 1928)。細菌學上應用的名詞，我們也應加以注意，必須能很明白的辨別：(1)不感受因寄生而起的影響，就是說，對於寄生勢力的不感受性(抵抗性)；(2)不感受寄生蟲來寄生，就是說，宿主對於寄生蟲孳生繁殖的不感受性。

關於多數寄生的蠕形動物，欲辨別宿主對於被寄生蟲孳生的性質，和宿主因寄生而起的影響，並沒有什麼困難。在細菌學研究中，這種辨別，往往略去。從醫學上的觀點而說，對於宿主所受的影響如何，很是重要。關於抵抗寄生蟲繁佈的性質，和抵抗寄生蟲損害影響的性質，兩者在許多地方，很不容易區別。動物對於細菌產生的毒素，有天然的不感受性，爲已知的事實。Kolmer (1923) 曾引證許多例子，在不感受性的動物體內，寄生蟲產生的毒素，不能在宿主細胞內，有適宜受納處，而確有抗毒素 Antitoxin 存在。Schwartz (1921) 曾表明犬十二指腸蟲 A. caninum 能產生一種分解赤血素質 hemolysin, 而正常的血漿具有抵抗性質，能夠阻止這種分解赤血素質的作用。這樣看來，可知宿主的易感受性對於寄生蟲的影響，不論在細菌的或蠕蟲的寄生裏，有相同的情形。但是我們現在的討論，將偏向於宿主受寄生蟲孳生繁殖後，將如何影響其易感受性的強弱，而略去他對於寄生勢力的不感受性。

關於十二指腸蟲的幾種反應，可以叫做『對於寄生蟲的不感受性質』，得分記在下面：(1)品種的不感受性 Racial immunity or species insusceptibility 我們已知十二指腸蟲的宿主，有特異固定性。著者曾研究這重要的事實，幼蟲引入不適當的宿主，則不能發育，而保持他原來的狀態，這個現象的意義，待後再論。(2)宿主年齡不合的不感受性 Insusceptibility correlated with the age of the host 已在前面說過，現在從略。(3)感受時的不感受性 Insusceptibility due to the presence of a previous infestation 精密

的實驗，可藉以知道已感受而尚未全愈的宿主，是否對於侵入的新幼蟲，有阻止他發育的能力。這個問題的決定，很屬需要。不過多數實驗，還難得要領。1923 年 Herrick 說，當第一次感染還沒有消退，第二次蟲侵入，毫無不感受性。有時若從前已有二三次的感染，而尚未消失者，則感染力似較小。檢查感染部分的大小，仍以排出卵數的多少做根據，他很留意的解釋他的結果。因犬年齡的增加而易感受性降低的事實，很容易使這種實驗結果不正確。大概這種不感受性，即使能夠成立，想必沒有很大的程度。(4) 另一問題是他種寄生蟲存在時是否有不感受性 Insusceptibility results from the presence of worms of other species。例如 Sarles 1929 年的記載，當一犬受多量的 A. caninum 感染時常不再感染 A. braziliense。這一個問題尚須繼續研究。

獲得的不感受性 Acquired immunity 和上面的因現存的騷擾而起的不感受性不同。現在的意義，是從前曾感受過而現今已全愈的動物，有無不感受性。我們在十二指腸蟲實驗上，還不能證實。Herrick 1928 年曾作實驗，顯示患十二指腸蟲病而用殺蟲藥治愈的犬，對於犬十二指腸蟲 A. caninum 的寄生，並不見有不感受性。

Ⅳ. 不感受性的生理機械

The Mechanism of Immunity

機械作用是研究不感受性的重要事項。有幾種不感受性的生理機械研究，已超出假設時代。對於寄生蟲的不感受性，現在還沒有極適合的假設。研究不感受性的生理機械作用以前，必須先能決定種種可以發生不感受性的情形。十二指腸蟲的研究，進步很快，現已大體能明瞭種種發生不感受性的情形。

大概動物皮膚常有局部的免除性，可以阻止十二指腸蟲的二次侵入。進一層說，這種免除性，想可從局部的面積佈及全身皮膚，或者也可能。這種作用，大約並不是阻止他的侵入，而是在皮膚內殺滅或阻止這新幼蟲。這兩

種說法，還沒有實驗能十分證明那一種是正確。1929 年 Sarles 用老犬試驗，由皮膚侵入幼蟲，發見有顯著的皮下反應而不能感染。從這些面積六十日後生活的幼蟲，仍能分離出來，在幼犬就沒有這種皮下反應。這區面積的斷面，可以顯示許多幼蟲的存在，有生活的，有已死的，圍有一層細胞膜。組織上更精密的實驗，當更可幫助了解關於免除性的任何細胞反應的機械作用。如能有適當的技術，那末抵抗幼蟲發育的抗毒體 Antibodies 的存在，或者也可以顯示出來。

當幼蟲由皮膚或口侵入完全不適合的宿主體內，常能在這宿主的腸內，發見生活幼蟲，此事已屢經實驗證明 (Scott, 1928; Sarles, 1929)。利用 Baermann 的分離器就可由各組織分出幼蟲。不感受反應的基本地點，想必在腸，而寄生蟲最關切的一點，爲能否開始在此發育。變常宿主的消滅寄生蟲，自然不是他的原意。1928 年 Scott 曾作許多正常和變常宿主的實驗，他的結果是兩種宿主內發育的蟲，無論或少或多，常有一部分剩餘而不曾發育。這等不發育的幼蟲，常從同一部分分離出來，仍然活着。例如：(1)以犬十二指腸蟲 A. caninum 的犬體感受性的品種，使他傳染於貓，44 日後解剖這貓，就祇見極少數的蟲成熟。同時從腸內檢出完全未發育的幼蟲很多，其大小絲毫未變。(2)同樣的幼蟲在鼠體內檢出，全數沒有發育。(3)在犬體的則大多數發育。現在所引起的問題，就是何以這等幼蟲不發育。從同一系統的幼蟲，引入不同的動物體內，在鼠體內則全不發育，在貓體則少數發育，多數不發育而仍生活着，在犬體則大多數發育，祇極少數沒有變化。同樣的幼蟲，引入不同的宿主，何以有這樣的不同。當然他的原因，不在引入的幼蟲，因這等幼蟲都出自同一來源。進一步研究這等不發育的幼蟲，如果再引入另一宿主，那末又仍能照常態的百分數發育。第二次分離出的未發育幼蟲，有一部分曾又引入第三宿主，結果也是像常態的百分數發育着。可見幼蟲發育的潛能力並不喪失，不過須藉宿主的情形如何，始能決定他發育的百分數。那末什麼是宿主必具的條件呢？這又是目前的大問題。這個原因，

或者是因爲宿主對於寄生蟲，有一定的抵抗性，足以阻止他一部分的發育。或者是因爲幼蟲的發育，必須有一定的情形，並且這種情形適合的程度怎樣，足以決定發育百分數的大小。

細菌免疫的依靠某種抗毒素阻止病菌的發育，似與現今的情形不同。現今的情形是十二指腸蟲在一宿主內完全不能發育，另一宿主內僅少數發育，第三個宿主內則大部分得發育。而這三種情形中，都有一小部分寄生蟲不能發育，但也不死亡，如遷移這餘剩的幼蟲到另一宿主，那末還是能發育。因年齡不適合而起的不感受性的變化，也發生相似的現象。這等複雜情形，似難應用任何已知的假設來解釋。

X. 現今的問題

Present Problems

我們每討論一事，都引起未解決的問題，現在集合重要的問題如下：

(1)關於各種品種的分佈情形和各有他的特殊宿主的特性。我們雖已得着許多報告，但是繼續的研究，以發見新事實，自屬重要，尤其是各種因宿主不同而生的變種的分佈，爲更切要的研究。

(2)皮膚侵入法的情形，雖已很早發見，并且這事已有許多實驗，但是我們仍遠不能在生物學上解釋他的反應。宿主對於皮膚侵入的反應和不感染反應發生這樣的密切關係，我們可將前一種反應，包括在後一種反應裏面而合併研究這個問題。

(3)從皮膚和口腔感染後的遷移情形，好像還沒有充分的記載。爲什麼幼蟲存留於老犬的皮膚內，比存留於幼犬內來得長久？又爲什麼留存於變常宿主的皮膚內也比較長久？我們已知從口腔感染的幼蟲，在正常宿主內直接到腸，不另有遷移，而在變常宿主就有時發生。那末究竟什麼原因發生這異點？日後的發育有沒有什麼影響？我們從十二指腸蟲生長速率的研究，已經知道成蟲時期的生長，和自由生活動物的生長有同樣的曲線。

(4)十二指腸蟲最顯著的變異，起因於宿主的變更。這個事實應當繼續

研究，藉以決定他所包含的機械作用。他種變異或起因於宿主感受性的強弱。

(5)早期發育的研究固然很難，但並不是不可能的，或可引起生物學上他種重要事實。

(6)產卵數的研究，當然須繼續無疑。這是我們估計受病大小的唯一方法。於實驗和實際工作上對於他的改變率很關重要，所以需要更確切的研究。

(7)宿主因十二指腸蟲寄生而生的影響的研究，現在剛才開始。就是極顯明患者的病理，比較上還是沒有詳細知道，宿主反應的病理研究，當然很重要。宿主和寄生蟲的相互關係，怎樣才得平衡，以前很少有研究。

(8)關於寄生蟲的變種，似乎由宿主的變更而發生者，我們所知道的還是很少。實際上對於他變異的原因怎樣？更加是談不到。已經講過的十二指腸蟲生理性質的變種底關係，和他種可能變種的關係，是一種很值得注意的地方。假使是一個遺傳上的事項，那末就遺傳規則加以實驗，當可解決這問題。假使不是遺傳上的關係，則試以能不能發生新的變異，應當是很有價值的。

(9)宿主對於寄生蟲的不感受性～又係一未解決的問題。第一，我們還須多收集關於不感受性的事實。其次(a)前次所感染的寄生蟲，沒有治愈時，是否能因此生不感受性？又前次所感染的寄生蟲，已治愈時，是否能因此生不感受性？(b)宿主年歲的增加，以怎樣的速率增加他的不感受性？(c)關於他的生理機械，又完全不知道。好像上面說的，如果能應用細菌免疫學裏應用的方法來試驗，無疑的一定可得着顯明的結果。但是現今所知的事實，大概可表示由於因產生抗毒體而起的阻止發育作用，大約並不像在細菌作用中的重要。我們已很明瞭，這種十二指腸蟲並不爲他的變常宿主所殺滅，而仍能維持他的生命，且仍有發育的能力。然而究竟何種條件，是他發育所必需或不可缺。這一個問題，大概是現今最切要的研究問題。

附注：　這篇論文是美國約翰霍金斯大學寄生蟲學系 Department of Helminthology, Johns Hopkins University 的作者所報告的，這個大學對於衞生和公衆健康學的研究很注意，同時又受洛氏基金國際衞生部 International Health Division of Rockefeller Foundation 的資助。載於美國生物學季刊 Qua. Rev. Biol. Vol. V, No. 1. ○ 譯者因時間匆促才學淺薄，譯筆未透出處和謬誤處，尙希讀者指教是幸。

水及水源之微菌學及衞生觀

胡夢玉

大千世界，芸芸衆生，食物之品料或可各別，惟空氣與水之需要則無國界種族之分，水之重要固盡人皆知，然水中之含有病菌能分佈疫癘若炸彈者，豈毒蛇猛獸之所能及？負強國健民之責者，視若無睹，可乎？

大地上無絕對純潔之水，惟海水被日光蒸發水汽上昇時確纖塵不染，氣而爲雲，雲凝爲雨，微菌已由空氣而進入，迨雨下降先爲空氣所沾汚，至地面上更爲汚穢之泥土，殘渣，溝渠所染穢，是故初雨之水含菌必較久雨後之水爲多，而城市雨水中之微菌之較鄉村之爲繁。

水之來源其淨潔之度可序列如下：(1)自流井或噴水井。(2)深井，深井之佳者含菌極少在膠質基中於20°c。之濕度下，一克之水所含之菌非僅爲27—25。(3)泉水。(4)大湖(中心)於日內瓦湖，中心所得之水每克含菌之數僅38。(5)河流(中流)。(6)小河流。(7)大湖近岸日內瓦湖近岸處，每克之水含菌有150,000之多。(8)淺井視其地位結構而定，以其自地面及地中之上層吸水，故其水甚易沾汚，微菌之含數，據調查所得，一克水中最少之數最爲100最多者爲20,000，普通爲740。(9)河流(近岸)。(10)池沼。

雪所含之菌數普通每克爲334—463，高山之雪則不若如此之多。

露中菌數亦視其地位而定故少者爲628多者爲21,000。

水中微菌

水中微菌之種類大別爲三曰：(1)水中固有之微菌。(2)微菌之由泥土滲入者。(3)微菌之由動物腸中排泄者。是類分法當不能稱爲嚴格，因水中之微菌能發現於土中，而土中之微菌亦未嘗不時現於水中也。

(1)水中固有之微菌大半係無害於人者，時現時滅於江湖流川中，今試

述其普通者於下：

a. B. fluorescens liquefaciens 係在普通者，生青色素，能溶明膠(gelatin)。

b. B. fluorescens non-liquefaciens 有 B. f. longus, B. f. tennis, B. f. aureus, 及 B. f. Cerassus 等，常見於江水中，不溶明膠，惟生色素。

c. 與 Protens 相似者如： B. liquefaciens B. punctatus 及 B. Circul aus 能溶明膠酸化牛奶者。

d. 生色素之球狀菌及桿狀菌內分：

1.生紅色素者：B. prodigiosus, B. ruber, B. indicus B. rubescens 及 B. rubefaciens。

2.生橙色者：B. aquatilis, B. ochracens, B. aurantiacus 及 B. flavus 等。

3.生紫色者：B. violacens, B. lividus B. amethystinus 及 B. coerulens 時現於江河及小溪中。

4.生黃色者：Sarcina lutea (八聯球菌)。

e. 其餘如 M. Candicans, M. navalis, M. aquatilis 不生色素亦不溶明膠。

(2)雨後及洪水後多量之微菌由土衝入水中。其中普通者爲 B. mycoides B. subtilis, B. megatherium B. Mesentericus vulgatus 及 B. m. fuscus 等是，其通性爲溶明膠，生胞子。

有名 Cladothrix dichotoma 者，一種線形菌時生棕色之邊緣繞於集落之四週，富於有機物豐厚之所。

(2)腸中微菌。

a. Protens group, 其中主要者有：B. vulgaris B. zenkeri, B. mirabilis B. zopfü 及 B. cloaa 。均能動，溶明膠，生炭氣及輕氣於

右旋糖（dextrose）及蔗糖（saccharose）中，脫養於硝酸鹽，凝牛奶，生綻基質，並生極難堪之氣味。

b. Sewage streptococci 此類微菌之發現。證明汚物侵入之時間尙不久，因此微菌不能久離人身也。

c. B. enteritidis sporogenes 係能生胞子者，故其存在於水中也不能爲汚物侵入之證。

d. B.coli 爲汚物侵入最佳之證物，種類繁多，存於糞便中者爲B. coli communis 圓柱形，不生胞子，草蘭色陰性，不溶明膠之通性厭氣菌。生酸與氣於葡萄糖及乳糖養基，出綻基質於百布頓液中B. coli之能使蔗糖酵者名 B. communior。

e. B. lactis aërogenes 與 B. coli 極相似。

f. B. typhosus, 培植甚難，其生存於水中至多十日然傷寒之於人生，重要已各明知。

g. Vibro comma 或稱霍亂菌，其猛烈及迅速有如炸藥然。

h. Bact. dysenteriae 亦係汚物侵入之一明證。

水之檢驗

微菌之檢查用以知水之良窳，已成最可靠之方法，供驗之水，須取于能容一二百克之帶蓋玻璃瓶(圖10)使用前，用乾熱法滅菌，上用曾經滅菌之羊皮紙或錫紙密包之，以防汚物之流入，取水之際，如爲自來水則先開龍頭，若係抽水機，宜先抽水，任水流出五至十分鐘後，揭開瓶蓋而接受之，水滿仍復加蓋，再用錫紙密封。如係井水或河水，則以繫有長索之已滅菌玻璃瓶(圖11)外套鉛鐵筒，預先滅菌，臨用時取出玻璃瓶手持索端，沈瓶於水內，將接連於瓶蓋之索提上，放水入瓶，復將索放鬆而密蓋之，取上後送驗愈早愈佳，如須送至遠地，則外須圍以冰塊，其裝入之冰塊須迄檢

（圖 10）

（圖 11）

查事尙未化盡爲度。如水之溫度不能保住於攝氏十度以上，則經二十四小時後水中原有細菌數大增，其不適於檢查也明矣。

細菌檢查有（1）菌芽數之測定及（2）大腸菌之測定二種。

菌芽數之測定多用稀釋法（Dilution method）普通之水一克中含菌一百以下者爲潔水，五百左右者爲中等水，一千以上者則爲不潔之水，數量測驗時見於自來水廠中，蓋當水經濾後欲觀『濾』之成功與否也。若欲僅以菌數之多寡以判別水質之優劣，殊屬匪易，若謂可定一標準含量如上述，一百以下爲良，一千以上爲劣，實不可能之事，蓋菌數之增高不能完全證明汚水之混入，其有他種原因致菌芽之增高而其對於衞生無妨者，固甚多也。如井水因不甚流動，其菌數每較多，然不能謂井水之不如河水也，反之，卽清澄耀目之水，有含危險性之病菌者亦何嘗鮮見？

惟此之故，細菌檢查最大之貢獻爲大腸菌之測定，目的又分爲二：（1）病菌之分離（2）汚物侵入之證明。

（1）病菌之分離

（a）霍亂菌，進入水中之數每較傷寒菌爲多，霍亂之傳染與分佈故可直溯於水源。Kock 氏曾發表一隔離霍亂菌之妙方，今試述之：以一克之百布頓（peptone）及一克之鹽和入百克之試驗水中，於攝氏三十七度半中過二十小時，浮面上卽起薄膜，以此薄膜移至史氏培基：

5.5(gram) 克 (agar)
5.0(gram) 克 肉汁
60 (gram) 克 百布頓(peptone)
8.5(gram) 克 鹽

} 於水一 liter 中

在此培基上霍亂菌之集落現粉紅色

(b)傷寒菌之分離成功甚難，其原因極爲複雜，(1)不常存於水中。(2)當其存在時，人每不留意，直至傷寒已始，九日十日之潛伏期已過，檢查水體時，菌每已絕蹤。(3)即使存在，爲數亦甚少，病人之糞便中 B. coli 之數每勝過傷寒菌，故當培植時，傷寒菌亦隱而不顯。

據去年之報告，一新之培養基名蔗汁乳糖凝菜培養基，爲鑑別傷寒菌最佳者(將詳述於下)。傷寒菌於此培養基上呈濃綠色圓形透明性集落。

(2)污物侵入之證明

病菌既難於分離，水之有否危險性則惟污物侵入之證明自賴，現今最常用者爲察B.coli之存否爲依歸，蓋B.coli爲糞便中最多之菌，此物之存在爲污物侵入之良好證據，方法頗多，舉一二要點略述之：

以欲驗之水加入乳糖羹之史密司氏之醱酵管中(smiths; fermentation tube)，保守於血温下二十四小時，如有 B. coli 存在，則閉管中有氣，然閉管之有氣，不能爲 B. coli 存在之明證，蓋能使乳糖生氣者，固不單 B. coli 也。乃必須進一步而試之，方法爲加入百分之二之乳糖牛胆，胆汁有能使非腸菌滅跡，而腸菌中除 B. coli 外，無有可使乳糖發酵者，是故，於此種情狀下，氣之發現於閉管者，則證 B. coli 果在，水已受污物所染穢。

另一方法，係用欲化驗之水置入平板內，和百分之一之乳糖及足量之石蕊色(litmus)液，使板色變藍。放於血温下二十四小時，B. coli 則成集落，集落之四週全呈紅色，係乳糖醱酵所生之酸質所致。

其餘如 Drigalski U. Couradi 氏培養基，遠藤氏 (Endo) 培養基及 Eosin-methylene blue 培養基等，其應用原理多利用其生理作用如分解乳糖作用，形成乳酸，使混入之標示藥變色而施鑑別者。惟此種培養基，製法均甚複雜，若製造者技術不精，每不得良好之成績，近有屠寶琦氏發明之蔗汁乳

糖凝菜培養基，製法極簡便，材料亦易取，水澤之地到處可得，成績極佳其成分爲：

（1）3%之中性凝菜培養基　1000 cc 以 Ph 7.4—7.6 者爲良（弱鹼）

（2）純乳糖　15 gr.

