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編者言

園藝事業，可分爲生產園藝與觀賞園藝二種。生產園藝，如生產果實，蔬菜等，爲人生主要之食品；至國際貿易，園藝品亦佔重要位置。查吾國園藝品之輸出入，年額約一千五百萬海關兩，輸入爲九百萬海關兩，輸出爲六百萬海關兩。輸入之主要者爲罐頭，柑橘等果；輸出之主要者爲栗，胡桃，棗，柿，及其他乾果等。吾國地居溫帶，果品生產豐富，提倡大規模之栽培，對於國際貿易，極有希望。觀賞園藝係利用植物佈置自然風景，造園花卉，能調和人類生活，康健體格，啟發思想，以改進文化。故園藝與國計民生之關係，至大且巨，豈容忽視!?

近數年來，吾國各省大學農學院，均設有園藝專科；民國十九年復又成立中國園藝學會。近更蒐集園藝界同人之究研著作，編成園藝專刊，足徵吾國年來園藝研究之進步矣。惟此次編輯園藝專刊，係屬創舉，徵稿期間又短，蒐集全國名著，勢所不能。希望將來每年能刊行專號一册，則各界研究專著，專號之內容，始可日臻完善也。

民國二十三年八月編輯同人謹啓

本會出售書目

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中國柑橘栽培之歷史與分佈

金陵大學農學院園藝學研究室

胡昌熾

目　次

一　柑橘之種類與原產地

柑橘類包含之種類可大別爲枳殼屬 (*Poncirus*) 金柑屬(*Fortunella*) 柑橘屬(*Citrus*)等三屬，種類甚多。枳殼古名枳，枳殼者以枳之實爲藥，蓋藥名也。學名 *Poncirus trifoliata*, Rafinesque. 原產長江流域，安徽，江西，湖南，湖北，雲南，貴州，四川等處，樹甚耐寒，北限能在山東，河南，等處栽培。枳殼主爲綠籬用，在稍寒地方用爲柑橘接本。

金柑屬有數種，皆原產吾國，如金豆(*Fortunella Hindsii.*, Swingle.) 野生安徽，浙江，香港等處。金彈(*Fortunella crassifolia*, Swingle)，羅浮(*Fortunella margarita*, Swingle)在浙江穿山，黃巖，溫州栽培，圓金柑(*Fortunella japonica*, Swingle)在安徽，江西栽培，金柑屬主產於長江

流域。

柑橘屬包含之種類甚多，主產於澳洲以北亞細亞之南部，如印度，暹邏，緬甸，安南，馬來，喜馬拉耶山，菲律濱，中國，日本等處。金橘 (*Citrus microcarpa*, Bunge.) 馬來羣島原產，吾國廣東福建栽培，供爲柑類接本。橘類(Loose skinned orange group)之種類甚多，吾國普通所栽培者如早橘，本地早，日本柑(溫州蜜柑)，乳橘，無核早橘，橘(溫州產)，甜橘，酸橘等，性狀與 *Citrus tachibana* Tanaka 及 *Citrus nobilis*, Lour. 類似。其原產地大致爲中國及印度，暹邏，緬甸等地，漸次北進，而改良爲今日之栽培種。早橘，本地早，在浙江黃巖栽培，爲該地之主要品種。日本柑卽溫州蜜柑，爲日本產之主要種，古代由吾國傳出，改良爲無核種，今在溫州平陽，江西南昌，湖南長沙等處均有栽培，將來在長江南部最有希望。乳橘在溫州黃巖均產，江西南豐尤爲著名。無核早橘黃岩栽培，產量尙不多。橘，溫州產，種類甚多，該地均混稱爲橘。甜橘，酸橘，廣東潮州新會等處產，台灣亦有栽培。

紅橘類(Tangerines group) *Citrus tangerina*, Hort. ex Tanaka 如紅橘，福州產，今在浙江塘棲，江西，湖北，四川均多栽培，亦爲吾國柑橘之主要種類。朱橘又名朱砂橘 *Citrus erythrosa*, Hort. ex Tanaka. 產長江流域，在黃巖，江西，湖北特多。早紅江蘇洞庭山產，性狀與紅橘或朱橘類似。

柑類(Mandarin group)吾國栽培之種類甚多，現在普通所產者，有次記各種；有柑又名椪柑 *Citrus poonensis*, Hort. 印度原產，與該地所產 Suntara, keonla類似，現在潮州栽培最多；漳州亦產，名蘆柑，台灣，日本均有栽培，爲東方著名之柑橘。吾國之柑名，或由Keonla之音譯而來，既柑溫州栽培，古代之乳柑或指此而言。四會柑原產印度，暹邏，今在廣東四

會，番禺，新會最爲普通，亦爲東方之優良柑橘。蕉柑異名桶柑，俗呼暹邏蜜柑，是否暹邏原產，尚屬不詳，今在廣東潮州栽培最多，漳州產亦不少，，台灣亦有栽培，正月成熟可貯藏至六月。

甜橙印度原產 (*Citrus sinensis*, Osbeck.)在吾國發達最早，橙字古名榱，由印度之Naranj而來，橙由吾國傳至葡萄牙，而西班牙，始至英美；甜橙在吾國產種類最多，有柳橙，甜橙，香水橙，雪柑等種，主產廣東四會，新會，潮州等處。美國產之 Navel orange 現在浙江黃岩有少量栽培，民國初年由日本輸入。酸橙(*Citrus Aurantium*, Linn.)原產印度，現在栽培不多，僅作柑橘之接本用，黃巖柑橘接本之鈎頭橙，應屬酸橙一種，其他溫州栽培之朱欒，蘇州栽培採花加入茶葉香料用之代代，黃巖產之小紅橙，均屬酸橙類，在長江一帶產酸橙亦屬不少。

橙子類(*Citrus junos*,Sieb. ex Tanaka)原產長江流域，日本名之曰柚，ユズ與吾國之指欒爲柚，完全不同。橙子類有香橙，羅漢橙，在蘇州，杭州，普通栽培，香橙分佈甚廣，在長江上流雲南，貴州均多栽培。

柚(*Citrus granis*, Osbeck) 原產印度及馬來羣島，異名欒(漳州)，抛(溫州)，吾國如廣西容縣之沙田，廣東番禺，福建浦南，四川重慶等處，俗呼文旦者係浦南之文旦柚，品種之名誤傳爲種名。世界之柚產地首推暹邏盤谷，品種以無核之 Kao Panne pnmmelo 爲最。

美國栽培之 Grapefruit(*Citrus paradisi*)西印度原產，吾國尚未聞有栽培，每年由美國輸入之果實爲數不少。

枸櫞(Citron),(*Citrus medica*. Linn.)印度原產，枸櫞係譯音，或由印度Turunj轉譯而來，吾國在廣東福建栽培，供觀賞及藥用。枸櫞之變種佛手柑 (*Citrus medica*, Linn. var. *sarcodactylis*, Swingle) 在福建

及江浙栽培，完全爲觀賞用。

檸檬(*Citrus limonia*, Osbeck)廣東俗呼檸檬，係 Otaheite orange 之一種，原產印度，廣東栽培者有紅檸檬(檸檬)與白檸檬，後者與爪哇產之 Kusaie lime 同一種類。

Lemon (*Citrus Limon*, Burm.) 印度及喜馬拉亞山麓原產，在地中海沿岸栽培發達，大約在元朝輸入吾國，稱曰香檬，現在僅廣東有少量之栽培，每年 lemon 之果實由美，意，西班牙及日本輸入吾國。柑橘之種類，與原產地概如上述。

要之，柑橘之原生中樞，如印度地帶原產枸櫞 Lemon, 檸檬，甜檸檬(Sweet lemon) (*Citrus limetta*, Risso.)酸橙甜橙，Lime(*Citrus aurantifolia*, Swingle)，柚，*Citrus macroptera*, Montr., *Citrus hystrix*. D.C. *Citrus latipes*, Tanaka: *Citrus indica*, Tanaka, and Loose Skinned oranges. 中國地帶原產之柑橘種類，雲南地接印度及交趾中國，廣東福建，浙江，沿海岸及長江流域，均產柑橘植物*Citrus*屬者如 *Citrus junos*, Sieb. ex Tanaka產長江流域，*Citrus depressa*, affinis. 如紅橘，印度及吾國原產，*Citrus tachibana*, affinis, 如乳橘，早橘，乳橘，枳殼屬之枳殼 *Poncirus trifoliata*, Raf. 長江流域野生 *Fortunella* spp. 沿海岸地帶原產，日本地帶野生 *Citrus tachibana* Tanaka. 馬來半島及印度中國地帶原產者 *Citrus nobilis* Lour. (安南 Hae 地方) 馬來羣島，太平洋諸島地帶產 *Citrus macroptera*, *Citrus hystrix* 及 *Citrus aurantifolia* 等。其他栽培種類甚爲豐富。中國柑橘之種類，與原產地及栽培之分佈，可概括如次表：

中國柑橘之種類與原產地

類別	種名	異名	原產地	栽培分佈
枳殼屬	*Poncirus trifoiiatc*, Raf 枳殼	枳枸橘	安徽，江西，湖北，湖南，四川	長江沿岸
金柑屬	*Fortunella Hindsii*, Swingle. 金豆	山金柑	浙江黃巖，香港	浙江
	Fortunella crassifolia, Swingle 金彈	寧波金柑	浙江寧山，黃巖，溫州	浙江
	Fortunella margarita, Swingle 羅浮	牛奶金柑	浙江寧山，黃巖，溫州	浙江
	Fortunella obovata, Swingle 月月橘	長壽金柑，壽橘	浙江，福建	浙江，福建，江蘇
柑橘屬 金橘類	*Citrus microcarpa*, Bunge 金橘	四季金柑，唐金柑	廣東，馬來羣島	浙江，廣東
橘類	早橘	黃巖蜜橘	中國	浙江黃巖
	本地早	天台山蜜橘	中國	浙江黃巖
	日本柑	溫州蜜柑	中國	浙江，江西，湖南，日本
	乳橘	蒔橘，南豐橘	中國	浙江黃巖，溫州，江西南豐
	無核早橘		中國	浙江黃巖
	橘	溫州橘	中國	浙江溫州
	甜橘		中國	廣東
	酸橘		中國	廣東
紅橘類	紅橘	福橘	中國	福建，浙江，江蘇，江西，湖北，湖南
	朱橘	硃砂紅	中國	四川，長江流域
	早紅		中國	浙江塘棲，蘇州洞庭山
柑類	*Citrus poonensis*, Tanaka, 布柑	潮州蜜橘，椪柑	印度	廣東潮州，浙江溫州，福建漳州，日本台灣，
	Citrus suavissima, Tanaka 甌柑	乳柑	印度？	浙江溫州

	Citrus suhoiensis, Tanaka 四會柑	新會柑	印度？	廣東四會，新會
	Citrus tankan, Hayata, 焦柑	桶柑	暹羅？	廣東潮州，福建漳州，台灣
甜橙類			印度	中國，日本，西班牙，美國，
	Citrus sinensis, var. *brasiliensis*, Hort. ex. Tanaka 美國臍橙	美國甜橙	美國 Bahia	中國，日本，美國
	Citrus sinensis, Osbeck 甜橙	新會甜橙	中國廣東新會	廣東
	香水橙		廣東新會	廣東
	柳橙		廣東新會	廣東
	Citrus sinensis form Sekkan, Hayata 雪柑	廣橘	廣東潮州	福建漳州，廣東潮州，台灣
酸橙類	*Citrus Aurantium*, Linn.		印度	中國，日本，西班牙
	朱欒		浙江溫州	浙江溫州
	鉤頭橙		浙江黃巖	浙江黃巖
	小紅橙		浙江黃巖	浙江黃巖
	代代		中國，日本	蘇州，日本
橙子類	*Citrus junos*, Tanaka	香橙，柚	長江流域	中國，日本
	香橙	橙子	浙江，江蘇	浙江，江蘇
	羅漢橙		浙江，江蘇	浙江，江蘇
宜昌柑類	*Citrus ichangensis*, Swingle		中國宜昌	湖北宜昌
柚類	*Citrus grandis*, Osbeck	欒，抛，文旦	印度，馬來羣島	暹羅盤谷，廣西沙田，廣東番禺，福建浦南，四川重慶
	沙田柚		廣西沙田	廣西，廣東
	文旦柚	文旦	福建浦南	福建台灣

	平山柚		福建浦南	福建
	四季抛		浙江平陽	浙江平陽
	大紅抛		浙江平陽	浙江平陽
柚雜種	*Citrus grandis*, var *Shangyuan*, Hu 香圓		長江流域	浙江江岸
枸櫞類	*Citrus medica*, Linn.		印度	熱帶地方
	枸櫞	香櫞	印度	廣東，福建
	Citrus medica var *sarcodactylis*, Swingle. 佛手柑	佛手	印度	廣東，福建
檸檬類	*Citrus limonia*, Osbeck	東東檸檬	印度	廣東，菲島，馬來羣島
	紅檸檬		印度	廣東新會
	白檸檬		印度	廣東新會
檸檬類	*Citrus Limon*, Burm f.	香檬	印度及喜馬拉亞山麓	日本，美國，地中海沿岸

二　中國古籍所記之柑橘栽培歷史

柑橘之原產地已如前節所述，以印度最多，其次馬來羣島，希馬拉亞山麓，中國及日本等處。柑橘之栽培由南部漸次北進，柑橘之栽培歷史，在古籍所記者，可分栽培歷史與種類品種之傳佈，地方栽培歷史等，記述如次：

甲　中國柑橘栽培歷史

中國栽培柑橘，始自虞夏(2286—1158B.C.)以前，夏書禹貢 (2200B.C.)曰 厥包橘柚錫貢。春秋戰國之世識者益衆，屈原(343—290B.C.)取其貞介作橘頌，而以爲像。韓非以爲貪美嗅香之果。其他古籍如爾雅(1100B.C.)周禮(1122—249B.C.)呂氏春秋(呂不韋,237B.C.)等書率多記載。據山

海經(周秦時人作)記載，荆州，綸山，銅山，洞庭山，葛山多植橘櫾之木，可見古代栽培柑橘既早，而且廣也。

周秦(250—207B.C.)以後栽培漸盛，士大夫視爲佳果良木，朝廷草野目爲珍品，遠方錫貢逾千萬里，國君以宴人臣外使及餽贈，載諸古籍者甚多。晏子春秋曰："晏子使楚，楚王進橘置削，晏子併食不剖。"吳志：'吳王餽魏文帝大橘，帝詔羣臣曰，南方有橘酢正裂人牙，時有甜耳。其他散見傳記一類之書者，亦不在少數。柑橘在文學方面更有其可記之價值，橘頌而後，各代文人學者每發爲頌，贊，啓，表，傳，賦，詩，詞，讚美 佳果，或以頌揚遠方之貢，如晋郭璞之橘櫾贊，魏曹植橘賦，左思蜀都賦，漢無名古詩，白居易揀貢橘書情，宋蘇軾，浣溪沙，皆其著者。至宋(1178年) 韓彦直時且有橘錄專書，流傳於後，由是頗可以覘古代文化之一斑。

吾國柑橘栽培歷史起源于西歷紀元二千年以前，(禹貢2200B.C.) 漢時栽培稍盛，至唐宋而爲栽培極盛之世。以地方言，則江南一帶栽培柑橘最多，歷史屢爲錫貢之地，於古書中可以見之。如漢武帝(140—87B.C.)置交趾橘官，主歲貢御橘之事。唐德宗卽位詔令江南柑橘歲一貢，以供宗廟而停餘貢(見舊唐書德宗本紀)。唐書地理志曰：蘇州，杭州，溫州土貢柑橘，撫州土貢朱橘。宋王栐燕翼貽謀錄曰："承平時溫州鼎州，廣州皆貢柑子。"柑橘栽培利益甚厚，古代已重視之，如司馬遷史記貨殖傳(163—85B.C.)有曰："蜀漢江陵千樹橘，其人與千戶侯等。"唐張籍詩："江南人家多橘樹。"梁任昉述異記："越多橘柚園，越人歲出橘稅，謂之橙橘戶，亦曰橘籍。"足見古代種橘之多。尙有足記者，卽個人經營柑橘事業已有多少人注意，漢末李叔平遣客十人往龍陽州種柑橘千株，及其成歲，而家道富足，唐柳宗元，宋蘇東坡，范成大(見羣芳譜)亦爲嗜種柑橘諸人。

外此關于栽培方法技術及管理諸事，其可記者，茲復於下列述之

1，氣候及土宜　氣候對於栽培柑橘關係，古代已注意及之，周禮考工記(11B.C.)有曰："橘踰淮而北爲枳，"此地氣使然也。漢劉安著淮南子曰：'橘柚有鄉，橘凋於北徙，榴懷於東移，"蓋早知柑橘適於暖地。羣芳譜避暑錄話：謂橘偶歲大寒多雪，卽立槁，雖厚苫覆不能救，學圃餘疏(明代)亦曰 橘性畏寒，值霜雪稍盛卽死，惟洞庭間柑橘稍不畏霜，(見郭橐駝種樹書)柑橘宜於江河沿岸平坦之地。橘錄(宋韓彥直)謂宜栽于斥鹵之地，四邑皆距江海不十里者；浙，閩，粵橘所產，皆距江河甚近，足以爲證。

2，繁殖法　古代栽培柑多用實生法，及切接法，據徐光啓農政全書(1562--1633A.D.)便民圖纂所載，實生法者正月間取核撒地上，冬季搭棚，春和撤去，待長二三尺餘，二三月卽可移栽。切接方法比較普通用之，法見古籍者甚多，如廣羣芳譜別錄曰 "種子及栽皆可以枳樹截接，或貼接尤易成。"便民圖纂亦曰："金橘將枳棘接之，八月移栽肥地。" 廣羣芳譜橘錄載之尤詳，其言曰："取朱欒核洗淨，下土中，一年而長，名曰砧，淡其根蓁蔟蔟然，明年移而疏之，又一年木大，如小兒之拳，遇春月乃接，取諸柑之佳與橘之美者，經年向陽之枝以爲貼，去地尺餘，細鋸截之，割其皮兩枝對接，勿動搖其根，撥掬土實其中，以防水蓑護其外麻束之，其所用砧多枳或朱欒一類。"現在廣東甜橙繁殖均壓條法，有柑蕉柑均切接法，用金橘(Citrus microcarpa, Bunge)酸橘爲接本，黃巖接早橘，本地早均用鉤頭橙爲接本，吾國柑橘繁殖接本種類之研究，是爲重要問題。

3，栽植　栽植柑橘多擇面南之地，以距江河附近，而土肥者植之，種植時高者畦壟，溝以泄水，每株相去七八尺(見羣芳譜橘錄)，移栽時間八月爲多，並灌以糞水，近代之柑橘栽培距離宜寬二十至二十五尺，栽植宜

中宜置以堆肥，時應在秋季。

4，管理

中耕施肥　移植以後耕鋤甚勤，每歲約四次，務使不見雜草，冬天收實以後，每以泥及大糞培壅其根，或于十一月內將橘樹根寬作盤形，澆大糞三次，春旱更以水或糞水澆之，至夏天則更灌以糞壤，使其多結果實，古代栽培柑橘對於中耕施肥頗爲注意，

灌溉及排水　古代視灌溉排水頗重，春夏旱時多施灌水，以補足土中缺乏之水分，又於種時，挖溝以泄水，以免浸根等害事，見橘錄及其他古書。

預防霜害　霜雪害之預防，古代栽培柑橘者極其注意，且頗適合科學方法。其預防方法有三：(1)每歲大寒，則於土風焚糞壤以溫之（見羣芳譜避暑錄話）。(2)於西北或北種竹，以蔽寒風。(3)常年均搭棚以護霜雪，大抵年於霜降搭棚，穀雨卸却。樹大者則用鼈糠襯根，柴草裹其幹，或用蘆蓆寬裹根幹，鼈糠實之，其法雖至今日仍多沿用之者。

防治病蟲　病蟲害之防治古代亦甚注意，惟方法幼稚，智識發達不如今日，依韓彥直橘錄及草本典所載，計有蘚蠹二種，受蘚病者枝幹疊枯，蟲蠹之害則木心受病，枝葉凋枯，實瓣被蟲蛀食，其防除方法分別述之如下：

防除病害方法，古昔時代，枝上有苔蘚，生時用鐵器刮去，枝條過密，及不能花實遮蔽日光者，悉剪去之，俾其助新枝生長。防除蟲害方法，凡木間視有蛀屑流出，則鑿開蛀處，用鉛絲鈎取，蟲被取出後，即用眞杉木作釘塞其孔，或用硫黃和土塞其孔，又有謂用眞杉木塞其孔，則蟲自死者。

吾國柑橘病蟲到處甚多，如介殼蟲，天牛，黑點病，瘡痂病等，不勝枚舉，宜注意研究其防治方法。

採摘及收藏　採摘分二次，一曰摘青，採之重陽，柑橘未黃之際，二次則于經霜之二三夕盡剪，多在天氣晴霽之時，用剪就枝間平蒂切斷，乃輕置入筐筥中收貯之。

收藏多在室內行之，法先將室內淨掃，于四壁有縫處預行密糊，勿使透風，乃布以稻草，而堆置柑橘于地上，遇旬上卽翻轉一次，其受損傷者必須揀出，否則附近柑橘被侵損者必更多。此外尙有掘坎，將柑橘連枝條覆入土中，及貯藏于錫器內，而雜以芝蔴者，然此法用之不多。柑橘之採摘及收藏，爲販賣所極重要，採摘時期，方法與冷藏方法，均爲近代所需改良者。

乙　中國柑橘種類品種之傳佈

中國栽培柑橘種類，除枳，香橙，橘，金柑，原產中國外，其他自印度，馬來原產，栽培之歷史旣古，傳佈之情形稽考非易，茲就古籍所見，分述如次：

枳*Poncirus trifoliata*, Raf. 周禮考工記(1100B.C.)：“橘踰淮而北爲枳。”可見周代已知以枳爲橘之接本，而行嫁接矣，現在長江流域之柑橘尙多用枳爲接本。枳原產長江流域，安徽，江西，湖北，四川均多栽培，枳實供藥用，枝有刺，可作籬圍。日本之枳，由吾國傳去，栽培之柑橘均用枳爲接本。美國農務省W.T. Swingle至中國採集柑橘，以枳與甜橙交配，產生Citrange 之雜種，獎勵爲柑橘接本。枳實供藥用，曰枳殼，據紹興本草圖所記，有汝州枳殼與成州枳殼兩種，後者應屬*Citrus ichangensis*.