（3）於每 10 cc 以上之質料中混

加蓍浸出液　3 cc

在火焰上暫時煮沸，使二者充分混和，作平板或高層均可。於平板上傷寒菌及赤痢菌等因酸化蓍浸出液而呈綠色，集落圓形而透明。大腸菌則呈圓形乳白色之集落，中央略帶黃色如二重輪狀，邊緣鋸齒形，其故因分解乳糖產生乳酸（蓍浸出液加鹼後再加乳酸卽成白色）而色由此而不變。

（蓍浸出之成分恐非葉綠素乃爲另一種色素）

B. coli之來源，欲別是否出於糞便者有下列爲鑑別之要點：

（1）二養化炭與輕氣之比……其在糞便中者氣比（CO_2+H_2）每較低。

（2）紅素試驗（Methyl-red test）……糞便中之菌起酸素還元作用，（B. coli 紅色鮮明）

（3）服潑氏反應（Voges Proskaure reaction）……糞中之菌，反應爲陰性。

（4）菌之自糞便中者不能生長於 Kosers 氏之尿酸及檸檬鈉基上。

淨　水　法

飲水之改良不僅於傷寒，痢疾，及霍亂諸病可減少，卽人民身體之康健亦不無進益，有自來水廠之城內，除上述諸病減少外，肺病腦膜炎諸症亦莫不爲之遞減，總之死亡率低人民之生活亦因之而安定。

淨水之目的爲去除（一）澤渣（二）氣味（三）顏色及鐵質（四）細菌（五）有機物更欲適於家庭及工業之用，故必減少硬度，中和酸性。

普通之水均有自淸之力，故環境與微菌數量之影響關係極大，今略舉其最要者述之：

(1)溫度……溫度低時，微菌之數每略減，惟盛暑時，水中細菌則不若普通之多，普通情形之下，溫度過低，腸菌之數每大減。

(2)日光……滅菌至強者，其殺菌力能深入水面三尺而有餘。

(3)有機物……其存在之多少與細菌成正比。

(4)空氣中之氧亦係滅菌之有力者。

(5)下級動植物及水藻等之存在，每使細菌之數有所減少。

(6)新水加入時：如新雨後，或山源洪漲時，水含之菌數，每被衝淡。

(7)沉澱……微菌每喜集團而沉於水底，沉後環境全非全比，致不能生長而死亡。

(8)至今猶爲疑案者卽印度恆河之水，能滅霍亂菌於三五小時之內，惟當水煮沸時，則滅菌之效力全失。

(9)清濾……一部分之水流經河底沙土，或中流水藻，水流每爲之遲緩，微菌被留。

是故自來水廠中每有極大之蓄水池，使水自沉澱，微菌互食（當腐菌卽係(decay-producing bacteria)或長時病菌每被食）且有數種病菌係不能久離人體者，倘貯以時日，不久卽自斃，然水之出自地層者(ground)汚物浸入之嫌疑或可避免，是故水源之愼定爲最大要點，惟各大城市所得之水，因要適合良好之地層，而多得自江湖。故水之入蓄水池，爲淨水之第一點。

然後加入明礬，澄水粉(硫酸鋁二分，炭酸鈉一分)使之纏團塵垢細粒及一部分之細菌卽卷入于沉澱。明礬之用量，以水之淨度爲準，平常則每一加侖水須三克。

水澄清後，須加氯氣以殺菌，(按氯氣爲最適宜之物，因其蹤跡不久留故也。)次氯酸鹽(Calcium hypochlorite)或臭氧(Ozone)加以氯化鉀(Calcium chloride)亦佳，臭氧消毒歐洲用之最廣，其法以一薄層之水流過臭氧瀰漫之空氣。然氯氣消毒係最普通，其用量依有機體存在之多少爲表準，因綠氣須與有機體化合之故也，既水之性質及有機體之含量各有不同，則

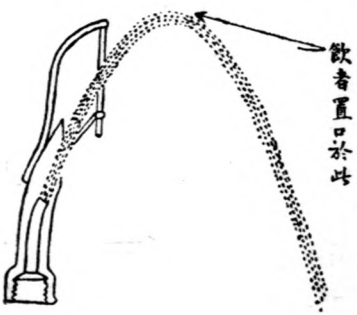
氯氣需用之多寡亦由此而須變異，測定之方法，係加碘化鉀入水（KI）和以澱粉，如水中氯氣而有餘，則氯氣與鉀合，碘素入于水，碘遇澱粉色變藍，若此則橙水中之氯氣已足殺菌而有餘，按普通以氯氣一分加入500,000分之水中，於十分鐘內，能除滅一切傷寒霍亂等菌。

消毒之水再經沙濾，沙深約尺許，初每不甚見效，數星期後上層之沙爲極薄之膜所包圍水乃至純清，經時日久，上層沙凝堅，水濾過遲，必須去除沙面補入新層，圍膜之沙與微菌若黏紙之於蒼蠅，故新沙每不若圍膜之沙有效也。

最末之步驟爲軟化木質，使適於工業及家庭之用，步驟方法各有不同，今舉其要點表之如下：

$$\left.\begin{matrix}CaSO_4\\CaCl_2\\Ca(NO_3)_2\end{matrix}\right\}+Na_2CO_3\rightleftarrows\left\{\begin{matrix}Na_2SO_4\\2NaCl\\2NaNO_3\end{matrix}\right\}+CaCO_3$$

水之經過若許手續者，已稱清潔，然尙須時時檢點，刻刻讓住於水之出口處及水管之安全等均宜注意，Minnesota 大學曾有一食水池之調查，普通者(如清華燕京等各樓院所有)均係水直向上，口外無物保護，而飲者之口卽於水出口之處，此種飲水池之口多數集有無數鏈菌（Streptococci）而所出之水中，亦含此菌，故飲者之口不必置於噴水口上卽能傳得，故飲水池之改良者，必須水出成斜角，飲者及水管之口無相接觸之可能。(如左圖)



當今自來水不能設立之時，最低限度公用井之構造上必須大加改良，今普通所見之井，井身之構造既不佳，四週之保護又不善，井口地面殘缺傾圮

，汚水任意傾倒，一旦傳染病起，不幸而病菌雜汚水而入井者，必死亡相繼；爲害之烈豈堪設想哉？

井有兩種曰自流井，普通井。自流井大率開鑿較深，水出自極深之『出水沙層』，故佳良之井，其井壁之上部均完密不透水，蓋表面地層（以地面下四五尺爲最）含菌極多，井週地面向外方傾斜，使井面廢水向井外暢流，而井口亦須封蓋，最好附裝抽水機。

汚物最大之來源爲汲水桶，公井井口既已開放，汲水桶仍爲居民所自備，彼汲水者多無細菌智識，隨時隨地豈能保汲水桶之不粘汚物？其欲保住水質清潔者，勢仍有所不能，故抽水機之設備實爲最急。萬一抽水機不能裝者，則採北方人常用之公用汲水桶，其法係設一木架于井口上，架上有輪軸，繩索繞其上，兩端各連一汲水桶，當輪軸轉動時，水桶可上下取水，此雖非根本辦法，然亦可爲救急之需。

總之自來水之設備，公井之改良，於今日之中國，實爲不可須臾或緩之事也。

參考書：

（1）醫藥學　第十卷，第六期　1 至 7 頁

（2）醫藥學　第十卷，第六期　75 至 92 頁

（3）醫藥學　第十卷，第四期　51 至 62 頁

（4）醫藥學　第八卷，第一期　9 至 14 頁

（5）Bacteriology for students in general and household science by Buchanan

（6）Text book of Bacteriology by Hans Zinsser

（7）The newer knowledge of Bacteriology by Jordan and Talk

（8）Water Purification Plants and their Operation by Milton F. Stein

（9）"A simple method of water purification" The China Medical Jo-

urnal. March, 1918 (by R. G. Mills)

(10)"Drinking fountains" by H. A. Whittaker. Public Health Reports. May 11, 1917, Pages 691-699.

(11)Microbiology by Warshall.

病菌滅蝗法

美國密歇根農業試驗場細菌研究員 Wyant, Zae Northrup 原著(1)

張和岑譯

我國近年蝗之爲害，時有所聞(2)(3)；其爲災之重，常出吾人之意想。僅據 1933 年吳福楨及鄭同善二氏之調查(4)，已見一年之內爲蝗所害之田面達 6,863,033 畝，以平均每畝損失兩元一角五分計算，則總數已達 14,779,213 圓，頗足驚人矣。

舊式治蝗之法雖多，但殊嫌簡陋。歐美諸國往往有利用天敵以制害蟲，頗著成效。以是益蟲益鳥之保護，爲護農極要之舉。惟蝗蟲之天敵如鷄，鴨，田鷄，黑蜂等等，多未能一時因蝗發而增加其繁殖，故其收效甚緩。茲見韋氏 (Z. N. Wyant) 著有昆蟲病害一篇，對於應用寄生菌却蝗之法，言之甚詳；且其法簡易，便于使用，而過去試驗之成績亦顯著。但其究能應用於吾國之蝗類(5)(6)者，當于試驗後方可斷定。惟據吳福楨鄭同善二氏之調查，此種寄生蝗疫菌亦已見于湖南之常德。若能以人工依法散佈，則蝗患問題，諒不難一舉永決也。

譯者識

(1)Marshall C. E. "Microbiology", pp. 912-918, Phildalphia, 1921.

(2)China Journal, Vol. IX, pp. 159-160, Sept. 1928.

(3)Sowerby A. De C.—The Menace of Locust in China.
China Jour. Vol. XIV, pp. 75-79, Feb. 1931.

(4)吳福楨，鄭同善——民國二十二年全國蝗患調查報告。
實業部中央農業實驗所特刊第五號。

(5)Chang H. S.—A Preliminary List of the Acrididae of China.
China Jour. Vol. I pp. 493, 1923.
China Jour. Vol. II pp. 64-70, 1924.

(6)鄧鍾琳——江蘇省蝗類誌略。
中華農學會報第一一八期 61 至 66 頁 1933.

病菌除蝗法

〔蝗疫〕 蝗疫菌或阿酷顛桿菌 (Bacillus acridiorum) 爲蝗疫之病原。該菌係赫雷爾 (d' Herelle) 氏發現于墨西哥之鬱克登 (Yucaton)。1909 年時，在美國南部過冬後飛來之蝗羣中，因染此菌，死亡頗衆。次年，蝗之死者更甚，並沿及其他蝗羣中。及至 1911 年，蝗羣至此，卽無一不遭此疫者，至 1912 年，墨境中之蝗災，卽行止息。

〔患疫病態〕 蝗之天然患疫者，其病態與人工沾染或飼食沾染者均同。傳染後，該菌須經二至四或八小時之潛伏期。潛伏期之長短，則以菌毒之強弱，蝗體抗疫力之大小，與當時溫度之高低，以及他種環境之差別而不同。病初發時，胃中物卽液化而呈黑色，極似凝結之血塊。此後蝗卽停食，體漸縮癟，跳躍無力而匿於短草之下。次則小腸內之食物亦液化，由黃色而漸呈黑色。此時如將腹部稍一擠捺，則黑液卽自肛門流出，呈普通瀉症之狀。此便泄物卽可染汚食草；再數小時後，蝗卽橫臥，足翅伸縮而斃。苟蝗之染菌爲極毒烈者，則於胃內物液化呈黑液時，蝗卽僵臥，死後小腸內物亦液化而全體變黑。

〔蝗疫菌〕 患疫之蝗，其小腸內幾爲該疫菌之純粹培種。最普通之腐植菌亦每混於其中，此爲一種遊動之短桿菌。其與疫菌之不同，卽在祇能由注射而致死，而不能由吞食而致死；且與致疫病菌可以在培養劑內及蝗體內不生臭味別之。有時球菌及草桿菌亦有攙入。苟此等腐植菌祇據總數百分之一，則疫菌之純粹分植卽爲極易之事。疫發時，蝗之各體素均被侵入。小腸內腐化時，蝗之血液內亦有疫菌，故其各體素或血液均得爲疫菌分植之苗。

致疫之菌，爲多形短桿細菌，長自 0.9—1.5㎛，闊自 0.4—0.6㎛。有時或現球形者，約 0.6㎛ 對徑。因週身有毛，故遊動極速。格氏 (Gram stain) 染色爲正性，各種 Anilin 染料均能染之；兩極之色較深，而尤以用 Ziehl carbol-fuchsin 者爲甚。培植時，此菌有可能除氧性，自攝氏十六度至四十三度均極易生長。於培養劑內，在 37°C 生長最速，四小時後可見液之混濁

；液面並生薄皮。至三星期後，薄皮卽不見，惟有極濃沉澱。如培養於凝脂上，其初生集落，常爲圓形，幷具膿質，且生長至速，在十二小時後，肉眼卽能察見。十八小時後，集落之對徑可達二三耗。面下之集落較小，球形白色不透明。此菌並不液化明膠，但能凝結牛乳，且能使變鹼性；在培殖玻管中洋蓂上，生長亦旺，並呈乳酪狀；且使管中水內菌數之密，常呈漿狀，而鹼性極高。右旋糖，左旋糖，麥芽糖，及加辣多糖等均能發酵；初則酸化，繼則成鹼性，因能生鋌故也。人工培植于密封管內，得生活至二年以上。

〔天然傳染〕 天然傳染之法不一。已患之蝗或幼蟲，以排泄之汚水沾染噬食之植物，若他蟲食之，卽被侵染；此沾染之最易者也。數種蝗類，因食物稀少，互相吞嚙，如強者食一患疫之蝗，遂染該疾。在產卵期間，無論雌雄患疫之蜢，交配後所產之卵，必被沾染；病菌卽藏於卵中或卵外之粘液內，及至孵化。蝗羣中常有一部，因得抗疫性而卽成菌之媒介者；此種媒介者皆係成蟲，亦能以菌傳佈。蝗之抗疫力在發育各時期，略有不同，以成蟲較爲易病。然在各期內之生活狀態，影響於傳染至要。幼蟲食量甚大，且進行時彼此磋磨，故易由患者或食潰汚之草而傳染。在脫眠之時，其抗疫力尤低。成蟲有翅，多時飛翔于空中，除天稍寒時，幾無相接之機；故疫常最烈于幼蟲羣中。若以幼蟲內各期相較，愈幼則抗疫力愈大；在第五脫眠時，乃爲抗力最低之時。成蟲在產卵之時爲最低。此菌旣爲侵血菌，故雖在脫眠之際，疫病之猛烈如常。

〔人工佈疫法〕 阿酷類菌(Bacillus acridiorum)在培養劑中，其毒烈卽行銳減。故如以之殺蝗，則蝗卽得抗疫性。他時雖以更烈之菌染之，亦得免疫；故以人工加增菌種之毒性，實爲至要之舉。菌之毒性，得由育于蝗體或幼蟲中而增加；其法可將欲增烈之種，加無菌水數滴，用尖銳之針，注射於蟲體內。注射時可以左手持蝗腹部，將針尖向腹部之第二三節間與側線之交接處插入，再推進約三耗許，使入腹腔，卽將菌液注入一二滴。如送針過淺，祇入角皮，則無效果。然送針過深，則注入之菌，皆在腸內而腸亦受傷；

故深淺須適當。如是以蝗蟲十二同時注射爲一批。待病發後，卽將死蝗之腹部微擠，使黑液流出，而收于一玻皿中，並將此液之一二滴注入于第二批之每蝗蟲體內。此第二批受注射之蝗，當較第一批死亡稍速。如是依法將首斃之二三蟲液，攙以等量之水或培養劑，注射于第三批。次將首斃之蝗液攙以二培之水量，注射於第四批蝗體內；依此繼續注射至十二批爲止。蝗如能于注射八小時後致死，則該菌烈度已足。應用此菌時，祇以該腸液百分之一注射蟲體內，卽能于二小時後大瀉，再一小時卽斃。此手續約需時五日至六日之久，故在應用前當預計此時間。惟該菌對於一種蝗類已行增烈法，而欲對他種蝗類再行增烈法時，則注射蝗之批數亦必增加。例如在非洲之 Algeria 對 Stauronatus Maroccanas 成八小時致死之烈度，須注射至五十二批之多。在 Cyprus 對同種蝗蟲注射十二批已足。第一批中蝗蟲亦需較多，蓋必有稍爲柔弱之蝗也。擠出腸液亦得因此而增加。注射時如未得十五小時致死之烈度，不得攙以水分。

此菌烈度旣足，乃由凝菜斜面或平板分離之，如卽欲佈染，卽可培植于一培養液內。

培養液之成分如下：

水	1 斾。
百布頓 Peptone	40 克。
鹽	5 克。
明膠 Gelatine	30 克。
右旋糖	5 克。

先將液煮沸使微鹹，過濾後分置瓶中，加以棉栓，將皮紙罩于瓶口後消毒 (120°C,30分鐘)。明膠能將菌粘于草上，湯中糖汁能使蝗蟲貪食。

應用時應注意數要點。一爲阿酷類菌 (Bacillus acridiorum) 之毒烈，在培養液中減少至速，雖不久移種，亦仍在減少，故培養液至久必須於二三日內用畢。如工作地之蝗患期至長，則工作全期間，當將菌繼續注射于蝗體，

普通以較常數多二三批爲妙。蓋注射次數稍少，則反使蝗體得抗疫力而一無成效也。

散佈工具，須爲一新置噴霧機。大如噴射于樹木者，至好內鍍錫皮。舊機已用于灑藥者，不適再用，蓋菌液不易洗滌淨盡也。純菌劑一現混霧，卽宜使用；有嗅味者，則不適用。普通將此菌液染于蝗身，愈多愈妙，使於最短期間，而致死亡。灑液之容量，當視患蝗面積而異。每斾大概足爲一萬方釈之用。如患蝗之區極大(100 H 至 200 H)*，則以十斾之液，每次半斾，灑于蝗蝻較多之二十處爲最宜，而須噴射于蝗所貪食之植物上，並在蝗羣行程之前；且于清晨日未上升時，或晚間日已下降時噴射爲最宜，蓋以日光及其熱力能減少毒烈至速也。如不得已而須于日中散佈者，則當擇稍陰之地點。此菌在培養劑內雖柔化極速，惟在蝗之排泄物及乾尸體內，則可保存其毒烈至七月之久。大雨後，疫焰稍衰，因雨水能將患疫者之排泄物洗淨；然雨後疫患漸漸復烈。細雨則有反使疫患增焰者。

患疫蝗羣過河流時，卽有一奇特現象。河之此岸必有大堆蝗尸，河之彼岸亦有蝗尸堆積，惟其數較少，一若疫焰已止。但數日後必且復發，其故卽在患疫較重之蝗及蝻，已無力涉水；較輕者涉水，力竭卽死，至彼岸苟能生存者，爲疫尙未發之幼蝻也。

疫期之長短，以環境及蝗種之不同，自數日數星期至數月而各異。總之疫期之長短，無關重要；能使蝗數大減，災害減輕，實爲至要。

如欲使疫菌播傳極遠，則必射擊能飛之成蟲。蝗種之飛力較大者，其傳播尤速。欲制不善飛之蝗種，則噴射之地點當爲較多。欲知散佈疫菌有無成效，可將蝗羣中任捕百蟲，擠其腹部，視其有否瀉疾，卽可斷定。

蝗羣在方產卵前而得疫者，其卵亦能腐化。多數雌蝗染疫後尙能產卵者，則其卵終不能長爲成蟲；故此種蝗羣，數日內必全死滅。蝗至末次脫眠期前而受疫者，則成無數變態成蟲，其翅翼之大，祇達正常者之半，而不能飛

* H 爲 Hectare＝一萬方釈

；其生殖器亦完全失效。

下表列易感受阿酷顛菌之昆蟲：

Ⅰ. 蝗蟲

Acridians 全屬，皆甚易感受。

Schistocerca americana (or pallens) 1908-1911 在 Yucaton 得天然疫，1912 在 Argentine Republic 使用人工沾染法而殲滅。

Celoptenus sp. 1912 在 Rio Negro 得天然疫。

Stauronautus maroccanus, 1913, 在 Algeria 及 Cyprus 島使用沾染法殲滅。

Schistocerca paranensis 在 Argentine Republic. 殲滅。

Geryllus pennsylvanicus, 普通田間蟋蟀。

Zonocercus elegans, 非洲大蜢。在此種蜢類，以天然環境之關係，利用疫菌，僅能爲附屬治蝗法。

Pachytylus migratoroides, 非島之飛蝗，亦曾使用播疫法，然未見成效。

Ⅱ. 螞蟻 (Ants)

Selenopsis gemminata, 1912 近 Buernos Aires 全被殲滅。

Atta sexdens 在熱帶全被殲滅。

Ⅲ. 蛾蝶幼蟲 (Caterpillars)

(Spilosoma) Diacrisia virginica, the yellow bear caterpillars.

阿酷顛菌與蠶蛾 (Bombyx mori) 全無傷害。

Melolontha vulgaris, 食之無妨，注入則死。

Ⅳ. 甲殼蟲 (Beettes)

洋薯甲蟲 (Colorado patato beetle), 無論幼蟲成蟲，均無傷害。

Ⅴ. 鳥類與哺乳動物大都均不感受。家鼠食之無妨，惟一種溝鼠 (Sewer rat), 注射數小時後，即病毒血而死。

牛乳內之細菌及殺菌法

張和岑　陸近仁

牛乳乃牝牛生產後，分泌之液，以飼犢者。其成分富有蛋白質，脂肪，乳糖以及維太命等。因其爲液狀，故消化也易。非惟爲犢牛之無上食料，亦爲人類至要之滋養美品。故歐美各國人民，無不應用以作飲料或食物；其體格之強健過人，未始非賴乎此。

因乳之富於滋養物，故細菌能生長與繁殖其中。此類細菌，能使乳腐敗，或傳染疾病。故用之有方，則可以養生；取置不善，卽足以罹病。茲將乳內之細菌，病原菌，以及菌之入乳原因，防止方法，殺菌法等，作一簡略之敍述；並將蘇州本城情形，亦作極短之報告。並提建議數則，以供參考。本篇之主旨，爲引起市民對於牛乳純潔之注意，並市政府對於人民應有之保障，得有相當認識；詞雖簡陋，切望殷焉。

(1)牛乳內之普通細菌

A. 乳房內之細菌——數種纖球菌(Micrococcus)及鏈菌(Streptococcus)，能使乳酸化及蛋白質分解，爲數種乾酪成熟之要素。有能液化膠質菌，若 Micrococcus casei acido-proteolyticus I ，及非液化膠質菌，若 M. casei acido-proteolyticus II ；有檸檬色者 M. casei amari 能製造苦味乾酪；亦有與乳酸化鏈菌 (Streptococcus lactis) 類似，而能液化膠質者，若 Streptococcus liquefaciens。

乳酸化鏈菌並不生長於乳房內。但病原鏈菌，與乳酸化之死物寄生菌最易混誤者頗多。Streptococcus mastitidis 爲最普通乳房傳染之鏈菌，此菌能製造多氣乾酪，及乳培養基內發生氣泡。史密司(Smith)與白郎 (Brown) 氏查出血毒喉痛鏈菌 (Streptococcus epidemicus)，常

生長乳房中。伊文司（Evans）氏食得乳房之乳，常沾染墮胎靜桿菌（Brucella abortus），此菌能使人患摩爾太熱（Malta fever or undulant fevr）。

乳房分泌體素，染有 Streptococcus mastitidis 者，則血液能入乳中，但不能使其酸度由 PH 7 者變爲 PH 6.5—6.6。雖此菌爲乳糖發酵者，將乳糖發酵成酸，而所得之乳，其酸度與血液相似。並含有多數白血球。

染有墮胎菌或生理病徵者，亦有相同現象。卽健全之牛，其乳亦時有血球與分泌腺細胞，細胞核，及腺膜細胞等，而於泌乳時期之始末尤多；此種現象，與乳房細菌沾染無關。

B．由外沾染之細菌——由用具，擠乳者，牛身汚穢等所沾染。

C．腐植菌類——藍乳菌（Vibrio cyanogenes），能使乳起藍色，並有酸化。藍色爲此菌所發生，而酸爲他菌所起。此菌有四端鞭毛，其液化膠質性不等，革蘭色陰性（Gram negtive），與 Pseudomonas fluorescens 極似。此種藍色乳，不常發現。尙有產生胞子者 Bacillus pyocyaneus，亦能生藍色。乳亦有成黃或綠色，亦爲細菌所起。

化乳酸鏈菌，能使乳糖發酵而成乳酸。此菌之來原，尙未明悉。但鏈菌在人或牛之口中及糞內頗多，或卽爲其來原。此菌能生長於不良情形之下，及高酸度乳內，故較易見。

D．大腸菌類——乳於常溫時化乳酸鏈菌生長最盛，而超越他菌。若溫度較高，則大腸菌 Escherichia acid lactici 及生氣菌 Aerobacter aerogenes 生長繁盛。

此二菌特性相似，前者所發生之氣體，二氧化炭與氫氣等量；後者則二氧化炭二倍於氫氣。前者爲紅素（Methyl red）陽性，（Methyl carbinol）陰性，產生靛基質（Indol）。後者適相反，並有莢膜，能發酵多種炭水化合物及酒精，惟不能液化膠質，糞中亦稀少。

E. 乳酸長桿菌，爲 Lactobacillus bulgaricus 及 L. acidophilus ，其所產生之乳酸較鏈菌爲高。

(2)牛乳產物內之細菌

A. 發酵乳——原人已知用發酵乳作飲料。其簡單作用，爲乳酸化鏈菌發酵，將此菌之純培養接種乳內，或容其自生。市上出售者，均用上法製造。惟此菌種類繁多，其所產之質味亦不同，故製時應選擇其種類。

布加里亞，及土耳其東部，所製之發酵乳 Yohourt, 應用 Lactobacillus bulgaricus 菌。此菌能發酵乳糖而產純乳酸，鏈菌則不然，雜有他酸。此菌於攝氏三五至四五度時，發酵尤速，至百分之三•八酸度時，常成鏈狀，而使乳稍凝。此純培養常與鏈菌混合，使乳酸度較淡，而不黏凝。

亞美尼亞之酸乳 Metzoon, 及埃及之 Leben, 與 Yohourt 類似，惟爲乳糖發酵釀母所成。

俄國發酵乳有二： Koumiss 爲馬乳發酵而成，除乳酸化外，產生少量酒精及氣泡，因二氧化炭氣極多之故。 Kefir 則不同，乳內接種 Kefir 粒(細菌及釀母)。發酵時不若上者藏於皮袋或露器內，故氣泡更多。酸乳中加以百分之一之蔗糖，接種釀母，儲藏於閉器中，溫度爲攝氏二〇至二五度，數日後，亦能得類同之發酵乳。