金柑屬 *Fortunella* sp. 金柑屬中種類甚多，栽培食用者，如金彈與雪浮爲佳。金柑屬植物原產于廣西，廣東，浙江，安徽之沿海岸。韓彥直橘錄(1178.A.D.)所記：“金柑比他柑特小，其大者如錢，小者如龍目。”金柑

由橘類分化而成，由古籍稽考栽培之歷史，恐在唐宋時代起始。歐洲之有金柑，由英人 Robert Fortune(1812年)至中國採集植物携歸後，由Swingle氏取其姓爲金柑屬之屬名。日本之有寧波金柑，在寬正十一年(1799由吾國之寧波帆船傳去，現在有少量之栽培。吾國金柑現在浙江穿山最盛，黃巖，溫州次之，果實主供蜜餞用。

金橘*Citrus microcarpa*, Bunge. 產馬來，吾國古籍上與金柑混稱，現在廣東潮州栽培，供爲柑橘接本，浙江溫州等均有少量之栽培。

橘類Loose skinned orange group 橘原產吾國，栽培至早，如夏書(2200B.C.) 周禮(1100B.C.) 均有記述，而現在中國橘之種類最多，而分佈最廣。韓彥直橘錄橘品凡十八種，現在廣東栽培之酸橘，甜橘；溫州產乳橘，橘；黃嚴產之早橘，本地早，乳橘；塘棲之蜜橘皆吾國原產。日本栽培之溫州蜜柑由吾國傳去，係溫州橘之一類，吾國橘之野生種尚待考查，將來發見，對於橘之進化，定多參考。

紅橘類Tangerine group 紅橘類中之種類，大別爲二系統，一、紅橘(*Citrus tangerina*, Tanaka)原產印度，現在主于福州栽培。二、朱橘(朱紅橘) (*Citrus erythrosa*) 在長江沿岸栽培最普通，係吾國原產。朱橘之記述見諸古籍者，如魏，曹植橘賦，陶宏景之名醫別錄 (452—536A.D.)，宋韓彥直橘錄等。

柑類Mandarin group 柑，齊民要術所記，郭義恭廣志 (502—551A D.) 曰：甘有二十一種，有成都平蒂甘(柑古作甘)，大如升，色蒼黃，犍爲南安縣出好黃甘，指四川古代產柑著名。周處風土記 (256—419A.D.)曰"甘橘之屬，滋味甜美，特異者也，有黃者，有赬者，謂之壺柑。"吾國產柑至早，柑原產印度，現在吾國所產之柑，可大別爲有柑，蕉柑，瓯柑，四會柑四

類。有柑與印度產之 Keonla, Suntara 類似，吾國之柑字或由 Keonla 譯音而來。羣芳譜所載，柑一名瑞聖奴（見清異錄，宋陶穀，天寶年(742—755 A.D.) 內中柑樹結實，帝日與貴妃賞御，呼爲瑞聖奴。）譯音類似。有柑現在廣東潮州產最多，福建漳州次之，台灣亦有，係福建傳去。有柑爲東方之最優良柑橘。蕉柑俗稱暹羅蜜橘，或由暹羅傳來，四會柑，甌柑皆非吾國原產，甌柑古名乳柑，自古著名，柑之分佈在南部爲多，其傳佈亦由南北進。

橙類 Orange group 通雅所記，橙一作榱，音 Chéng，印度原產，印度名此爲 Naranj, 吾國之橙或榱，由此音譯而來。橙在吾國自古栽培，在齊民要術中已有記述，唐書地理志曰："江陵府土貢柑，橙，橘，稗，巴州土貢橙，金州土貢橙，台州土貢橙。"至唐宋益爲發達，甜橙之傳入歐洲，係葡萄牙之僧侶來吾國傳教，在吾國南方携歸，最初 1848 年在葡萄牙之國都 Lisbon 之 Count de St. Laurent 園中栽培，後傳至西班牙而美國。橙中有甜橙，酸橙兩種，甜橙現主產廣東，有柳橙，香水橙，甜橙，雪柑等種。酸橙吾國種類甚少，在長江沿岸有一部分之栽培，蘇州產代代橙係酸橙一種，代代名稱之由來，尚待查考。美國之臍橙 (Washington Navel Orange) 原產南美 Bahia，民國十年前後，由日本傳入，今在黃巖，廣東，有少量之栽培。

橙子類 Citrus junos, Tanaka. 橙子日本稱此曰柚(ユズ)，係吾國古名，說文 (121A.D.) 所記，曰："柚條也，似橙實酢。"我國今日柚字用于 *Citrus grandis*, Osbeck. 日本則稱柚爲文旦，與吾國長江流域同，柚指 *Citrus grandis*, Osbeck, 亦相傳已古，見裴淵記(500A.D.)曰："廣州別有柚，號曰雷柚，實如升大。"橙子古名曰柚，吾國原產，在長江流域栽培，取其皮供糖漬用，味特香。日本近代以橙子爲接本，頗適於栽培柑橘之用，

橙子在浙江塘棲產者，有香橙，羅漢橙兩種。

柚類 *Citrus grandis*, Osbeck 柚印度原產，名 *Chakotra*, Matabbi, 在吾國柚之異名甚多，抛(溫州)，欒(Laun)(漳州)，文旦(長江沿岸)，名見閩產錄異，抛近入貢者，皆漳產，名文旦者，小旦文姓，種在長泰縣東，不過四五十樹。柚，馬來名 Usse, Ussi, 或由此譯音而來。柚名之沿用亦至早，裴淵記 (500A.D.) 曰："廣州別有柚，號曰雷柚，實如升大。" 廣志曰 (502—551A.D.) "成都有柚大如斗。"當指 *Citrus grandis*, Osbeck. 無疑。吾國柚之栽培，在西曆紀元五百年以前，現在產柚之著名區域，如廣西容縣，產沙田柚，廣東番禺產年柚，斗柚，蜜柚，橙柚等；福建漳州浦南亦爲吾國之著名柚產地，品種著名者爲平山柚，文旦柚等；溫州平陽蒲門產四季抛，品質之佳，大可注意，四川重慶亦以產柚著名。

枸櫞 枸櫞原產印度，名 Turunj, 枸櫞之名或由此音譯而來，在南方草木狀 (290—307A.D.)，最初記載，宋圖經本草記有枸櫞，又曰香櫞，浙江一帶栽有香圓，係柚之雜種，*Citrus grandis*, var, *Shangyuan*, Hu 長江沿岸亦有指枳殼與酸橙之雜種爲香圓者，Citron 應寫枸櫞，爲正確。吾國之有枸櫞由印度傳來，今廣東福建栽培，果實供玩賞及糖漬用。枸櫞之變種佛手柑。亦輸入種，在閩廣栽培，名見本草綱目，八閩通誌，及廣東新語(屈大均著1700年)等書。

檸檬類 *Citrus limonia*, Osbeck. 檸檬原產印度，異名宜母子，見南越筆記，大約宋代傳入，今在廣東栽培，黎檬見名實圖攷。

檸檬類 *Citrus Limon*, Burm. 檸檬印度及希馬拉耶山麓原產，發達於地中海沿岸栽培，吾國栽培至少，古書所記香檬，或爲今日之 Lemon 至早當在元代時傳入。

丙、中國地方柑橘栽培歷史

中國地方柑橘栽培歷史，可知栽培柑橘之發達原因與分佈之適應要素，爲研究栽培所需要之參考材料。茲就古農書，方誌，及著者實地訪問之材料，分別記述如次。吾國適宜栽培柑橘省分，計有廣東，廣西，雲南，福建，江西，貴州，湖南，四川，浙江，湖北，安徽，江蘇等十二省。

1. 廣東省　廣東自古栽培柑橘，在裴淵廣州記中，即載有廣州產柚，粵產柑橘，爲全國之冠，自古賦貢，如宋王栐燕翼詒謀錄："承平時溫州，鼎州，廣州皆貢柑。"又宋莊季裕雞肋篇廣州可耕之地方，民多種柑橘以圖利。今廣東之主要柑橘產地，如番禺，四會，新會，潮州等處，番禺縣記（李福泰：同治十年）有產柑，橘，金橘，香橼，黎檬等。

四會縣誌（光緒）記有四會柑得名最久，李時診本草綱目云，產四會者光滑，名漁凍柑。其他有茶枝柑，酸柑，柑，橙.中以柳橙爲最。橘，柚，金橘，明陶奭柑子苦詩序，縣產柑特佳，歲例供制府下，以及羣僚各有差，故輸柑一萬餘顆，新會縣誌記有甜橙，雹橙（有紋），香水橙，酸橙，柑，黎檬子等以產甜橙著名，主要栽培地若東甲，西甲，產橙最多，爲全縣之冠，鼠熊，長熊，馬熊，熊子塔附近，及梅江鄉等地則大宗產柑，外海鄉所產之橘亦極有名。

潮州潮陽縣誌（周恆重光緒10年）記產柑，橘，柚，香橼，橙，佛手柑等。今潮屬栽培柑橘範圍甚廣，潮安縣揭陽縣栽培最多，潮海，澄海二縣亦不少；潮安縣分四都，其產柑橘最盛之鄉，爲西林鄉，塔下鄉，山兜鄉，沙溪頭，古樓鄉，鶴巢鄉，銀湖鄉，前隴鄉，內地鄉，高廈鄉，龐溪鄉，大寨鄉，孫厝鄉，高厝鄉，橫隴鄉，高石鄉等處，產柑之處，皆沿小溪平坦之地，每年產柑約五百萬元，爲吾國主要柑橘生產區域。

2. 廣西省　容縣沙田產沙田柚著名，其他，柳州，梧州，等處亦種柑

橘。

3. 雲南省　自古栽培柑橘，惟史籍之記載不詳，產橘，柑，香櫞，佛手柑，黃果等。張詠雲南風土記，黃果大如柑，產浪穹縣者佳。

4. 福建省　閩爲古代橘柚錫貢之地，所產柑橘自古著名，古今圖書集成，草木典，閩書，曰："近時天下之柑，以浙之衢州，閩之漳州。" 今之主要產地爲福州漳州，福州在南鄉，南嶼，南港，各地產紅橘爲大宗。龍溪，漳浦，南靖等處產盧柑，桶柑，紅橘，浦南產柚，爲東方之著名產地。

5. 江西省　產柑橘自古著名，方誌記載，如乳柑，各處出，豐城白州最佳，產地如建昌，南豐，南城，贛州；南豐蜜橘卽乳橘一類，在江西最爲著名。

6. 貴州省　黔省產柑橘，在誌載甚詳，貴陽，永甯，黎平均產柑橘，栽培品種誌籍所記，如公孫橘，壽星橘，獅頭柑，佛手柑，橙，香櫞，枳殼，蜜筩柑，柚等，種類之多，大可注意。

7. 湖南省　柑橘栽培，歷史至早，見之古著者，如淵鑒類函所記，唐太宗蓬萊殿九日宴羣臣，賜湖南新橘。山海經洞庭之山，其木多柤梨，橘，櫾，雲麓之漫抄洞庭湖多柑橘；唐地理誌，朗州土貢柑等，洞庭產橘自古著名。

8. 四川省　四川亦自古產柑橘，廣志 (502—551A.D.) 曰：甘有二十一種，有成都平蔕，柑大如升，色蒼黃，犍爲南安縣出好黃甘。足證四川古代產柑著名。四川產柑橘之地，如重慶府，保甯府，順慶府，敘州府，夔州府 龍安府，嘉定府，潼州，瀘州，資州，綿州等，四川之柑橘歷史之早，種類之富，吾人大可注意。

9. 浙江省　浙江產柑橘已有千數百年之歷史，以溫州，衢州，杭州，台州生產爲最。王世懋果疏(見圖書集成1726年)曰："柑橘產于洞庭，然終

不如浙溫之乳柑。"宋韓彥直橘錄，略曰："橘東出蘇州，台州，西出荊州，南出閩廣撫州，皆不如溫州者爲上也。"浙江栽橘似于唐宋時代起始發達。

溫州　溫州產橘，詳見宋韓彥直橘錄，品種以眞柑卽乳柑最爲著名，日本溫州蜜柑卽以溫州橘類所改良。橘錄所記，柑之品類有乳柑，生枝柑，海紅柑，洞庭柑，朱柑，木柑，甜柑。橘有黃橘，塌橘，包橘，綿橘，荔枝橘，軟條穿橘，油乳綠橘，乳橘，自然橘，早黃橘，凍橘等。金柑，羅浮，金橘，朱欒，香欒，香圓，枸橘者。溫州柑橘栽培之發達，當在唐宋時代，今則出產不如浙江之黃巖矣。

衢州　衢州亦產柑橘著名，宋樂史著太平環宇記，內有衢州土產橘。又宋景祐年趙清獻在衢州詠橘詩，已欣懷袖滿，仍覺齒牙寒。又南宋陸游道柯山上詩，柯山在衢縣東南，有午酌金丸橘等，足徵衢州產橘在唐宋時代已甚發達。衢州栽培柑橘，易受寒害，故現產量不多，主要品種爲朱橘類，其他有福橘，廣橙，拋等。

杭州　杭州產橘，以塘棲著名，塘棲誌中，譚古瑯鴛鴦湖櫂歌曰："秋來蜜橘自塘棲，露冷微霜烏夜啼，帶至南亭香未改，勝傳柑子鳳樓西。"塘棲柑橘栽培之發達，當亦在唐宋時代，栽培品類，有朱紅橘，福橘，蜜橘，假蜜橘，洞庭紅，早紅，橙子類有香橙，羅漢橙等。

台州　台州產橘首推黃巖，今年產百數十萬元，爲浙江之冠，在赤城誌中，詳記柑橘物產，黃巖柑橘起源，當在唐宋時代，近因與上海交通關係，柑橘生產益爲發達。

10. 湖北省　湖北產柑橘記錄甚古，呂氏春秋(呂不韋 237B.C.)：果之美者有雲夢之柚，栽培種類之多，亦非他處所及。山海經云：荊山其木多橘櫾。湖北產橘之地，首推宜昌，品類有秀柑，大柑，獅頭柑，乳柑，黃柑，

支縣柑，宜多柑，香柑，蜜羅。橘有牛奶橘，壽星橘，公孫橘，金橘等，其他有佛手柑，橙，柚等。

11. 安徽省　安徽產橘不多，南部有少量栽培，婺源野生金豆 *Fortunella japonica*, Swingle.

12. 江蘇省　蘇州洞庭山產橘，栽培歷史亦發達於唐宋時代，如白居易揀貢橘書，書情："洞庭貢橘揀宜精，太守勤王請自行，珠顆形容隨日長，瓊漿氣味得霜成，登山敢惜驚駘力，望闕難申螻蟻誠，詩賤無由親跪獻，願憑朱實表丹忱。"栽培品類有綠橘，平橘，蜜橘，金柑，金豆，橙子，香圓，多由長江上流傳來。洞庭山多湖南移民，柑橘種類之傳來，與湖南不無關係，現產早紅，橙子，香圓，每年甚多，亦爲洞庭山之大宗出產。

以上所述，吾國十二省柑橘栽培史，可知南部之廣東，中部之湖北，湖南，自古發達。南部之栽培種與印度，馬來交通至有關係。中部之栽培種，多數由吾國原產之橘。柚(橙子)，枳，金柑進化而成。吾國柑橘栽培之早，與文化固有關係，地理要素亦爲主要原因，吾國地接印度交趾，同時自國亦野生柑橘，故沿海岸，珠江流域，長江流域，洞庭湖等處，爲世界柑橘生產發達最早之區域也。以歷史與地理之關係，改良吾國柑橘生產事業，應注意栽培大宗生產及販賣之經濟組織。

三　中國栽培柑橘之種類與分佈

中國栽培柑橘之歷史既古，種類亦富，種類名稱相傳已久，往往有誤用之者，例橙子古名柚，說文所記，指*Citrus junos*, Tanaka. 而言；今之柚指 *Citrus grandis*, Osbeck 而言。金柑(*Fortunella sp.*) 有書或曰金橘，但金橘溫州潮州指*Citrus microcarpa*, Bunge. 而言。香櫞或曰香圓，

枸橼同物異名，往往難于辨別。黎檬(Otahite orange)古名宜母子，廣東栽培誤認爲檸檬。代代(*Citrus Aurantium*, L.)之名不知何來，未見古籍所載。柑橘因栽培歷史之久，種類之多，種類之區別，傳誤至多。著者研究柑橘分類，茲就古籍所記，與實地考察所得，研究中國栽培柑橘之種類與分佈如次：

(一)枳殼屬

枳殼 *Poncirus trifoliata*, Rafinesque-Schmaltz in Sylva Telluriana p. 143,1838 (註1)

異名　枳殼(本草綱目，名實圖考)，枳(周官考工記)，枸橘(俗稱)

分佈　枳殼原產吾國長江沿岸，在貴州，四川，湖南，湖北，安徽，江西浙江，江蘇，福建均栽之。日本由朝鮮傳去，朝鮮在濟州島及對馬有半野生化之枳殼。歐美由吾國傳去。

性狀記載　枳殼樹小，圓形而落葉性，小枝多刺，葉爲複葉，由三枚小葉集生而成，花芽着生于一年生枝，花先葉開展，花梗甚短，殆僅于無一葉腋着生一花，或數花，花瓣狹長，花絲基部雜生，子房外面有毛。內部心室有6—8，果實球形甚小，大小縱徑2.0×橫徑 2.3cm 果皮暗黃色，表面有柔毛，油胞不顯著，有特種香氣。種子多，每果實中有三十餘粒，每室數粒，形卵形，先端尖，基部圓，子葉白色，胚單胚或多胚性。

用途　果實藥用，有去痰 利尿，發汗，消化之能，長江流域用枳殼樹爲籬圍，用枳殼爲柑橘接本，性能耐寒，穿山金柑均用枳殼爲接本。

枳殼之變種　枳殼中有一種飛龍，枝葉均短小，學名 *Poncirus trifoliata, Raf*, var. *monstrosa*. Swingle.枳殼與甜橙之雜種曰 Citran-

(註1)順序：漢名，　(屬名，種名，著者名)。原記文典書名。頁數或圖數，出版年號。

ge, Citrange 與金柑之雜交種曰 Citrangequat. 皆美國 Swingle 氏與 Webber 氏育成之雜種，適宜爲柑橘接本之用。

(二)金柑屬

金柑吾國特產，野生沿海岸，如浙江，福建，廣東，廣西均有之，主要種類有金豆，野生浙江，香港，廣西等處。山金柑野生安徽，羅浮，金彈在浙之穿山，黃巖，溫州栽培著名。壽星橘產浙江，福建，廣東，在江蘇揚州花圃亦有；長葉金柑產廣東汕頭與海南島。

金柑屬之特徵與金柑屬之分類

Genus Fortunella 之特徵，據 W.T.Swingle 之記載，灌木或小喬木，嫩枝有稜，老枝圓形，葉腋在芽之一側，有刺或缺，葉單葉稍厚鈍頭，有時先端凹入，基部鈍形或圓形，葉脈表面明瞭，底面不明，下面淡綠色，密生油胞點，葉柄爲狹翼葉。花在葉腋單出，或少數叢生，兩性由五數而成，少數爲4,6,7,花蕾小形，長8—10mm.斷面成多角形，瓣片5，少數4或6 白色，銳頭，長8—12mm.雄蕊18或20本，或不規則之束狀而合着，花絲雖闊，先端漸尖，雌蕊生在花盤上，子房球形，3—7室(通常3—6室)，各室側立胚珠2，花柱比子房短，有時比柱頭亦短，柱頭頭狀，左右整齊，果實小，形長徑，18—35mm.直徑 15—25mm. 卵形乃至球形，外皮厚，多肉而香，有甘味，藏多數埋沒之油胞，心室3—6，少數爲7。汁胞少，紡綞形或稍圓形，有柄，含有酸汁。種子外形卵形，平滑，胚綠色，發芽有地下性之子葉，初葉廣卵形，無柄對生如柑橘。

金柑屬與柑橘屬之異點：

1， 子房室數與花瓣數等，或少 (3—5少數6—7)，不若柑橘之數多 (8—18)。

2，子房室中之胚珠2個側立。

3，柱頭內部有少數深凹大形裂縛之油腺細胞，組織疏鬆。

4，葉之裏面淡色，葉脈不顯，有甚多小而深色之油胞點。

5，果皮甘可食，有若干之肉瓤質。

6，花蕾小，形少成多角形。

金柑屬種之索引

據田中長三郎氏所編金柑屬種索引表如次：

(1)果實球形直徑 25mm. 以內，普通約 20mm.心室數4—5,球形，外皮薄，花小形，花蕾長5mm.內外。

(2)果實直徑10—15mm.球形，心室3—4……*F. Hindsii*

(2)葉極小，長7cm.以內……*F. japonica*

(2)葉極長，長 15cm. 以上……*F. polyandra*

(1)果實直徑20mm.以上，普通倒卵形，乃至長倒卵形，近似球形，有時基部稍狹；心室數5—7，外皮厚，花稍大，花蕾長7mm.左右。

(2)果實長倒卵形，直徑約20mm.葉長形，往往達10cm.以上

……*F.margarita*

(2)果實廣倒卵形，直徑25mm，以上，葉不長大，5 cm.內外

(3)果實基部甚狹窄，果頂部稍廣凹入，葉廣倒卵形，極闊，長爲幅之倍以下，頂端圓形，乃至鈍形。……*F. obovata*

(3)果實基部不狹窄，而帶圓形，果頂不凹入，葉橢圓形，長爲幅之倍以上，頂端尖……*F. crassifolia*

1，金豆(本草綱目)

Fortunella Hindsii, Swimgle in Wash. Acad. Sci. 5(5):172,

1915 Syn. *Sckrostylis Hindsii,* Champion in Hooker Journ. Bot. 3: 327,1851。

異名　山金柑，山金橘(韓彥直橘錄)