製發酵乳應用 Lactobacillus acidophilus 以代 Lactobacillus bulgaricus 者頗多，因其所起之化學變化較簡。

新節發酵乳與健康頗有關係，飲之能使腸內酸度增高，而使他種腸菌不能生長或使之死亡，因之可改少疾病，及延年益壽也。

B. 煉乳——此乳以牛乳加蔗糖、蒸發至其體積之半而成，凝結後，蔗糖約在百分之四〇至四五之間，其滲透壓力，能使細菌不能生長。然亦有細菌不爲阻止者。若蔗糖濃度稍底，則有球菌 (Coccus) 生長，將糖發酵，使乳厚而味惡。

蔗糖之濃度，不能阻止釀母之生長。乳中常有釀母，產生氣體，而使其不適飲食。

C．蒸發乳 ——乳用眞空蒸發至其量之半，以熱滅菌及保藏。此滅菌溫度，能不使乳凝結，常與細菌生長有關。酸度亦有關係，若增加則使乳凝結點改低，然亦有相反者。

蒸發乳常有胞子菌爲患，因其於滅菌時不爲溫度所滅。此種係酪酸菌類與胞子腐敗菌類，能生有氣發酵，使儲乳罐漲大或爆裂。

D．奶粉 ——奶粉之製造法有二：一將牛乳散成薄層於蒸汽熱旋轉之鼓上，以氣壓或眞空，使其乾燥，然後刮下，磨成細粉。一爲通用之散灑法。將乳散灑成小點，入熱氣流中乾之。

前法用氣壓，其溫度足將病原菌，若結核菌殺滅，故含細菌極少。即有細菌，均爲胞子菌，一克內不過數百。

奶粉所含水份，在百分之五以下，故儲藏時細菌數不能增加。然製粉及裝罐手續極易沾染細菌。

後法空氣溫度爲華氏一九〇度，乳點面積蒸發極速；在乾燥前，溫度恐未至細菌熱殺點以上。但此溫度，已較巴氏殺菌溫度爲高，故細菌數當減少。

奶粉之質味改變，恐屬氧化或他種化學作用，而與細菌無關。

E．冰結淋 ——冰結淋所用之成份，若乳酪，糖，凝乳，膠質等，均含多數細菌。製造時其數能增加，故製法不當，細菌數極多，每克有百萬以上，並能傳染流行症若傷寒，猩紅熱，白喉等。

F．奶油 ——製造奶油之乳酪，常接種乳酸化菌，使其酸化或成熟。乳酪應用巴氏殺菌法殺菌，並用純培養。所用細菌爲 Streptoccus latis，然起漿時，最佳含有他種鏈菌，使產生醋酸及他酸，使其味增美。其味半爲乳酪之味，半爲細菌所成。但有一定程度，過此則腐敗。奶油之腐敗原因有三：乳酵素，或乳或酪內細菌分泌之酵素；細菌之影響，奶油或乳

酪；及化學改變。乳酵素（Lipase）與奶油之香味，極有關係。惟殺菌之乳，則此酵素失去效用。細菌之酵素，亦爲原因之一，每克鮮乳酪熟成之奶油，有細菌數百萬。若爲殺菌之乳酪所成者，祇有接種之乳酸化鏈菌。若藏於冷處，此菌漸減少；高溫度則增加。鹽味之奶油，微生物並不增加；因奶油中百分之十五水中，含有百分之二•五至三•五鹽質。然假釀母及耐鹽菌，尙能生長。若裝置不合法，或儲藏於冰度或以上，則黴菌能生長其上，而起變化。此種微生物，恐與腐敗無關係。

細菌之直接影響奶油，而使其味惡之說，已被事實推翻；因奶油儲藏於冷處者，細菌不能生長。然其乳或酪內之副產物，實爲香味之先導。酸度能加速腐敗。

奶油體積，百分之十爲空氣，成小氣泡。於短時間內，氧氣由乳酪成份氧化而消失，乃經原子間重排列，而使脂肪氧化。此種氧化，爲銅鐵及鋅鹽類接觸作用而增速。此種鹽類，爲罐，殺菌器，及其他用具所溶解者。

G. 乾酪——乾酪之有各種特味，均爲細菌或其他微生物生長而成。每種乾酪，均有定種微生物。此種微生物，與香味無甚關係，但與發酵相關，並預備其他能生香味之細菌或黴菌之生長。然亦與溫度，水份，及鹽量相關。

最簡單之乾酪爲 Neufehâtel 類，此乾酪並不成熟，惟藉乳酸發酵而得香味。此凝乳之酸度，有保存作用。但時爲 Oidium lactis 及厭氣胞子菌腐敗，而成酸苦味。

硬乾酪若 Cheddar, Edam, Emmental, Swiss, 及 Parmesian 等，爲凝乳經複雜之乾燥手續，而使硬如橡皮質。不溶解之副酪素（Paracaseins）變成溶解物若蛋白糖（Albumose），百布頓（Peptone），氮輕基酸質（Amino-acids），亞母尼亞，及二氧化氫等。在蛋白質分解作用內，乳之酵質，胃液精及乳酸化菌，均甚重要。

Cheddar 乾酪侍凝乳之緩和作用，使發酵繼續，直至糖均消耗爲止。起始時，乳酪鏈菌數極多。成熟時，此菌漸減少；繼之以 Lactobacilli 及液化膠質球菌之增多。此菌能產生香味。殺菌乳所製之乾酪，則缺少此特味。Emmental 或 Swiss 乾酪，製造時溫度爲攝氏五〇至五五度之間，故細菌之生長，爲其阻止或殺滅。凝乳溫度冷却，而使乳內之 Lactobacilli 或接種者生長。此菌將乳糖發酵，阻止腸類菌及生氣菌之生長。設在溫室內(攝氏七〇至七二度)，則三炭脂菌生長，而產生三炭脂酸及二氧化炭氣。

Cheddar 乾酪之氣泡易失。Swiss 乾酪，則氣泡不失去，其味恐爲三炭脂菌所產生。Parmesian 乾酪與 Emmental 乾酪之製造手續類同；惟脂肪與水份較低，而鹽度較高。雖亦有氣泡，而其味大不相同。露保乾酪 (Limburger)，凝乳水份較高，酪素極速分解，而有多味之靛基質 (Indol)，糞臭素 (Skatol) 及亞母尼亞。

Camembert, 及類似之乾酪，其香味爲二種黴菌之作用所成。此菌生長於面上，其內外之成熟，極不相同。Roquefort, Gorgonzola, 及 Stilton 乾酪，黴菌生長於內，而成熟甚均。此種乾酪，均有乳酸發酵，乳糖發酵，而蛋白質改變若硬乾酪。Camembert 及類似之乾酪，黴菌生長其上，而必泌酵質，使凝化成半液質。

Roquefort 爲羊乳於極潮冷之地窖內，成熟而成。其高鹽度 (百分之四) 及低溫度(華氏四八度)使細菌不易生長。乳菌化鏈菌生長極少，而耐鹽性之 Lactobacilli 及球菌極多。與成熟相關之徵生物爲 Penicillum roqueforti, 由乾培養加入凝乳。此乾培養，乃由黴菌生長於麵包上，容其生胞子，而後將麵包乾燥，磨成細末；於成熟時，應用於乾酪上，刺孔以容空氣進入。在此情形，其他黴菌，不易生長。P. roquetorti 所分泌之脂解酵質，加水分解脂肪，而成羊脂羧 Capric, caprylic 及次亞羊脂酸 Caproic 等，使其有辛辣味。

極多細菌，能使乾酪，起不良發酵。腸類菌能起多氣發酵，亦由脈氣菌 Clostridium welchii 類，及腐敗動桿菌，及生色細菌，時使乾酪呈紅色點。假釀母則使乾酪有苦味。

(3)牛乳所傳染之疾病

A. 結核症一由多數檢查之結果，證實牛乳內有結核病原菌之可能。此菌如何入乳之道不一。牛之乳房患有結核症者(約百分之一或二)，其乳當有此菌。然患此症之牛，雖其乳腺無病徵，而細菌得進入乳腺，而入乳中。英國皇家結核症研究會，曾作實驗：將結核病原菌，由肩後皮下注射入牛體。七日後，乳內即現此菌，直至病亡。牛乳之有此菌，或由牛糞沾染。牛患此症者，其糞常有此菌，蓋先由肺部咳出，嚥入食道，而由糞泄出。市上出售之乳，難免沾有牛糞，而牛患結核症者頗衆，故此症由乳傳染與人極易。據美國各大城記載，此症由乳傳染者，有百分之五至四十六之多。

裘林 (Behring) 氏所持之說：爲成人之患肺結核症，其原因爲幼時飲乳沾染，此說雖過甚其詞，然牛乳實爲原因之一。史密司 (Smith)氏等曾於幼孩之腸膜淋巴腺核內，查得牛型結核菌 (Bovine type)。牛之有無結核症，可以結核菌苗作用(Tuberculin reaction)診斷。其法在未注射菌苗之前，每隔相當時間，測得牛之體溫，然後以百分之二五蝟菌苗，注射入牛體皮下，於六至八小時後，二十四小時內，每隔二小時一次，再量其體溫。若患有此症者，則體溫增高，於注射後十至十八小時內尤甚，最少爲華氏十度。此法若應用適當，極爲可靠。若檢定爲陽性者，當即將其隔離，以免傳染他牛，及沾染牛乳也。

乳內之結核菌，可用天笠鼠(Guinea-pig)注射法分離。先將乳用離心器 (Centrifuge)，使其沉澱；乃將沉澱五瓦，及浮於乳面之乳酪，注射入於鼠體之皮下或腹中。若乳內有結核菌，則數星期內，天笠鼠染有此症，並可由淋巴腺核內，分離此菌。

B．傷寒症——此症流行，常爲牛乳所傳染。除水而外，牛乳實爲傳染此症之最大原因。休特氏(Schueder)分析六五〇次流行傷寒症，查出四六二次爲水所傳佈，一一〇次爲乳所傳染，七八次爲其他原因；足見乳傳傷寒之多。傷寒病原菌，能生長乳內，而乳之色味不變。此菌之沾染於乳，半由傳菌者，及用沾染此菌之水，以洗用具；或應用患此症用戶所還之瓶罐等。康拉狄(Conradi)氏，曾於乳內分離此菌。此菌能生長乳內至三十日之多，乳酪，冰結淋，及含乳之食物，均能傳染此症及副傷寒。傳菌者，爲患有此症之人，而其體富有抵抗力，使無劇烈之病徵，惟細菌能由其傳布。

C．猩紅熱症——此症爲一種溶解血球之鏈菌(Streptococcus haemolyticus.)所發生。牛類無此症，爲人所沾染。但有鏈菌，使牛患類似之症。屈拉司克(Trask)氏查出五十一次流行症，爲乳所傳佈。冰結淋亦能傳染此症，底温度不能殺滅此菌，亦不能減其毒質。

D．白喉症——此症亦時爲乳所傳染。屈拉司克氏報告二十三次流行症中，其二爲乳所傳佈。愛雷(Eyre)氏等查出此菌能久居乳內。白喉菌之入牛乳均由人患此症者及傳菌者所沾染。凡乳頭患有膿瘡時，沾染此菌，而入乳中，但此現象極鮮，故傳染亦較結核症，傷寒症等爲稀。

E．血毒喉痛——此流行症之由乳傳染，各國均有記載。史密司及白郎(Brown)氏查出此症之細菌爲 Streptococcus epidemicus，牛類者爲牛型菌，二菌均爲分解血球者。牛型菌使牛患乳腺炎，但不使人起扁桃腺炎。人型菌則使人患血毒喉痛，而與牛無影響。人型菌極易沾染於牛之乳房，當擠乳時，用染菌之布揩抹，或用毛通乳腺，而沾染乳中。此菌雖不使牛起疾病，而能生長於乳內六星期之久，故能將此菌傳染與人也。

F．風土病(Milk sickness)——此症流行於美國西部，爲急性無熱症，因食患有乳毒病之乳與肉而起。其特徵爲衰弱，嘔吐，及不消化；死亡率頗高。此症爲牛之疾病，而人次之。牛者爲乳毒病，因食植物 Aplopap-

pus 及 Heterophyllus 毒質所起。

G. 摩爾太熱 (Malta fever) ——此症爲羊疾，而人次之，由羊乳所傳染。病原菌爲 Brucella melitensis 。其特徵爲發熱，出汗，關節痛，神經炎及睾丸炎等。

H. 流行性關節紅疹 (Epidemie arthritic erythema) —— 此疾特徵爲發冷及熱，頭痛，發疹及關節腫痛。其沾染原因，尙未明悉。

I. 足與口疾 (Foot-and-mouth disease) ——此症爲牛類傳染病，其特徵爲口與蹄部起泡疹，其毒素能經過濾管。若飲患此症之牛乳，乳酪，奶油等，能傳染於人。其病徵與牛相似，惟較和善，若發熱，嘔吐，嚥食疼痛，口燥與熱，喉管黏膜出泡疹，以及扁桃腺炎與淋巴腺炎。有時手指亦起大如豌豆之泡疹，此疹隨破隨癒，惟不致死亡。

J. 霍亂——霍亂菌因乳之酸度過高，不易生長。然辛柏遜(Simpson)報告此疾亦有由乳傳染者。

K. 泄瀉與痢疾——痢疾菌能生長乳中，故能由乳傳染。夏季兒童之泄瀉多因飲沾染牛乳而起。

L. 小兒驚風 (Infantile paralysis) ——牛乳亦能傳染；乳酪，冰結淋等亦得傳染。

M. 疔瘡 (Anthrax) ——牛乳雖不能傳染此症，然包顯的(Boschetti)氏曾於擠出二星期之乳，分離此菌。

(4)細菌如何入乳

A. 始初傳染——康健之牛，其體素無細菌，故其乳亦無細菌。然牛之乳腺，乳房及乳頭，常居有細菌。若患有疾病，則病原菌能入乳中。初擠出之乳，較後擠出者，細菌數多。卽康健之牛，應用清潔擠乳手續，所得之乳每瓶亦有一百至五百細菌。乳內營養適宜，細菌繁殖極速，數乃劇增。此種增加，雖與溫度相關，惟與時間之關係尤大。若乳擠出後，容其久置，則細菌可增至億兆。

B．牛身之傳染——牛身之皮毛，最易沾染灰塵及細菌。若不將牛身洗淨，及擠乳時，不用水洗淨及揩抹，則細菌極易沾染乳中。牛囊中沾染細菌極多，而易沾染於牛身，若不洗抹，亦爲細菌沾染之一大原因。

C．空氣沾染——牛廐及乳房之空氣，爲細菌沾染乳內之要因，因其空氣中易入乳中，使菌數增加。故衞生之農場，常盡力減少空氣內之灰塵，而尤注意擠乳時之情形也。

D．擠乳者傳染——擠乳者若於擠乳時，不克洗手或更換清潔衣服，亦爲細菌傳染之要素，擠乳或裝乳者工作時，往往談笑或咳嗽，致唾滴灑飛，亦能使乳沾染病原菌。

E．用具傳染——用具如有缺點，及不經適當之洗濯及滅菌，細菌能繁殖於其隙罅中，而使牛乳之細菌增多。若用具潮濕而久留於空氣中，則細菌增殖尤多。故所有用具應洗淨，須經蒸汽滅菌。若用沸水滅菌亦可，惟水須在沸點之上，因有抗熱菌能存在故也。

F．水之傳染——若用沾染之水，以洗用具，亦能沾染細菌。若不經正當滅菌，則能傳佈流行症，若傷寒等疾病。

(5)防止牛乳沾染細菌

除上言之病原菌外，其他生長於乳內之細菌，亦往往能使乳內之養料酸化或腐化而變爲全無滋養，或且有害於身體之質。故非病原菌，亦須應用衞生之方以防止其侵入乳中，方使用戶得飲乳之實效。

防止牛乳沾染細菌有下列數法。

A．乳牛檢查——乳牛應檢查其有無疾病。康健之牛，乳房雖有細菌，此數不足爲患。若其數過多者，應即將其隔離。

B．牛身之清潔——爲避免沾染細菌計，牛身應常潔淨，不使積有灰塵。近乳房之處尤須注意，或將其毛剪去，以免汚穢墮入乳中。於擠乳時應先洗濯，以潔淨之潮布揩之，方能減少沾染。所用之擠乳桶，以口稍小者爲宜，因口大者灰塵易入也。

C．避免空氣中之灰塵——細菌之由灰塵沾染，既如上述。若欲減少細菌數，則應避免灰塵。

D．用具滅菌——用具爲沾染細菌之媒介，故一切用具，應檢查其有無缺點，並用蒸汽或沸水滅菌；然後乾燥之，藏於潔淨處。

E．擠乳者之檢查——擠乳者應檢查有無傳染疾病或傳菌者。擠乳時應先洗手及更換衣服，以免沾染細菌。擠乳機較爲清潔，然其橡皮管洗濯不易，時有沾染細菌之虞。

牛乳內既染細菌，應設法將其殺滅，或防止其繁殖。有用藥品以延遲細菌之生長，若漂白粉，硼砂及福末林等。雖牛乳能保存其品質，然與健康有關，爲法律所不許。可靠之法，莫若巴氏殺菌法 (Pasteurization)。巴氏殺菌法者，卽將牛乳熱至一溫度，能殺滅細菌之大部及病原菌，乃冷至低溫度，以阻止餘菌之生長是也。其用器極多，方法不一，茲將最普通者，略述如下。

(6)乳之殺菌作用(消毒)

鮮牛乳本含有得自血液之物質而能殺菌。乳之殺菌作用，各牛不同；卽同一牛，各季亦有不同。此作用於溫度華氏一六七度(攝氏七〇度)十五分鐘毀滅，或於華氏一七六至一九〇度間(攝氏八〇與九〇度之間)二分鐘失去。在華氏一四二至一四五度(攝氏六〇至六三度)三〇分鐘，微有影響。但此作用，力薄易變，無大效用。市上出售之乳，此作用已失。

實驗結果，乳內之細菌，先減少而後增多，此種現象，於牛乳擠出後八至十二時內尤顯。細菌數雖減少，然不至全滅；殘之細菌迅速繁殖至無數。故乳之限制細菌繁殖力，祇限於六至二十四小時，尙須視乳儲藏溫度而定。若爲攝氏三七度，則細菌祇能於八至十小時內減少。若冷至攝氏十度，則此作用少效，而時間得延長。此作用之失去，與乳之凝集極有關係。

總上所言，全藉乳之殺菌力，實未能妥善可靠。欲以安全計，則必須以高溫度以殺之。

A. 溫度與乳之影響

溫度之影響，當視溫度之高低，及時間之長短而定。華氏一四五度三〇分鐘，於乳之物質及化學方面，均無改變。溫度過高則不然；蛋白質及氮類化合物易起顯化；有機燐能減少，而礦質燐增加；鈣，鉀鹽類及燐酸鹽起沉澱；二氧化炭氣放出；一部份之乳糖燒去，而成棕色；乳狀液改變，使脂肪球併合。設熱至一六七度，則蛋白質凝結，酵素殺滅，維太命C亦受影響。

煮沸之乳，則有煮味，於華氏一五八度以上即起，此味恐與蛋白質分解有關係。煮時所失去之氣，亦能改變乳味，故乳應以閉器內熱之。

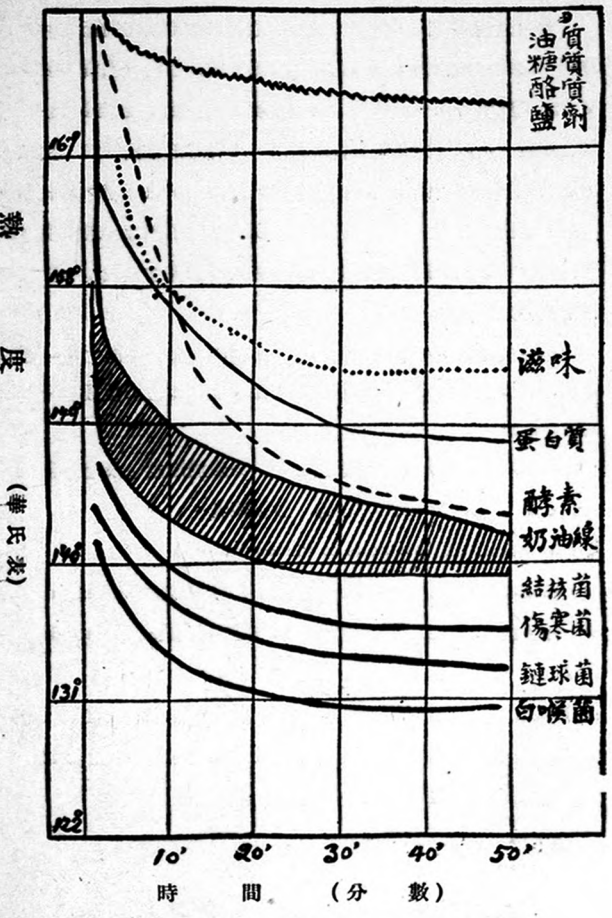
如乳於露器中，熱至一四〇度時，則面上起衣，取去後能再生。此衣含有酪素及類似蛋白質百分之五〇•八六，脂肪體百分之四五•四二，及灰燼百分之三•七二。於閉器中熱之，則即至煮沸亦無此衣。此衣恐爲乳之上層乾燥而成。溫度能改變乳之酸度，及影響膠質。

溫度能影響鈣與燐質。殺菌溫度，能使鈣鹽失去。但用速熱法，則無此弊，而尤適於幼孩之飲料。

乳以華氏一四二至一四五度殺菌即冷之，其味與鮮乳相同，而無改變。乳酪量(即能見之乳酪浮於乳上者)亦不爲溫度華氏一四五度三十分鐘所改變。溫度較高，則其量能減少。

乳酪量亦與牛之食物，以及分泌情形，脂肪成份，乳液之黏性，攪乳酪時之溫度，乳經分離器，乳酪與乳再混和，乳之攪拌等有關。於殺菌器，則視澄清，攪拌，冷却，溫度，及儲藏而定。

由多量之實驗因得溫度對於乳內各種養料以及各種微菌之結果示於下圖。



乳中各成分在一定時間內受不同熱度之影響圖

（由 Jordan and Falk 405 面，做 U.S. Pub. Health Bull., 147,1925）

B．巴氏殺菌法之標準

殺菌溫度與時間，當視能殺滅病原菌之溫度及時間而定。凡溫度與時間，能殺滅結核菌，則餘菌亦能殺滅。因此菌富有蠟質，較能抵抗溫度。然溫度至華氏一三八度，三〇分鐘，或一四〇度（卽攝氏六〇度），二〇分鐘，足以殺滅此菌。實驗結果，凡乳熱至華氏一四二度二〇分鐘，能殺滅結核菌，傷寒菌，副傷寒菌，痢疾菌，白喉菌，猩紅熱菌，喉痛菌，摩爾太熱菌，足與口症毒素，以及無胞子細菌。若熱度增高，時間得改少，華氏一四五度則上列細菌於六分鐘內卽殺滅；一五五度，則三十二秒足矣。

但爲安全計，牛乳之殺菌溫度，最適應在華氏一四二至一四五度，時間不可少於三〇分鐘，加熱時間旣足，卽冷至五〇度或以下。所用殺菌器應無缺點。

殺菌之乳，應用加蓋機迅速加蓋，保藏於冷處，及迅速運送用戶。裝乳之瓶，須用蒸汽或沸水消毒，然後裝乳。

C．巴氏殺菌法之種類(Methods of Pasteurization)

商用之巴氏殺菌法，可分爲數類：（1）保熱法(holding method)，若用桶，囊，續流及瓶乳殺菌器。（2）速熱法（flash method)，應用蒸汽或電流。

(一)保熱法——此法爲美國所通用者。將牛乳熱至殺菌溫度（華氏一四二與一四五度之間），維持牛乳於此溫度最少至三十分鐘，而後卽冷至華氏五十度或以下。

(甲)桶式殺菌器（vat-type pasteurizer)爲一隔離或護熱之桶。殺菌作用，可用下法之一：(子)牛乳可用熱乳器熱至殺菌溫度，然後放入一或數桶內；此桶可維持溫度，經三十分鐘後，抽出或流於冷乳器上。(丑)牛乳於桶內，用環熱管或護熱套及攪拌器，熱至殺菌溫度，三十分鐘後，流於冷乳器上冷却之。(寅)爲

子，丑二法合併所成。以熱乳器將牛乳熱至華氏一百至一四〇度，然後放入桶中，用環熱管或護熱套熱至殺菌溫度，維持三十分鐘後冷之(卯)牛乳用上法殺菌後，用冷水或冷鹽水，通入管中，使桶內之乳冷却。普通所用熱乳器與冷乳器爲二，但亦有因乳酪膩黏，用同一器以熱及冷之。

(乙)囊式殺菌器 (pocket-type pasteurizer) ——此器內有連續之小桶。各桶或囊均隔離或護熱，或備有攪拌器。牛乳先由熱乳器熱至殺菌溫度，放入囊中，由自動活門，次第流入各囊。

市用有二種圓形者，能定率轉動，使扇形囊次第儲滿由管流入之牛乳，經三十分鐘後，使次第流出於冷乳器上。

(丙)續流殺菌器 (continuous-flow pasteurizer) ——一種爲柱形筒，內有巢狀曲折，使熱乳於頂端放入時，漸漸流下；然後自底抽出，於冷乳器上冷之。

一種爲連續之金屬管，直徑爲五又四分之三或七英寸，裝置於箱形之室內，管稍傾斜。此室之空氣，熱至一定溫度。乃將牛乳熱至殺菌溫度，流入管中，而使其流出時，相隔約三〇分鐘，乃抽出冷之。

(丁)瓶乳殺菌器(in-bottle pasteurizer)——即將已裝瓶之乳殺菌。小者爲蒸氣及冰箱合併而成。內放瓶乳之箱，瓶口覆以紙蓋，用蒸汽熱至殺菌溫度三〇分鐘後，用水或冰冷之，乃將瓶取出，蓋以蠟紙。

大者有瓶乳箱帶行機。瓶乳先熱至華氏一〇〇度，覆以紙蓋，此箱乃由帶行機帶至連續之熱水間，先熱至殺菌溫度，三〇分鐘後，冷之。

此法有二弊(1)此殺菌器昂貴，(2)用戶所得之乳，常不滿瓶，而有空隙，因熱與冷時牛乳體積之差異故也。然其優點

爲能改少細菌沾染機會。蓋應用他法，牛乳於殺菌後裝瓶時，甚易沾染也。

(二)速熱法——此法將乳極速熱至約華氏一六〇度，迅卽冷之。然普通所用溫度太低，不能將細菌殺滅，致傳佈疾病。有時因溫度太高，將乳酸菌殺死，此種牛乳，若久置則起腐敗，並因溫度不均及過高，而使酪量銳減。

此法可用離心熱器，桶熱器，或管熱器，並可應用溫度調節器，使溫度平均，及不須用手活門抑制。用以熱乳者，爲熱水或蒸汽。或用電流殺菌，先將乳經冷熱器，熱至華氏一二〇度；然後經濾清器，流入電流室。此室內有電流經過，由阻力而熱至華氏一六〇度。此乳乃流出而入用鹽水之冷乳間冷之。

D．巴氏殺菌器之缺點及補救方法

通用殺菌器，常有缺點而失殺菌之效。若死端，活門洩漏，泡沫及潑濺，續流單位之缺點，以及不良溫度表等。茲分述如下：

(一)死端——爲管或囊之一部份，其溫度較低，使殺菌力少。補救方法，爲減去此種部份，代以活門等。若爲瓶殺菌器，則務使每瓶之牛乳，均得殺菌溫度。

(二)活門洩漏——各種活門，均有洩漏之處，而以久用者尤甚。設爲向內洩漏者，則能容生乳流入殺菌器內；向外洩漏者，則使尙未完全殺菌之乳流出。上列缺點，均能使乳所受之溫度，不足殺菌。

補救方法，可俟乳滿殺菌器後，將流入及流出管關閉。若欲節省手續等，可裝置阻漏器。此器能使漏出之乳，不經活門，而於底部流出。現有無活門之殺菌器，應用眞空或氣壓，使乳流入或流出。

(三)泡沫及潑濺——泡沫爲空氣進入乳之面層，而成浮於乳上之泡沫。若殺菌器內之乳有泡沫，則溫度常爲此冷空氣減低，至華氏八至十

度之多。補救之法，爲廢除起泡之部份，或將器內之空氣，熱之使泡沫亦至殺菌溫度。凡易起泡沫之器具，爲分離器，舊式澄清器，離心式熱乳器及桶式熱乳器，以及抽氣筒等。乳之滴入器內，最易起泡。經研究改良結果，如乳流入殺菌器，其管可裝置於器邊或底部，則各器能減少或不起泡沫。

若無法減少泡沫，則泡沫應用蒸汽熱至殺菌溫度；並可裝置自動整溫器 (thermostat) 或線輪筒 (solenoid)，或含氣或蒸氣之震動球所管理之蒸汽活門，於殺菌器之頂部。使有足量蒸汽，使空氣及泡沫，常在殺菌溫度之上。牛乳濺濺於殺菌器之蓋或邊部冷後，重滴入乳中使溫度低下。此缺點尤於環桶內爲甚，因其環轉太速，易致濺濺。補救方法，卽將轉動改緩至每分鐘三十轉。

(四)續流單位之缺點——續流殺菌器，若不能將乳之各部熱至殺菌溫度，卽爲缺點。圓柱形筒內有巢形曲折者，最不可靠，應改用他種殺菌器。若爲管續流器，應用水於殺菌溫度，並加化學物，若澱粉或氯磺(chloramine)，視其能否維持三〇分鐘。若時間或溫度稍有差別，當卽設法補救。若須時間改短，若乳用蒸汽噴筒抽入器內者，可將活門開放，使抽動速率增加；或將活塞噴筒聯於定率之發動機上，將速率配準，使乳於三分鐘內滿器。

欲使乳維持三〇分鐘，當牛乳終流時，當裝置外向活門，此門可半開放，使乳漸流出，而保持三〇分鐘。

溫度之缺點，大致因於起始時，未將殺菌器熱至殺菌溫度以上，因乳初進管時，其熱之一部份放出以熱金屬管，直至其至殺菌熱度爲止。若須免除此缺點，可裝置一空氣溫度表於殺菌器之氣室上，並於起始時，先將器熱至殺菌溫度以上，然後容乳流入。氣室之溫度，應不使其下降。

續流熱乳器，應與囊式或續流式殺菌器同用，亦適用於桶式者

。如不能將乳維持殺菌溫度時刻，卽屬缺點。如爲桶或囊式殺菌器，少許溫度較低之乳，能與餘乳混合，使溫度減低近一度許。如結果溫度較低半度或以上，則溫度應加高；增加熱度，祇適用於環熱管或護熱器，而於桶或囊隔離者，則溫度無法增加。若爲續流管熱器，則溫度較低之乳，不能以高溫度者混合也。故當有自動關閉活門。設溫度低落，可停止乳流。

(五)不良溫度表——溫度表極精緻，若應用不合法，或受震動，卽易損壞。其所刻度數，常有闊狹不均，並度數不準確。若太低，卽不至殺菌溫度；太高則乳酪減少。如爲小溫度表，則難得準確之溫度。故應裝置一準確之汞溫度表於每一殺菌桶上。每度之距離，應爲一英寸十六分之一，可使讀時準確。如爲續流或囊式殺菌器，則應有二溫度表，裝於器之進出各管處。

E. 巴氏殺菌法之利弊

巴氏殺菌法，雖或有指爲非至善方法，蓋但能防止疾病傳染，而不能改善乳之品質。腐敗及汚濁之乳，經殺菌後，仍爲腐敗或汚濁者。作此論者當知純潔之鮮乳，較殺菌者固佳，然難免沾染病菌之患也。

昔人以爲乳酸化，卽爲有害之徵，巴氏殺菌法不殺酸化菌故不阻止乳酸化，不過較緩。實則乳能酸化倒能阻止腐化菌之發生，故酸化非害徵；且有用以作飲料，已於乳產物一段論及之矣。反之，乳內若有結核及他種病原菌，而其味質不變，然其爲害反至要。殺菌法之弊，有謂不能毀滅抗熱之毒素。此說亦有未當，因若忽視乳之清潔而乳內有此種毒素，則此毒存在於未殺菌前之乳內，且更多矣。或有反對殺菌者，其理由爲應用殺菌法後，菌數旣減，農場卽不必注意清潔。然各奶場當不因殺菌法而於清潔更懈者也。

欲使此法更臻完善，當有市政府專員檢查，諭示各項應有條件。凡爲殺菌牛乳者，則應載明溫度，時間，及日期。若爲假冒者，或用不當

之殺菌法者，則政府可處罰，或停止其出售；並應檢查其場址，乳牛，殺菌器等，及將其乳作細菌數計，以斷定其方法之完善及乳之品質。殺菌法爲根據科學實驗，證爲可靠，並非由本於少數之人意見，實爲保障健康之唯一良法。其問題爲能推廣應用與否而已。

(7)乳內細菌數計法

A. 稀釋法——此法應用瓊脂基或膠質基扁平培養法。取乳樣之時，應先將其內容搖和，因乳酪含菌較多。然後去蓋，用除菌之量滴管，置於除菌之試管或燒瓶內。若須稀釋，則用除菌之滋養羹或食鹽水。設將一噸之乳，和以百噸之滋養羹或食鹽水；此液之一噸，或十分之一噸，卽爲原乳百分之一，或千分之一噸。照此稀釋，可得各種徵量。然後將此量滴入彼得氏盆，以徵温之瓊脂基或膠質基溶液傾入，搖和使成薄層，置於平面上，容其凝結；乃放入保温器內，温度爲攝氏三七度，二天；或三〇度，五天。而後數計其細菌集落，乘以相當之倍數，使成一噸乳內所有之細菌數。

B. 直接數計法——此法爲柏里司高德及白里特二氏所介紹。以除菌之量滴管取乳百分之一噸，塗於潔淨之玻片上，成一種平方之薄層。俟其乾後，用酒精固定。乳之脂肪體，可用柴愛羅或哥羅方溶去。然後用青素（methylene blue）或其他色素染色，於顯徵鏡之浸油接物鏡下數計細菌。先將顯徵鏡之抽筒上下移動，而以鏡臺顯徵尺，使視界成百分之二平方耗（對徑 0.16 mm.）；或用目鏡顯徵尺亦可。然後將數次數計之平均數以五千倍之，卽爲百分之一噸之細菌數。此法應與上法相輔而行之。

C. 青素退色作用試驗。

凡細菌生長多需氧氣，故能將青素退色。若細菌數多，則退色也速，故可用以檢定乳內細菌之多寡。其法以除菌之量滴管，將青素（一分色素和以二十萬份蒸餾水）一噸，置於除菌之試管中，加入乳十噸；將其混和，置於重湯器（water bath）內，温度爲攝氏三七度。計其色素退

去時間，依照下表，定其品質之優劣。

細菌數及青素退色時間檢定牛乳品質表。

乳之品質	一塭內之細菌數	青素退色時間
最優	五萬以下	十小時以上
優	五十萬以下	五小時半以上
平	五十萬與四百萬之間	二小時以上，五小時半以下
劣	四百萬與二千萬之間	二十分鐘以上，二小時以下
最劣	二千萬以上	二十分鐘以下

作者嘗將蘇州各農場之牛乳內之細菌數作數次之檢查，並試其青素退色速度。其結果詳於下表：

蘇州各農場牛乳內之細菌數計(1)

農場＼檢驗日期及氣溫		每塭細菌數		
		氣溫攝氏二度二十二年十二月二十日室溫攝氏十度	二十二年五月五日攝氏十八度	二十三年十二月二十日，攝氏十三度
經殺菌者	自由	7,133 (生乳 495,750)	45,000	200
	合作(2)	920,000	10,000,000	3,600
	民康	239,167	197,000,000	27,000
惠蘇		1,581,666	360,000	170,000
蘇州(蘇邁爾)		1,654,408	6,400,000	450,000
通和			4,300,000	100,000
民生		1,736,666	1,300,000	1,610,000
強生				1,100,000

(1)本表首末二次結果係得自東吳大學生物學系微菌學實驗課。

(2)首二次檢驗之乳未經殺菌，末次檢驗之乳，爲已經殺菌者。

蘇州各農場牛乳之青素退色時間

檢驗日期及氣溫 / 農場	梅青退色時間		
	二十二年十二月二十日氣溫攝氏二度室溫攝氏十度	二十二年五月五日攝氏十八度	二十三年十二月二十日攝氏十三度
自由	十小時以上	十小時以上	五小時半以上
合作			,,
民康	十小時以上	二十分鐘	,,
惠蘇	五小時半以上	十小時以上	,,
蘇州(蘇邁爾)	五小時半	二小時	,,
通和			五小時半以上
民生	五小時半以上	二十分鐘以上二小時以下	二小時以上五小時半以下
強生			二小時以上五小時半以下

(8)對於衛生機關應舉辦農場調查及牛乳檢查之意見

牛乳既爲至要飲料，其清潔與否，與市民之健康有莫大關係。小至傳染疾病，大至散佈流行症。歐美各國，無不注力，求其純潔，以保障國民之安全也。吾國各地，雖亦設有衛生科局。然事繁力薄，對於牛乳衛生尙少計及。茲就管見，因提最低限度之檢查農場工作，或能一日實現於我國之城市。

衛生科應添立改良牛乳股。研究農場應有設備之最低限度以及應注意之衛生各點，頒發各農場，以供其參考。

設有專員，調查各農場情況，若有不適當處，可由衛生科指導其改良，若不遵命，則可處罰或停止其營業。

應由獸醫檢查各農場乳牛，有無疾病；並應用結核菌苗試驗，以檢定有無結核症牛。此種檢查，每年一二次足矣。其費用可由各農場分擔。

將各農場乳樣，作細菌數計，及青素退色作用試驗，以定其品質之優劣。此種工作可請醫院或學校設有細菌學課者代作之。

應注意乳瓶滅菌及裝置等手續。如爲殺菌者，則視察其有無缺點，並應於蓋上書明溫度及時間等。凡未殺菌者，不得應用消毒，或殺菌等字樣，違者可處罰。

應將調查結果，於報紙上發表，以便市民有所選擇。

參　考　書

(1) Buchanan, E. D., and R. E. Buchanan——Bacteriology.-Macmillan Co., 1932.

(2) Jordan, E. O., and I. S. Falk——The Newer Knowledge of Bacteriology and Immunology.-The Univevsity of Chicago Press, 1928.

(3) Marshall, C. E.——Microbiology.-P. Blakiston's Son & Co., 1921.

(4) N. M. A. C.——A List of Bacteriological and Immunological Terms. 1918.

(5) Zinsser, H——A Textbook of Bacteriology.-D. Appleton & Co., 1931.

(6) 姜白民編——實用細菌學。商務書館，一九三三。

(7) 志賀潔著 湯爾和譯——近世病原微生物及免疫學，商務書館，一九二八。

SALIVARY GLANDS IN DIPTERA

Yin-chi Hsu

The dipterous insects are the true flies with a single pair of wings born on the mesonotum and with the metathoracic wings degenerated into a pair of knob-like halteres. Structurally Diptera are among the most highly specialized members of the Class Insecta. Quite a lot of them have acquired blood-sucking habits. The blood-sucking forms include almost the whole of Culicidae, besides the Simulidae, Tabanidae, and Pupipara, also certain members of the Chironomidae, Psychodidae, and Muscidae. Because of this very habit of these insects, the order has acquired great significance in relation to medical science. A great number of investigations have been made with reference to their morphological structures in relation to disease transmission. Among some of the most important phases of investigations are the mouthparts, the alimentary canal, and the salivary glands, etc. The present paper has no attempt to go into the discussion of the first two other than the last one only.

1. Salivary Glands in Diptera in General.

The salivary glands in Diptera are generally two pairs in number, one situated in the beak and the other in the thorax. They are usually elongate and tubular, but exhibit great variation in length. In the larvae there is a single pair. Kraepelin described a third pair in the Muscidae at the point of transition from the fulcrum to the oesophagus, but this needs confirmation. Comparatively little is known relative to the functions of the salivary glands. In many blood-sucking insects the saliva possesses poisonous or irritant properties. In some flies, Cornwall and Patton (1914) have detected a powerful anticoagulin.

2. Salivary Gland in Mosquito (Culicidae)

a. Gross Anatomy.

1) In Adults. Figs. 1, 2, and 3.

The glands are in two sets, one on each side in the antero-inferior region of the prothorax. Each set consists of three glands, two of which are of usual aspect of salivary glands, (resembling in structure), but not proportionately as long as, the single salivary gland on each side of the prothorax of the housefly. The third gland, which occupies the center of each set, is different, being evenly granular and staring more deeply than the others; its function being without doubt the secretion of poison. Each gland is about one-third of a millimeter long, and one twenty-fifth of a millimeter broad; the three are arranged like the leaves of a trefoil; and each is traversed throughout by a fine ductule, the three ductules uniting at the base to form a common duct, which is like a pedicel of the trefoil and is one of the branches of the bifurcated venomo-salivary duct. The ductules of the lateral glands of each set receive a minute branchlet near the base. Thus there are six glands, three on each side, two of them poisonous and four salivary. The two salivary ducts, one from each set of glands, carry forward and commingle the venomo-salivary products in the main duct: and the stream is then carried by the main duct to the reservoir at the base of the hypopharynx.

2) In Pupae.

The salivary glands are unbranched sac-like glands in the anterior part of the thorax on the sides of the alimentary canal. Their ducts unite beneath the sub-oesophageal glanglia, and from this point the single median duct runs forward to open in the floor of the mouth.

3) In Larvae. Fig. 4

There are two tube-like salivary glands lying close to the oesophagus in the head.

b. Histology. Figs. 5 and 10

Each gland acinus consists of a single layer of large cells limited on the outside by a delicate basement membrane and inside by the intra glandular duct wall. In Anopheles the intra-glandular duct becomes larger as it approaches the termination of the acinus, and forms a large cavity. In Culex the duct remains of the same diameter throughout the acinus, and terminates abruptly near the end of the acinus without any dilation.

In both Culex and Anopheles there are two types of gland acinus, namely the granular type and the colloid type.

1) The Granular Type. Fig. 6

The greater portion of the acinus consists of cells whose nucleus and protoplasm has been pushed to the outer portion of the cell by a large mass of secretion which occupies almost the whole of the cell. In the fresh gland this secretion appears as a clear refractile substence and can by pressure be made to exude from the cell in refractile globules. In specimens hardened in alcohol, this clear secretion appears as a granular mass occupying the greater portion of the cell. Considerable variations exist, however, in the appearance of this granular secretion both in the different mosquitoes and in the different parts of the same gland. In Anopheles the greater portion of the gland contains cells densely crowded with granular material. Very frequently, however, the terminal portion contains cells in which only a few large globular masses exist. The protoplasm of the cell occupies in the fully-matured gland only the extreme peri-

phery, and the nucleus, which is much degenerated, is pushed to the outer portion of the cell, and usually lies in the angular interval left at the base of two or more contiguous cells. In the granular type of gland this disappearance of the protoplasm and nucleus from view is more pronounced than in the clear type of gland.

2) The Clear or Colloid-like Type. Fig. 10

In the present type there is but a single acinus upon each side, which lies between the two acini of granular type. In the fresh gland the cell outlines are not so distinct as in the granular type, and the secretion when extended by pressure is much less refractive. In alcoholic-hardened specimens, the acinar cells contain a large mass of clear homogeneous secretion which, as in the last-mentioned type, fills almost the entire cell, and pushes the protoplasm and nucelus to the periphery. In the clear type, however, the protoplasm is always in greater amount than is the case with the granular type, and the nucleus never becomes so greatly degenerated. The clear homogeneous secretion stains readily with haematein. It resembles very much in appearance the colloid substence as it is seen in the mammalian thyroid. In Anopheles this substance also distends the central duct space within the acinus.

3. Salivary Glands in Midge (Chironomidae)

a. Gross Anatomy. Fig. 7

In midge larvae the salivary glands are two large glandular sacs, which are connected with the alimentary canal and open by ringed ducts, uniting to form a common duct which opens into the oesophagus immediately behind the mouth.

b. Histology. Figs. 8 and 9

Like other glandular structures of insects they are simple

though somewhat irregular in shape. The glandular cells are of considerable size and are nucleated and slightly granular in aspect, but there is nothing unusual in their appearance. On other occasions, however, the nuclei present a very peculiar aspect. The nuclei enclose firstly, two large nucleoli, sometimes separate, sometimes more or less united; and secondly, a coiled, cylindrical cord of slightly varying diameter; sometimes continuous, sometimes interrupted, and occasionally doubled; the extremities of which pierce the nucleoli. At a small distance from each extremity there is an abrupt discoid swelling, which may be described as a ring which the cord traverses a little before the extremity pierces the nucleolus. The structure of the cord presents alternate dark and light bands, the former of which appears to be formed by a solid substance, the latter by a liquid. These bands are the expression of thin discs, which are quite independent of each other, as may be seen when separated by pressure. The cord is the homologue of the intra-unclear network of other nuclei, which are generally described as consisting of homologenous threads continuous with the walls of the nucleus, and branching and anastomosing therein.

4. Salivary Gland in housefly (Muscidae)

In housefly in connection with the alimentary canal mention must be made of the two pairs of salivary glands, the lingual and the labial. The lingual salivary glands are of great length, and consist of blind-ended tubes. From the blind ends, which are situated near the posterior part of the abdomen, the glands pass forward into the thorax, and run along the ventriculus, when they are much convoluted. Thence they run forwards along the sides of the oesophagus, losing their glandular structure, and becoming ducts in the neck region. Finally in the neck they

unite below the oesophagus as the single duct runs directly to the end of the hypostome, where it opens. The labial salivary glands lie at the base of the oral lobes of the proboscis and their ducts open into the oral pits.

5. Salivary Gland of Tsetse-fly (Clossina. Muscidae) Figs. 11

The salivary glands are the appendages of the digestive tract, starting from their distal end as two long tubes, much coiled, and occupying a very superficial dorsal position in the abdomen on each side of the heart, above the alar muscles. Very transparent in the fresh condition, the salivary glands become glistening white in color when put in alcohol. Only tracheae and fat-body come between them and dorsal body-wall. The coils of the tubes extend back as far as the fourth abdominal segment, but the distal extermity of the gland may lie further forward than this. With many twists and turns the tubes run forward to the waist and then pass into the thorax, at the same time dimisnishing rapidly in calibre, straghtening out their coils, and descending to the ventral side of the body. From this point the salivary gland becomes the salivary duct. The two ducts run a parallel course through the thorax, on a level with the duct of the sucking stomach, and on each side of it, passing under the stomach and above the thoracic ganglion. When they reach the neck, the salivary ducts become so extremely attenuated that their course through the head is very difficult to follow. As they enter the neck the ducts curve over towards each other, and pass under the connective nerve-band, thus parting company from the oesophagus, which passes above the connective. The ducts pass under the brain and then under the pharynx.

If the head of a fly be examined from below, there will be found immediately behind the bulb of the proboscis, an area

covered by soft flexible integument, which recalls the soft skin at the base of a parrot's beak, and has a similar function, that is to say, to allow free play for the movements of the proboscis.