分佈　本種分佈廣西，廣東，福建，浙江等處。

性狀記載　樹形小，叢生性，枝上多短刺，葉卵橢圓形，兩端尖圓，果實甚小，圓形，如大豆大。瓤囊三四瓣，果肉果汁近無，種子三四粒，膨而卵形，子葉綠色，果實不堪食用。

2，圓金柑(胡昌熾，果樹講義)

Fortunella japonica, Swingle. in Wash, Acad. Sci. 5(5): 172 1915 Syn. *Citrus japonica,* Thunberg. *Kaempferus Illustratns* in Nov. Act. Upsal. 3:110, pl31, 1741

異名　金橘(本草綱目)，楾(羣芳譜)，日名 丸金柑

分佈　安徽，江西

性狀記載　葉小，長橢圓形，兩端稍尖，上部鈍尖而圓，下部尖而銳，葉柄不短，葉底面乾後呈黃金色，葉脈呈廣角度，有刺短而銳，花甚小，長約5mm.瓣片不甚開張，線狀，長橢圓形，銳頭，大小7×2mm.表面默少，蕚裂片淺，三角形而平滑，周緣有纖毛，後成腺，果實外皮肉質，果肉粒狀有5—7室，如櫻桃大。

3，金彈(黃巖縣誌，溫州誌)

Fortunella crassifolia, Swingle. in Wasb. Acad. Sci. 5(5):172 1915

異名　金柑(韓彥直橘錄，王象晉羣芳譜，李時珍本草綱目)

日名　甯波金柑

分佈　主要產地爲浙江溫州，黃巖，穿山，以穿山尤著名，穿山栽培區域及面積，據潘劍帷氏民國十九年之調查，穿山以河頭，崑亭，三山，蕊岙，合岙等處爲多，面積約計五千畝，栽培地勢皆山麓。栽培種類有金彈，羅浮，金棗等，江西亦產金彈，早見古籍，如宋韓彥直橘錄所記，金柑出江西，北人不識，景祐(1034年)中，始至汴都，因溫成皇后嗜之，價遂貴重，今產地在臨川，金溪，遂川爲著名。歐洲之有金柑，十八世紀英人 Robert Fortune 氏來中國採集植物傳去。日本稱金彈曰寧波金柑，因在寬正十一年(1799)甯波船渡航日本，停泊靜岡三保地方，同地柴田孝太郎氏得此果實，播種養苗，而傳佈各地也。

性狀記載　樹矮性喬木，或灌木，有時無刺，有時有 3—10mm, 之短刺，小枝瘦長，直徑2.5—5.0mm. 新梢有稜，暗綠色，葉披針形，或卵狀披針形，4—9×1.5—4cm. 兩端收縮緩或急，尖端突出，圓形者甚少，基部楔形，有時爲闊圓形。葉緣中部以下無缺刻，有時尖端亦全緣，普通$\frac{1}{3}$—$\frac{1}{2}$，微有鈍鋸齒，葉厚硬，在中肋呈V或U狀，表面有光澤，暗綠色或黃綠色，葉脈不明，裏面青白色，油胞腺暗綠色，無數散在，似葉脈，葉柄長7—10mm. 基部帶圓筒狀，直徑1—2mm.先端有狹翼，闊2.5—4.0mm.花在葉腋生一二朵，萼最初尖端爲5裂片，後斷面帶五角形。果實倒卵圓形，2.5—3.5×2.5—2.8cm.一室內種子有一二個，5—7室，亦有無種子之心室，種子廣橢圓形，先端突出有縐紋，單胚或多胚綠色。

4，羅浮(溫州府誌，永嘉縣誌)

Fortunella margarita, Swingle. in Wash. Acad. Sci 5(5):172, 1915 Syn *Citrus margarita,* Lour. in Flora Cochinchinensis 2: 467. 1790

異名　牛奶金柑(汝南圃史)，金橘(花歷百詠)，橘橘(宣州府志)牛奶橘(湖北通誌)。

分佈　羅浮爲溫州地名，在溫州產特多，其他黃巖，穿山，江西，長江上流各地均有栽培。

性狀記載　羅浮樹小，圓形，枝密生，節間短，葉對生，長橢圓形，先端尖，基部圓形，葉緣有波狀鋸齒。六月下旬開花，果實長圓形或長倒卵形，大小 3.1×1.9cm. 果重 10gm. 先端圓形，基部稍尖，果梗細而綠色，萼 5 片，萼片圓形。果實滑澤，呈黃金色，油胞密生而大，圓形，而平生果面或凸出，果皮厚有特殊香氣，瓤囊五瓣，長圓形，心皮厚柔而白色，中心柱甚小。果肉黃金色，汁胞短而膨大，成卵形，果汁無色，汁多，稍有酸味，品質佳良。種子四粒，或有無核果實，卵圓形，子葉濃綠色。Chalaza 紫色，單胚，果實十二月中旬成熟。

用途　品質不如金彈，用途與金彈同。

5，月月橘(溫州)

Fortunella obovata, Tanaka, in 支那台灣柑橘調查報1919年

異名　長壽金柑(福州)，壽橘(南京)，壽星橘(湖北通誌)

分佈　溫州，福州，漳州，揚州花圃

性狀記載　盆栽品種形小，葉橢圓形，或倒卵形圓，先端圓，基部稍尖，全緣無缺刻。花小，萼帶紫色，果實倒卵形，頂端凹入，基部稍尖，大小兩徑均 3.1cm. 果皮淡黃色，厚 1.5mm. 甚薄，有金柑香味，油胞大，稍凸出，瓤囊八瓣，種子少僅二三粒，卵形，子葉綠色，多胚性。

用途　觀賞用

6，長葉金柑(柑橘研究 Vol. 6, No. 1933)

Fortunella polyandra, Tanaka, n. Comb. in Studia Citrologica Vol. 6,no.1, 1933

Syn. *Atalantia polyandra,* Ridley. Fl. Malay Penn. 5:295,1925

Fortunella Swinglei, Tanaka in Bull. Soc. Bot. France, Ser 5,4: 714 1928

分佈　汕頭,海南島

性狀記載　無刺無毛之灌木,小枝平滑,葉柄垂生稜形,葉薄革質,單生,小葉披針形,鈍銳尖頭,基部狹窄, 主脈纖細,約十對。葉大小14.5×4.5cm.或13.5×4.5cm. 葉柄長 1.8cm. 上方有葉翼,花少數,普通葉腋有二朵,小梗8mm.萼裂片五,卵形,銳頭短。花瓣五,線狀,長橢圓形,鈍頭。雄蕊24,成筒狀癒合,花藥卵形。子房在花盤上,長橢形,多腺, 有3—5室; 花柱短粗,柱頭長橢圓,而成棍棒狀,有5肋起,果實球形,直徑1.5cm. 有3—5室,果皮薄,有多數大油胞。

(三)柑橘屬 *Citrus*

1, 金橘類 *Citrus microcarpa,* Bunge.

金橘 (溫州,潮州,羣芳譜)

Citrus microcarpa, Bunge in Memorie de la Academia Imperial Pour Savant Etrangers de st. Petersbourg. 2:84, 1833

異名　四季橘(漳州,台灣)唐金柑(日本)

分佈　廣東,福建,浙江,均有栽培,台灣,日本亦產之。

總說　金橘與金柑不同,瓤囊有十五瓣,果肉橙黃色。

性狀記載　金橘樹性半圓形,枝屈曲密生,葉長橢圓形,兩端鈍尖:葉緣有波狀鋸齒。果實扁圓形,大小2.05×3.225 cm.果重 15gm. 兩端凹入,

基端有肋起，果梗纖細綠色，萼有5裂片，圓形，果面滑澤，果皮朱紅色，油胞數多，細小圓形，多數凹入，皮厚0.2cm.甚薄，有臭味，瓤囊15瓣，小而腎臟形，果心大而成空洞。果肉橙黃色，汁胞紡錘形，短小，果汁淡橙黃色，多汁，酸味强，品質不良，不堪生食，種子18粒，卵圓形，種皮白色。子葉淡綠色。Chalaza 淡褐色，多胚性。

標本採集地　溫州山脚門外清明橋，四明公所庭內

用途　在廣東潮州用金橘爲有柑接本，盆栽觀賞及果實製金橘餅用。

2，　橘類Loose skinned orange group

橘類在吾國栽培之品種甚多，大概由吾國原產之橘(Citrus tachibana, Tanaka)及印度中國原產之 King orange (Citrus nobilis, Loureiro)種進化而來。故橘類尙可分出多數之系統，甚難以一二種名包括數多之種。茲先就著者在實地調查，及古籍，方誌，所見之橘類品種分記如次，再論其性狀及區別。

廣東省　化州仙橘(廣東通誌)，金橘(潮陽縣誌)(仁化縣誌)硃砂橘，金橘(番禺縣誌)，枝橘(冬紅橘或大紅橘)，硃砂橘，塔橘(溫文光，柑橘類果樹栽培改良法)，甜橘，酸橘(海陽縣誌)。民國十八年廣州柑橘展覽會，有下記橘類出品：紅橘，塔橘，硃砂橘，大年橘，甜橘，大硃砂橘，花通橘，酸刺橘，小年橘，年橘，甜硃砂橘，金橘，橘仔，酸橘，年晚橘，酸硃砂橘，青橘，冬紅橘，曲水橘，晚年橘等。

雲南省　橘(雲南府誌)

福建省　公孫橘，四時橘(漳州府誌)

江西省　金橘，蜜橘，朱橘(江西通誌)，遲紅，黃皮橘（宋邵三湖柑橘調查紀要)

貴州省　公孫橘，壽星橘（貴陽縣誌）

湖南省　丹橘，遲紅（湖南長沙來標本）

四川省　橘（四川通誌），橘柑（銅罐鄉產），（四川農業第一卷第一號）

浙江省　橘，蜜橘（浙江通誌），朱橘，綠橘，獅橘，豆橘，漆蝶紅橘，金扁橘，（撫州，衢州府誌），大紅，遲福橘（蔣芸生：浙江之柑橘，衢州）黃橘，塌橘，包橘，綿橘，汁橘，荔枝橘，軟條穿橘，油橘，綠橘，乳橘，自然橘，早黃橘，凍橘（韓彥直橘錄），橘，金橘（溫州），朱橘，本地早，早橘，槾，乳橘，黃皮橘，狗橘，本地廣橘（黃巖），朱紅橘，福橘（卽紅橘），蜜橘，假蜜橘，洞庭紅，早紅（塘棲），（見胡昌熾浙江省柑橘調查報告）。

湖北省　橘，公孫橘，金橘（湖北通誌），金錢橘（宜昌府誌）。

江蘇省　綠橘，平橘，蜜橘，洞庭紅（江南通誌）。

化州橘產廣東化州，製橘紅爲藥材。

金橘指*Citrus microcarpa*, Bunge.而言，少數書籍認爲金柑。

橘類品種說明：

(1)蜜橘（塘棲誌，羣芳譜）

產地　浙江塘棲

總說　塘棲蜜橘自古著名，見譚吉璁鴛鴦湖櫂歌。本種果實與乳橘(*Citrus kinokuni*, Hort. ex Tanaka)類似。

性狀記載　標本採集地：浙江塘棲上河堤沈叙才產。樹性開張，枝密生，葉橢圓形，兩端尖，葉緣有淺鋸齒缺刻，短枝之葉狹而小。果實扁圓形甚小，2.5×3.3cm.果重17.9gm.先端凹入，基部圓形，果梗細而綠色，萼小分五裂片，尖形，果皮光滑，橙黃色，油胞密生，圓形，果皮易剝，甚薄。橘絡少而白色，瓤囊十瓣，腎臟形甚小，囊皮薄，中心柱小而充實，果肉深橙

色，汁胞紡綞形，小而膨大。果汁橙黃色，汁多甚甜，肉易化，有香味，品質甚優，惟果實小爲缺點。種子甚少，有二粒，形卵橢圓形，子葉綠色，Chalaza淡褐色，單胚。

在塘棲產有一種，名假蜜橘，與蜜橘同，惟味酸爲異耳。

(2)乳橘 （韓彥直橘錄，黃巖縣誌）

Citrus kinokuni, Hort. ex Tannka in Mem. Tan. Cit. Exp Stat. (11):29, 1927

異名 時橘(黃巖)，金錢蜜橘(上海)，蜜橘(南豐)

日名 紀州蜜柑

分佈 浙江溫州，黃巖，江西，南豐，日本九州一帶，宜昌之蜜橘或屬此類。

性狀記載 標本採集地，黃巖南門外西林園五號樹。樹開張性，內部枝梢密生，長梢之葉長橢圓形，狹而長，大小 6.3×2.85cm. 兩端尖，葉緣有波狀鋸齒，翼葉不明。枝上有短刺，短梢之葉長橢圓形，小而狹，兩端尖葉緣有波狀缺刻。果實小，扁圓形，頂端稍凹入，基部圓，稍成肋起，果梗細而綠色，萼小，萼片5瓣，尖形，果面粗而有皺紋，油胞圓形，凹生，果皮黃色，厚 0.175cm.甚薄易剝。瓤囊有十一瓣，形小成腎臟形，心皮厚而柔軟。果心小而空洞，果肉橙黃色，汁胞紡綞形，短而膨大。果汁橙黃色，多汁富甘味，種子少僅數粒，形紡綞或倒卵形，種皮灰白色，子葉綠色，Chalaza紫色，品質雖佳，果實小爲缺點。

(3) 早橘(黃巖縣誌)

Citrus nobilis var *subcompressa,* Tanaka. in Memoirs of Tanaka Citrus Experiment Station. 1(1)1927

異名　黃巖蜜橘(上海)

分佈　浙江黃巖,年產六七十萬元。

總說　本種主在黃巖地方栽培,日本之溫州蜜柑與此類似,或與早橘同一系統,本種早熟,豐產爲特點。

性狀記載　標本採集地　黃巖南門外西林園。

樹直立性,新梢發育旺盛,結果枝不彎曲,而直立。長梢之葉橢圓形,兩端皆尖,有淺波狀缺刻,葉脈,中肋皆不明。果實扁圓形; 大小4.45×5.50cm.重76gm. 先端圓而凹入,基部圓而肋起,果梗粗而綠色。萼片五瓣,尖形,果面平滑,果皮橙黃色,油胞圓形,小而密生,果面無凹凸。果皮厚0.225cm.薄而柔軟。瓤囊十瓣,凹月形,兩端圓.心皮强靭,白色,果心大而有空洞,直徑1.87cm.果肉橙黃色,多汁味甘,微酸,品質中,種子多,十七粒,卵圓形,灰白色,子葉綠色。Chalaza淡紫色, 多胚性, 果實十月至十一月成熟。

(4)　無核早橘

總說　果實近似早橘,因無種子,故名無核早橘。

性狀記載　標本採集地　浙江黃巖西門外大樹下牟則沛家產。

無核早橘調查之壽齡約四十年生,高4.5m.幅4.5m.樹性開張,枝條疏生,强而直立,葉橢圓形,兩端鈍尖,葉緣有淺波狀缺刻,葉脈突出。五月上旬開花,結果枝長 1.64—6.35cm. 花普通單生,亦間有一花序四花者, 花蕾長圓形,花瓣卵形,開展性,花梗長0.58cm 雄蕊18本 長0.66cm.雌雄蕊同長,柱頭圓形,果實扁圓形,大小 2.72×4.15cm.果重 34gm. 先端凹入,基部圓而肋起,果梗細而綠色。萼片五瓣,綠色圓形,果面平滑,油胞小,圓而平生,果皮厚0.125cm. 薄而柔。瓤囊十瓣,心皮薄而强靭,果心大而空洞,汁胞紡錘形而膨大,果汁橙黃色,多汁,味甘而微酸。無種子,品質優良,果實

十月中旬成熟。

(5) 橘(本草綱目，羣芳譜，名實圖考)

異名 本地橘(溫州)，溫州橘(上海)

分佈 長江流域之橘或橘柑與此類似。

產地 浙江溫州茶山。

總說 橘，溫州茶山自古栽培，溫州之橘細分之，可有數多系統，選種方面應加注意研究。

性狀記載 標本採集地：浙江溫州茶山

樹三十年生，高3m. 樹開張性，稍帶屈曲，無刺。葉橢圓形，先端鈍，基部尖，葉緣淺有波狀缺刻，無翼葉。果實扁圓形，大小 3.35×5.27cm 果重 48gm. 果頂凹入，梗窪部稍肋起，果梗細而綠色，萼小五瓣，綠色鈍尖形，果面平滑，橙黃色，油胞細小，圓而密生，頂部者多凹點，基部者突生，果皮易剝，厚0.175cm. 瓤囊九瓣，心皮厚而强靭，果心大而空洞。果肉淡橙黃色，汁胞粗短膨大，成紡錘形。果汁淡橙黃色，多汁，甘味强，品質佳良。種子約五粒，極少，形小，卵形，種皮灰白色，子葉淡綠色。Chalaza 色紫，單胚，果實十一月中旬成熟。

(6) 本地早(黃巖俗呼)

Citrus succosa, Hort. ex Tanaka in Memoirs ot Tanaka Citrus Experiment Station 1(1) p.30, 1927

異名 天台山蜜橘(上海)

日名 土佐地蜜柑

總說 本種名稱記錄不詳，品質佳良，爲有望品種，黃巖俗呼黃巖橘子，吃功要算本地早，極言其橘之品質，以本地早爲最。

分佈　浙江黃巖，日本九州

性狀記載　標本採集地：浙江黃巖西林園

樹半開張性，枝密生，半圓形，枝之生長整齊，長梢之葉橢圓形，先端鈍圓，基部同，葉緣有波狀缺刻。果實扁圓，先端圓，大小3．7×4．55cm．果重53gm．基部稍有肋起，果梗粗而綠色，萼大五瓣，尖形。果面粗糙，有時有疣狀突起，果皮橙黃色，油胞圓形，密生，基部之油胞凸出，頂部平生，果皮比較難剝，果皮厚0,18cm．甚薄，果皮有一種香氣甚佳，瓤囊九瓣，腎臟形，心皮甚薄，果心小而充實，果肉深橙色，汁胞細長，紡綞形。果汁濃橙色，多汁富甘味，品質極優良。種子 8—10粒，卵形，外種皮淡黃色，子葉濃綠色。Chalaza 紫色，單胚，或多胚性，果實十一月中旬成熟。

(7)　日本柑(溫州)

Citrus unshiu, Marcovitch.in Izvestia Sochinskoi Oblast noi i Sukhumskoi i sel'sko-khozaistvennoi opytnoi stan tsŭ (2)5,1921

日名　溫州蜜柑

分佈　溫州，江西南昌，湖南長沙，日本，美國 Florida.

產地　浙江溫州平陽鄭樓小學

總說　日本之溫州蜜柑由吾國傳去，改良爲無核種，溫州平陽鄭樓小學校主王羣氏，在十餘年前由日本輸入苗木，今在該校種植，已能結果。聞在江西南昌及湖南長沙，亦有輸入日本溫州蜜柑，栽種成績甚佳。

性狀記載　樹形盃狀葉厚大而爲長橢圓形，有長葉翼。果實球形或扁圓形，果頂微凹入，萼凹形，裂片不整。果面橙黃色，有光澤，油胞點稍大，有凸出亦有淺凹者，容易剝皮，橘絡多，肉橙黃色而多汁，有香味，甘酸適宜，種子無，或有一二粒，胚綠色，多胚性。

溫州蜜柑現日本改良之系統甚多，將來在吾國長江南部栽培甚有希望，是亦吾國改良栽培柑橘可注意之問題。

(8)甜橘(海陽縣誌)

Citrus ponki, Hort. ex Tanaka in Memoirs of Tanaka Citrus Experiment station p.31. 1929

異名　椪橘(台灣)

產地　廣東潮州東廂鄉溪口

性狀記載　甜橘五六年生，高約2m.圓形，有突出之徒長枝，無刺。葉橢圓形，兩端鈍尖，果多扁圓形，大小3.75×4.86cm.果面平滑，油胞小，果皮黃色，厚0.2cm.甚薄，肉瓤十瓣，腎臟形。果肉淡橙黃色，汁胞大而粗。果汁多而甜，味强品質中等，果實小，貯藏力弱爲缺點，種子十數粒，卵圓形，子葉綠色，多胚性。

(9)酸橘(海陽縣誌)

Citrus sunki, Hort. ex sakurai in studia citrologica 4 (1)39, 1930

分佈　廣東潮州，台灣

產地　廣東潮州東廂鄉

性狀記載　樹高約 4m.，枝開張性，有刺，翼葉近缺，葉基部圓形，花白色，蕚緣有毛；果實小，比金橘稍大，扁圓形。果皮橙黃色，滑澤易剝皮，果肉酸味强，種子作砧木用。

用途　作柑類接本

以上所舉橘類品種性狀區別，可分下記各亞類：

1　乳橘亞類……乳橘，蜜橘，假蜜橘。

2　早橘亞類……·……早橘,無核早橘,溫州橘,日本柑。

3　本地早亞類……本地早

4　椪橘亞類……甜橘,酸橘

3,　紅橘類　Tangerines group

本類包含紅橘,*Citrus tangerina*, Hort. ex Tanaka與朱橘*Citrus erythrosa*, Hort. ex Tanaka二系統。前者在福州栽培,後者爲長江沿岸普通栽培之柑橘。

(1)紅橘(福州,漳州)

Citrus tangerina, Hort. ex Tanaka in Memoir of Tanaka Citrus Experiment Station 1(1):29 1927

異名　紅橘(漳州),福橘,綠橘(塘棲)漳橘(溫州茶山)

分佈　主要栽培地爲福州螺州,日本,歐洲,美國(名 Tangerine)

總說　本種爲福州橘產地之唯一栽培種類,福州稱曰橘,或紅橘,外埠稱曰福橘,綠橘,漳橘等。本種與美國栽培之Tangerine 爲同物。

產地　福州螺州陳竹生園

性狀記載　樹性半圓形,枝疏生,稍披倒性,節間長,葉橢圓形,兩端尖,翼葉細長。果實扁圓形,大小4.52×6.65cm.果重104gm.先端凹入,基部稍尖有肋起,果梗細而綠色,萼小呈綠色,果面光澤,呈朱紅色,油胞密生,多在果面平生或凸出,凹入者甚少。果皮易剝,厚0.5mm. 脆而有佳良之香氣。瓤囊9—11瓣,腎臟形,心皮厚,果心大而空洞。果肉橙黃色,甘而微酸,品質中等。種子多,有16—19粒,小而卵形,先端有長嘴形突起,子葉綠色。Chalaza紫褐色,多胚性,果實十二月初旬成熟。