6. Salivary Gland of sand-fly (Phlebetomus, Psychodidae)

From the salivary glands situated close behind the head arise the salivary ducts of either side. These are stout tubes with taenidial thickenings. They pass through the occipital foramen close to its ventral edge and on either side of the ganglionic connectives to lie in grooves on the posterior aspect of the sub-oesophageal ganglionic mass where the two ducts unite to form the common salivary duct. The common salivary duct resembles in appearance the salivary ducts but is somewhat stouter; it passes forward in the mandibulo-maxillary prominence in the median line to the level of the base of the mentum where it enters the salivary pump.

7. Salivary Gland of cranefly larva (Tipulidae)

In the larvae of crane-fly there is a pair of simple tube-like salivary glands lying above and on the sides of the alimentary canal. Each gland is folded once. The salivary ducts unite to form a common duct as usual above the oesophagus. Each gland is composed of large angulated cells.

8. Salivary Gland of horse-fly (Tabanidae) Fig. 12

The salivary glands in Tabanus adults are two long, slender tube-like glands running from the rectum forward to the anterior border of the appendicular caeca, where each gland terminates into a salivary duct. The two ducts unite to form a common salivary duct above the oesophagus. The glands lie above and on the sides of the alimentary canal. Each gland is made of a single layer of columnal cells with a lumen inside.

9. Salivary Gland of Sryphidae Fig. 13

In the larvae of Eristalis the salivary glands are two simple convoluted tube-like structures lying above and on the sides of the digestive tract. The salivary ducts in this case are as usual.

10. Salivary Gland of Piophilidae

a. In adults. Fig. 15

The salivary glands of Piophila adults are very similar to that of the Tabanus in that the glands are two long slender tube-like structures, running from the rectum to oesophagus, where each gland terminates into a salivary duct. The two ducts unite to form a common duct.

b. In Larvae. Fig. 14

In the larvae the salivary glands are two club-like organs with two swellings and constricted at the middle. They lie above and on the sides of the alimentary canal. The outer surface of the glands are sinuated and not smooth at all. Each gland terminates into a slender salivary duct. The two ducts unite above the oesophagus and open between the two buccal armatures. The cellular structures are as usual.

11. Salivary Gland of Calliphoridae

a. In Adults. Fig. 17

In the adults of Calliphora the salivary glands are two long slender tube-like structures, running from rectum forward to oesophagus, where each gland terminates into a salivary duct. The two ducts unite to form a common salivary duct above the oesophagus. Each gland is coiled many times behind the oesophagus and then become a straight simple tube to the rectum.

b. In Larvae Fig. 16

In the larvae the salivary glands are kidney-shaped with large angulated cells. The salivary ducts and cellular structures are as usual.

BIBLIOGRAPHY

Alverdes, Friedrich ('12). "Die Entwicklung des Kernfadens in in der Speicheldrase der Chironomus larve". Zool. Anz. Leipzig 39 (1-6).

Alverdes, Friedrich ('13). "Nochmals aber die Kerne in den Speicheldrasen der Chironomus larve". Zool. Anz. Leipzig 42 (565-574).

Balbiani, E. G. ('81). "Sur la structure du noyau des cellules salivaires chez les larves de Chironomus". Zool. Anz. iv, pp. 637-641, 662-666 wood-cuts. An abstract on pp. 238 Ins. Zool. Rec. 1881.

Berlese, Antonio ('96). "Le cocciniglie Italiane vivente sngli agrumi". Firenze, 12 pls. and 200 figs.

Berlese, Antonio ('09). "Cli Insetti". 1:511-514.

Bolsius, H. ('11). "Sur la structure spiralee ou discoide de l' element chromatique dans les glandes salivaires des larves de Chironomus". Cellule Lonvain 27, pp. 75-86

Brown, ('10). "Some points in the anatomy of the larva of Tipula maxima". Trans. Linn. Soc. Zool. 11.

Christophers, ('01). "The anatomy and histology of the adulto mosouito". Dep. Malaria Coum. Roy. Soc. London, 4.

Cornwall, J. W. & Patton, W. S. ('14). "Some Observations on the salivary secretion of the commoner blood-sucking insects and ticks". Ind. Journal Med. Res. Calcutta 2. pp. 569-593.

Erhard, Hubert ('10). "Uber den Aufbau der Speicheldrasenkerne der Chironomus larve". Arch. mikr. Anat. Bonn. 76, pp. 114-124, mit 1 Taf.

Faussek, V. V. ('12). "Zur Grage aber den Bau des Zellkerns in den Speicheldrasen der Chironomus larve (In Russian)". At Peterburg Trav. Soc. Nat. c.r. Siances 43, 1, pp. 74-94, and deutsch Re's 127-128.

Faussek, W. ('13). "Zur Fräge äber den Bau des Zellkernes in den Speicheldräsen der larve von Chironomus". Arch. mirk. Anat. Bonn. 82 Abt. 1, pp. 39-57, mit 2 Taf.

Folsom, J. W. ('22). "Entomology with Special Reference to It's Ecological Aspects". pp. 107-108.

Giles, G. M. ('00). "A Handbook of the Gnats or Mosquitoes giving the anatomy and life history of the Culicidae". London, 8 vo. pp. viii & 374 illustrations.

Grassi, B. ('01). "Die Malaria-Studien eines Zoologen". Gena, 4 to, viii & 250 pp., 8 pls.

Grassi, B. ( ). "Studü di uno zoologo sulla malaria". Mem. Acc. Incei (5) iii, pp. 299-516, pls. A. & i-iv, 9 fig. in text.

Hammond, A. ('85). "Chironomus prasinus". J. Micr. & Nat. Sci. iv pp. 65-74 & 165-172 pls. ix-x, contains much anatomical and histological information, as well as figures of the metamorphosis.

Hennegny, L. F. ('04). "Les Insectes". pp. 77-80.

Herwerden, M. A. van ('10). "De bouw der kernen in de speekselklieren der Chironomus larve (Der Bau der Kerne in den Speicheldrüsen der Chironomus larve)". Utrecht Onderzoekingen Phyiolohisch Laboratorium (Ser. 5) 11, pp. 40-60.

Herwerden, M. A. van ('10) "Ueber die Kernstruktur in den Speicheldrüsen der Chironomus larve". Anat. Anz. Jena 86, pp. 193-207, mit 1 Taf.

Herwerden, M. A. van ('11) "Ueber den Kernforden und den Nucleolus in den Speicheldräsenkernen der Chironomus larve". Anat. Anz. Jena 38, pp. 387-393.

Herwerden, M. A. van. ('11) "Kerndraad en Nucleolus in de speekselkernen der Chironomus larve (Kerndrath und Nukleolus in den Speicheldräsenkernen der Chironomus larve)". Utrecht Ouder-zoekingen Physiologisch Laboratorium (Ser. 5) 12, pp. 1-10.

Keilin, D. ('13). "Sur diverses glandes des larves de Diptires: glands mandibularres, hypodermiques et peristigmatiques". Arch. Zool. Paris 52. (Notes et Revues 1-8).

Keilin, D. ('13). "Sur une formation fibrillaire intra- cellulaire dans la tunique de la glande salivaire chez les larves de Syrphidae". Paris C. R. Acad. Sci. 156, pp. 908-910.

Kellogg, V. L. ( ). "The anatomy of the larva of the giant cranefly (Holorusia rubiginosa)". Psyche ix, pp. 207-213.

Knüppel, A. ('86). "Ueber Speicheldrüsen von Insekten". Archiv für Naturf. Jahrg. 52, pp. 269-303, 2 Taf.

Knüppel, A. ('87). "Ueber Speicheldrüsen von Insekten". Tijdschr. Ent. xiii, pp. 67-69.

Knüppel, A. ('87). "Die Speicheldrüsen einiger Insekten". SB. Nat. Fr., pp. 28-30.

Korschelt, E. ('84). "Ueber die eigentumlichen Bildungen in der Zellkernen der Speicheldrüsen von Chironomus plumose". Zool. Anzeiger, pp. 189-194, 221-225, 241-246.

Kowalevsky, A. ('87) "Beiträge zur Kenntinss der nachembryonalen Entwicklung der Musciden". I Theil. Z. wiss. Zool. XIV, pp. 542-594, pls. xxvi-xxx. A preliminary

account of these researches was given in Zool. Anz. viii (cf. Zool. Rec. xii, Insecta, titles (173). The changes in muscles, alimentary canal, salivary glands, and larval hypodermis are the pyints treated in this point. (Summary, J. R. Micro. Soc., 11. 744.

Kulagin, N. ( ). "Zur Erage uber die Struktur der Zellkerne der Speicheldrasen und des Magens bei Chironomus". Zeitchr. Insbiol. i, pp. 409-414.

Lebredo, M. ('04) "Algunas observaciones sobre la Anatomia del Mosquito, con dibujos briginales". Revist. Medicina trop., 6 pls.

Leydig, F. ('59). "Zur Anatomie der Insekten" Archiv. Anat. und Phys.

Leydig, F. ('83). "Untersuchungen Zur Anatomie und Histologie der Tiere". Boon. 1883, pp. 174, 8 Taf.

Leydig, F. ('90). "Intra-und interzellulare Gänge". Biolog. Centralblatt, x, pp. 392-396.

Lowne, B. T. ('70). "The anatomy and Physiology of the Blow, fly". London: 8 vo., pp. viii & 121' with 10 pls. A most exhaustive work on the common Blow-fly (cf. Stud., pp. 28-36)

Lloyd, L. ('12). "Notes on Glossina moritans in North Rhodesia (Salivary Glands)". Bull. entom. research London 3, pp. 95-96.

Macloskie, G. ('87-'88). "The Poison-aparatus of Mosquito". Amer. Nat., vol. xxii, pp. 884-888, 1 fig. Anche in Science, pp. 106.

Nitzulescu, V. ('27). "Contribution a l'etude de la pompe salivaire des Culicides". Bull. Soc. Path. exotique, Paris 20, pp. 851-857, 6 figs. erratum No. 10.

Nitzulescu, V. ('27). "Contribution a l'etude de la pompe salivaire des Tabanides". Bull. Soc. Path. exotique, Paris 20-pp. 846-851, 4 figs.

Nitzulescu, V. ('27). "Contribution & l'etude de la pompe salivaire des Simulides". Bull. Soc. Path. exotique, Paris 20, pp. 748-753, 5 figs.

Packard, A. S. ('98) "A Text-book of Entomology", pp. 333

Pazos Y Caballero, J. H. ('03). "Del exterior é interior del Mosquito, Apuntes sobre la anatomiay Morfalogia". Rev. Medic. trop.

Perfiliev, P. P. ('22). "Sur l'anatomie des Phlebotomes (Dipt. Psychodidae)". Bull. Soc. Path. exotique, Paris 21, pp. 159-171, 254-257, 3 pls.

Perfiliev, P. P. ('26). "Zur Anatomae der Phlebotomus Arten (Dipt)". In Russian with Germany snmmary. Rev. russe Ent. Leningrad 20, pp. 308-319, 7 figs.

Rambousek, Fr. J. ('12). "Cytologicke poměry slinnych zlaz u larev Chironomus plumosus lin. (Cytologische Verhältnisse der Speicheldrusen der Chironomus larve)". Prag Věstu. Kral Ceske Spol. Nauk No. 2 (24) Taf.

Schiemenz, P. ('83). "Ueber das Herkommen des Futtersaftes und die Speicheldrasen der Biene nebst einen Auhang uber das Feichorgan". Zeits. wiss. Zool., bd. 38, pp. 71-135 Trf. 5-7.

Schröder, Christoph ('28). "Handouch der Entomologie" 1:285-296.

Valle, L. ('99). "Sur les glands salivaires des Muscides et des Piophilides". Arch. Zool. exp. Notes, pp. v-viii.

Valle, L. ('00). "Recherches sur les glandes des Dipteres". These Paris, 80 p. con 7 tav.

Wandolleck, B. ( ). "Zur Anatomie der cycloraphen Dipteren larven. Anatomie der Larve von Platycephala planifrous (F)". Abh. Mus. Dresden, Festschuft, No. 7, 39 pp., 2 pls.

Wolff, M. ( ). "Die Lebensweise des Zwischenwirtes der Malaria, Nach den Beobachtungen von Grassi". Biol. Centrbl. xxi, pp. 278-287.

INDEX TO FIGURES

Ab. I - Abdominal intestine.

Ba - Buccal armature.

Cer - Cerebrum.

Coe - Appendicular caecum.

CSD - Common salivary duct.

Ct - Colloid type.

Dr - Dorsal reservoir.

DS.ST - Duct of sucking stomach.

Fb - Fat bodies.

Gt - Granulrr type.

Hy - Hypopharynx.

I - Intestine.

L. ep - Labrum-epipharynx.

M - Muscles.

Mg - Midgut.

NC - Nerve commissure.

Oe - Oesophagus.

P - Proboscis.

Pb - Pharyngeal bulb.

Pg - Poison gland.

Ph - Pharynx.

R - Rectum.

SD - Salivary duct.

SG - Salivary gland.

S. St - Sucking stomach.

St - Stomach.

Th. I - Thoracic intestine.

Vr - Ventral reservoir.

EXPLANATION OF THE PLATE

Fig. 1. Side view of the head and thorax of a female anopheles mosquito showing the salivary glands, salivary ducts and other internal organs.
(After W. B. Herms, partly)

2. A set of salivary glands on one side showing the poison gland in between the two salivary glands, and the connection of the two salivary ducts.
(After G. MaCloskie)

3. Cross section of the salivary gland of Culex pipiens larva.
(After Louis Valle)

4. Salivary glands of Culex pipiens larva.
(After Louis Valle)

5. Cross section of the salivary gland of anopheles mosquito showing the fat bodies, granular and colloid types of gland.
(After S. R. Christophers)

6. Longitudinal section of the salivary gland of anopheles mosquito showing the granular type of gland.
(After S. R. Christophers)

7. Chironomus prasinus larva showing the salivary glands and alimentary canal.
(After A. Hammond)

8. Nuclear cord and nucleoli from cell of salivary gland.
(After Balbiani)

9. A portion of salivary gland of Chironomus prasinus, showing simple condition of cells.
(After A. Hammond)

10. Cross section of the salivary gland of culex mosquito showing the granular and colloid types of gland.
(After S. R. Christophers)

11. General view of the internal organs of Glossina palpalis showing particularly the convoluted salivary glands in the abdomen.
(After E. A. Minchin)

12. Salivary glands and digestive tract of Tabanus bovis adult.
(After Lonis Valle)

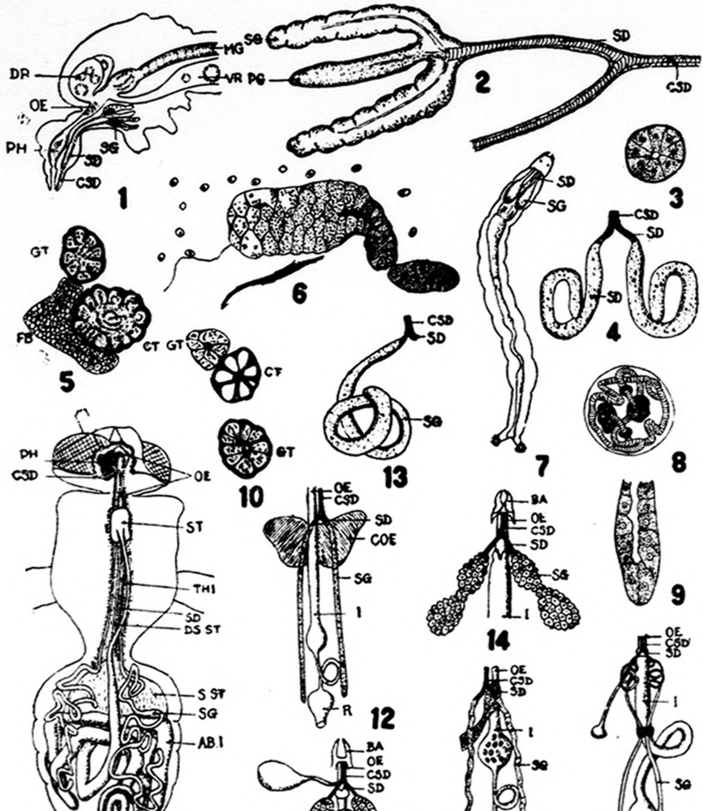
13. Salivary glands of Eristalis tenax (Syrphidae) larva.
(After Louis Valle)

14. Salivary glands and digestive tract of Piophila casei larva. (Piophilidae)
(After Louis Valle)

15. Salivary glands and digestive tract of Piophila nigrimana adult.
(After Louis Valle)

16. Salivary glands and part of the digestive tract of Calliphora vomitora (Calliphoridae) larva.
(After Louis Valle)

17. Salivary glands and digestive tract of Calliphora vomitora adult.
(After Louis Valle)



MG
SG
SD
DR
VR
PG
2
CSD
OE
PH
SG
SD
CSD
1
SD
SG
3
CSD
SD
GT
SD
6
FB
4
CT
GT
CSD
SD
CT
5
SG
8
PH
GT
CSD
OE
10
13
7
OE
CSD
BA
ST
SD
COE
OE
CSD
SD
SG
SG
THI
1
SD
DS ST
1
14
9
OE
CSD
SD
OE
CSD
SD
S ST
SG
R
12
1
AB.1
BA
OE
CSD
SD
SG
SG
1
SG
SG
R
R
R
1
11
16
15
17

FROGS AND TOADS

C. C. Liu

Frogs and toads, especially the former, are the most beautiful animals in the animal kingdom. They enjoy nature much more then we do. When the glorious season of growth comes, frogs and toads, waking up from their long winter sleep, come out from their homes to enjoy the delicious odors of early blossoms* the green mists of soft young leaves, the warm touch of the sun, and the echoing voices of the birds. They have social meetings of adult males and females entertained by choruses of the former sex in pools and ponds, the banks of which are still covered with brown fallen leaves of last year. The babies and immature youth however are not qualified to attend those musical fetes.

During such a spring season, the males usually go to the ponds preceding the females by one or more days. As with birds, the male frogs and toads select calling stations and endeavor to lure the females toward them by their beautiful songs. Similarly, it is true that the females will go to those places guided by the chorus to meet their friends. The problem of the causes of such migration has two different aspects. The first process is primarily controlled by seasonal hepertrophy of the gonads, which in turn are under hormonal control. The second factor of the migratory impulse is a climatic change. Frogs are as sensitive to changes of temperature as are human beings. Gentle or heavy showers usually initiate the migration.

The first males which happen to reach suitable breeding grounds, either pools, ponds, or rice fields, begin to call, seem-

*This paper on frogs and toads is written from the point of view of papular interest, rather than technical biology.

ingly to direct the migratory route for later comers. The Amphibia, frogs and toads, were apparently the first vertebrates to develop a voice. This voice is used not only for the attraction of the mates and for sex recognition, but also for the restriction of the range of the colony of the same species in the water. Only the males are provided with a loud voice, the females being either mute or, at most only able to make cries lower than those of the males.

The apparatus for croaking are the vocal sacs which are directly connected with the mouth cavity through one or two round or slit-like openings which are situated lateral to the tongue. The males of the common pond frog of Soochow, *Rana nigromaculata*, have two external lateral vocal sacs with two round openings; while the males of the Soochow rice field frog, *Rana limnocharis*, are provided with an external median subgular vocal sac with one or two round or slit-lik eopenings. When the frog croaks, the mouth and the nostrils are tightly closed and the air is driven back and forth between the vocal sacs, mouth cavity, and the lungs. Sound is thus produced when the air passes through the larynx which in some frogs is provided with a very complicated cartilaginous and muscular apparatus.

There are two kinds of croaks during the breeding season; one is the calling croak as a factor to guide migration; and the other is the warning croak for sex recognition. The calling croak is produced before and at the time of egg laying by the unpaired and untouched males with their vocal sacs fully contracted. If a male, especially a paired one, is interfered with by other males or females, his croak is sharper and higher to tell other animals near by that he is not a female. The males release the under individuals with a warning croak, and stay on those animals

without such a croak.

Males of Soochow common pond frogs are beautifully dressed with skin of different bright colors and black spots of various designs scattered over the entire back of the animal. One of the common patterns has a delicate yellowish green back-ground with rather small patches in deeper green scattered irregularly; another common type is an apple green background with black or golden roundish patches irregularly distributed over the entire back. Most of the females have the dorsal side deep greenish-gray or black with three distinct parallel white stripes running from the head region to the posterior region of the body. Some of the males may have two or three stripes on the back with various colors.

The eggs of the frogs are distinguished from the eggs of toads by the fact that frog eggs are laid in masses, and toad eggs in strings. Each mass consists of a large number of eggs which are enclosed by three layers of transparent gelatinous envelopes. The eggs of the toads are arranged mostly in two rows which are protected by transparent double jelly-like tubes. Such eggs are laid in the shallow and stationary water of pools, ponds, and rice fields during the breeding season.

Tadpoles will hatch out on the fourth day, if the condition is favorable. At first, they are minute, flattened, blackish objects, with conspicuous branching filaments, the external gills, at one end, a large rudder like appendage, the tail, at the other. The little creature at this period grows rapidly by living upon the nutriment from the original yolk-sac now stored in its own abdomen. Within two weeks, the mouth parts are well formed with a sharply hooked beak, suggesting that a parrot, and adorning the front of the tadpole's head, and with a number of rows

of horny teeth developed on the upper and lower lips. The animal of this stage, lives mostly on green algae, and only in part on animal matter. They swim around in the water usually in groups, as do fish, propelling themselves by their long pointed well developed tails. The external gills have long since disappeared, and the internal gills have taken their places for respiration, with a tube and an opening on the left side near the head region. Before the tadpole is many weeks old, a pair of bud-like growths sprouts near the base of the tail, and shortly those elongate into a pair of hind legs equipped with five toes, which closely resemble those of the adults. In the same time, arms make their appearance under the skin near the head region on the ventro-lateral sides, but they are not visible. Soon the arms burst through the skin with four fingers fully developed. Now the young fellow can hop out on the bank in a true frog fashion and breathe the air freely through the nostrils. With the formation of his legs and arms, his head structure has likewise changed. The scraping black beak gave place to the wise mouth characteristic of the adult frog; the staring eyes acquired their upper and lower lids and a third eye-lid, the nictitating membrane; a tympanum appeared; a definite color pattern showed on the skin; and ridges of glandular cells appeared on the skin over the back. Now only the tail remains to tell of his former aquatic habits. Day by day it is absorbed into the body during metamorphosis, and is not dropped off at a certain stage as some commonly suppose. At last our little friend, the young frog, is completely metamorphosed and can go freely on the shore with his brothers and sisters to catch flies and other insects among the plants bordering their ancestral pools, ponds, or rice fields.

After the breeding season, during the day time, the adults

and the young ones hide themselves among the grasses near the pools or ponds, or on the edges of the water of the rice fields as they are not well equipped for fighting offensively or defensively. The young ones, and sometimes the adults, especially toads, come out at twilight after rainy days and gather under lights or on masses of feces in order to get insects for food. It is so interesting that heaps of manure are the feeding grounds for toads not for frogs as to the former, people think that they are rather dirty animals. But the toads are the best insect eaters and have important economical value for the farmers and also medicinal value for the apothecary.

At the approach of the sharp autumn weather, the old toads and frogs, and the young adults particularly the former are less in number at their meeting places. It is not improbable that some of them, especially the old ones, are more sensitive to the change of weather and go for their long winter sleep much earlier than others. At the onset of the winter everything is silent, but with sleep, not death. Near the borders of the ponds, buried under logs and stones in the mud, or moist earth, the old and young have begun hibernation for the winter. A wise provision of the nature slows down their life processes to suit them to this complete inactivity and apparent inanition. The hibernating places are different for different species. The big toads may find their sleeping pleces under dead aquatic plants or roots of trees or rocks which are in the water. Toads burrow into the ground or dead vegetations on approach of cold weather and while digging with their hind feet presumably keep their original orientation as regards light. Frogs may hibernate in mud in the bottom of ponds or in the damp places, and some merely dig under decaying vegetations or other debris in their

normal habitats. In hibernation, they can pass a whole winter beneath the mud because they are not breathing as during the spring, summer, and autumn. But the energizing warmth of the returning spring calls them to another cycle of singing, mating, and enjoying the natural beauty of spring, summer, and autumn. The life of frogs and toads goes on peacefully in those corners of the world where no body ever pays any special attention except those frog-hunters and the most unpleasant animals, the snakes, which constitute the chief enemies of the peaceful frog-kingdom.

MORPHOLOGY AND LIFE HISTORY OF AMPHITOBIUS FAGI, PANZ.*

殷 尚 恩

Introduction

The beetle, Amphitobius fagi, Panz., commonly known as 洋蟲 is one of the most common forms occur here locally. From the medical stand point, it is considered as an useful insect because of its peculiar property when combined with other Chinese drugs to be used as Chinese medicines. It is believed that such kind of medicine can cure quite a number of diseases in China. Because of that it is reared on large scale by many people in this country in order to supply the need. The development of the beetle is fast in warm days and less so during cold weather. Although the beetle is of such great importance in Chinese medicine, yet very little work has been done to this insect. Therefore, the writer made the present investigation on the morphology and life history of the beetle during the year 1933-1934. The morphology of the adult and larva and the life history have been completely worked out. The results, herewith present in this paper, are discussed under the following parts: Part I Morphology of adult, Part II Morphology of larva, and Part III Life history.

PART I

MORPHOLOGY OF ADULT

Method

For studying the external structures, specimens were either preserved directly in 95% alcohol, or killed and fixed in Diedrich solution by injecting the solution into the body cavity with a syringe. After 24 hours the specimens were transfered to 95% alcohol in which the specimens were kept.

*This investigation was suggested by and carried on under the direction and supervision of Dr. Yin-chi Hsu, to whom the writer is indebted for his helpful suggestions and kindly criticisms.

Specimens treated with Diedrich solution were well relaxed and hardened to certain extent, so they are more satisfactory for the work. Specimens have also been boiled in 2% caustic potash to study the sutures and sclerites.

The binocular microscope was used to make dissections and a pair of minuten nadeln inserted on two match sticks was used as dissecting needles for micro-dissection. The drawings were made under Edinger Drawing Apparatus.

Diedrich solution	
40% of formalin	12 parts
95% of alcohol	30 parts
glacial acetic acid	2 parts
Distilled water	60 parts

General Morphology (figure 1)

The adult is oval in shape and is brownish black in color. It measures 0.65 cm. in length and 0.3 cm. in width. The head is very small, concealed beneath the prothorax. The three thoracic segments each bears a pair of legs and the mesothorax and metathorax each bears a pair of wings. There are six visible abdominal segments on the dorsal side and five on the ventral side.

1. Head

a. Fixed parts

The head is small and heavily chitnized. The vertex, front and gena are fused into a single large piece. The clypeus lies immediately cephalad of the epicranum and is trapezoid in shape. The labrum is articulated to its distal margin. One pair of antennae is articulated on the cephalo-lateral corners of the head. The compound eyes are located immediatelybehind the antennae. The occipital forman is behind the epicranium and connects to the prothorax.

b. Appendages

(1) Antennae (figure 2) There is a pair of very mobile and

many jointed appendages which are attached to the head between eyes. They are brown, serrate, and pubescent all over. They are about one fourth the length of the body. The number of segments is constant and is eleven in number. The scape is usually large, and forms the condyle for the articulation. The following segments gradually increase in size to near the distal end.

(2) Labrum (figure 3) The labrum or upper lip, is a more or less flap-like, convex and chitinized sclerite. It is articulated to the cephalic boarder of the clypeus. Its upper surface and margins are covered with hairs, and on the ventral surface there are along the anterior margin two rows of sense pits with numerous sense hairs.

(3) Mandible (figure 5) Each mandible is heavily chitinized and is provided with several tooth-like structure at the distal end and a ridged molar surface behind the teeth. They are articulated to the cephalo-lateral corners of the head by condyle between the insertion of two antennae.

(4) Maxillae (figure 6) Each maxilla is composed of the following parts: (1) cardo, (2) stipes, (3) palpifer, (4) galea (5) lacinia. The maxillary palpus consists of four segments and is pubescent all over. The basal segment is short and small, the second and third segments are subequal in length and the distal one is longer which is about three times as long as the basal segment, and twice as long as the second or third segment. The cardo is the basal part of the maxilla and is heavily chitinized. It is triangular in shape and forms the articulation of the maxilla. The stipes is the central part of the maxilla. It is chitinized and more or less triangular in shape which joins the cardo on its caudal margin.

The palpifer is a narrow sclerite, which is located laterad of the stipes and between the cardo and maxillary palpus. The galea is borne on the lateral margin of the stipes, and subdivided into the basal galea and distal galea. They are pubescent all over and the galea is provided with a group of bristles at its distal end. The lacinia is chitinized with a group of bristles on the inner margin at its distal end. It is attached to the anterior margin of the stipes.

(5) Labium (figure 4) The labium is pubescent all over and consists of four principle parts namely: submentum, mentum, lingula, and palpi. The submentum is the basal part of labium and articulates on the epicranium. The mentum is articulated in the center of submentum, on its ventral surface. The lingula is heavily pubescent all over. On its distal margin, there are many long hairs and on both its lateral corners there are many sense pits. It is attached on the distal margin of mentum. The two labial palpi are chitinized, arising from the lateral margins of the lingula. Each palpus is composed of three segments. The basal two segments are short and small, and third one is large and long. The tip of third segment is provided with sense papillae.

2. Thorax

The thorax consists of three segments: the prothorax, mesothorax, and metathorax. The mesothorax, and metathorax bear two pairs of wings: fore wing, the elytra, and hind wing, which are folded and membranous. The three thoracic segments bear each a pair of legs.

a. Prothorax (figure 7, 8)

All the tergal sclerites of the prothorax are completely fused together to form a single piece, the pronotum. It is brownish black in color and is puntate all over.

The prosternum is a cup-shaped sclerite. The cadual region of it is connected with the mesothorax.

The epimeron and episternum on the lateral side are fused into more or less a single rectangular piece which is sometimes called pro-pleuron, and is heavily chitinized.

b. Mesothorax (figure 21, 22)

Mesothorax is modified into a short thoracic segment which connects the prothorax and with that of metathorax.

The prescutum is the anterior sclerite. It is convex and is separated into two equal pieces by means of longitudinal depression. Immediately below it there attaches a heart-shaped sclerite, which is the scutum. On the side of it, there is the scutellum. It is triangular in shape. The post-scutellum is located behind the scutellum. The elytra are borne between the scutellum and pleuron.

c. Metathorax (figure 21, 22)

The metathorax is fused with mesothorax. The metascutum is a long and narrow sclerite. On both side of it, there are the scutellum. They are the large sclerites which bear the hind wings on the cephalo-lateral corners. On the ventral side the sternum is fused into a single piece. On the lateral side of it is the pleuron. The hind legs are located between the metasternum and the first abdominal sternum.

d. Wings

There are two pairs of wings. The forewings are borne by the metathorax. They are heavily chitinized and cover the entire body. The hind wings are menbranous and folded. They are borne by the metathorax and are completely protected by the fore wing, the elytra.

e. Venation of the hind wing (figure 9)

The venation of the hind wing is greatly modified. The hind wings are many folded, so as to be concealed beneath the elytra.

The subcostal vein runs about along the costal margin. The branches of the radius are greatly reduced, only R_1 extends shortly along the costal margin. The single media extends parallel to costa and branches into M_{1+2} and M_{3+4}. Cubital vein has two branches. One is Cu_{1+2} and the other is Cu_2 which fused with first anal to from CU_3+IA. The remaining veins are IIA and IIIA. The cross veins are greatly reduced, only a medio-cubital cross vein extends from media to cubitus.

f. Legs (figure 10, 11, 12)

Each of the three thoracic segments bears a pair of legs at the junction of the pleuron and sternum. The three pairs of legs are called the fore-legs, mid-legs and hind-legs respectively. They are covered all over with short hairs. Each leg is composed of five distinct parts, which are separately described below.

1. Coxa The coxa is the proximal segment of the leg and is provided with a groove to receive the trochanter and the base of femur.

2. Trochanter The trochanter constitutes the second part of the leg and is a small triangular segment.

3. Femur The femur is the third and the heaviest part of leg. It is convex above, compressed on the side and flat beneath.

4. Tibia The tibia forms the fourth division of the leg. It is slender and long, and is provided with a pair of tibial spurs at its distal end. Along its ventral side there is a row of small bristles.

5. Tarsus The tarsus is the last segment of the leg, consisting of five segments in fore and mid-legs and of four segments

in hind legs. It bears long bristles on each segment. On the hind leg the first and last segments are long and subequal in length, while the other two are small and short, being only one-third as long as the preceeding two. The fifth segment is long, while the other are small and short being about one-third the length of the fifth segment. The last segment bears a pair of tarsal claws at the distal end.

3. Abdomen

The abdomen consists of six visible segments. These segments are visible on the dorsal side, while on the ventral side there are only five visible sterna which are heavily chitinized. The segments are connected with one another by transverse conjunctiva.

PART II

MORPHOLOGY OF LARVA

General Morphology (figure 15)

The larva of the beetle is worm-like. The body is long and cylindrical. The length of the body varies from 1.1 cm. to 1.2 cm.. Hairs are present at various parts. Two rod-like projections are located at the posterior end of the body on the ventral side. They are pubescent all over and two segmented.

1. Head

a. Fixed parts

The head is a chitinized capsule. The main part of the head constitutes the epicranium. The clypeus separates from the epicranium by U shaped suture. The mouth parts is borne on the distal margin of the epicranium. A pair of antennae is articulated at the cephalo-lateral corners of the head.

b. Appendages

(1) Atennae (figure 16) The antennae are short and minute.

They are yellow in color, and four segmented.The basal segment is widened and short, the second segment is more or less square in shape, the third segment is long about two times as long as the second one but narrow, and the distal segment is very small, narrow and short, on which bears some long hairs.

(2) Labrum (figure 18) The labrum or the upper lip is more or less flap-like, convex and chitinized sclerite. It is pubescent all over, hinged to the distal margin of the clypeus. There are two median rows of sense hairs and many sense pits scattered on the ventral surface.

(3) Mandible (figure 17) The two mandibles are greatly chitinized and each is provided with several bluntly pointed teeth at the distal end and a molar surface behind the teeth. It is articulated to the mandibular sclerite by a knob-like condyle.

(4) Maxillae (figure 20) Each maxilla is composed of five principle parts namely: cardo, stipes, palpifer and lacinia. The cardo is the basal part of the maxilla and is heavily chitinized. It forms the articulation of the maxilla. The stipes is the central part of the maxilla and is united with the cardo on its cadual margin. It is greatly chitinized, pubescent all over, and triangular in shape. The palpifer is a long and narrow sclerite situated laterad to the stipes and is located between the cardo and the maxillary palpus. It bears a long four jointed maxillary palpus, which is pubescent all over. The basal segment of the palpus is short, while the other three segments are subequal in length, each is more or less two times as long as the basal segment. The lacinia and galea are fused together and are attached at the anterior margin of the stipes. It is pubescent all over with two rows of bristles on the margin.

(5) Labium (figure 19) The labium is pubescent all over and consists of four main parts, namely: submentum, mentum, lingula, and labial palpi. The submentum is the largest part of the labium. The mentum is much chitinized and is located at the center on the ventral surface of the submentum. Its basal margin is coincide with that of mentum. The lingula is articulated to the distal margin of the mentum and is situated between two palpi. It is heavily pubescent. The two palpi are chitinized, arising at the lateral margin of lingula. Each palpus is two segmented and its distal segment is short and is slender than the basal one.

2. Thorax

The thorax consists of three segments, namely: prothorax, mesothorax, and metathorax. The three segments are distinct and each bears a pair of legs.

a. Legs (figures 23-24-25)

Each of the three thoracic segments bears a pair of legs on the ventral side. The three pairs of legs are designated as fore legs, mid legs, and hind legs respectively. They are short, weak, and pubescent all over. Each leg is divided into five distinct and chitinized segments as follows:

(1) Coxa The coxa is the basal segment of the leg and articulates the leg to the thorax.

(2) Trochanter The trochanter is the second segment of the leg and a small triangular piece.

(3) Femur The femur is the third and heaviest segment of the leg.

(4) Tibia The tibia is long and more or less cylindrical and it forms the fourth division of the leg.

(5) Tarsus The tarsus is single segmented and attached to the distal margin of the tibia and forms the last segment of the

leg which is pointed at the tip.

3. Abdomen

The abdomen is cylindrical, long and pointed at the tip. It is yellowish in color. There are nine segments to the abdomen Each segment is armed with plenty of hairs. There are two rod-like projections on the ventral surface of the last segment, which are pubescent and two segmented.

PART III

LIFE HISTORY

The life history has been worked out completely during the summer of 1934. The result of the life history study is discussed as following.

1. Method of Rearing Both larvae and adults were reared in ordinary boxes with seeds of Nymphaca alba, L. (S. T.) 蓮心, Zizyphus vulgaris, Cas (Br. Ch. G.) 紅棗, and Juglan regia, L. var. Sinensis, (Ch. M. G.) 胡桃 as their food. For experimental purpose, each pair of beetles was reared in a separate vial, 5 cm. in length and 1.5 cm. in diameter. The vial was stopped at the top with a single layer of cheesecloth containing cotton. Each vial was numbered.

As soon as a mass of eggs was laid on the surface of the cheesecloth, the adults were removed out from the vial. After the eggs were hatched the larvae were then isolated in separate small vials, 2.6 cm. in length and 0.7 cm. in diameter, stopped with cotton. They were transfered to the larger vials until they were during the sixth stadium. Observations were taken two times daily at eight hours interval The records are shown in the tables.

2. Mating Habits About ten days after transformation the adults reach their sexual maturity. Mating habit was observed

in rearing dish. After several minutes of courtship, the female remained quite or might walk about slowly, the male climbed up her back with the external genitalia extended out. By repeated trails the male finally succeeded in inserting the external genitalia into the vagina. During mating the female stood still but sometimes walked a little bit. The duration of copulation about was five to six minutes. If disturbed during mating the genitalia was usually disconnected.

3. Preoviposition The preoviposition was not satisfactorily determined. Mating has been observed on the ninth day after transformation into adult during the first part of August. The preoviposition period is probably about ten days.

4. Oviposition The length of oviposition was only twenty or more hours which was observed during middle of May. In low temperature the length of oviposition is longer (Table).

5. Incubation and Hatching of Egg As mentioned above a pair of copulated adults was placed in a vial with a piece of seed of Nymphaca alba, L. (ST.) 蓮心 as their food. On September 23, they were placed in a vial and were observed daily until September 25, at which time about twelve eggs were laid. The eggs were elongate and turned their color to dilute yellow when they began to hatch. Most of the eggs hatched on September 29. The incubation period of the eggs varies from four to five days. (Table II) Under temperature below 20°C the eggs may not hatch until one week later.

6. Number of Larval Instars There are eight larval instars. The rearing work was done from about the end of April to the middle of June. The duration of the eight larval stadium and molting time are indicated in table III.

Table I

Duration of oviposition (under the average temperature 25°C)

Rear number	Date of copulation	Date of egg laying	Duration of oviposition
1	May 18 2. P.M.	May 19 A. M.	21 hours approx.
2	,,	,,	,,
3	May 19 2. P.M.	May 20 morning	20 hours approx.
5	May 19 10 A.M.	May 20 morning	24 hours approx.
6	May 22 2:30 P.M.	May 23 morning	19 hours approx.
8	May 22 2:30 P.M.	,,	,,
23	May 25 9:30 A.M.	May 26 morning	20 hours approx.

Table II

Incubation period (under the average temperature 23.4°C)

Rear number	Date of egg laying	Date of egg hatching	Duration of incubation period
5	Sept. 25	Sept. 29	4 days
7	,, 29	Oct. 4	5 days
17	,, 29	,, 4	5 days
20	,, 30	,, 3	3 days
23	,, 27	Sept. 30	3 days
26	Oct. 1	Oct. 6	5 days
28	Sept. 27	Sept. 30	3 days
29	Oct. 1	Oct. 6	5 days

7. Molting The larvae ceased feeding two or three hours before molting. The larvae appeared to be swollen and unnatural a short time before molting. At the time of molting the old skin splitted along the median line of the thorax and then

extended to the head. The body emerged out through this longitudinal split.

Table III

Date of Molting and Length of Stadia (under the average Temperature 24.5°C) From April 28 to June 20, 1934.

Rear number	16	18	21	19	27	26
Date of egg laying	April 29	April 29	April 29	April 30	April 30	April 28
Date of egg hatching	May 4	May 4	May 5	May 5	May 6	May 3
1st. stadium	5 days	5 days	5 days	5 days	5 days	6 days
1st. molting	May 9	May 9	May 10	May 10	May 11	May 9
2nd. stadium	5 days	5 days	5 days	4 days	4 days	4 days
2nd. molting	May 14	May 14	May 15	May 14	May 15	May 13
3rd. stadium	5 days	5 days	5 days	6 days	5 days	7 days
3rd. molting	May 19	May 20	May 21	May 20	May 20	May 20
4th. stadium	4 days	4 days	5 days	5 days	5 days	5 days
4th. molting	May 23	May 24	May 26	May 25	May 25	May 25
5th. stadium	7 days	7 days	5 days	5 days	5 days	5 days
5th. molting	May 30	May 31	May 31	May 30	May 30	May 30
6th. stadium	5 days	7 days	7 days	4 days	4 days	4 days
6th. molting	June 4	June 7	June 7	June 4	June 4	June 4
7th. stadium	6 days	?	6 days	8 days	?	6 days
7th. molting	June 10	?	June 13	June 12	?	June 10
8th. stadium	10 days	?	?	?	?	5 days
Date of pupation	June 20	?	?	?	?	June 15

8. Longevity Approximately the longevity of the beetle is,

about three months. It was observed that they live longer in warm days than in the cold weather.

9. Number of generations Each generation was completed in about five to six weeks during August and the first half of September. According to the local climate there could be as many as four or more generations per year.

10. Food Both larvae and adults feed on several kinds of fruits, namely: seed of Nymphaca alba L. (ST.) 蓮心 Zizphus vulgaris, Lam. (Br. Ch. G.) 紅棗, Juglan regia, L. var. sinensis, Cas (Ch. M. G.) 胡桃, and several kinds Chinese drugs namely: Areca Catechu Wilid (J.M.) 檳榔, Eucommia vlmoides, O. Liv (Hc. Pg. Wils.) 杜仲, and Cricus Salivus, L. (JM.) 紅花. The later is not their main food.

Description of Life History Stages

Egg (figure 13) The eggs are somewhat oval in shape measuring 83 u in length and 32u in width. They are traparent and whitish in color when first laid, but as development goes on, they gradually become elongate and turn their color to dilute yellow at the time of hatching. They are laid in irregular masses, usually on the soft cork of the rearing vials on the side of the rearing boxes. Each mass contains one to ten eggs. The average number is five. Most of them hatch into larvae. The percentage of unhatched eggs is small.

Larva (figure 15) The body of the larva is wormlike and consists of thirteen segments. It is pubescent all. The larva molts seven times. The length and width of each larval instar is indicated in the table of measurement. (Table IV)

Pupa (figure 14) When the larva is ready to pupate the anterior part of the body bends itself under the abdomen. After about few hours the larval skin splits and the pupa emerges

as a whitish object. It is inactive and cessation of food. The pupa measures 0.62 cm. in length and 0.23 cm. in width. The length of pupal stage varies from six to eleven days under the temperature of 20° to 27°c (Table V) In low temperature it may be as long as twenty or more days.

Table IV

The average length and width of larval instars during larval stadia.

Larvae	Length of body from labium to the tip of abdomen	With of head between two atennae
1st. Larval instar	146 u.	21 u.
2nd. Larval instar	187 u.	25 u.
3rd. Larval instar	243 u.	31 u.
4th. Larval instar	314 u.	35 u.
5th. Larval instar	396 u.	39 u.
6th. Larval instar	573 u.	43 u.
7th. Larval instar	756 u.	47 u.
8th. Larval instar	1296 u.	61 u.

Adult (figure 1) The adult is oval in shape and brownish black in color with a small head concealed under the prothorax and provided with a pair of long antennae truncated at the tip, two large compound eyes, under the prothorax and provided with a pair of long antenna truncated at the tip, two compound eyes, and mouth parts for biting. Each of the three thoracic segments bears a pair of legs, and the mesothorax and metathorax each bears a pair of wings. The first pair of wings is modified into hard wing covers, the elytra, which cover the

mesothorax, metathorax, and abdomen. The adult measures 0.65 cm. in length and 0.3 cm. in width.

The adult emerges by forcing its way out through the split on the dorso-median line of pupal skin. It takes only few minutes to complete the emergence. Just after emergence the body is soft and the elytra is white in color. A few days later the body becomes hardened and the whole body assumes the normal coloration. The adult is not very active, until one or two days after transformation.

Table V

Duration of pupal stage (under the average temperature 21.4°C)

Rear number	13	16	18	11	25	29
Date of pupation	Sept. 27	Sept. 28	Sept. 29	Sept. 28 p. m.	Sept. 30 morning	Sept. 30 p. m.
Date of emergence into adult	Oct. 3	Oct. 3 morning	Oct. 9 p. m.	Oct. 9 a. m.	Oct. 10 p. m.	Oct. 11 a. m.
Duration of pupal stage	6 days	6.5 days	10.5 days	11 days	10.5 days	10.5 days

Literature Cited.

Comstock, J. H. and A. B. Comstock.
"A manual for the Study of Insects."
Comstock Publish Co.

Comstock, J. H.
"The Wings of Insect."
Comstock Publish Co.

Comstock, J. H.
"An Introduction to Entomology"
Comstock Publish Co.

Carpenter, G. H.
The Biology of Insect."

Macmillan

Imm, A. D.
"Text Book of Entomology."
Mechuen

B. E. Read and J. C. Liu.
"Plantee Medicinalis Sinensis."
Flora Sinensis, Series A, Vol. I

Wu. C. F.
"Morphology, Anatomy, and Ethology of Nemoura."
Bullentin of the Lloyd Library of Botany, Natural History Pharmacy and Materia Medica Entomology Series, No. 3

Hsu. Y. C.
"Morphology, Anatomy and Ethology of Gryllus mitratus, Burm."
Lingnan Sci. Jour. Vol. 10, No. 2-3

T'ao H. C.
"Morphology, Anatomy, and Ethology and Taxonomy of the Soochow Coccinllidae." Lingnan Sci. Jr.

William E. Hoffmann.
"The Economic Status of the Lygreds and notes on the Life history of Lygaeoue Haspes Feba. (Hemiptera, Lygaeidae)."
Lingnan Sci. Jour. Vol. 11 No. 1

Willuam E. Hoffmann.
"Additional Data of the Life History of Lethocerus indeous (Hemiptera, Belostomidae)."
Lingnan Sci. Jour. Vol. 12 No. 4

William E. Hoffmann.
"Life History Note on Some Kwantung China Coreido (Hemiptera, Coreidae)."
Lingnann Sci. jour. Vol. 12 No. 1

Shih H. K.

"The Rice Grain Beetle, Tenebriodes Marritanicus L. (Trigestidac, Coleoptera) An unpublished thesis

Explanation of Figuees

Figure 1 Adult, Dorsal View

" 2 Adult, Antenna.