各地產紅橘果實比較

產地	重量	大小	果皮厚	瓤囊數	種子數
塘棲	56 gm.	4.23×4.89 cm.	0.2 cm.	8	20
溫州	82	4.00×6.04	0.25	12	5—8
螺州	104	4.52×6.65	0.1	11	16
漳州	132	3.20×6.50	0.2	12	16

依照上表漳州產紅橘，各種品質最優，塘棲產果實小種子多，因氣溫影響，北部產品質皆不如南部。

(2) 朱橘(本草綱目，羣芳譜)

Citrus erythrosa, Hort. ex Tanaka, in Memoirs of Tanaka Citrus Experiment Station p.30, 1927

異名 朱砂橘(黃巖，番禺縣誌)朱紅橘(塘棲)，遲紅 (衢州，溫州，江西三湖，湖南長沙)。

分佈 廣東，福建，浙江，江西，湖南，湖北。

總說 朱橘在羣芳譜中所記："朱橘實小，色赤如火。"本種分佈甚廣，在南部及浙江流域普通栽培，在溫州，黃巖有數百年老樹之朱橘，足徵品種之由來已古。

性狀記載 標本採集地：溫州茶山項善光，黃巖南門外西林園，塘棲洪家莊朱榮標。

樹齡五十年生，高6m. 幅6m.半直立性，枝疏生，徒長枝上有刺。葉橢圓形，兩端尖，大小9.115×3.47cm.翼葉細長1.58cm.葉緣無缺刻，或有波狀缺刻，表面深綠色，底面淡綠色，葉脈中肋稍凸出。果實扁圓形，或圓形，大小3.8×4.68cm,或4.04×3.545cm. 果重 45gm. 頂端稍凹，有乳頭狀突起，基部圓形，稍有肋起，果梗纖細綠色，萼小五裂成尖形，果面粗糙，有皺襞，果皮朱紅色，油胞圓形，小而凹入．厚0.225cm.瓤囊七瓣，成腎臟形，心

皮薄，柔軟無色，果心小，成空洞。果肉赤橙色，汁胞紡綞形，長而膨大，果汁橙黃色，多汁甘味强，品質中等。種子約八粒，卵形，先端有短嘴狀突起，子葉綠色，單胚，果實十月下旬成熟。

(3)早紅　(蘇州洞庭山)

異名　洞庭紅(江南通誌，塘棲)

分佈　蘇州洞庭山，浙江塘棲。

總說　本種在蘇州洞庭山，栽培爲多，因早熟，頗受市場之歡迎。

性狀記載　標本採集地：塘棲三家村金浪沈園。

早紅樹性直立，高 5.5m.幅2.5m. 枝疏生，葉長橢圓形，兩端甚尖，大小10.7×3.6cm.葉柄長 1.3cm. 果實扁圓形，頂端凹入，果梗粗，綠色，蔕片小，圓而綠色，果面朱紅色而光滑，油胞小而密生，圓形凹入。果皮易剝，厚0.15cm.甚薄。瓤囊九瓣，心皮薄，果心小而充實，果肉朱紅色，汁胞紡綞形，果汁橙赤色，味甘微酸。種子十粒，卵形，先端有短嘴狀突起，子葉綠色，單胚，果實十月初成熟。

本種性狀近似朱紅，應屬朱紅一類。

4，柑類　Mandarin orange group

柑字由印度產之Keonla音譯，指寬皮大柑而言，果實比橘大，而品質優良。外國譯之曰Mandarin orange極言其品質優良，爲宦官所賞。

柑之種類　柑在吾國栽培甚古，故種類亦多，茲就古籍方誌所記之柑、摘錄以供參考如次：

廣東省　柑(潮陽縣誌，仁化縣誌，番隅縣誌，新會縣誌)四會柑(魚凍柑)茶枝柑，酸柑(四會縣誌)。

民國二十二年廣州柑橘展覽會出品之柑類：(1)茶枝柑，(2)四會柑，

(3)祿柑,(4)有柑,(5)蕉柑,(6)沙柑,(7)潮柑,(8)厚皮柑,(9)扁柑,(10)貪皮柑,(11)貢柑,(12)米柑,(13)酸柑,(14)大紅柑,(15)紅柑,(16)五利柑,(17)盒柑,(18)甜柑,(19)硃柑。

廣西省　柑(廣西通誌,梧州府誌,百色廳,臨桂縣)

雲南省　柑(雲南府誌),黃果(浪穹縣誌)

福建省　柑(建甯府),獅頭柑,蜜羅柑,(邵武府)仙柑,紅柑,盧柑,虎頭柑,蜜桶柑(漳州府誌)

江西省　乳柑,薄皮柑,獅頭柑,洞庭柑,黃柑(江西通誌)柑(建昌,南城縣,贛州府等誌)。

貴州省　獅頭柑(貴陽縣誌),蜜羅柑(永甯誌),柑(黎平誌),蜜筒柑,黃果(黎平誌)。

湖南省　柑(湖南誌),佛頭柑,霜柑(明統志)

四川省　黃柑(順慶府)

浙江省　朱柑,乳柑,生枝柑,海紅柑等(橘錄)。

湖北省　柑(湖北通誌),秀柑(寰宇記),大柑(黃州府誌),獅頭柑(廣濟縣誌),乳柑,黃柑(湖北通誌),支縣柑(太平御覽引荆州記),宜都柑(荆州記),香柑(宜昌府誌),蜜羅柑(施南府誌)。

江蘇省　眞柑(吳郡志)

據以上各省方誌所記,柑之種類甚多,不下數十餘種,但栽培之主要者,不外廣東之有柑,蕉柑,四會柑,茶枝柑等。浙江溫州乳柑(瓯柑有大宗出產),四川,湖北,江西產黃柑,長江上流所產獅頭柑或與日本所產之獅子柚爲一類之物。

柑之栽培南部比較發達,因柑原產印度,係由南而北進之果樹,故適

宜于南部生長，柑中種類甚多，性狀各別，頗難以一學名包括數種類。下記柑類說明，茲就著者實地調查所得，記述如次：

柑類說明：

(I)　有柑類*Citrus poonensis*, Hort. ex Tanaka in International Review of the Science and Practice of Agriculture, New Series 1(1): 34, 1932

Syn. *Citrus nobilis*, var. *poonensis*, Hayata. in Icones Plantarum Formosanarum Vol. VIII p.14—32 1919

(1)有柑(Pan kan, Mo kan)潮州地方呼名，

異名　盧柑(漳州誌)，椪柑(台灣)，密桶柑(海陽縣誌)，汕頭密橘(上海)。Chinese Honey or Wanurco (美國 Florida).

分佈　廣東，福建，溫州，台灣日本，美國 Florida.

總說　有柑音 Pan kan 或 Mo kan, 有係廣東特殊之字，爲寬皮空心之意。本種爲潮州柑橘中之重要栽培品種，品質之優良非他種可比。現台灣改良椪柑最力，在東方將有多量之生產，日本九州亦產有柑，在美之 Florida 州亦有少量栽培。

性狀記載　標本採集地：潮州塔下大路，

樹齡五六年生者高 2m. 幅2.5m. 直立性，枝長，節間亦長，葉橢圓形，兩端鈍頭，葉緣有波狀缺刻，翼葉細長。果實大而扁圓形，先端凹入，基部圓，有肋起，大小5.7×7.4cm.果重145gm. 果梗纖細，綠色，萼小呈綠色，萼片五瓣圓形。果皮粗糙，呈橙黃色，油胞圓形，小而蜜生，多數凸出，頂端有凹點，果皮易剝，厚0.265cm.瓤囊九瓣，大而成腎臟形。果肉橙黃色，汁胞紡綞形，短而膨大，果汁橙黃色，多而味甘，微酸，有香氣，品質之優，爲寬皮橘

之冠。種子少，卵形，子葉綠色，Chalaza紫色，單胚，果實十二月中旬成熟。

漳州之盧柑，係潮州移去之有柑，同物異名耳。

(2) 蜜糖柑，潮州

異名 蜜桶柑，蜜柑

產地 廣東，潮州

果實記載 果實扁圓形，大小5.01×5.80cm. 頂端微凹，底部有溝紋及肋起。果皮橙黃色，皮厚0.38cm.油胞圓形而凸起，細而多，瓤囊九瓣，心皮薄，呈黃白色，多橘絡，味甘而有香氣。種子卵形，呈黃白色，子葉淡綠色。

(3) 槾橘，黃巖

Cirus tardiferax, Hort. ex Tanaka in Memoirs of Tanaka Citrus Experiment Station 30, 1929

異名 槾

分佈 浙江黃巖

總說 黃巖古代無槾橘，據黃巖王仁圃氏談，槾橘係有柑之實生，樹性，葉形，果形等，與有柑類似。

性狀記載 標本採集地，黃巖西林園一號樹。

槾橘樹性開張，結果枝因果實之重而倒垂。葉橢圓形，先端鈍尖基部鈍角形，大小6.8×4.24cm. 葉緣有深波狀缺刻，短枝之葉與長枝同形，而稍小，大小5.7×3.1cm. 果實形狀有二種，一種爲圓形或扁圓形，大小5.4×7.5cm.果重140gm.先端凹入，基部圓形有肋起。他種異型爲蒂高形，果實圓形，基部尖圓，頂端圓形，稍凹入，大小 4.4×4.85cm. 果重 62gm. 等二種果型。果梗皆粗，萼片有五瓣，呈綠色，果面粗糙，呈黃金色，油胞平生，頂部者成凹點，皮厚 0.2cm. 甚薄，柔軟有香氣，瓤囊有十瓣，腎臟形，

心皮薄柔軟無色，果心大成空洞。果肉橙黃色，汁胞紡錘形而膨大，果汁橙黃色，多汁味甘，品質優良，種子二十六個，甚多，形小卵圓形，子葉綠色。Chalaza紫色，單胚，果實十一月下旬成熟。

(II)　蕉柑類*Citrus tankan*, Hayata, in Icones plantarum Formosanarum 8:26, 1919

(1)　蕉柑(光緒庚子年海陽縣誌)

異名　桶柑(漳州，台灣)，招柑(潮州)。

分佈　潮州，漳州，台灣。

總說　本種之來源尚不明，現廣東潮州與福建漳州栽培甚多，年產額約四五百萬元，上海市場皆呼蕉柑爲暹羅蜜橘，本種與暹羅有何關係尚不明瞭，須待日後之再查。

性狀記載　標本採集地 廣東潮州古樓，鶴巢。

樹半圓形，有突出之徒長枝，細枝密生而無刺，節間短，葉橢圓形，細長，兩頭尖，翼葉狹長形。果實本種有數多果型，普通圓形或扁圓形，其他有蒂高型粗皮型等。普通型之大小 4.40×5.33cm. 果重80gm.先端圓，基部圓而稍有肋起，果梗纖細綠色，萼小綠色，萼片五瓣，尖形，果面平滑，有光澤，呈濃橙黃色，油胞數多圓形，細小，多數凸生，少數爲凹點。果皮易剝，厚0.225cm.柔而有香氣，橘絡柔而黃白色，瓤囊十瓣，腎臟形，心皮甚薄，呈橙黃色，果心小而充實，果肉橙紅色，汁胞紡錘形而細小，果汁濃橙黃色，多汁而味甘，品質優良，且富貯藏性，可貯藏至七月。種子甚少，普通一二粒，亦有無核果實，形小卵形，種皮黃白色，子葉白色或淡綠色。Chalaza紫色，多胚性，果實一二月中成熟，爲柑橘中之晚熟種。

(III)四會柑類 *Citrus suhoiensis*, Tanaka in Memoirs of Tan-

aka Citrus Experiment Station 1.1929

(1) 四會柑 廣州呼名

異名 柑(新會)

分佈 廣東新會，四會

性狀記載 標本採集地 新會東甲。

四會柑樹齡十三年生者，高1.5m.幅約2m. 半圓形，枝纖細密生。葉細長橢圓形，兩端尖，葉緣有粗鋸齒．葉柄長，葉翼不明。果實大小4.25×5.10cm. 果重 72gm. 扁圓形。蒂部尖圓。頂部圓而稍凹入，果梗纖細綠色。萼五瓣尖形，果皮光滑成黃色，油胞密而小，多數平生有凸出或凹入者。果皮易剝，極薄，橘絡不多，瓤囊有十二瓣，腎臟形，心皮薄而强靭果心小而空洞果肉橙黃色，汁胞卵形，短而粗，果汁黃色，多汁味甘，品質優良，種子二十粒，小而卵形，先端有短嘴狀突起，子葉綠色。Chalaza紫色，多胚，果實十二月中旬成熟。

(IV) 茶枝柑類

(1)茶枝柑(四會縣誌)

分佈 廣東番禺，四會

性狀記載 標本採集地：廣州河南島上 四年生樹，幹徑4.2cm.枝條繁茂，枝纖細而向上生，節間短，無刺，新枝深綠色，老枝深灰色，葉長橢圓形，而小，大小5×2cm.先端銳尖而微凹，基部銳尖，葉柄纖細長1.2cm. 無翼葉。葉片與葉柄連接處有明顯之關節，葉面暗深綠色，葉脈不顯著，葉底暗淡綠色。油胞細而多，不顯著，葉片薄而靭。果實扁圓形大小，6.5×8.2 cm. 果重 134gm. 頂部稍突，有菊花狀之幅射紋，基部微凹，近萼之周有稜狀隆起及溝紋，萼五片，銳尖形。果皮微粗有光澤，多凹凸處，皮薄，0.3cm. 易剝離，果心大而空洞，瓤囊十一瓣，腎臟形，大小不一．汁胞短而

豐滿。紡錘形，排列不整齊，互相粘着，渣多而靭，粗而常有硬化之汁胞，汁多，味甘微酸。種子十餘粒，倒卵形先端尖基部圓，種皮淡黃色，子葉綠色。Chalaza 赭色，多胚性，十月至十二月成熟，爲廣東栽培之早熟種。

(V)甌柑類 *Citrus suavissima*, Hort. nov. Tanaka in Studia citrologica Vol. 1, no. 2 1927

(1) 甌柑(溫州府誌)

異名　柑(溫州)眞柑，乳柑(韓彥直橘錄)

分佈　浙江溫州

總說　本種卽韓彥直橘錄所記之眞柑、乳柑。"眞柑一名乳柑，謂其味之似乳酪，溫四邑之柑泥山爲最，地不彌一里，所產柑，其大不七寸圍，皮薄而味珍，脈不粘瓣，食不留滓，一顆之核，纔一二，有間全無者。" 本種起源亦古，唐書中記："溫州土貢柑。"現溫州栽柑尙盛 甌柑爲主要品種，惜本種有苦味爲缺點耳。

性狀記載　標本採集地：溫州甌海中學近旁。

樹高 1.5—2m. 枝疏生而披張性，葉橢圓形，短枝之葉葉緣無缺刻，長枝之葉有波狀缺刻，無刺，果實扁圓或長圓形，大小5.85×7.16cm.果重170gm. 先端稍凹，有基部尖圓與截圓之兩型。果梗粗而綠色，萼綠色，萼片五瓣，鈍尖形，果皮粗有皺襞，橙黃色，油胞圓形，多數凹生。果皮易剝，厚 0.365cm. 橘絡多而柔軟，白色此橘絡在甌柑中有一種苦味。瓤囊十瓣，腎臟形，心皮甚薄，果心小而充實。果肉橙黃色，汁胞紡錘形，長而膨大，果汁橙黃色，多汁有甘味，稍帶苦，此係橘絡之苦味，本種除苦味外，實爲優良種，種子四粒，甚少，卵形，先端尖，種皮蒼白色，子葉白色或淡綠色。Chalaza 紫色，多胚，果實十一月中旬成熟。

以上所舉之柑類爲吾國栽培之重要者，其他誌書所記之黃柑，產長江上流，著者實物尚未調查，記錄暫缺，此種或爲長江上流地方栽培之重要品種。

5， 甜橙類Sweet orange group

古籍中關于甜橙之記述皆不詳，古書之橙(齊民要術) 包含酸橙與甜橙，證類本草之橙子，則指 *Citrns junos,* Tanaka 而言。開寶本草所記橙，今以廣東新會者爲天下冠。甜橙栽培歷史至古，品種亦不少，惟生產不如柑橘爲多。甜橙一類耐貯藏，可以運輸至遠。吾國甜橙由美國輸入者年達百萬元，需要日多，甜橙栽培在吾國宜注意改良。

古籍中所記之橙類，就古籍及方誌中所記之橙類品種如次：

廣東省 橙(海陽縣誌，仁化縣誌)水橙(廣州府誌)柳橙(四會縣誌)，甜橙，雷橙(有紋)，香水橙，酸橙(新會縣誌)。

民國十八年廣州柑橘展覽會出品之橙類：明柳橙，暗柳橙，鵝旦甜橙，年晚橙，夾橙，光身甜橙，香橙，甜橙，幼葉柳橙，雪柑，臍橙，水橙， 紅皮光身橙，香水橙，酸橙，中山橙，黃皮柳橙，紅皮柳橙，鐵綫柳橙，大明柳橙，金山橙等二十一種。

福建省 橙(福建省誌)

江西省 橙(建昌府誌，商城縣誌，贛州府誌。)

甜橙 產瑞金，贛縣爲最(宋郤江西柑橘之種類與其分佈之概況)

酸橙 到處栽培供藥用(宋郤江西柑橘之種類與其分佈之概況)

貴州省 橙，晚熟產古州者佳。

湖南省 橙(長沙府誌)

四川省 橙(唐志巴州貢)橙，利州產(寰宇記)

浙江省　橙(浙江通誌,衢州志)青橙,皺橙，香綿橙(赤城誌)，廣橙(蔣芸生:浙江之柑橘衢州)。

湖北省　橙(湖北通誌)橙,釋名金球(宜昌府志)

江蘇省　橙,皮香甕酢大者名蜜橙,指*Citrus junos*, Tanaka 而言。

吾國古籍方誌之記橙字,包含甜橙*Citrus sinensis*, Osbeck.酸橙*Citrus Aurantium*, Linn.香橙 *Citrus junos*, Tanaka 三種,閱者宜爲注意。

甜橙類品種　在吾國現在栽培者,可分臍橙類與圓橙類二種,在地中海沿岸栽培者,尚有血橙類一種(Blood Orange)。

(I)　臍橙類　(Navel orange group)

(1)　美國臍橙(黃巖呼名)美國 Washington Navel Orange, 本種美國原產,黃巖地方在十數年前,由日本輸入,今黃巖南門外,林讓士氏園栽有數十株,每年有少量之生產,同地臍橙栽培,並非最適地方。

(2)屠模孫改良臍橙(Thompson's Improved Navel Orange)今在廣州中山大學有栽培。

(II)　圓橙類(Round Orange group)

(1)　甜橙(名實圖考,新會呼名)(*Citrus sinensis*, Osbeck in Reise nach Ostindien und China p.250. 1795

分佈　廣東新會及廣東其他各地。

性狀記載　標本採集地:新會東甲。

樹直立性，多徒長枝，有刺,葉大，橢圓形,先端尖,基部圓，葉片厚,葉脈疏，翼葉橢圓形。果實圓形，大小5.44×5.99cm. 果重 110gm. 小果兩端皆圓形,果皮粗橙黃色,油胞密,而平生，果皮難剝,皮厚0.285cm.極薄,呈橙黃色,有香氣。瓤囊十瓣,小而成腎臟形,心皮薄而柔軟,果心小而

充實，汁胞紡綞形。果汁黃色，汁多味甘，種子一粒，或無核，形楔形，或卵形，子葉白色。Chalaza 紫色，單胚，果實十一月中旬成熟。

(2) 柳橙 (廣州)

異名 霤橙(新會縣誌)

分佈 廣東番禺，四會，新會。

性狀記載 錄溫文光著：柑橘類果樹栽培改良法 p. 73, 1932. 枝多刺，老枝多直立性，葉橢圓形，大小11.5×7.00cm.翼葉1.2×0.5cm. 葉頂端有缺刻，基部則甚少。果實圓形，果面有溝紋，故名柳橙，或霤橙，大小7.0×7.5cm.果重250gm.果頂有圓圈，基部圓形，果皮粗糙，厚約3mm. 不易剝離，油胞密生，圓而大。瓤囊十瓣，中心柱稍大，直徑約1cm 充實，汁胞短卵形而膨大，果肉深黃色，種子10—16粒，成熟早，十一月至十二月中。本種中變種甚多，如有大葉柳橙，半截柳橙，企身明柳橙，晴柳橙崙頭柳橙等。

(3) 香水橙(新會名稱)

分佈 廣東新會

性狀記載 標本採集地：新會東甲。

樹半圓形，枝密生，葉橢圓形，兩端尖，翼葉長。果實長圓形，大小4.835×5.29cm.果重 76gm.兩端圓而滑澤，果面亦然，油胞多平生，少數凹入，果皮難剝，金黃色，厚 0.5cm. 瓤囊十瓣，小而成腎臟形，心皮薄而無色，果實小而充實。果肉金黃色，汁胞紡綞形，而細長，果汁黃色多汁，味甘，品質優良。種子六粒，小而卵形，或長圓形，種皮黃色，子葉白色。Chalaza 紫色，多胚性，果實一二月中成熟。

(4) 雪柑 潮州，台灣

Citrus sinensis, Osbeck, Form Sekkan. Hayata in Icones plantarum Formosanarum 8.2 .1919

異名　廣橘(上海市場)

分佈　廣東潮州，福建漳州，台灣。

總說　雪柑產廣東，本種屬甜橙類，果實大。品質多汁，甘酸適宜，爲有望品種，今台灣亦有栽培。

性狀記載　標本採集地：潮州東廂鄉溪口。

樹性叢生性，有突生之徒長枝，枝有短刺。葉大先端尖，翼葉稍大，無鋸齒。果實圓形或長圓形，大小 6.875×6. 775cm. 果重 215gm. 兩端圓，果梗粗而綠色，萼片五瓣，鈍角形，綠色.果皮滑澤，呈橙黃色。油胞圓形，小而平生或凸出，果皮難剝，厚 0.6cm. 瓤囊十瓣，腎臟形，心皮薄，黃白色，果心小而充實，汁胞紡綞形而長。果汁橙黃色，豐富，味甘，品質優良。果實一二月中成熟。無種子，