" 3 Adult, Labrum

" 4 Adult, Labium

" 5 Adult, Mandible

" 6 Adult, Maxillae

" 7 Adult, Prothorax, Dorsal View

" 8 Adult, Prothorax, Ventral View

" 9 Adult, Hind Wing, Venation

" 10 Adult, Fore-leg

" 11 Adult, Mid-leg

" 12 Adult, Hind-leg

" 13 Egg

" 14 Pupa, Ventral View

" 15 Larva, Dorsal View

" 16 Larva, Antenna

" 17 Larva, Mandible

" 18 Larva, Labrum

" 19 Larva, Labium

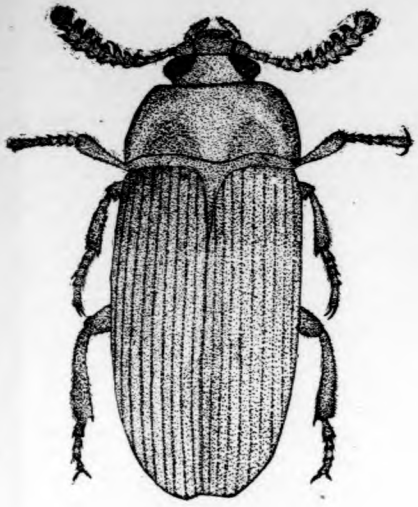
" 20 Larva, Maxilla

" 21 Adult, Mesothorax, Metathorax, and Abdomen, Ventral View

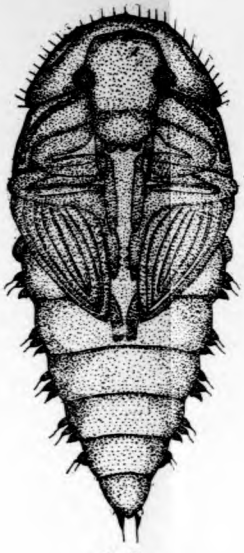
" 22 Adult, Mesothorax, Metathorax, and Abdomen, Dorsal View

" 23 Larva, For-leg

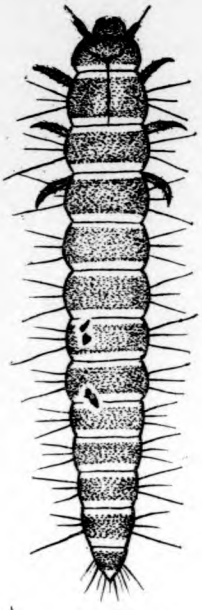
" 24 Larva, Mid-leg



1



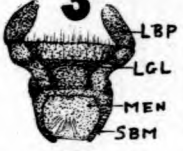
14



15

2

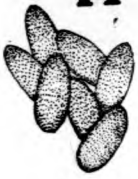
3



4

5

6

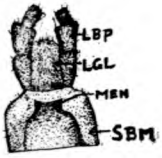


13

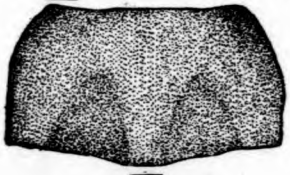
16

17

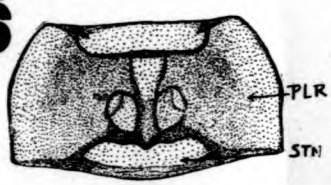
18



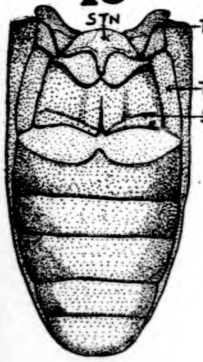
19



7



8



21

20

10

9

23

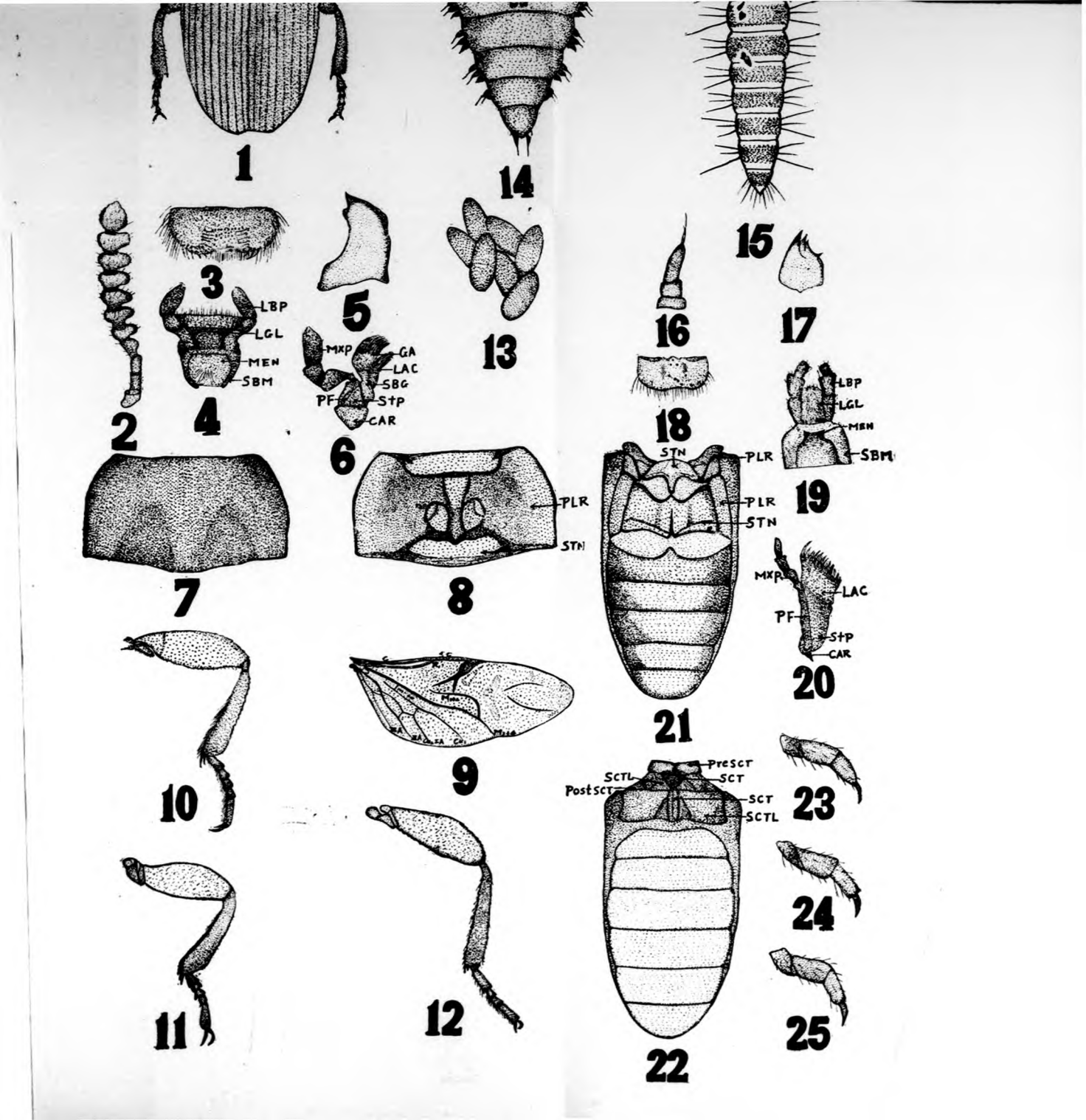

1
14
15
2
3
4
LBP
LGL
MEN
SBM
5
13
16
17
6
MXP
GA
LAC
SBG
PF
STP
CAR
18
19
LBP
LGL
MEN
SBM
7
8
PLR
STN
21
PLR
PLR
STN
STN
20
MXP
LAC
PF
STP
CAR
9
10
23
SCTL
PreSCT
SCT
PostSCT
SCT
SCTL
24
11
12
22
25

Figure 25 Larva, Hind-leg

Index to Figures

IIA	Second anal vein
IIIA	Third anal vein
C	Costa
Cu_1	Cubitus one
Cu_2 IA	Cubitus two and first anal
Car	Cardo
Ga	Galea
LAC	Lacinia
LBP	Labial Palpus
LGL	Lingula
M	Media
MEN	Mentum
MXP	Maxillary Palpus
PreStn	Pre-sternum
PreSCT	Pre-scutum
SBM	Sub-mentum
Sc	Subcostal
SCTL	Scutellum
SCT	Scutum
STN	Sternum
STP	Stipes
PF	Palpier
m-cu	Medio-cubital vein
PlR	Pleura
POSTSCTL	Post-scutellum

STUDIES IN THE MORPHOLOGY OF THE FLOWER OF ARACHIS HYPOGAEA L.

Parker K. Chou

I. INTRODUCTION

As the peanut is a very important food plant and source of vegetable oil, a knowledge of its floral morphology and the unusual manner in which it sets fruit is therefore of great interest.

It is easily recognized as a leguminous plant, but its divergence in floral structure from other members of the group deserves particular attention. In recent years investigations have been made by different workers, and papers dealing with the subject have appeared from time to time, with some mere compilations from previous works. In spite of those works it still seems that popular ignorance of the floral structure of the peanut plant is rather prevalent.

Marcgraf and Piso (5) were the first persons who figured the whole plant of Arachis hypogaea. Their figure is correct except that it shows no blossoms and represents the "nuts" as developing from the lateral roots.

Waldron (10) has made detailed study of the anatomy of the plant, particularly the gynophore. He states: "Sections of gynophore when very young, show a sessile ovary with usually two partial ovules; eleven to thirteen bundles extend from the base to the tip, branching more or less in their course. Along the inner edge of each bundle are tannin pockets".

Besides, Pettit (6) worked on the cambium layer and the stamens, Richter (7) on root hairs, Winton (11) on the pericarp, and Solereder (9) on the phenomenon of the burying of seeds in the ground.

Much has been learned of Arachis, but there are still differences of opinion regarding its flower morphology. In the array of workers on this plant, a number of investigators have reported the Arachis as a plant with dimorphic flowers. Waldron insists that the fertile flowers are located only on the basal portion of the stem, while the sterile ones are located higher up the branches. Thus this author claimed the presence of dimorphic flowers (fertile and sterile) located in different positions on the stem.

Robbins (8), in his Botany of Crop Plants, reports the different locations of the fertile and sterile flowers on the stem as Waldron.

Bentham (2) and Bailey (1) went even so far as to say that those two sorts of flowers are borne with structural differences. They assert, with descriptions more or less similar, that the fertile flowers possess no perianth, while the petal-bearing ones are sterile.

Yeu Ching (友誠 12) maintains that the fertile flowers are produced after the sterile ones have withered, thus emphasizing the fact that the sterile flowers are borne preceding the fertile ones.

Casual observation of the flowers and the manner in which the fruits are set seem to show that there is no such dimorphism in the peanut flowers. A reexamination of these points would be necessary. A study of the flower morphology of Arachis is therefore undertaken with the two objects of elucidating those points and thus removing the prevalent popular ignorance of its flower structure.

II. MATERIALS AND METHODS

Two varieties of Arachis hypogaea are used in this study:

one having one to two seeds in a pod; the other having three to four seeds. No dissimilarity is found in the external morphology of these two varieties. The statements here, therefore, hold true for both.

Arachis hypogaea is a low annual with an upright central stem, and more or less decumbent branches. The stems are thick, angular, branching, and hairy. The leaves are pinnately compound with two pairs of subsessile, entire leaflets, and no tendrils; the elongated stipules being adnate to the petiole base. It has a tap root with numerous laterals, extending to a radius of several inches in the ground. The central stem as well as all the branches bear flowers and fruits. It is not uncommon to find gynophores (stalk of the pod) extending downward from leaf axils as high as several inches from the ground, with a number of fruits being produced from them.

The plants which furnished materials for this investigation were grown in a garden. The plant as a whole has been studied briefly in the field. Flower buds, freshly opened blossoms, blossoms with withered perianth, and the elongating gynophores in various stages, were brought into laboratory and dissected. The killing and fixing agent was either formalin acetic alcohol, or Bouin's Fluid, the latter giving greater satisfaction in fixation of young embryo sacs. To ensure the best possible penetration of fixing, clearing, and imbedding agents, the perianths of the young flower buds were trimmed off, and suction was applied. Sections have been made by the paraffin method, following both Sharp's and Yamanouchi's schedules, and stained crystal violet with erythrosin counterstain. Serial sections were cut in thickness from six to ten micra with the rotary microtome. The developing gynophores of various stages have been studied also

in field conditions; special attention was paid to the phenomenon of burying the seeds in the ground. Methods have been made to determine the causal factors of the downward growth of the gynophore, and to study the manner in which the plant sets its "nuts".

III. GROSS MORPHOLOGY OF THE FLOWER

The flowers of Arachis hypogaea are borne in axillary clusters, of usually three flowers each on short pedicels. Field grown plants, late in the season, produce flowers not only in the leaf axils on the main central stem, but also in the axils on all the branches of this stem. All flowers are said to be complete. The perfect, polypetalous, zygomorphic flower measures about 1 cm. in diameter when fully opened.

The calyx is synsepalous, making a hypanthium of a slender tube about an inch long, terminating with four irregular lobes, of which three are still united, leaving the anterior one pointed, long, and free (Fig. 1). All the lobes of the sepals seem to have their origins from the posterior side of the calyx tube. This modification in position may probably be the result of twisting. The coalescence of the united sepals is so complete that it looks as if it consisted of only one sepal. Robbins reported that the four superior lobes are united, while the inferior one is free. The disagreement in the number of the calyx lobes may be due to the further fusion of the united members.

The corolla consists of five, irregular, yellow petals, inserted on the throat of the calyx tube; the standard is posterior; the wings are lateral. The keels, covered by the wings and entirely cohering to form a prow-shaped body, are obliquely anterior, as in many papilionaceous flowers of other legumes.

The androecium, inserted on the calyx tube, consists of eight

monadelphous stamens, the filaments of which are fused into a tubular structure for about two-thirds of their length.

Bailey (1) observes that there are nine monadelphous stamens in the androecium, while Pettit and Robbins report as many as ten in number. In the cross section of the androecium, it is true that there are nine traces, indicating nine filaments originally, but the posterior trace fuses with its neighbor at the point where the androecium separates into the eight distinct filaments. Consequently, eight free and distinct stamens in the flower are discernible. Two sorts of stamens, as indicated by the vascular strands, may be easily recognized to alternate with each other. There are four larger stamens which bear at their tips a long anther of two cells dehiscing longitudinally. The other four bear spherical anthers, each containing two cells also. This observation disagrees with that of Pettit, who maintains that the spherical anthers are one-celled.

Originally, Arachis might probably have possessed ten diadelphous stamens. The reduction of the number of the stamens from ten to eight may have taken place by two stages: first, a change from diadelphous into monadelphous by reducing the posterior free stamen, and then the degeneration of another posterior one among the nine, leaving a trace of the bundle which later fuses with the bundle of another weak stamen.

At the base of the calyx tube is located the ovary. The pistil is superior, sessile, and consists of a single carpel, which contains one to several ovules (according to varieties) with constrictions of ovary walls between them (Fig. 2). A long thread-like style extends through the center of the curved tubular structure of the androecium. By the time the flower opens, trichomes of either unicellular or multicellular nature are found covering the

surface of the free part of the style, which is terminated with a small stigma.

The receptacle supports the ovary and the calyx tube and, in turn, is supported by a short pedicel. It is this pedicel that grows into the gynophore when the floral parts fall off and begin to set fruits.

IV. THE EMERGENCE OF THE FLORAL ORGANS

The first sign of a flower of Arachis hypogaea is the appearance of a knoblike primordium in the axil of a bract. The calyx lobes arise first, followed by the petals (Fig. 3). Early in their development the bases of the calyx lobes broaden until they meet, and finally the whole structure is pushed up as the calyx tube. While the petal primordia are still young, the primordia of the stamens appear. The four larger ones rapidly develop into large stamens, which occupy fully the space enclosed by the perianth. All the stamens are separate at first, but later their filaments are elevated as a single structure by the pushing up of a basal region of meristematic tissue. At the upper portion of each stamen is sharply differentiated a row of archesporial cells, which give rise to the sporogenous tissue and primary parietal cells by two cell divisions. The sporogenous tissue thus formed consists of a single but continuous row, which when further developed are separated by longitudinal sterile plates into four masses. Tetrads of spores are formed at the time the flower bud is ready to open.

The primordium of the carpel appears almost simultaneously with the emergence of the stamens, but the tissues do not differentiate as early as the stamens. At the time when the flower opens, trichomes are beginning to form on the upper part of the style.

The growth of the corolla and the calyx seems to cease, when they reach a certain size, until the mircospores begin to develop in the anthers, when the calyx tube rapidly elongates, the petals rapidly grow, pushing the calyx lobes apart, and the flower opens.

V. THE OVULE

The ovule of Arachis hypogaea is anatropous with micropyle directed upward (Fig. 5). In some sections where the ovules are pressed together with each other, the micropylar end may point slightly toward the free side of the ovule. This deviation of the micropyle is adapted probably for the entrance of the pollen tube. Two integuments may be discernible at the micropylar end as in many other legumes. At the basal region the layers are not so distinct, but the cells may be seen to consist of at least four types: (1) the vascular tissue running from the funiculus; (2) a layer of large cells immediately surrounding the nucellus; (3) a group of several lignified cells at the chalazal region; and (4) the common wall cells. Next to the inner layer of the integument is the nucellus, which consists of an incomplete layer of cells near the micropylar end, making itself as a crown for the embryo sac (Fig. 4).

The embryo sac is oval in shape with a tubular chalazal end and is centrally placed in the ovule. When very young it is filled with starch grains, which may be detected by staining with iodine solution. At this stage the nucleus of the macrospore begins to divide, until eight free nuclei are formed, two of which fuse later to form the endosperm nucleus. The free nuclei here differ from the endosperm nuclei by the larger size and deeper stain. They are first scattered in the cytoplasm and then arranged in the characteristic position for fertilization with the

egg apparatus at the micropylar end, antipodals at the antipodal end, and the endosperm nuclei at the center (Fig. 4). It may be of interest to point out that the maturation of the embryo sac may take place at any time within the interval from the flower buds to the time the gynophore elongates after the flower has withered, as it has been observed for several times in gynophore sections where the embryo sacs were still in a two-nucleate stage and were filled with starch grains. This is probably a case of real sterility of Arachis flowers. In most cases the embryo sacs mature before the flower opens.

After fertilization the starch grains previously mentioned entirely disappear, having been utilized probably as food material for the development of the embryo. The endosperm nucleus now rapidly divides. As a result, a large number of free nuclei are formed and arrange themselves into a layer suspended in dense cytoplasm against the wall (Fig. 5). At the time when the fertilized egg is going to develop, cell walls are formed around the free nuclei, beginning from the portion near the proembryo.

An embryo of four cells then resulted by two successive periclinal divisions of the fertilized egg, the lower three forming the suspensor, and the upper-most one dividing longitudinally into two cells (Fig. 5). which after further development gives rise to the rudimentary tissues. The development of the embryo is very slow before the gynophore reaches the ground, and becomes rapid when it gets into the earth. That is the reason why the enlargement of the gynophore results shortly after burial in the ground.

VI. THE GYNOPHORE

As soon as the act of fertilization is accomplished, the re-

ceptacle of the pedicel, which lies immediately below the ovary, begin to elongate. The structure later becomes indistinguishable from the ovary at the tip. This elongating structure is known as the gynophore. A tittle later, it turns downward in such a direction as to reach the earth in the shortest distance. As soon as it has pierced the ground to a depth of about 5 cm., the ovary at the tip of the gynophore swells, and the ovules within begin to develop. The farthest ovule from the tip develops first, and is then followed by the others in succession. If any ovule fails to develop, it must be the one in the end of the ovary.

Cross sections of the gynophore at the ovule region show different layers of tissues: the ovule at the center, surrounded by bundles about thirteen in number, in the form of a ring; the peripheral cortex; and outer epidermis. In the sections where no ovules occur, large pith cells occupy the ovule position.

A longitudinal section of the gynophore tip shows well developed vascular bundles, one locule, and one or several ovules. At the extremity, the elongation of the epidermal cells assume the shape of a cap, which efficiently serves to pierce the ground (Fig. 2).

The vascular bundles present in the gynophore usually are numbered about thirteen, but it is not uncommon to find as many as fifteen or sixteen. The separate and circular arrangement of the vascular bundles shows the stele typical of dicotyledons. In each strand, traces of cambium can be found, and the phloem occurs outside of the xylem in a pith-containing cylinder, known as the ectophloic siphonostele. The xylem elements are very weakly stained and very few in number when young. Internal to each of the vascular strands is a tannin pocket, as Waldron has already found.

Experiments have shown that the downward growth of the gynophore is due to positive geotropism and has nothing to do with light, as Waldron reports.

The plant matures its fruits under the ground by means of elongating the gynophore, in which is the ovary, so as to bring the ovules five to six cm. into the ground. Robbins says: "If the ovary is not brought under the ground, it withers, and fails to mature."

It is true that if the gynophores in the upper portion of the stem fail to get into the earth, they may develop chlorophyll and become swollen at the tip, but no seed will be formed.

VII. DISCUSSION OF THE DIMORPHISM OF THE FLOWER

As pointed out in the introduction, a number of investigators have held a common opinion as to the presence of dimorphic flowers in Arachis.

George Bentham in his Flora of Brazil speaks of Arachis as a plant with two kinds of flowers, fertile and sterile, which have structural difference from each other. He states that the flowers usually seen with perianth are sterile. The fertile flowers usually possess neither calyx, petals, nor stamens, but only an ovary.

Bailey in his Manual of Cultivated Plants describes the showy flowers as yellow and sterile, soon withering; fertile flowers as borne on stout, recurving stipes, without envelopes and soon entering the ground where the ovary ripens into the reticulated pod or "nut".

In accordance with the opinion of the present writer it is observed that all flowers of Arachis, fertile or sterile, are petal-bearing. By sterility here is meant the fact that the flowers

would have no chance to set fruits; nothing is implied as to the factors which predetermine the sterility. The causal factors of the sterility of flower may be either the failure in pollination or the location too high up the stem so that it is impossible for the gynophore to get into the ground. Briefly, all flowers are structurally fertile without difference in perianth and stamens, but some may later become sterile due to the abortive ovule in addition to the conditions mentioned above.

It is not impossible that Bentham and Bailey mistook the gynophores for the fertile flowers which they maintained possessed neither perianth nor stamens, since the gynophore is the structure developed from the petal-bearing flower after the perianth has fallen off.

Waldron insists that the fertile flowers are usually produced at the basal region of the stem, while the sterile ones are located higher up. The difference in location of sterile and fertile flowers was reported also by Robbins (8) in his Botany of Crop Plants. He states: "Sterile flowers are most numerous in the upper axils on long, slender pedicels; they have monadelphous stamens (nine united one abortive) and an abortive ovary."

As mentioned previously, maturation of the fruits of Arachis must take place under the ground. The gynophores developed from the flower located higher up the stem usually have no possibility of burying themselves in the ground, fail to mature seeds, and therefore become sterile. It has been determined in the present investigation that the flowers located highly up the stem may also develop into fruits if they can be buried in the ground. This will explain satisfactorily what has been observed for the sterile flowers by Waldron and Robbins.

Some account of dimorphic flowers of Arachis has been

given by Yeu Ching (12) when he studied the ecology of this plant. He observed that the yellow sterile flowers are borne on the stem shortly after the emergence of the leaves, but they wither off very soon. Consequently, another sort of fertile flowers is borne, entirely hidden in the axils by the leaves. Those flowers possess perianth with a calyx tube about one inch long, but without stalk.

It is seen that the flowers of Arachis on the clusters on the lower region of the stem open earlier than those on the clusters higher up the stem. The inflorescence is indefinite; that is, the flower lower in the cluster opens first, and is followed by the higher ones in succession. According to the present observation, the flowers producing seeds are mainly those which open early, since they are located lower and are more easily buried in the ground.

VIII. CONCLUSIONS

The flowers of Arachis hypogaea are borne in axillary clusters. A mature flower consists of a long calyx tube with four unequal lobes, of which three are united, five irregular but distinct petals, eight monadelphous stamens, and a single carpel. All flowers fertile or sterile, are petal-bearing.

The flower primordium appears first as a protuberance in the axil of a bract. The order of emergence of the floral organs is from outer cycle to inner cycle, i. e., sepals, petals, stamens, and pistil.

Arachis hypogaea sets its fruits under the surface of the ground by elongating the pedicel region to form a gynophore. The gynophore has a typical stem structure and is positively geotropic. If it fails to bury itself into the ground, it develops chlorophyll, but never matures "nuts".

The embryo sac may mature early in the flower buds, but it may remain still in the two-nucleate stage after the flower has withered. The egg apparatus, antipodals, and endosperm nuclei are normally developed and placed as in other dicotyledons. The whole embryo sac is filled with starch grains, which will disappear when the embryo develops. The endosperm nucleus divides into numerous free nuclei, which later form a layer of cells lining the sac.

Two successive divisions of the fertilized egg give a chain of four cells, the lower three being the suspensor and the uppermost one being the terminal cell, from which a massive embryo will be produced.

ACKNOWLEDGMENTS

The writer wishes to express grateful appreciation to Professor H. T. Chang and to Professor J. W. Dyson for their suggestions and criticisms during this investigation and preparation of the manuscript. He is indebted also to Mr. Robert Y. Chao for kindly allowing space on his farm where the material for the present study was planted.

LITERATURE CITED

(1) Bailey, Manual of Cultivated Plants, 1924

(2) Bentham, George, Flora of Brazil

(3) Chamberlin, Methods in Plant Histology

(4) Gray, Structural and Systematic Botany

(5) Marcgraf and Piso, Brazil. edit. 1648

(6) Pettit, Arachis hypogaea, Mem. Torr. Bot. Club Vol. IV. 1895

(7) Richter, Beitrage zur Biologie der Arachis Hypogaea, Inang. Diss. 1899

(8) Robbins, Botany of Crop Plants

(9) Solereder, H., Anatomy of Dicotyledonous Plants
Vol. I. 1908

(10) Waldron, R. A., The Peanut (Arachis hypogaea), its History, Histology, Physiology, and Utility.
Contr. Bot. Lab. Univ. Pa. Vol. IV, No. 2

(11) Winton, Anatomy of the Peanut
Conn. Report. Pt. 2, 1904

(12) Yeu Ching (友誠) 落花生之種植法
科學第一卷第二十期

Explanation of Figures

Fig. 1. - Diagramatic vertical section of the flower, side view, showing the hypanthium (hy), the sessile ovary (o), the androecium (an), the keel (kl), the wing (wg), a part of the standard (sd), and a portion of the calyx (cx),

Fig. 2. - Longitudinal section of gynophore, showing two anatropous ovules and a pair of vascular tissues,

Fig. 3. - A flower primordium showing the emergence of floral parts: bract (bt), calyx (cx), standard (sd), keel (kl), stamens (st), and pistil (pl),

Fig. 4. - An ovule with a mature embryo sac, filled with starch grains; micropyle (Mi), integuments Int), nucellus (Nuls),

Fig. 5. - Proembryo, showing the suspensor cells and the terminal cell. (Ter).

LIST OF SHRUBS, TREES, ORNAMENTAL GRASSES & WOODY VINES ON SOOCHOW UNIVERSITY CAMPUS

H. T. Chang, J. W. Dyson, and H. L. Li.
(Department of Biology, Soochow University)

Acer japonicum Thunb. (varieties) 羽扇槭樹 Maple (槭樹科 Aceraceae)

Acer trifidum Hook. & Arn. 三角槭 Maple (槭樹科 Aceraceae)

Albizzia julibrissin Durazz. 合歡 Albizzia (荳科 Leguminosae)

Alchornea Davidi Franch. 丹物爹包葉 Dovewood (大戟科 Euphorbiaceae)

Ardisia japonica Bl. 紫金牛 "Earthly Bamboo" (紫金牛科 Myrsinaceae)

Bamboo (several species) 竹(各種) Bamboo (禾本科 Gramineae)

Berberis Thunbergii DC. 小檗 Japanese Barberry (小檗科 Berberidaceae)

Broussonetia papyrifera Vent. 穀樹 Paper-Mulberry (桑科 Moraceae)

Buddleia Lindleyana Fort. 五霸蓋(醉魚草) Buddleia (馬錢科 Loganiaceae)

Buxus sempervirens L. 黃楊 Box (黃楊科 Buxaceae)

Callicarpa dichotoma Raeusch. (尖尾楓) 紫珠 Beautyberry (馬鞭草科 Verbenaceae)

Camellia japonica L. 山茶 Camellia (山茶科 Theaceae)

Campsis radicans Seem. 美國凌霄 Trumpet-Creeper (紫威科 Bignoniaceae)

Carya pecan Engl. & Graebn. 西洋長核桃 Pecan (胡桃科 Juglandaceae)

Catalpa ovata Don. 楸 Chinese Catalpa (紫威科 Bignoniaceae)

Cedrela sinensis Juss. 香椿 Cedrela (楝科 Meliaceae)

Cedrus deodara Laws. 雪松 Deodar (Indian Cedar) (松柏科 Pinaceae)

Celastrus scandens L. 落霜紅 Bittersweet (衞矛科 Celastraceae)

Cercis chinensis Bge. 紫荊 Redbud, Judas Tree (荳科 Leguminosae)

Cinnamomum camphora Nees. 樟 Camphor Tree (樟科 Lauraceae)

Citrus Aurantium L. 橙 Sour Orange (芸香科 Rutaceae)

Citrus spp. (Potted) 柑橘 (芸香科 Rutaceae)

Clematis sp. 鐵綫蓮 Clematis (毛茛科 Ranunculaceae)

Cornus florida L. var. *rubra* West. 大花山茱萸 Flowering Dogwood (山茱萸科 Cornaceae)

Cornus stolonifera Michx. 紅莖山茱萸 Red-Osier Dogwood (山茱萸科 Cornaceae)

Cortaderia argentea. Stapf. Pampas-Grass. (禾本科 Gramineae)

Cryptomeria japonica D. Don. 孔雀杉 Cryptomeria (松柏科 Pinaceae)

Cunninghamia lanceolata Hook. 杉 Chinese "Fir" (松柏科 Pinaceae)

Cycas revoluta Thunb. 鳳尾松 (鐵樹) Sago (鐵樹科 Cycadaceae)

Daphne odora Thunb. 瑞香 Winter Daphne (瑞香科 Thymelaeaceae)

Deutzia scabra Thunb. 溲疏 Deutzia (虎耳草科 Saxifragaceae)

Daphne genkwa S. & Z. 芫花 Lilac Daphne(瑞香科 Thymelaeceae)

Diervilla coraeensis DC. 錦帶花 Wiegela (忍冬科 Caprifoliaceae)

Eriobotrya japonica Lindl. 枇杷 Bibo; Loquat (薔薇科 Rosaceae)

Erythrina indica Lam. 刺桐 Coral-Tree (荳科 Leguminosae)

Euonymus japonicus L. 黃龍爪樹 Spindle-Tree (衛矛科 Celastraceae)

Euonymus radicans Sieb. 扶芳藤 Spindle-Tree (衛矛科 Celastraceae)

Euonymus japonicus L. var. *aureo-variegatus* Reg. 玉邊黃龍爪 (衛矛科 Celastraceae)

Exochorda grandiflora Lindl. 金瓜菓樹 Pearl-Bush (薔薇科 Rosaceae)

Fatsia japonica D. & P. 八角金盤 Fatsia (五加科 Araliaceae)

Ficus Carica L. 無花菓 Edible Fig (桑科 Moraceae)

Ficus pumila L. 薜荔 (木蓮) Climbing Fig(桑科 Moraceae)

Firmiana simplex Wight 梧桐 Phoenix Tree or Wutung (梧桐科 Sterculiaceae)

Forsythia viridissima Lindl. 深碧連翹 Golden Bell (木犀科 Oleaceae)

Fraxinus chinensis Roxb. 白蠟樹 Ash (木犀科 Oleaceae)

Gardenia jasminoides Ellis 梔子 Cape Jasmine (茜草科 Rubiaceae)

Ginkgo biloba L. 銀杏 (公孫樹) Maidenhair Tree (銀杏科 Ginkgoaceae)

Hedera Helix L. 常春藤 English Ivy (五加科 Araliaceae)

Hibiscus mutabilis L. 木芙蓉 Hibiscus or Rosemallow (錦葵科 Malvaceae)

Hibiscus syriacus L. 木槿 "Althea" (錦葵科 Malvaceae)

Hovenia dulcis Thunb. 枳椇 (金鉤子，枳椇) Raisin-Tree (鼠李科 Rhamnaceae)

Hydrangea chinensis Max. 華八仙花 Hydrangea (虎耳草科 Saxifragaceae)

Hypericum patulum Thunb. 金絲梅 St. John's Wort (金絲桃科 Hypericaceae)

Ilex cornuta Lindl. & Paxt. 狗骨 (鳥不宿，貓兒刺) Chinese Holly (冬青科 Aquifoliaceae)

Jasminum floridum Bge. 探春花 Jasmine (木犀科 Oleaceae)

Jasminum nudiflorum Lindl. 迎春花 Winter Jasmine (木犀科 Oleaceae)

Juglans nigra L. 胡桃 Black walnut (胡桃科 Juglandaceae)

Juniperus chinensis L. 檜柏 (圓柏) Chinese Juniper (松柏科 Pinaceae)

Juniperus prōcumbens Sieb. 矮檜 "Prostrate" Juniper; (松柏科 Pinaceae)

Juniperus chinensis var. *kaizuka* 龍柏 Juniper (松柏科 Pinaceae)

Juniperus formosana Hayata 櫻絡檜 Formosan Juniper (松柏科 Pinaceae)

Kerria japonica DC. 棣棠花 Kerria (薔薇科 Rosaceae)

Koelreuteria paniculata Laxm. 欒樹 Goldenrain-Tree (無患子科 Sapindaceae)

Lagerstroemia indica L. 紫薇 Crape-Myrtle (千屈菜科 Lythraceae)

Ligustrum lucidum Ait. 女貞 (冬青) Privet (木犀科 Oleaceae)

Liquidambar formosana Hance 楓 Formosa Sweet-Gum (金縷梅科 Hamamelidaceae)

Lonicera japonica Thunb. 忍冬 Chinese Honeysuckle (忍冬科 Capri-

foliaceae)

Lycium chinense Mill. 枸杞 Matrimony-Vine (茄科 Solanaceae)

Magnolia denudata Desrouss. 玉蘭 Magnolia (木蘭科 Magnoliaceae)

Magnolia grandiflora L. 洋玉蘭 Southern Magnolia (木蘭科 Magnoliaceae)

Magnolia liliflora Desrouss. 木蘭 (辛夷) Magnolia (木蘭科 Magnoliaceae)

Mahonia spp. 小檗 Holly-Grape (小檗科 Berberidaceae)

Malus spectabilis Borkh. 海棠 Chinese Flowering Crab. (薔薇科 Rosaceae)

Melia Azedarach L. 楝 (苦楝) China-Berry (楝科 Meliaceae)

Meratia praecox R. & W. 臘梅 Wintersweet. (臘梅科 Calycanthaceae)

Miscanthus sinensis Anderss. 芒 Eulalia (禾本科 Gramineae)

Morus alba L. 桑 Mulberry (桑科 Moraceae)

Musa Basjoo Sieb. 芭蕉 Banana (芭蕉科 Musaceae)

Nandina domestica Thunb. 南天竹 (天竹) "Heavenly Bamboo" (小檗科 Berberidaceae)

Nerium odorum Ait. 夾竹桃 Oleander (夾竹桃科 Apocynaceae)

Osmanthus fragrans Lour. 木犀花 (桂花) Sweet Olive (木犀科 Oleaceae)

Parthenocissus tricuspidata Planch. 地錦 Boston Ivy (葡萄科 Vitaceae)

Philadelphus coronarius L. 山梅花 Mock Orange (虎耳草科 Saxifragaceae)

Photinia serrulata Lindl. 石楠 Low Photinia (薔薇科 Rosaceae)

Photinia sp. DC. 扇骨木 Japanese Photinia (薔薇科 Rosaceae)

Pinus massoniana Lamb. 馬尾松 Chinese Red Pine (松柏科 Pinaceae)

Pinus spp. (many species) 松 Pine (松柏科 Pinaceae)

Pistacia chinensis Bge. 楷 (黃連茶) Chinese Pistachio (漆樹科 Anacardiaceae)

Pittosporum Tobira Ait. 海桐 Tobira (海桐科 Pittosporaceae)

Platanus acerifolia Willd. 篠懸木 Plane-Tree (篠懸木科 Platanaceae)

Platycarya strobilacea **Sieb. & Zucc.** 化香樹 (懷香) **Platycarya** (胡桃科 **Juglandaceae**)

Podocarpus neriifolia **D. Don.** 羅漢松 **Podocarpus, or Luhan "Pine"** (紫杉科 **Taxaceae**)

Populus nigra **L., var.** *italica* **Dur.** 美國白楊 **Lombardy Poplar** (楊柳科 **Salicaceae**)

Prunus armeniaca **L.** 杏 **Apricot** (薔薇科 **Rosaceae**)

Prunus Lannesiana **Wils.** 櫻花 **Japanese Flowering Cherry** (薔薇科 **Rosaceae**)

Prunus mume **Sieb. & Zucc.** 梅 **Japanese Apricot** (薔薇科 **Rosaceae**)

Prunus persica **Batsch.** 桃 **Edible Peach** (薔薇科 **Rosaceae**)

Prunus persica **Batsch. var.** 碧桃 (千葉桃) **Flowering Peach** (薔薇科 **Rosaceae**)

Prunus sp. 雪梅 **Wild Flowering Cherry** (薔薇科 **Rosaceae**)

Pterocarya stenoptera **C. DC.** 楓楊 (櫰柳, 元寶樹) **Chinese Wingnut** (胡桃科 **Juglandaceae**)

Punica Granatum **L.** 石榴 **Pomegranate** (安石榴科 **Punicaceae**)

Pyracantha crenulata **Roem.** 薛若 **Firethorn** (薔薇科 **Rosaceae**)

Quercus serrata **Thunb.** 櫟 **Oak** (山毛櫸科 **Fagaceae**)

Rhododendron spp. **(potted)** 杜鵑 **Azalea** (石南科 **Ericaceae**)

Rosa Banksiae **R. Br.** 木香 **Banksia Rose** (薔薇科 **Rosaceae**)

Rosa spp. **(many species)** 薔薇 **Rose** (薔薇科 **Rosaceae**)

Salix babylonica **L.** 柳 (垂柳) **Weeping Willow** (楊柳科 **Salicaceae**)

Sapium sebiferum **Roxb.** 烏臼 **Candleberry** (大戟科 **Euphorbiaceae**)

Smilax sp. 牛尾菜 **Catbrier** (百合科 **Liliaceae**)

Sophora japonica **L.** 槐 **Pagoda-Tree** (荳科 **Leguminosae**)

Sophora japonica **L. var.** *pendula* **Loudon** 盤槐 **Weeping Sophora** (荳科 **Leguminosae**

Spiraea Vanhouttei **Zabel.** 繡線花 **Spiraea** (薔薇科 **Rosaceae**)

Spiraea spp. 繡線花 **Spiraea** (薔薇科 **Rosaceae**)

Syringa vulgaris L. 紫丁香花 Lilac (木犀科 Oleaceae)

Syringa vulgaris L. var. *alba* West 白丁香花 White Lilac (木犀科 Oleaceae)

Thuja orientalis L. 側柏 (扁柏) Arbor-Vitae (松柏科 Pinaceae)

Trachelospermum jasminoides Lem. 絡石 Star Jasmine (夾竹桃科 Apocynaceae)

Trachycarpus excelsus H. Wend. 棕櫚 Windmill Palm (棕櫚科 Palmae)

Ulmus parvifolia Jacq. 榔榆 Chinese Elm (榆科 Ulmaceae)

Viburnum odoratissimum Ker. 珊瑚樹 Sweet Viburnum (忍冬科 Caprifoliaceae)

Viburnum tomentosum Thunb. 蝴蝶戲珠花 (蝴蝶樹) Wild Snowball (忍冬科 Caprifoliaceae)

Viburnum macrocephalum L. 大球荚蒾 Snowball (忍冬科 Caprifoliaceae)

Vitis vinifera L. 葡萄 Grape (葡萄科 Vitaceae)

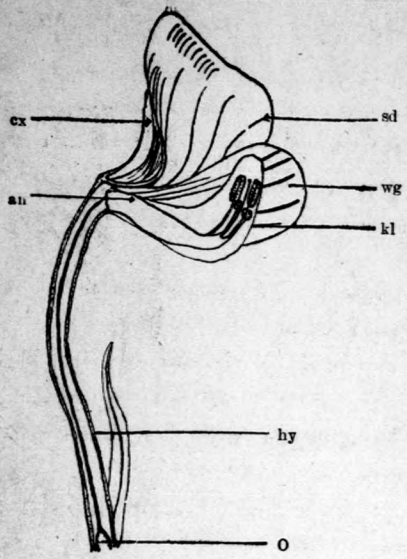
Wistaria chinensis DC. 紫藤 Chinese Wisteria (豆科 Leguminosae)

Yucca filamentosa L. 絲蘭 "Adam's Needle" (百合科 Liliaceae)

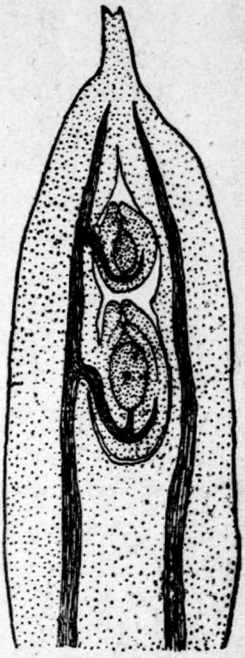
Zanthoxylum alatum Roxb. 花椒 Prickly Ash (芸香科 Rutaceae)

Zelkova sinica Schneid. 櫸樹 Chinese Zelkova (榆科 Ulmaceae)

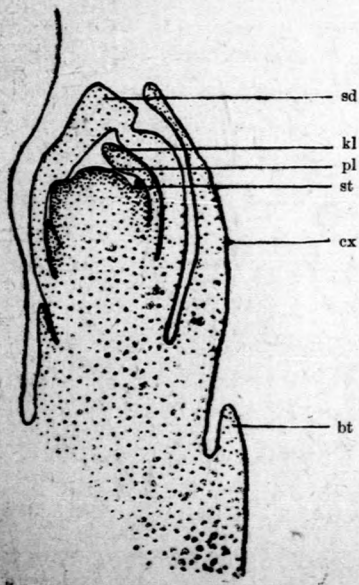
Zizyphus sativa Gaertn. 棗 Jujube (鼠李科 Rhamnaceae)



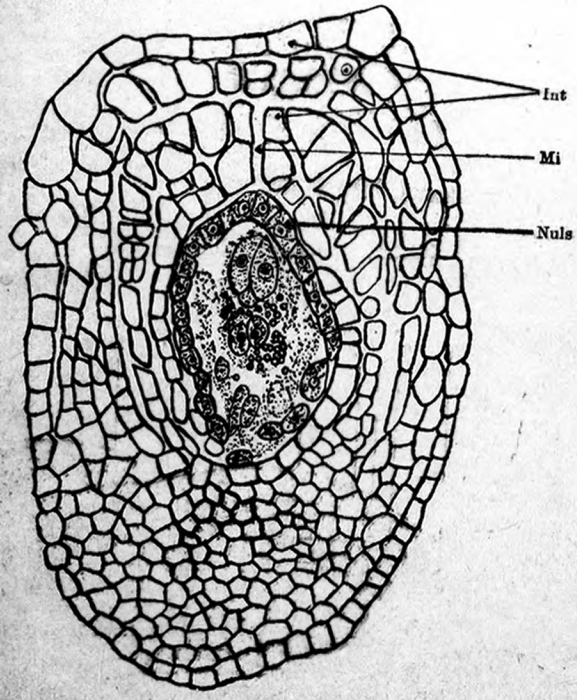
1



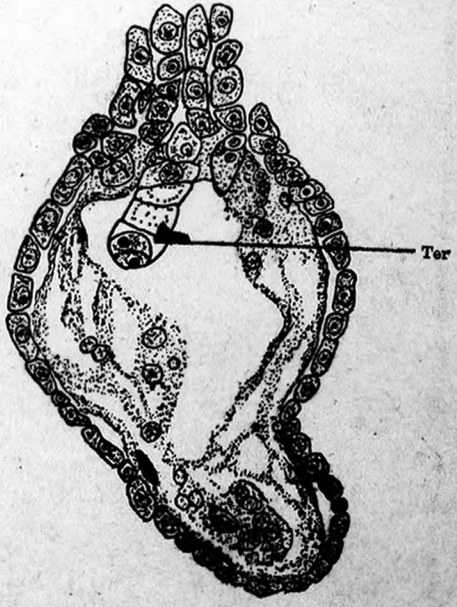
2



3



5



法學雜誌

八卷一期出版要目如下

價格

每册實洋三角五分定閱全年六册連郵二元

社址

上海嵩山路一四六號

分售處

上海會文堂　作者書社

民智書社　現代書局

大昌祥　上海雜誌公司

光華書局　蘇州東吳大學

文怡書局　南京正中書局

中央書局　安慶世界書局

天津大公報　北平佩文齋

太原覺民報社

蘇州東吳大學

生物材料處

創始 民國十三年(西曆一九二四年)。

宗旨 提倡國內生物學教育，供給及交換各種廉價適用生物標本及解剖採集等用具。

出品概況

(一)保藏標本——動物及植物，浸製或乾標本。

(二)玻片標本——各種微小生物，動物及植物之組織，胚胎，器官等全體裝片或切片。

(三)裝置標本——課室及實驗室指示用，動植物之發育史及解剖等標本，裝置玻瓶或玻面紙匣。

(四)骨骼標本——各種普通脊椎動物之骨骼，裝置木架或玻面紙匣。

(五)應用儀器——各式實驗，解剖，採集用具，玻璃片，擴大鏡等。

刊物

(一)兩月刊——中文及英文二種，溝通生物學教育界，登載各種關係生物學課程，實驗以及技術文字，徵求或交換標本，介紹書籍雜誌及本處新出品，按期寄贈海內外各學校生物學教員及科學機關。

(二)價目表——大學及中學兩種，函索即寄，

老豫泰

LOAU YUE TAI & CO.

GLASS BOTTLES AND WARES
MANUFACTURER

No. 256, A. B. North Shansi Road;
No. 377, Peking Road, Shanghai.

本號特聘高等工業技師設廠專製各種玻璃器械兼用煤氣細工精造化學用玻璃器皿以及一切量器出品優良價格公道

第一發行所 上海北山西路七浦路南二百五十六號

第二發行所 上海北京路三百七十七號

東吳學報

第三卷　第一期

生物專號

中華民國二十四年四月出版

編　輯　生物學會會員

編輯主任　尤　大　壽

廣告主任　陳　名　燮

發行者　蘇州東吳大學東吳學報社

印刷者　蘇州利蘇印書社