一九一九年廣東嶺南大學郭華秀曾作廣東柑橘類調查未發表文，所計橙類計十一種，特錄之以供參考(說明照原文甚略)

1　甜橙　果身曰字形，無酸橙色之紅，底有圓圈，皮稍滑，味甜。

2　柳橙　果身有柳紋，底有圓圈，日字形，皮無酸橙之紅，味甜。

3　酸柳橙　狀與甜柳橙同，惟果鮮紅。

4　嗜柳橙　其貌及味與甜橙同。

5　酸橙　果大鮮紅，皮粗味酸。

6　大葉酸橙　葉大果大，其他與酸橙同。

7　香水橙　底有圈，味香甜。

8　蘭花葉橙　幼葉酸橙，果細鮮紅，味酸甜。

9 潮州橙，卽雪柑。

10 水橙 果大扁圓如柑皮黃色，形如細柚，味酸苦。

11 橙 味酸。

6，酸橙類*Citrus Aurantium*, Linn. in Species Plantarum p.782 1 753

酸橙 吾國栽培不多，古書所記亦少。浙江有朱欒，鈎頭橙，小紅橙等供接本用。蘇州栽培之代代橙，係採花蕾焙乾，做茶葉香料，長江上流栽培之酸橙製藥用。

a 朱欒 宋韓彥直橘錄

異名 酸欒(溫州)

分佈 浙江溫州

總說 本種名見宋彥直橘錄，現在溫州尚有栽培，供作橘之接本。

性狀記載 標本採集地：溫州山脚門外柯柯來產。

朱欒樹高約 5m. 枝披倒性而有刺，葉橢圓形而細長，先端尖，而有翼葉，果實扁圓形，大小 8.0×9.5cm. 果皮橙紅色，果肉淡黃色。種子甚多，一個果實中有30至40粒，卵圓形，先端有鬧嘴狀突起，味酸不堪生食。

用途 橘接本。

b 皮頭橙

異名 鈎頭橙

分佈 浙江黃巖

性狀記載 標本採集地：黃巖南門外西林園。

皮頭橙樹形坡倒性，枝細長疏生，有刺，葉橢圓形，先端鈍尖，基部圓，葉緣有淺波狀缺刻，翼葉耳狀，細長。果實扁圓形，大小4.4×5.93cm. 果皮粗糙，多凹點，油胞普通平生。瓤囊十瓣，心皮厚，果肉呈淡黃色，種子二十

粒以上,卵形,先端鈍形,表面有助紋;子葉白色.單胚。果汁酸强,不堪生食。

用途　供橘類接本用,在黃巖地方比枳殼爲優良。

c　代代　(江蘇,浙江俗稱)

日名　代代

分佈　江蘇蘇州虎邱栽培,浙江黃巖塘棲。

性狀記載　標本採集地:黃巖西門覇頭八保坦林家

代代五六年生者,高1m.枝疏生,開張性,葉橢圓形或卵形,先端鈍尖,基部圓形,葉片甚厚,翼葉廣大。果實扁圓形,大小5.4×6.4cm.果皮橙紅色。瓤囊十瓣,心皮厚白色,果肉淡黃色,種子橢圓形,先端戈楔狀,子葉白色。Chalaza紫色.單胚.果汁甚酸.不堪生食,本種專採花蕾焙乾.做茶之香料用。

7,　橙子類 *Citrus junos*, Sieb. ex Tanaka, in Siebold Festschrift p. 65 1924

橙子　名見唐愼微證類本草卷八(1108 A.D.) "橙子皮苦辛溫,作醬醋香美,散陽味惡氣消食,去胃中浮風。其瓤味酸,多惡心,不可多食,傷肝氣,又以瓤洗去酸汁,細切和鹽蜜煎或煎食之,去中浮風。其樹亦如橘樹而葉大,其形圓,大于橘而香,皮厚而皺,八月熟。

橙子古名柚,如說文所記曰:"柚條也,似橙實酢。"呂氏春秋曰:"果之美者雲夢之柚。"皆指橙子而言。橙子長江沿岸栽培爲多,產江蘇,浙江,安徽,江西,湖北,湖南,四川,雲南,貴州等處。

橙子之用途主爲藥用,其他果皮製蜜餞,日本以橙爲甜橘接本,橙子之品種,著者實地調查所得,有下記二種:

(1)　香橙　浙江,江蘇呼名

分佈　江蘇蘇州洞庭山,浙江塘棲

性狀記載　標本採集地:浙江塘棲上河提沈叙才家產。

樹高6m. 半開張性，枝細長有刺，葉橢圓形，3.3 ×3.095cm. 先端尖，基部尖圓，翼葉狹長，長1.85cm.葉緣有淺波缺刻或無缺刻，葉表面深綠色葉底綠色，葉脈不顯明。果實扁圓形，大小3.475×4.635cm. 先端稍凹，基部圓，果梗細而綠色，萼片五瓣，鈍尖形。果面粗有皺襞，呈淡黃色，圓形而凹生，果皮易剝，厚0.39cm.甚厚，有特種香氣。瓤囊十瓣，腎臟形，心皮厚而强靭，果心小而充實。果肉淡黃色，汁胞紡綞形，短而膨大。果汁淡黃色，多汁酸味强，不堪生食，唯果皮果汁有一種香氣，可作香料。種子二十粒，大而卵形，子葉白色，單胚，果實十月上旬成熟，甚早。本種在研究可注意者，爲在長江沿岸栽培柑橘，用此種爲砧木之價值。

(2)　羅漢橙　浙江塘棲

分佈　浙江，江蘇

性狀記載　標本採集地:浙江塘棲。

樹高5.5m. 開張直立性，枝粗長，有粗刺，葉橢圓形，先端尖，基部圓，大小 8.385×4.075 cm. 短枝葉稍小，翼葉細，長 1.375cm. 果實扁圓形，頂端圓而有輪形之凹部，基部圓有肋起，果梗粗而綠色，萼綠色，有萼片五瓣，鈍尖形，果面粗有皺襞，油胞密生，圓形而凹入。果皮厚0.55cm. 甚厚，有特殊香氣。瓤囊有十瓣，腎臟形，心皮厚，白色，果心小而充實，果肉黃色，汁胞紡綞形，短而膨大。果汁黃色，汁多味甚酸。種子約有二十粒，卵形，子葉白色。Chalaza 紫色，單胚，果實十月中旬成熟甚早。

用途　與香橙同

8,　宜昌柑類

宜昌柑(或曰橘) *Citrus ichangensis*, Swingle in Journal of Ag-

riculture Research 1(1):10, 1923

分佈　長江上流及美國 Florida 栽培

性狀記載　譯錄 W. T. Swingle 氏原文：灌木或喬木，高1—10m.普通1—5m.嫩枝有稜，多刺，徑2—4mm.葉狹，長6—13.5cm.幅 1.5—3.3cm.普通長8—11.5cm.幅1—3cm.葉柄廣翼形，與葉面同長，而或過之，卵狀橢圓形，或長橢圓狀，長篦形，基部漸尖，頂部圓頭或截形，或亞心臟形。葉身卵狀，銳尖，稍有毛，頂部少突出，基部正圓或鈍楔形。花大形，直徑20—35 mm.由5數而成，單出腋生，小梗長3—5mm. 萼片三角形，長幅均3.0mm.緣邊有細之微毛.瓣片長橢圓形，長1.5—2cm.幅0.5-0.8cm雄蕊二十本，長0.8—1cm.花柱長3—4cm.原1.5mm.普通花柱長 2—2.5cm.厚3mm. 子房兩徑均3mm. 果實檔檬形，長8—10cm (3—4吋)先端闊，有輪紋，瓤囊8—11瓣，果肉酸，有香氣。種子甚大，厚而成卵狀楔形，長$\frac{1}{2}$—$\frac{3}{4}$厚$\frac{1}{4}$—$\frac{3}{4}$吋，子葉白色。

用途　觀賞及藥用

9,　柚類 *Citrus grandis*, Osbeck. in Dagbok öfwer en Ostindisk Rosa, p. 98, 1757

柚在吾國異名甚多如文旦(長江沿岸)抛(福建，浙江)欒(福建，浙江)等，柚爲馬來及印度原產輸入中國故異名甚多，古籍之柚似指橙子而言。柚在吾國栽培範圍甚廣，茲就方誌所記及著者調查所得者，摘錄如次：

古籍中所記之柚類

廣東省　雷柚(裴淵記)，柚子(嶺南雜記)，柚(潮陽縣誌，仁化縣誌，四會縣誌)

民國十八年廣州柑橘展覽會柚類之出品：柚，樽柚，蜜柚，沙田柚，降

柚，大年柚，晚年柚，賀年柚，古銅柚，細年柚，香柚，乾水甜柚，金蘭柚，乾柚，紅牙柚，賀正柚，白密柚，香柚仔，年晚柚，恭城柚等二十種。

廣西省　柚(容縣沙田著名)

福建省　柚(產浦南，有平山，紅猴，文旦等種)

江西省　柚(產泰和，贛州，臨川等縣)品種有齊婆子柚（南康)，紅瓤柚(泰和)(宋卻江西柑橘之種類與其分佈之概況)

四川省　柚(產長壽，墊江，梁山)，品種有沙田柚，白柚，尖頂柚，平頂柚等(四川農業第一卷第一號1934)

浙江省　四季拋，紅拋等(產溫州平陽蒲門)，白糖拋，西瓜拋，水紅拋，葫蘆拋，壽星拋，大紅拋等(產衢州)

柚在吾國以福建浦南爲最佳，廣西沙田，廣東番禺次之，浙江溫州及四川僅有少量之栽培。柚類生產宜注意品種改良，年由暹羅輸入之西施蜜柚，及美國 grape fruit 數量不在少數，

柚類品種

(1)　文旦柚　（閩產錄異)

閩產錄異.“拋近入貢者皆漳產，名文旦，文旦小旦者文姓種，在長泰縣溪東，不過四五十樹。”

分佈　福建漳州浦南，台灣

性狀記載　標本採集地：漳州浦南。

果實扁圓形基部稍尖，大小10.5×11.3cm.果重735gm. 果皮滑澤，呈黃色，油胞多圓形，在果面凸出，果皮厚1.1cm.瓤囊十八瓣，腎臟形，心皮厚而强靭，果肉淡黃色，汁胞細長而成紡綞形。種子楔形，約有八十粒，子葉白色。Chalaza 紫色，單胚，九月中旬成熟。

(2)　平山柚

分佈　福建漳州浦南

性狀記載　標本採集地:漳州浦南。

果實倒卵形,果皮平滑呈黃色,油胞大凸生,果肉黃白色,種子楔形。

(3)　四季拋

分佈　浙江溫州平陽蒲門

性狀記載　標本採集地: 浙江溫州平陽北港木頭街周錫光園內。

四季拋溫州平陽蒲門產,量不多,樹高3.5m.餘,枝幹稍屈曲性, 葉對生橢圓形,先端尖,基部圓形,翼葉楯形,葉片甚厚。年開花四次:第一次四月上旬,其後每二十日開花一次,第一次之花結實最佳。果實倒卵圓形, 頂端圓,基部尖形,大小16.5×12.8cm果重 1040gm.瓤囊十二瓣,腎臟形而甚大,心皮薄,柔軟白色,果心小而充實。汁胞灰白色,紡錘形而長,多汁, 甘酸適宜。果肉富融解性,品質極優良。種子少每果實約十九粒,形楔形, 黃色,子葉白色Chalaza 紫色,單胚,果實十一月中旬成熟。

(4)　大紅拋

分佈　福建,浙江溫州,衢州

性狀記載　標本採集地:浙江平陽北港施行如家。

樹高約 7.5m. 枝開張性有刺,葉卵形,翼葉小。果實11.4×9.45cm.果重460gm. 圓形或長圓形。果皮滑澤呈黃色,油胞在果面凸生,果皮難剝,厚1.225cm. 瓤囊十六瓣, 腎臟形,心皮厚而白色,果心小而充實。果肉桃紅色,汁胞紡錘形,長而膨大,果汁淡桃紅色,而多汁,味甘微酸,果肉易溶,品質優良。種子約四粒,楔形 呈白色,Chalaza紫色,單胚,十一月中旬成熟。

(5)　沙田柚

分佈　廣西容縣沙田，廣東番禺。

性狀記載 標本採集地：廣西省容縣沙田產。

果實大小 20.7×16.0cm. 果重 780gm. 例卵形，基部尖，成洋梨形，果梗粗而綠色，萼大呈綠色，萼片圓形。果面粗而黃色，油胞圓形而小，稍凸出，果皮難剝，厚 1.24cm. 瓤囊十二瓣，腎臟形而大，心皮厚而强靭，果心小而充實。汁胞紡錘形而長，果汁無色，不多；富甘味，品質比暹羅柚爲次。種子17粒，甚多，形大成楔形，子葉白色。Chalaza 紫色，單胚，十一月中旬成熟。

一九一九年廣東嶺南大學郭華秀曾作廣東柑橘調查，所記柚計二十五種，茲特摘錄之以供參考。

1　金蘭柚　柚皮光滑細膩，美麗可觀。

2　甘蕭柚　柚皮粗，柚身四正，長圓形，頂部與底部同大。

3　桑麻柚　柚皮凸凹不端正，果大而輕，皮最青綠。

4　假桑麻柚　與桑麻柚同貌，油胞略大，味亦不及桑麻柚之佳。

5　白面桑麻柚

6　白惠桑麻柚

7　絲綿脚　果身圓形，油胞大小相同。

8　扁孤青　身扁圓，大顆青黃色。

9　無花果柚　其果最細，長圓形，果皮深綠色，底有短柄，凸出二三分長，易斷，肉色紅。

10　土華不知名柚

11　象角不知名柚

12　菊花柚　果身似羊額柚，惟底有菊花紋，底大頂細，且底有圓圈。

13　降柚　果身長圓，油胞大小相同，似甘蕭柚熟于霜降前後。

14 豐柚　果身扁圓而大，肉胭脂色，又有高身而多肉者。

15 蜜柚　卽羊額柚。

16 羊額柚　油胞圓細，果重，頂部圓細。

17 樽柚　其底闊，頂高而細，似樽形故名，果色黃而光美。

18 沙田柚　底闊，頂高而細，果身頗高。

19 香柚

20 橘紅　身圓，皮黃色，肉潔白，極滑，汁胞不粘部分，以指分之，汁胞卽彈開，食之肉似有油。

21 野生山柚　身似扁孤者，惟無扁孤之大，色黃，肉紅似斗柚。

22 胭脂脚　果身與絲綿脚同，惟果肉帶胭脂色，味較絲綿脚爲優。

23 年柚　果極大，身凹凸，極芳香，爲柚之冠，有高身及扁身。

24 黃柚　果身圓，黃色。

25 檳柚　果身圓，肉胭脂色。

廣東產柚品種甚多，有整理採擇優良品種之必要。

柚雜種：

香圓 *Citrus grandis* var. *Shangyuan*, Hu.

分佈　長江流域

總說　香圓在宜昌，安徽，江西，江蘇，浙江多栽培，供觀賞用，富耐寒性，形態與柚類似，故定名爲柚之雜種。古籍所記香櫞，係枸櫞 (Citrus medica. L.)'性狀完全與本種不同。

性狀記載　標本採集地：浙江塘棲王家莊莫家蕩產。

樹高約10m. 餘，幅1m.餘，枝披倒性而密生，有刺。葉橢圓形，8×5.5 cm. 翼葉心臟形，大小4×3cm. 花四五月上旬開花 結果枝長0.7cm. 一花

序花有一至三朵，花蕾倒卵圓形，大小1.6×0.84cm.萼淡綠色，萼片五瓣，鈍尖形，無毛，花梗長1.0cm.花瓣白色，反轉性，雄蕊約三十六本，長2.24cm. 比雌蕊長，柱頭大而圓形，子房圓形，淡綠色。果實長圓形，大小 6.9×6.15cm. 先端稍有乳頭狀突起，基部圓而帶尖。果極粗，呈綠色，果皮粗有皺襞，呈黃色，油胞平生果面，果皮厚0.95cm.有彈性。瓤囊十瓣，心皮厚靭而白色，果心小而充實。果肉灰白色，汁胞疏少，成短紡錘形，果汁無色，酸强味苦，不堪生食。本種果皮供藥用，或果實供觀賞用。種子多，有三十粒，先端楔形，子葉白色，單胚，果實十一月中旬成熟。

10， 枸櫞類 *Citrus medica*, Linn, in Species *Plantarum* p. 782. 1753.

枸櫞 宋本草圖經，本草綱目。

異名 香櫞(廣東)香圓(溫州；宋韓彥直橘錄)

枸櫞印度原產；名Turunj枸櫞或由此音譯而來，香櫞，香圓皆轉訛之名，用之不甚適當。香圓係俗稱柑橘類之香而圓者，均曰香圓，如北平盆栽之 Lime, 亦稱香圓。

分佈 廣東，廣西，福建，浙江，湖南，四川，湖北。

性狀記載 標本採集地：浙江永嘉慈湖南村。

樹形小，開張性，枝上有硬刺，葉長橢圓形，大小 8.2×40cm. 葉緣有波狀或鋸狀缺刻，呈深綠色無葉翼。果實長圓形，先端有乳頭狀突起，基部圓形，果梗粗而淡綠色，萼片五瓣，先端尖，果面粗，有肋紋，油胞圓形，小在果面平生，味酸强有苦味不堪生食，供觀賞用。種子七至八粒，形小，卵圓形，先端尖，子葉白色。Chalaza 紫色，單胚。

變種 佛手柑 *Citrus medica*, Linn. var. *sarcodactylis*, Swi-

ngle in L. H. Bailey, The standard cyclopedia of Horticulture, p. 781 1925

本種與枸櫞不同之點，果實有分指，作拳形，或開張，有香氣，置室內或衣服中甚芳香，或栽培盆景，供觀賞用，產廣東，福建，浙江爲多，江蘇蘇州，楊州亦有之，本種扦插或嫁接，甚易活。

11，黎檬類 *Citrus limonia*, Osbeck, in Raise nach Ostindien und China, p.250, 1765

(1) 黎檬　名實圖考，番禺縣誌，新會縣誌，嶺外代答。

異名　檸檬(廣東新會俗呼)，宜母子(南越筆記)宜母果，宜濛子（新會縣誌)

黎檬在新會縣誌所記，黎檬子又曰宜濛子，又名宜母果，似橙而小，二三月黃色，味極酸，婦人懷孕不安食之良，故有宜母之名；製爲漿，甘酸辟暑，名解渴水。他邑傳新會梅薑，蓋以黎檬子醋醃之以成者，採其渣去核蒸熟，鹽醃暴乾，久則色黑，俗謂檸檬餅，能消食開胃，點茶最佳。

嶺外代答所記黎檬子，或云自南蕃來，番人多不用醋，專以此調羹，其酸可知。

分佈　廣東番禺，新會

總說　黎檬學名 *Citrus limonia*, Osbeck.甚久時代，誤認於香檸檬 Common lemon, 實則兩者性狀完全不同，1925年田中教授發表一文，廣東 Lemon（九州帝國大學學藝雜誌 Vol. 1, no. 3)糾正黎檬之學名爲 *Citrus limonia*, Osbeck, 檸檬 (Common lemmon) 之學名以 *Citrus Limon* Burm.爲正當云。

黎檬之種類　共分紅黎檬，白黎檬兩種

a 紅黎檬 新會

性狀記載 標本採集地:廣東新會東甲

黎檬高1m. 寬 1.5m. 叢生性，枝細而有刺，葉橢圓形，兩端圓形，翼葉不顯著。果實朱紅色，球形，大小 4.55×5.085cm. 果重 40gm. 兩端圓,先端有乳頭狀突起,果梗粗而綠色,萼綠色有五瓣,尖形,果面滑澤,油胞密而平生,果皮易剝，厚0.25cm.瓤囊有八瓣,心皮薄而無色,果心小而充實,果肉橙黃色,汁胞紡綞形,果汁橙黃色,多汁,味極酸。種子少約有三四粒，小而卵圓形,子葉綠色。Chalaza 紫色,單胚,果實十二月一日成熟。

用途 製枸櫞酸及培養柑橘接本用。

b 白黎檬

分佈 廣州,菲律濱,非洲,爪哇。

爪哇稱白黎檬曰 Kusai lime.

12, 檸檬類 *Citrus Limon*, Burman filius in Flora Indica p 173, 1786.

檸檬 Common lemon

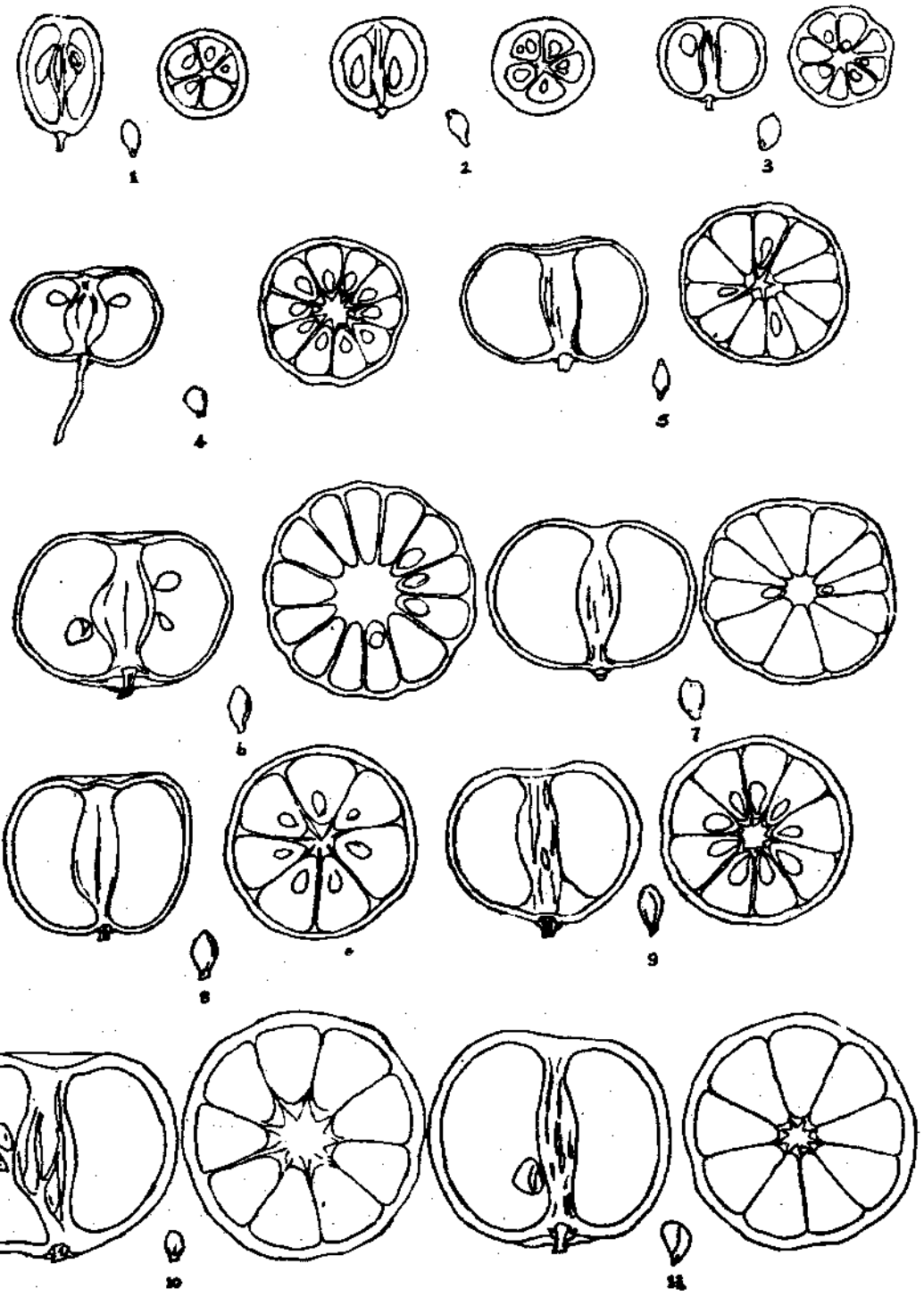
在吾國栽培尚少,古籍所記亦不多,現在廣州僅有少量之栽培。

嶺外代答所記廣州下茅香檬,蓋元時栽種者,尤香馥云; 此香檬或指lemon而言。現廣東稱Lemon爲香檸檬,吾國之有檸檬,始於元代,現在廣東僅有少量之栽培,不足計數也。

品種 Eureka 美國產,廣東中山大學農科,曾於民國十七年由美輸入,聞今已起始結實矣。其他有Lisbon(葡萄牙產), Villafranca, Genoa 伊大利產,均爲優良品種,吾國每年由美,伊大利,日本輸入檸檬甚多，宜注意栽培。

圖版一　中國主要栽培柑橘類之果實(⅓)

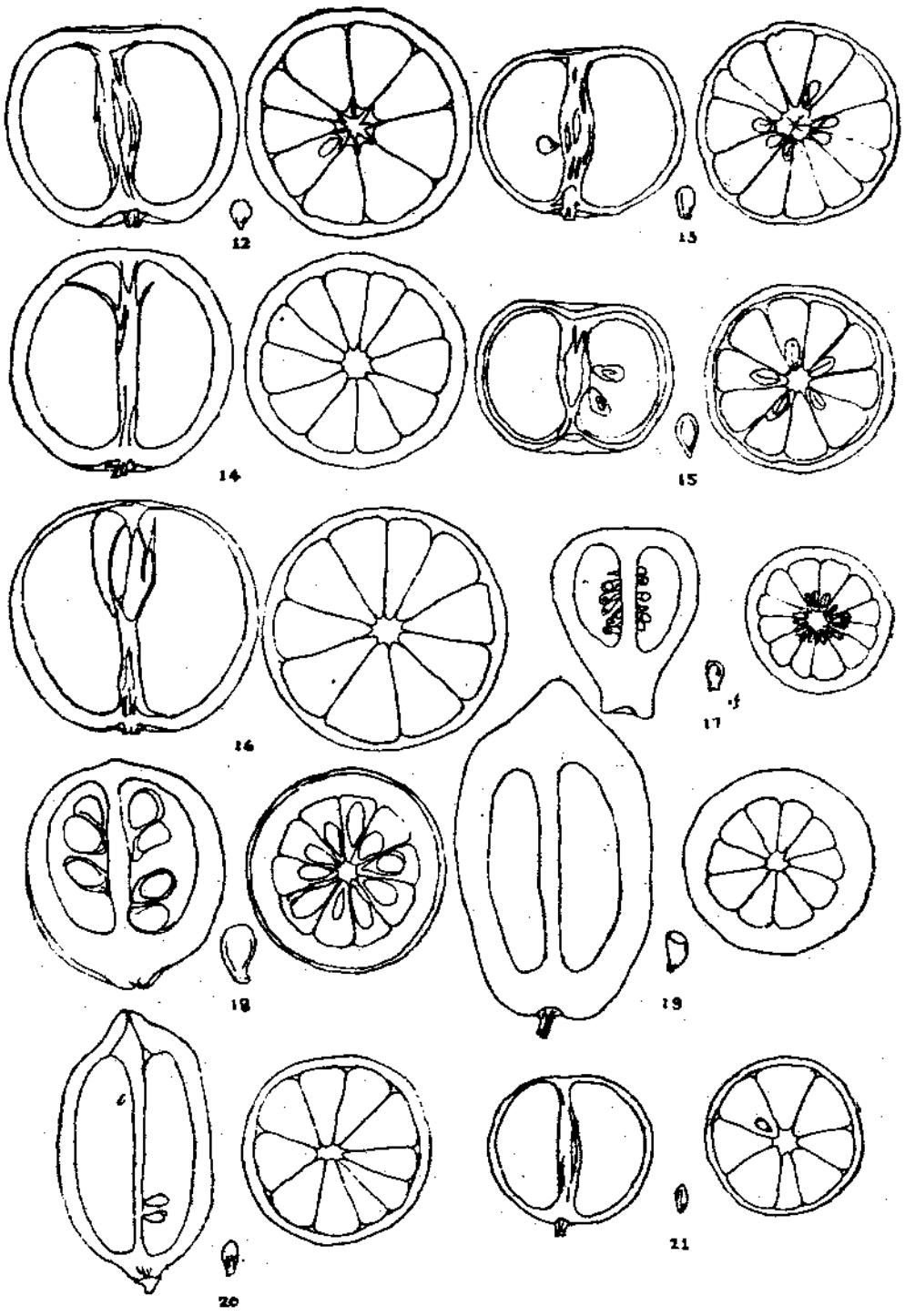
THE CHIEF CITRUS FRUITS COLTIVATED IN CHINA (PLATE ONE)



No.1. *Fortunella margarita*, Swingle 羅浮
2. *Fortunella crassifolia*, Swingle 金彈
3. *Fortunella obovata*, Tanaka 長壽金柑
4. *Citrus microcarpa*, Bunge 金橘
5. *Citrus kinokuni*, Hort. Tanaka 乳橘
6. *Citrus nobilis* Lour. var. *subcompressa*, Tanaka. 早橘
7. *Citrus unshiu*, Tanaka 溫州蜜柑
8. *Citrus erythrosa*, Tanaka 朱橘
9. *Citrus tangerina*, Hort. ex. Tanaka. 紅橘
10. *Citrus poonensis*, Hort. ex. Tanaka. 布柑
11. *Citrus tankan*, Hayata 蕉柑

圖版二 中國主要栽培柑橘之果實(⅓)

THE CHIEF CITRUS FRUITS CULTIVATED IN CHINA (PLATE TWO)



No, 12. *Citrus suavissima*, Tanaka 酸柑
13. *Citrus suhoiensis*, Tanaka 四會柑
14. *Citrus sinensis*, Osbeck form Sekkan, Hayata 雪柑
15. *Citrus junos*, Tanaka 橙子
16. *Citrus sinensis* var, *brassilliensis*. Tanaka (Washington Navel Orange) 美國臍橙
17. *Citrus grandis*, Osbeck 沙田柚
18. *Citrus graudis*, *var. Shangpuan Hn* 香圓
19. *Citrus medica*, Linn. (Citron) 枸櫞
20. *Citrus Limon*, Burm (Lemon) 檸檬
21. *Citrus limonia*, Osbeck (Canton Lemon) 粭檬

圖版三　中國栽培柑橘類之葉(⅓)

LEAVES OF CITRUS CULTIVATED IN CHINA (PLATE THREE—FIVE)

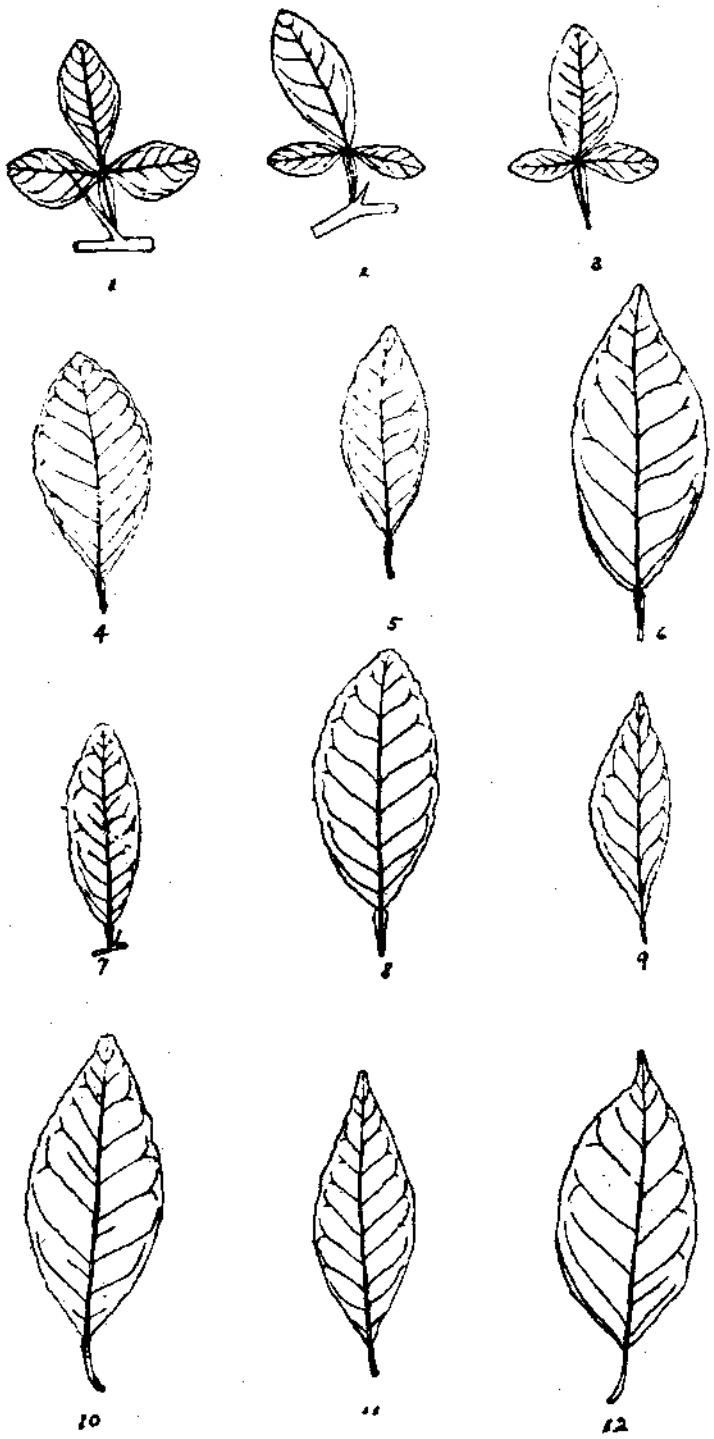


Fig. 1. *Poncirus trifoliata*, Raf. 枳殼

2-3. *Hybrid* of *Poncirus* trifoliata, Raf. 枳殼雜種

4. *Fortunella obovata*, Tanaka 月月橘, 長壽金柑

5. *Fortunella margarita*, Swingle 羅浮

6. *Fortunella cassifojia*, Swingle 金彈

7. *Forunella Hindsii*, Swingle 金豆

8. *Citrus Poonensis*, Hort. ex Tanaka. 柠柑

9. *Citrus kinokuni*, Tanaka 乳橘

10. *Citrus tangerina*, Hort. ex Tanaka 紅橘

11. *Citrus erythrosa*, Hort ex Tanaka 朱橘

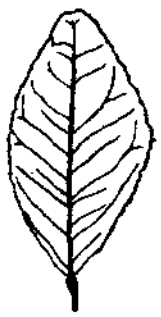
12. *Citrus uushiu*, Tanaka 溫州蜜柑

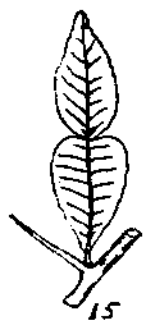
13. *Citrus nobilis*, Lour (King Orange)

圖版四 中國栽培柑橘類之葉(⅓)

LEAVES OF CITRUS CULTIVATED IN CHINA (PLATE FOUR)

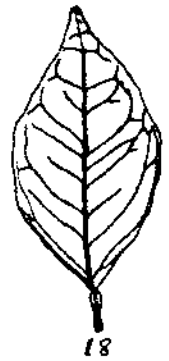

13

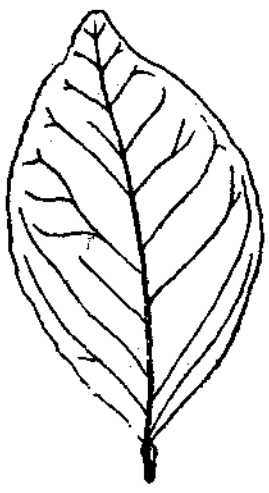

14

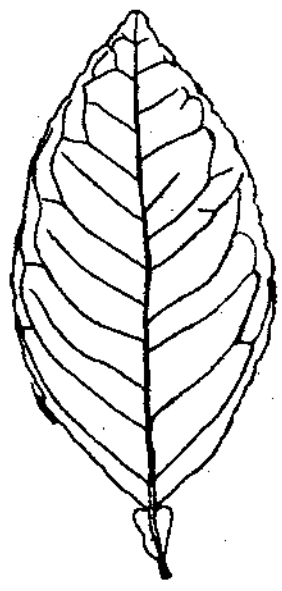

15


16


17


18


19


20

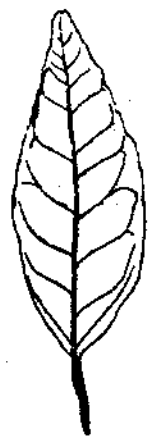

21

Fig. 14. *Citrus nobilis* var. *sunki*, Hayata 酸橘

15. *Cirus ichangensis*, Swingle 宜昌柑

16. *Citrus microcarpa*, Bunge 金橘

17. *Citrus tankan*, Hayata 蕉柑

18. *Citrus sinensis*, Osbeck form Sekkan 雪柑

19. *Citrus sinensis*. Osbeck甜橙

20. *Citrus sinensis*, var. *brasiliensis*, Tanaka 美國臍橙

21. *Citrus junos*, Tanaka橙子

圖版五　中國栽培柑橘類之葉(⅓)

LEAVES OF CITRUS CULTIVATED IN CHINA (PLATE FIVE)

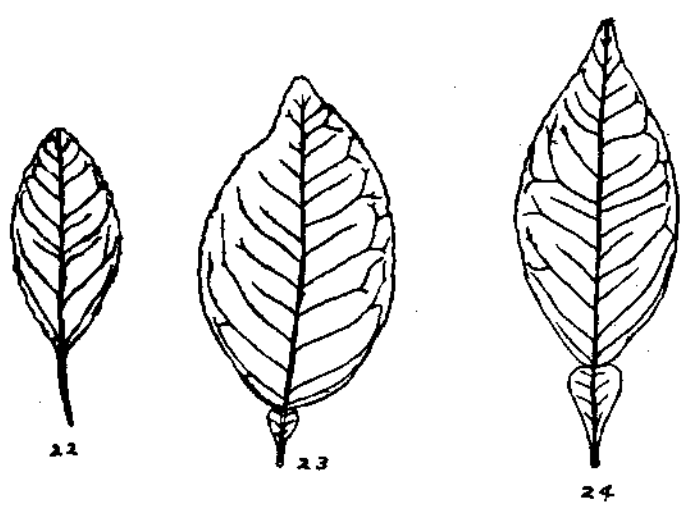


Fig. 22. *Citrus suhoeinsis* Tanaka 四會柑

23. *Citrus hotokan*, Hayata 虎頭柑

24. *Citrus Aurantium*, L. 酸橙

25. *Citrus limonia*, Osbeck 檸檬

26. *Citrus Limon*, Burm 檸檬

27. *Citrus medica* L. 枸櫞

28. *Citrus grandis*, Osbeck

29. *Citrus Grandis* var. *Shangpuan*, Hu 香圓

30. *Citrus suavissima*, Tanaka 甌柑

四 中國栽培柑橘之歷史分佈與柑橘業發達之關係

吾國柑橘栽培之歷史與柑橘種類之分佈，已如上述；吾國柑橘栽培之古，見夏書禹貢曰："厥包橘柚錫貢。"在西歷紀元前二千二百年，鉅今爲四千百餘年之記事 栽培歷史之早，當爲世界列國之冠。柑橘栽培分佈之區域，在緯度 20°N 至 30°N 間爲最適宜，吾國地處溫帶，適宜栽培柑橘之地點，占全世界三分之二，倘然獎勵柑橘生產事業，不畏不成世界之霸，美國加州之注意柑橘栽培。僅在十九世紀末葉，能應用科學，銳意改進，今日加州產之 Orang,, Lemon, Grape fruit 運銷世界各大市場，甚至吾國四川僻地，每年消費美國之 Orange 亦爲數不少。現吾國每年由美國，日本，西班牙輸入之橘，甜橙，檸檬，Grape fruit等，自1929年至1932年之輸出入統計如次表：

中國海關報告之柑橘類果實輸出入統計表

輸出					備考
種類	1929年	1930年	1931年	1932年	
橘	847,929關兩	851,661關兩	878,524關兩	818,316關兩	主輸往南洋各地

輸入					備考
種類	1929年 關兩	1930年 關兩	1931年 關兩	1932年 關兩	
橘及甜橙	2,288,258	1,425,123	1,313,206	1,405,005	主由美國日本輸入
檸檬	146,113 "	195,848 "	202,924 "	143,619 "	

每年柑橘果實之輸入數量，當在150—200萬海關兩，以柑橘栽培歷史最古與最適宜區域最廣之吾國，每年尚有數百萬關兩柑橘之輸入，每年雖亦有輸出，僅八九十萬關兩，不足抵輸入之三分之一。吾國柑橘栽培因種

類之不統一，栽培方法之幼稚，與運輸之不完善，柑橘果實不能與美國之輸入品相競爭，輸入品多數爲甜橙，檸檬，美國小柚等，堪耐貯藏運輸，能在夏季供給，銷路尤廣。吾國生產之柑橘以寬皮橘爲大宗，甜橙類甚屬少數，供不應求。檸檬，美國小柚可說全無生產；寬皮橘不能貯藏至夏季，所以夏季柑橘有多量推銷於吾國。在吾國風土甜橙，檸檬，美國小柚並非不宜栽培，尙無人注意提倡耳。卽在吾國古有之柑橘種類中，加以選擇，亦有夏季成熟之柑橘果實，選擇柑橘之優良品種，與統一栽培，改良運輸銷路，均爲柑橘生產事業改良之重要問題，不但柑橘，卽其他果樹亦需要此同一方法之改良也。

吾國原產橘，柚(*Citrus junos*, Tanaka)，枳，分佈南部及長江流域，枳柚兩種果實均不堪食用，僅能作柑橘接本，橘亦形小，不堪貯藏，不適於輸出栽培。柑印度原產，大約漢時輸入吾國栽培古書所記之壺柑，或卽爲今日有柑之類。漢代對於柑橘極爲注意，漢武帝置交趾橘官，主歲貢御橘之事。柑類在吾國特爲發達，種類品種甚多，主要者如有柑，蕉柑，四會柑，茶枝柑，甌柑，黃柑等，品質固爲柑橘中之最優良者，但不耐貯藏，不能運輸至遠爲缺點。有柑，蕉柑廣東潮州產，每年僅能運至上海，往北部者至爲少數，北部所銷者皆爲日本橘及美國甜橙。

橙類吾國亦自古栽培，剝皮不易，味亦稍酸，不合國人嗜好，故卽不注意栽培，現在廣東方面有少量栽培，不如柑與橘之多；但廣東栽培之橙類品種不少，大可注意選擇優種與改良栽培方法。在日本現有一種廣東橙(Canton Orange)係廣東傳去，每年六月成熟，豐產，指爲日本栽培夏橙(Summer Orange)之優良品種。著者在廣東調查所見之香水橙，酸橙，雪柑，成熟亦遲，大約可留樹上至四五月，品質之佳實亦不亞于美國輸入

之 Valencia Late 與 Washington Navel Orange 也。現在吾國柑橘栽培，選擇夏季產之橙類，獎勵栽培，爲減少輸入柑橘之重要問題。

檸檬現在吾國完全無生產，每年由美國加州及西班牙輸入，年額約二十萬海關兩，爲數亦不少；倘自國能生產，尚能增加消費。廣東產之黎檬，酸而無香氣，作檸檬之代用品，價值甚低。檸檬栽培在廣東，福建之乾燥地方大可試驗栽培。

柚類吾國生產尚不敷供給，大可再事廣充栽培，吾國所產之沙田柚，平山柚等，果形太大，能改良稍小，如暹邏柚，則銷路尤廣。美國之 Grape Fruit (*Citrus paradisi*) 果形如小柚，四季能產，周年可供給需要，歐美人以grape fruit爲朝食，需量甚巨；近年吾國亦有少量之輸入，將來需要亦有日增之勢，故 grape fruit之提倡栽培，亦屬不可再緩。在吾國栽培柚類中，亦類似 grape fruit 者，倘有優良之種，大可選擇本國固有之種，獎勵栽培，易收成效，柚類之生產，可在自廣西至浙江南部一帶推廣栽培。

日本柑(溫州蜜橘)與早橘類似，由吾國溫州傳去，而經日人改良爲無核種，此種早熟，可應新年之需要，每年輸往美國有數百萬元，吾國北部數十萬元，北部柑橘市場均爲日本柑所佔。吾國南部之柑橘不能運至北方。有數種原因，如生產不敷，捐稅太重，貯藏運輸不注意，故不能與日貨競爭，振興實業，非借重政治力量，其成功至難。

橘子汁近年以來，各處銷費甚巨，此種橘子汁原料不必輸入美國甜橙，四川重慶，湖北宜昌產之橘，橙，柑等，大可應用：供爲橘子汁之原料，現尚無人注意，甚爲可惜。

吾國柑橘栽培歷史雖屬至早，分佈區域雖屬至廣，而柑橘之生產事業不如日美，其主要原因在栽培方法之不知改良，品種不統一，貯藏運輸不

完善，吾國柑橘生產區域，在南部沿海岸爲最有希望，其次在長江南部。在南部沿海岸可注重栽培需要高溫之柑橘，如柚，檸檬，有柑，甜橙。長江南部可獎勵栽培耐寒性强之柑橘如，甜橙之一部分及日本柑，本地早，早橘等。吾國如在廣西梧州附近，廣東之潮州，福建之漳州、浙江之溫州，江西之贛縣，瑞金，湖南之洞庭湖附近，湖北之宜昌，四川之重慶等處，注意改良柑橘，卽不難解決供給之需要，與抵制外貨之輸入。將來吾國有優良之柑橘，不但供給自國需要，尙可銷往俄國及歐洲。

吾國南部爲柑橘之天產區域，自然環境甚爲適宜，倘加以人工之改良，吾國柑橘之生產事業，不難在世界市場占相當之地位，觀吾國栽培柑橘之歷史分佈，與柑橘事業發達之關係，古代注重小規模栽培，供給一家一地之需要，所以品種選擇皆無一定標準。現在則都市發達，交通便利，柑橘之生產應注意於大規模栽培，有大量生產，則運輸銷售均屬便利。

吾國南自廣東，廣西，雲南，福建，江西，貴州，湖南，北至四川，浙江，湖北，安徽，江蘇等十二省，均有野生及栽培柑橘，以土宜氣候而論均適宜柑橘。以現在情形而論，廣東柑橘之栽培最發達，年額約六七百萬元，占全國生產額之60％以上。廣東固屬土宜，氣候適於柑橘栽培，而人民經濟富裕，能栽培比較需資本之柑橘，亦其發達之原因。廣東柑橘生產地之最有希望者，爲潮州，海運便利，自汕頭至上海三天可達，路線短，運輸便利。潮州現在主產有柑，蕉柑，雪柑，將來對於美國臍橙，檸檬亦可注意試栽。

廣西在容縣產柚，柑橘之出產不如廣東，概由于交通不便，農民經濟凋蔽，所以比較需資本之果樹栽培尙不能發達。

現在吾國果樹栽培，宜注意于減少生產費用，增加生產能力，至爲重要。

雲南有野生柑橘及栽培，現尚無人注意調查雲南柑橘生產情形，無參考材料。

福建在漳州及福州栽培柑橘最發達，漳州龍溪產盧柑（卽有柑），桶柑（卽蕉柑），雪柑，浦南產柚最多，該地雨量比較少，將來可提倡美國臍橙，Valencia Late，檸檬等種栽培。福州主產紅橘，不耐運輸貯藏，非適于大規模生產之品種，福建年產柑橘約二百萬元，建甌等處尙可擴充柑橘栽培。

江西南豐產蜜橘著名，全省到處栽培柑橘，將來能在北部栽培日本柑，南部栽培甜橙，柚類，可成爲長江流域之柑橘新生產區域。

貴州產柑橘亦多，去年友人採得甜橙類之標本送余，則知貴州亦產甜橙。改良夏季生長之甜橙，爲吾國柑橘生產之重要問題，在長江南部有此生產區域，則將來發達頗有希望，

湖南洞庭湖旁產橘，自古著名，惜栽培之品種不良，皆朱紅橘，品質不佳。倘改種日本柑或本地早，則產品可以推銷北部。

四川柑橘之栽培甚發達，惜交通不便利，不能運銷外部爲可惜耳。現在柑橘均以橘皮及橘乾運銷下江。四川產橘將來大可改良，栽培甜橙類及橘類。

浙江溫台產橘，唐宋時代發達 溫州柑橘因病蟲害關係，日趨衰敗，溫州甌柑本銷天津，今因與日貨競爭關係，處于劣敗地位，改良方法唯有注意栽培選果，包裝，運輸，貯藏等，或可挽回銷售之地位。黃巖產橘前數年雖受綿吹介殼蟲之爲害，略受頓挫：現已有防治方法，柑橘生產已恢復如常，將來當日益發達，因地居江浙，銷路甚佳，現在年產額百數十萬元，占據全國生產額百分之十左右。

湖北野生枳，橘，柚，柑橘之栽培亦自古著名，長江上流湖北亦爲生產柑橘之有希望之區域。

安徽南部產少量之橘，將來可注意栽培耐寒性强之橘類。

江蘇氣候寒冷，不適栽柑橘，僅洞庭山利用南面傾斜地栽培耐寒性强之橘類。

改良柑橘生產計劃宜注意下記各項：

1　柑橘分佈之氣候及土宜。

2　改良栽培方法提倡大規模生產。

3　選擇優良品種及改良接本。

4　注意病蟲害防治。

5　改良包裝，運輸，貯藏。

以上所舉改良各點，均須有研究試驗機關與團體，實行改良之組織，工作無系統聯絡，則事業改良當然難收成效也。

五　結　論

1　柑橘類原產吾國者，橘，柚，枳，金柑等。分佈于南部及長江流域。

2　柑印度原產，有柑與印度產之 Keonla, Suntara 類似，或爲同一系統，吾國之柑字由 Keonla 音譯而來。

3　橙吾國自古栽培，橙字或由印度之 Naranj, 音譯而來。

4　柚印度，馬來羣島原產。

5　廣東栽培之黎檬，印度原產爲 Otaheite Orange 之一種。

6　吾國之柑橘栽培歷史，依據夏書禹貢(2200B.C.)曰："厥包橘柚錫貢。"早在虞夏時代以前已有栽培，距今爲四千數百年，爲世界柑橘栽培史

之最古者。

7 吾國古時柑橘繁殖，即知用嫁接法，以枳爲接本，如羣芳譜別錄(1630A.D.)所記，"種子及栽皆可以枳樹截接，或貼接尤易成。"

8 橘，柚，枳，在吾國栽培最早，當在四千年以前，(查禹貢，周禮，說文等書)。

9 紅橘，柑，橙等大約漢代傳入，於唐宋時代發達栽培，

10 柚之傳入歷史亦早，大約在漢代，柚之異名甚多，欒(福建)，抛(溫州)，文旦(上海)，文旦係人名，小旦文姓所產，日文旦柚，並非種名。柚(yu)或由馬來之 Usse 音譯而來。吾國古書之柚係指橙子 Citrus junos, Tanaka, 而言，乃同名異物。

11 枸櫞印度原產，名 Turunj, 枸櫞之名或由此字音譯而來。南方草木狀(290—307A.D.) 記有枸櫞在吾國栽培之起源，約在西曆紀元三百年。

12 長江流域栽培之香櫞，係柚之雜種，學名 *Citrus grandis* Osbeck, var. *Shangyuan*, Hu.

13 吾國廣東栽培之黎檬，學名爲*Citrus limonia*, Osbeck, 檸檬爲 *Citrus Limon*, Burmann.(依據田中博士之糾正)

14 廣東柑橘栽培起源之歷史，參照裴淵廣州記 (500A.D.)，即載有廣東產柚。長江流域湖南洞庭之橘，在山海經上已有記述。四川古代產柑，在廣志 (502—551A.D.) 記有犍爲，南安出好黃柑。浙江柑橘發達于唐宋時代，見宋韓彥直橘錄。廣東栽培柑，紅橘，橙，柚等，由印度，馬來等處傳來。長江沿岸自古栽培之橘，柚，枳，係吾國原產，栽培之歷史最早。金柑原產吾國，恐爲唐宋時代起始之栽培品。

15　吾國栽培之橘類種類品種最多，可大別爲四類：

a. 乳橘亞類　乳橘，蜜橘，假蜜橘。

b. 早橘亞類　早橘，無核早橘，日本柑。

c. 本地早亞類　本地早。

d. 椪橘亞類　甜橘，酸橘，

16　紅橘類中可分正紅橘與朱橘兩種。

17　吾國栽培之柑，性質各異，可大別爲五亞類：

a. 有柑亞類　有柑，盧柑，蜜糖柑，槾。

b. 蕉柑亞類　蕉柑桶柑。

c. 四會柑亞類　四會柑。

d. 茶枝柑亞類　茶枝柑

e. 甌柑亞類　甌柑(乳柑)

18　甜橙栽培之品種甚多，約有二十餘種，以甜橙、香水橙，柳橙爲著名。現美國產之 Washington Navel Orange 及 Valencia late 在廣東均有試栽。

19　酸橙栽培甚少，有鉤頭橙，產黃巖，自古賞用，爲柑橘之接本；蘇州產之代代橙，係採花蕾焙乾，混入茶市，使增香氣。

20　橙子名見證類本草(唐愼微1108A.D.)古名柚，現在長江流域栽培，果皮甚香作蜜餞用及藥用。

21　宜昌柑原產宜昌，爲我國特有之種，異名枳殼，供藥材用。

22　柚產廣西，廣東，福建，浙江，四川，以福建浦南爲最著名。

23　黎檬子在廣東栽培，供柑類接本，及做解渴水用。

24　吾國柑橘類中 Summer Orange, Lemon, Grape fruit之栽培

均屬缺少，宜注意提倡，增加生產。

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THE HISTORY AND DISTRIBUTION OF CITRUS FRUIT IN CHINA

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Resume

1. The Chieh (橘)*Citrus* spp., Yu (柚)*Citrus junos* Tanaka, Chih (枳) *Poncirus trifolista* Raf. and Ching Kan(金柑)*Fortunella* spp., the indigeneous Citrus fruits in China, are cultivated and occasionally grow wild in Southern China and the Yangtze Valley.
2. Kan (柑)originated in India. The Chinese Mo Kan(有柑) is the same as Keonla and Suntara which are cultivated in India. They are probably of the same variety. The Chinese character Kan (柑) may be a translation of Keonla.
3. Cheng(橙)*Citrus sinensis* Osbeck. is very rarely cultivated in China. The character Cheng (橙) may be a translation

of naranj, an Indian term.

4. The pumelo originated in India and the Malay Islands.

5. The Canton lemon(廣東檸檬) *Citrus limonia* Osbeck. is cultivated in Kwangtung.

   It is the same variety as the Otaheit orange which originated in India.

6. According to old literature. such as the Sha Shu Yu Kon (夏書禹貢) in 2200 B.C., Chieh (橘) and Yu (柚) were cultivated inChina about four thousand years ago.

7. In ancient times, Trifoliate orange (*Poncirus trifoliata* Raf inesque) was used as stock for grafting. This is described in the Chung Fan Pu(羣芳譜), 1630 A. D.

8. According to old Chinese Literature, i.e. the Yu Kon (禹貢) in 2200 B. C, Chou Li(周禮)in 1110 B. C. and Sai Bun(說文) in 121 A. D., Chieh(橘), Yu(柚), and Chih(枳) were cultivated in China four thousand years ago.

9. Hong Chieh(紅橘) (tangerine), Kan (柑) (mandarin orange)' Cheng (橙) (orange), were probably introduced during the Han dynasty. They were more extensively cultivated during the Tan and Sung Dynasties(唐宋時代)

10. Keu Yuan (枸櫞) originated in India. The Chinese name (枸櫞) is a translation from the Indian term Turunj.

11. The pumelo was introduced into China, possibly in the Han

Dynasty (漢代) There are various names for pumelo in China, such as Laun(欒),Pao(拋)and Buntan (文旦) Buntan is the name of a person who developed a variety of pumelo called Bun Tan Yu in Chonchow, Fukien. The term Yu (柚) is now more commonly used. This is possibly a translation of the Malay character "usse" for pumelo. In ancient times the name Yu(柚) was applied to Cheng Tse (橙子) *Citrus, junos* Tanaka.

12. Along the Yangtze Valley a hybrid of pumelo Shangyuan (香圓) is cultivated. Its scientific name is *Citrus grandis* Osbeck var. *Shangyuan* Hu

13. According to Kwangchow Ki written by Pei Yuan(裴淵廣州記) (Canton Historical Sketch, 500 A. D.) pumelo was grown in Canton. Citrus culture in Kwangtung was begun very early In the San Hai Chin (山海經), Tong Ting Hu, Hunan, (洞庭湖,湖南) was mentioned as being famous for the production of Chieh(橘), In Kwang Chi,(廣志) 502-551 A. D. the Hwang Kan (黃柑) is mentioned as being famous in Szechuan. According to the Chieh Lou written by Hang Nien Shou (Orange culture in Wenchow)(韓彥直橘錄) orange culture in Chekiang was developed in the Tang and Sung Dynasties. The Kan(柑) mandarin orange, the Hong Chieh(紅橘) tangerine, Cheng(橙) orange, and Yu (柚) pu-

melo, originated in India and the Malay States. The Chieh (橘), loose skinned orange, was cultivated very early in China in the Yangtze Valley. The kumquat, indigenous to China, was probably cultivated in the Tang and SungD ynasties.

14. The Li Mong (檸檬)Otaheit orange in Kwangtung, is *Citrus limonia* Osbeck while Ning Mong (檸檬), common lemon, is *Citrus limon Burmann* (Verified by Dr. Tanaka.)

15. The loose-skinned oranges cultivated in China can be divided into four subgroups.

Subgroup l-Ju Chieh (*Citrus kinokuni* Hort. Tanaka)

Ju Chien (乳橘)

Mi Chieh (蜜橘)

Kai Mi Chieh (假蜜橘)

Subgroup 2-Tso Chieh (*Citrus nobilis* var. *subcompressa*, Tanaka)

Tzo Chieh(早橘)

Mu Ho Tzo Chieh(無核早橘)

Chieh(橘)

Satsuma orange(日本柑)

Subgroup 3-Penditzo (*Citrus succosa* Hort. Tanaka)

Penditzo(本地早)

Subgroup 4 Pon Chieh(椪橘)(*Citrus ponki* and *Citrus sunki.*)

Tien Chieh (甜橘)

San Chieh(酸橘)

16. Tangerine group include Hong Chieh(紅橘)*Citrus tangerina* Hort. Tanaka, and Chu Chieh (朱橘) *Citrus erythrosa* Hort. Tanaka.

17. The mandarin orange group can be divided into five subgroups.

Subgroup 1- Mo Kan(有柑)*Citrus Poonensis* Hort. Tanaka

Mo Kan(有柑)

Lou Kan(盧柑)

Mi Tan Kan(蜜糖柑)

Man(槾)

Subgroup 2-Sheo Kan(蕉柑) *Citrus tankan,* Hayata

Sheo Kan (蕉柑)

Ton Kan (桶柑)

Subgroup 3 Suhoi Kan(四會柑) *Citrus suhoiensis* Tanaka

Suhoikan(四會柑)

Subgroup 4-Cha Chu Kan(茶枝柑)

Cha Chu Kan(茶枝柑)

Subgroup 5-Erkan (甌柑) *Citrus suavissima* Hort. Tanaka

Erkan(甌柑)

18. Among the sweet oranges cultivated in Kwangtung, Tien Cheng(甜橙) Shang Sui Cheng (香水橙) and Liu Cheng (柳橙) are the most famous varieties. The American Washing-

ton Navel orange and Valencia Late orange were introduce into Canton several years ago.

19. Very few sour oranges are grown in China. The Kiu Toa Cheng (鉤頭橙) grown in Hwang Yien (黃巖) is used for Citrus stock. The blossoms of the Dai Dai Cheng(代代橙) grown in Soochow are dried and used in tea to make it fragrant.

20. The name Cheng Tse(橙子) appeared in the Chen Liu Pen Tso (證類本草)(edited by Tan Chin Fi (唐愼微) 1108 A. D.) although the old name Yu was used. Cheng Tse is grown in the Yangtze Valley. The peel is used for making candy and medicine.

21. Ichang Kan (宜昌柑) *Citrus ichangensis,* Swingle, originates from Ichang, Hupeh.(Chih Ko(枳殼) is an old name of this variety). The peel is used for medicinal purposes.

22. Pumelos are produced in Kwangsi, Kwangtung, Fukien, Chekiang and Szechuan. The Pu Nan pumelo, from Fukien is the most famous in China.

23. Li Mong Tse (檸檬子) cultivated in Kwangtung is used for Citrus stock and the fruit to make lemonade.

24. The cultivation of summer oranges, lemons, grapefruit, etc. in China is insufficient. This needs to be encouraged.

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中國農村

中國農村發刊旨趣： 有系統地研究中國農村經濟問題；提供農村調查材料；報告農村最近情況；討論農村經濟的理論問題；以中國經濟爲世界經濟底一部份的觀點，傳達世界農業知識；以中國農村經濟爲國民經濟底一部份的觀點；從經濟生活底各部門來攷察中國農村

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中國農村創刊號要目

INHERITANCE OF SOME PLANT CHARACTERS IN CABBAGE, *BRASSICA OLERACEA, VAR. CAPITATA*[1]

C. C. Kwan

INTRODUCTION

The common cabbage, Brassica oleracea var. capitata, is an open-fertilized plant which has shown striking variations. Very little work has been reported on the genetics of cabbage. The studies reported herein are the genetic analysis of certain plant colors, and foliage types. In addition plant height and head weight were studied.

LITERATURE REVIEW

Plant Colors

Up to the present only two genetic colors of cabbage plants have been reported, "Red" or "purple", and green.

Kristofferson (6) reported extensive investigations on a light-red color of the mid-vein in cabbage and in brussels sprouts. In both cases, crosses were made with broccoli which is green in these parts. In the F_1 the mid-vein was light-red. A monohybrid segregation followed in F_2 with a ratio of 3 light-red : 1 green mid-vein. He designated this factor for light-red color of mid-vein in cabbage and brussels sprouts as *B*. Broccoli, therefore, is *b*. A cross between light-red mid-veined cabbage and a similar type in brussels sprouts produced only light red in F_1 and F_2, showing that the two factors are the same. This light red type is probably the same as that referred to here by the writer as "sun color". When kale, which has a green mid-vein, was crossed with this same cabbage of light red type, the F_1 had a dark-red-violet mid-vein. The F_2 plants segregated into dark-red-violet, light-red, and green in a ratio approximating 9 : 3 : 4.

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[1] A thesis presented to the faculty of the Graduate School of Cornell University in partial fulfillment for the degree of Doctor of Philosophy.

When the non-dark red classes, that is, light-red and green vein, are considered together, the ratio between dark red and non-dark red is approximately 9 : 7. This would indicate complementary factors for the dark red-violet color. He assumed a factor *A* in the kale which interacts with a factor *C* in cabbage or brussels sprouts to produce this dark-red-violet vein color. With respect to these factors, kale is *A c* and cabbage or brussels sprouts is *a C*. In the F_2 there was a deficiency of the light red type carrying *B*, and a proportional excess of the green *b* type. This deviation he suggested might be due to linkage of *B* with either *A* or *C*. Since the crosses of broccoli with cabbage and of broccoli with brussels sprouts did not give dark red-violet mid-rib, broccoli must be *a*.

In further studies, Kristofferson (6) found complete dominance of dark red leaf color in the cross of the green leaved light-red mid-veined cabbage with a dark red leaved type. In the F_2 there was segregation of approximately 3 dark red leaved plants to 1 green leaved plant. This also held true in crosses of dark red leaved cabbage with kale, with brussels sprouts, and with broccoli. He suggested the factor *D* for this dark coloration of red cabbage. In the cross of kale with green leaved light red-vein cabbage or with brussels sprouts, the leaf color of the F_1 was dark red-violet. The F_2 ratio could not be interpreted since the variation was continuous. Most plants had a darker or lighter trace of violet, and a rather large number of the plants were as dark colored as the red cabbage. In the cross between red cabbage and tall kale, the F_2 ratio of intermediate and green to dark red is approximately 3 : 1. In the light-red cabbage, he assumes there is a factor *E* for extension of dark color when *A* and *C* are both present.

From his experimental results he formulated the most probable genetical constitutions as follows:

Cabbage	dd	aa	BB	CC	EE
Red Cabbage	DD	AA	bb	cc	ee

Brussel sprouts	dd	aa	BB	CC	EE
Kale	dd	AA	bb	cc	ee
Broccoli	dd	aa	bb	CC	EE

From the cross of purple kohl-rabi x green savoy cabbage reported by Pease (9) a purple F_1 was obtained. The F_2 population segregated into 9 purple: 7 green. This ratio indicates two complementary factors for purple.

Sutton in 1924 (14) in crosses between red and green cabbage concluded that "red" is due to a single dominant or incompletely dominant factor.

Allgayer (1) made a cross between green cabbage and a type called "Rot kohl" with wine-red stalk (stem) and vein. All of the F_1 plants from the cross between these two types were pigmented. In the F_2 generation the plants were grouped into three classes depending upon the amount and distribution of pigment. In one class, "ganz", the color was present upon the leaf stem (petiole or mid-rib), leaf surface and all parts of the plant. In a second class "ader" the pigment showed only on the leaf veins while the leaf surface remained green. The third class comprised those plants in which no pigment was observed. The F_2 ratio of pigmented : green was 3 : 1, from which he concluded that pigmentation is due to a single dominant factor. designated $\underline{P}$.

About six years ago, Dr. C. H. Myers of the Department of Plant Breeding of Cornell University, found a color type among the proneny of a selfed plant of Danish Round Red variety. This new type was named "Magenta". With the bloom present the color on the stem and outer leaves of "Magenta" matches fairly well with Ridgway's Daphne Pink or Daphne Red. In the seedlings the color is more dilute, varying between light Persian Lilac and Persian Lilac. The color in the interior of the head especially where chlorophyl and bloom are absent, agrees fairly well with Ridgway's Spinal Red. This type has been studied genetically by Magruder.

Magruder (7) obtained purple plants in the F_1 of a cross between sun color and magenta plants. In the F_2 there was segregation of 9 purple: 3 magenta: 3 sun red: 1 green. The assumption of two factors explains these results. The factor *M* is designated as the one responsible for the production of magenta and *S* for the production of sun color. The purple type then is *M S* and *m s* is green.

Foliage Characters

The wrinkled leaf character, as found in the savoy cabbage, has been reported to be dominant over the smooth leaf type. Price (I0) crossed Drumhead savoy with the smooth-leaf variety known as Volga. In reciprocal crosses the F_1 hybrids in both cases were of the savoy type. No segregation was obtained, not a single plant with smooth foliage could be found in F_2 or F_3 populations. Moreover, this wrinkled condition was more highly developed in the F_3 population. The author stated that "such behavior might be given a Mendelian interpretation by utilizing the hypothesis of Nilsson-Ehle and East, assuming the Savoy parent to possess a large number of factors fo. crinkling". However, such an interpretation does not harmonize with results reported by Tschermak (after Fruwith) in which curled leaf was found to be dominant over the smooth leaf, but segregation occurred in F_2.

In the cross between cabbage which has an entire leaf, with kale whose leaf is deeply lobed, Kristofferson (6) obtained an F_1 with intermediate type of lobing. With respect to curliness of leaf the F_2 plants showed wide variation. However, a few plants closely resembled the kale parent. In crossing brussels sprouts with kale, plants intermediate in amount of curling were obtained in F_1. In the F_2 there was almost continuous variation between the two parental types. Only a few plants were similar to the parents. The author concluded that four or five factors were concerned in the production of the curly leaf of kale.

Rasmusson (I2) crossed common cabbage with the savoy variety,

the F_1 plants were all savoy type. The wrinkling of the leaves in the savoy variety therefore, is dominant. Only 10 plants out of 780 F_2 individuals had leaves similar to those of the common cabbage parent. The author suggests that wrinkling of the leaves is inherited as a quantitative character.

MATERIALS AND METHODS

The materials used in this study were three pure inbred strains from the improved commercial stock of Professor C. H. Myers of the Plant Breeding Department, Cornell University. The pure strain of "Purple" (pedigree number "1085-5) has purple color which matches very well with Ridgway's Indian Purple. The color extends over the blade with varying degrees of intensity and becomes more distinct in the middle vein. It has smooth foliage and has a plant height of 9.36±0.199 inches under the field growing conditions at Ithaca. This purple is probably the same as the "red" or "dark red" reported in the literature by Kristofferson and Sutton.

Another homozygous strain, (pedigree number "341") is "sun red" in color. The term "sun red" is applied to this type because it develops color only on the portions of the plant exposed to the light. This strain has wrinkled foliage and a plant height of 8.08±0.190 inches. This type is probably the same as the green blade, light red mid-vein type reported in the literature by Kristofferson and Allgayer.

Another pure line, "342" is green in color. This line is pure green and never develops any pigment. This strain was used for plant color studies only.

The cultural and other methods employed in the experiments were worked out by Myers and have been described in detail by Magruder (7). Only a few of the important points will be noted here,

The seedlings were started in flats. Then after two weeks they were transplanted into other flats for wider spacing of the plants.

Three weeks later they were transplanted to the experimental plots. As soon as the plants were well matured, the color types, foliage characters, and plant height were studied. Heads for further crosses and studies were saved and placed in cold storage for two months at an average temperature of 40°F. Then they were potted and grown in a greenhouse carried at 75°F. for crossing and selfing.

Flowers to be crossed were emasculated the day before pollination. Self-pollination was effected by rubbing freshly opened anthers on the stigmas of all the open flowers on the same plant. Glassine bags were used to cover the individual flower stalks.

Plants of the parental lines were grown each year for comparison with the F_1 and F_2 families.

In connection with the study of plant colors special attention was paid to classification methods. It has been observed that in both strains intensity of the color is increased by sunlight. The presence of chlorophyll in the exposed leaves also makes classification into different grades of intensity difficult. Therefore, the color of the inner leaves wrapped up in head formation as well as that of the outer ones was studied.

Four classes of intensity of purple color based on the color of the outer head leaves have been arbitrarily set up, namely, A, B, C, D, ranging from lightest to darkest. In recording these grades of color leaves which had not been exposed to light were examined with great care. After completion of individual recording, heads of each pedigree were cut off and placed in groups to match and compare their color intensities. This scheme increases the accuracy of color classification.

In studying foliage characters the parental types served as the criterion for classification.

Height of plants and head weight were also studied. Each plant was measured with a vernier caliper in the field, considering its height as the distance from the surface of the ground to the tip of the head. These individual heads were carefully cut off at the base and

weighed.

INHERITANCE OF PLANT COLOR TYPES

In the study of plant color types, two different crosses were made: purple x sun-red and purple x green. The cross between the purple and sun-red types will be considered first.

Crosses Between Purple and Sun-red.

F_1 and F_2 Results

The cross of purple with sun-red plants gives an F_1 which is intermediate in pigmentation, corresponding to class "B" in the arbitrary scale of intensity of purple.

In the F_2 generation, both parental types were recovered, but the vast majority of the plants fall in grades of purple lighter than that of the purple parent. There usually is a clear-cut separation of the sun-red type from the purple, The F_2 resufts are given in Table I.

Table I. F_2 data from the cross purple x sun-red cabbage, and F_3 families which segregated sun-reds.

Pedigree			Purple	Sun-red	X^2	P	Odds
F_2	370—1	Obs.	444	26			
		Cal. (15:1)	440.6	29.4	0.4222	.4787	1:1
	370—3	Obs.	191	4			
		Cal. (15:1)	182.81	12.19	5.8694	.0138	71:1
	370—5	Cbs,	190	7			
		Cal. (15:1)	184.69	12.31	2.2905	.2957	2:1
	Total				8.7347	.0364	27:1
F_3	370—1—22	Obs.	105	7			
		Cal. (15:1)	105	7	0	0	0
	370—1—75	Obs.	98	9			
		Cal. (15:1)	100.30	6.70	0.8422	0.4925	1:1
	370—1—78	Obs.	131	12			
		Cal. (15:1)	134.06	8.94	1.1172	0.2924	2:1

370—1—121	Obs.	174	17			
	Cal. (15:1)	179.06	11.94	2.2872	0.1585	5:1
370—1—62	Obs.	186	7			
	Cal. (15:1)	180.94	12.06	2.2645	0.1415	6:1
370—1—98	Obs.	177	18			
	Cal. (15:1)	182.82	12.18	2.9660	0.0615	16:1
370—1—13	Obs.	179	18			
	Cal. (15:1)	184.69	12.31	2.8052	0.0956	9:1
370—1—122	Obs.	168	22			
	Cal. (15:1)	178.13	11.87	9.2211	0.01	99:1

This table also includes F_3 results from purple which segregated purples and sun-reds. This is legitimate since the later data show that these are comparable to the F_2 results. The ratio of "purple" to "sun-red" plants suggests a 15:1, indicating that duplicate genes may be involved. Using the X^2 test for goodness of fit (Fisher's Table III) (4), we find the deviation from a 15:1 in the F_2 results probably is not significant, P is 0.0364, corresponding to odds of 27:1. When the F_3 and F_2 results are totaled the ratio is very close to a 15.1. Out of 2,220 plants 147 were sun-reds where 139 are expected, $X^2 = 0.4604$, $P = .50$, corresponding to odds of 1:1. In one of the cultures (370-3) there is a large deficiency of sun-red plants, suggesting that triplicate factors were involved in this case. This same plant when tested in back-crosses (considered below) gave ratios indicating duplicate factors. In another culture, an F_3 (370-1-13) there was excess of sun-reds.

Baekcrosses of (Purple x Sun-red) F_1 x Sun-red

The hypothesis was further tested by means of backcrosses of the F_1 of Purple x Sun-red to the recessive sun-red type. Four of the F_1 purple plants, including the one which gave the deficient ratio in F_2 (370-3) were tested. In every case, the progeny was distributed in a ratio of approximately 3 purple to 1 sun-red as shown in the comparison in Table II.

Table II. Data from the backcross of (purple x sun-red) F_1 x sun-red.

Crosses		Purple	Sun-red	X^2	P	Odds
370—3 x 370—1—12	Obs.	66	25			
F_1 S.R.	Cal. (3:1)	68.25	22.75	0.2967	0.6023	2:1
370—4 x 370—1—1	Obs.	53	23			
F_1 S.R.	Cal. (3:1)	57	19	0.9228	0.4511	1:1
370—5 x 370—1—1	Obs.	16	9			
F_1 S.R.	Cal. (3:1)	18.75	6.25	1.1228	0.3489	2:1
370—4 x 370—1—37	Obs.	84	37			
F_1 S.R.	Cal. (3:1)	90.75	30.25	2.0083	0.1364	6:1
Total				4.3506	.3069	2:1

The fit of expected to observed on the basis of a 3:1 distribution is good, P equaling .3069 and odds about 2:1. That is, in one trial out of 3, a deviation as great as this would be expected due to chance alone. None of the cultures deviates significantly from a 3:1. Had triplicate factors been present in the F_1 plant (370-3) a 7:1 ratio would have been obtained in the above backcross.

These tests support the assumption that two independent duplicate factors are responsible for the production of the purple color. The symbols R_1 and R_2 have been assigned to these factors. In the pure purple strain both these factors, R_1 and R_2, are present in homozygous condition. When both R_1 and R_2 are absent, a sun-red plant results.

Intercrosses of different F_2 sun-reds.

Two F_2 sun-red plants were intercrossed and all of the 49 plants were sun-red. They exhibited a much more intense sun-red color than did their parents. This increase in intensity of sun-red may be due to an intensifying factor brought in by the purple parent.

Segregation in F_2 for purple intensity and F_3 tests of different grades.

An attempt was made to classify the F_2 into different grades of intensity of purple. The F_1 type and the parental purples were used as standards. Two additional classes were made, "C" which is intermediate between the F_1 and pure purple and "A" which is lighter than the F_1. It should be mentioned that the separation into these

Table III. Data on the segregation for color intensity in the cross of purple x sun-red F_2 results and F_3 from families segregating sun-reds.

	Pedigree		Purple intensity types D	C	B	A	X^2	P	Odds
F_2	370—1	Obs.	27	121	183	112			
		Cal. (1:4:6:4)	29.60	118.40	177.60	118.40	0.7935	.90	9:1
	370—3	Obs.	13	53	80	45			
		Cal. (1:4:6:4)	12.75	50.92	76.43	50.92	0.9458	.8141	8:1
	370—5	Obs.	10	50	89	41			
		Cal. (1:4:6:4)	12.67	50.68	75.97	50.68	4.7376	.20	5:1
	Tatal						6.4769	.6809	2:1
F_3	370—1—22	Obs.	8	25	44	28			
		Cal. (1:4:6:4)	7.0	28.0	42.0	28.0	0.5695	.9055	9:1
	370—1—98	Obs.	16	44	69	48			
		Cal. (1:4:6:4)	11.80	47.20	70.80	47.20	1.7712	.6262	1:1
	370—1—62	Obs.	9	54	77	46			
		Cal. (1:4:6:4)	12.4	49.6	74.4	49.6	1.5930	.6641	2:1
	370—1—75	Obs.	4	25	39	30			
		Cal. (1:4:6:4)	6.53	26.12	39.23	26.12	1.6059	.6592	2:1
	370—1—78	Obs.	10	39	56	24			
		Cal. (1:4:6:4)	8.73	34.92	52.43	34.92	4.3194	.2330	4:1
	370—1—121	Obs.	9	38	82	45			
		Cal. (1:4:6:4)	11.60	46.40	69.60	46.40	4.3551	.2293	4:1
	370—1—122	Obs.	19	55	60	34			
		Cal. (1:4:6:4)	11.20	44.80	67.20	44.80	11.1294	.0114	86:1
	370—1—13	Obs.	9	32	63	75			
		Cal. (1:4:6:4)	11.93	47.72	71.63	47.72	22.5329	.01	99:1

four classes is not in every case clear-cut. The variation in intensity is more or less continuous. It is not uncommon to find several heads on the borderline between two classes. However, they were grouped as accurately as possible. The frequencies of the color types in F_2 are shown in Table III. The F_3 populations which segregated purple and sun-reds are also included.

If we assume a cumulative effect of these factors, then the intensity of color will depend on the number of dominant Rs present, Either R_1 or R_2 or both. The parent purple type which is $R_1R_1R_2R_2$ is the darkest type "D". When either factor is present in homozygous condition or when both are present in heterozygous condition, the F_1 type should be produced; this should correspond to class "B". When three doses of R are present, the color should be a little lighter than that of the purple parent. This would correspond to class "C". In a F_2 from $R_1R_1R_2R_2$ x $r_1r_1r_2r_2$, the following distribution with respect to number of R's present should be obtained if the factors are cumulative in effect:

Genotypes	Color types	Frequency
$R_1R_1R_2R_2$	Purple "D"	1
$R_1R_1R_2r_2$	,, "C"	4
$R_1r_1R_2R_2$		
$R_1r_1R_2r_2$	,, "B"	6
$R_1R_1r_2r_2$		
$r_1r_1R_2R_2$		
$r_1r_1R_2r_2$	,, "A"	4
$R_1r_1r_2r_2$		
$r_1r_1r_2r_2$	sun-red	1

The expected frequencies based on this hypothesis are compared with the observed ones in Table III.

In all three F_2 progenies, the observed frequencies fit the calcu-

lated ones fairly closely, P equaling .6809, with odds of about 3:1.

In culture 370-5, separation into the four classes was more difficult than in the other two F_2 cultures; yet the X^2 test shows a good fit.

Although the fits are close to the expected results, it is necessary to make genetic tests of the hypothesis that the duplicate factors are cumulative in effect. Individuals from the different F_2 purple intensity classes, were tested in F_3 and in intercrosses with sun-reds. On the duplicate factor hypothesis we should expect to find eight genotypes of purples in the F_2. If R_1 and R_2 are not distinguishable then only five can be recognized. Their frequencies and F_3 behavior are indicated below:

F_2 Frequency	F_2 Genotype	Color Class	Frequencies of F_3 segregation types	F_3 color types				
				Purple				Sun-red
				D	C	B	A	
1	$R_1R_1R_2R_2$	"D"	1	all				
2	$R_1R_1R_2r_2$	"C"	4	1	2	1		
2	$R_1r_1R_2R_2$							
4	$R_1r_1R_2r_2$	"B"	4	1	4	6	4	1
1	$R_1R_1r_2r_2$	"B"	2			all		
1	$r_1r_1R_2R_2$					all		
2	$R_1r_1r_2r_2$	"A"	4			1	2	1
2	$r_1r_1R_2r_2$					1	2	1

Accordingly there are only five types of behavior in F_3 from the F_2 purples.

On account of the limited space available in the greenhouse only 28 F_2 purple plants could be grown. Seed was obtained from only 16. These were grown in the experimental plots during the season of 1932. The results are given in Tables I, III. and IV. The results from the different F_2 color classes will be considered separately.

F_3 behavior of "B" type F_2 purple plants.

Eleven of the 16 F_2 purple plants had been graded as "B" type in the field classification. On the basis of the theory outlined, F_2 purples from class "B" should show only two types of segregation in F_3; one a ratio of 15 purple : 1 sun-red, and the other should give only "B" type plants. If the selection of these ten plants were purely at random, the proportion of these two types should be 2 : 1 in the above scheme.

Eight of them produced 15:1 ratios similar to the original F_2 ratio. (see Table I in the F_2 section.) These plants, therefore, were heterozygous for both the R_1 and R_2 factors. With one exception (370-1-122) all cultures showed a good agreement between the observed frequencies and those calculated on the basis of a 15:1 ratio. They also showed the four classes of intensity of purple color. The results from the classification for intensity are given in Table III, along with the F_2's.

In progeny 370-1-122 there is a significant excess of sun-reds. However, the deviation from a 3:1 is even greater.

The other three F_2 "B" type plants gave no sun-reds. One progeny. 370-1-42, and the other, 370-1-74, produced 197 and 48 purple plants, respectively, which were all of "B" type. These plants should be either $R_1R_1r_2r_2$ or $r_1r_1R_2R_2$ genetically. The other plant, 370-1-103 produced 3 purple of "B" type and 5 of "A" type. The F_2 parent might have been a plant which really belonged to the "A" class in which case a ratio of 1 "B" : 2 "A" : 1 sun-red should have resulted. The number of indivduals is too small to be certain of the genotype of this F_2 plant.

F_3 behavior of "A" type F_2 purple plants.

Progeny from three F_2 purple plants of "A" type were grown. These should all segregate purple; sun-reds in a ratio of 3 : 1. All three produced purple and sun-reds in ratios approximating 3:1. They were either $R_1r_1r_2r_2$ or $r_1r_1R_2r_2$ genetically. In two cases the purples were of type "B" and "A" in a ratio approximating 1:2. The

observed frequencies are compared with the expected ones in Table IV.

Table IV Data on the F_3 segregation for color intensity of "A" type F_2 plants from the cross purple x sun-red

Pedigree		Purple intensity B	Purple intensity A	Sun red	X^2	P	Odds
370—1—69	Obs.	27	75	23			
	Cal. (1:2:1)	31.25	62.50	31.25	5.2560	0.0765	12:1
370—1—115	Obs.	60	99	38			
	Cal. (1:2:1)	49.25	98.50	49.25	4.9200	0.0886	10:1

The fits of observed to calculated results are good.

In the other progeny (370-1-83) the purples were all "B" type. It is difficult to explain this lack of segregation into the expected "B" and "A" classes. Possibly there is a separate factor modifying the action of R.

F_3 behavior of "C" type F_2 purple plants.

F_2 plants of class "C" should give only purple progeny. Only one F_2 purple plant 370-1-15 which was graded as "C" type was tested. It produced only "C" type purple plants where "D", "C", and "B" were expected.

F_3 behavior of "D" type F_2 purple plants.

F_2 plants of this class should breed true for purple.

Although three "D" type heads were selected only one gave progeny. This did not breed true for "D" type. This culture, 370-1-123 produced three classes of purples, namely "D" "C", and "B", indicating that this plant was either $R_1R_1R_2r_2$ or $R_1r_1R_2R_2$ and therefore, actually belonged to the "C" class. The distribution of the three classes deviates widely from expectation.

Further tests of the hypothesis that the duplicate genes are cumulative in effect were made by intercrossing the F_2 purples with sun-

reds.

Intercrosses of F_2 purple with F_2 syn.red.

The intercrosses between different F_2 purples with F_2 sun-reds are really backcrosses since sun-red plants have been shown to be r_1r_2 with respect to the factors for purple color production. Eleven intercrosses were made.

They include crosses with six of the same purple "B" type plants used for the F_3 tests. The results of these crosses are given in Table V.

Table V. Data from intercrosses between F_2 "B" type purples and sun-reds from the cross purple x sun-red.

Crosses		Purple	Sun-Red	X^2	P	Odds
370—1—1 x 370—1—75	Obs.	62	14			
S. R. Purple	Cal. (3:1)	57	19	0.4448	0.5060	1:1
370—1—121 x 370—1—12	Obs.	35	18			
S.R.	Cal. (3:1)	36	12	0.1110	0.7441	3:1
370—1—78 x 370—1—12	Obs.	37	22			
S.R.	Cal. (3:1)	44.25	14.75	4.7513	0.0326	29:1
370—1—98 x 370—1—12	Obs.	72	43			
S.R.	Cal. (3:1)	86.25	28.75	10.0897	.01	99:1
370—1—122 x 370—1—12	Obs.	92	13			
S.R.	Cal. (3:1)	78.75	26.25	8.9175	.01	99:1
370—1—62 x 370—1—73	Obs.	24	19			
S.R.	Cal. (3:1)	32.25	10.75	8.4418	.01	99:1

Based upon the F_3 results, these plants should produce 1 purple "B" : 2 purple "A" : 1 sun-red or 3 purples : 1 sun-red. In two out of the six progenies the observed frequencies agree closely with a 3 : 1 ratio, (see Table V) The odds are 1 : 1 and 3 : 1 respectively.

In the last three progenies, the deviations are significant. Considering the F_3 results from these same plants, there seems to be no logical explanation. In one case, 370-1-122, in F_3 there was an excess

of sun-reds, while in the backcross there was a deficiency.

Two of the three F_2 purple "A" type plants for which F_2 results were obtained were also crossed with pure sun-red. These results are given in Table VI.

Table VI. Data from intercrosses between F_2 "A" type purples and sun-reds from the cross purple x sun-red.

Crosses		Purple "A"	Sun-red	X^2	P	Odds
370—1—115 x 370—1—1 S.R.	Obs.	24	26			
	Cal. (1:1)	25	25	0.0800	0.7809	4:1
370—1—69 x 370—1—1 S.R.	Obs.	53	39			
	Cal. (1:1)	46	46	2.1304	0.1541	6:1
370—1—115 x 370—1—73 S.R.	Obs.	59	41			
	Cal. (1:1)	50	50	3.204	0.0780	11:1

They gave the expected ratio of 1 purple "A" : 1 sun-red, the fits in all three cases being good. Odds are 4:1, 6:1, and 11:1. This indicates their genotype was either $R_1r_1r_2r_2$ or $r_1r_1R_2r_2$. This agrees with the F_3 test of the same plants.

The comparison between observed and calculated on the basis of a 1:1 ratio is given in Table VI,

The one F_2 purple "D" plant that produced only purple plants in the F_3 was backcrossed to sun-red. The results show that different classes of purple plants segregated (16 "D" : 43 "C" : 22 "B" : 18 "A"). Therefore, "D" probably was not the proper original classificationi The absence of sun-red plants proves that the genotype must have been either $R_1R_1R_2r_2$ or $R_1r_1R_2R_2$. Genotypically, therefore, this plant was a "C" type. This agrees with the F_3 results. The presence of "C" and "D" classes in the backcross where only "A" and " B" are expected cannot be explained unless modifying factors were present.

In those cases where the F_2 purple plants were tested by crossing with the double recessive sun-red the results corroborated the genotypes formulated as a result of the F_3 test.

Further tests of the hypothesis are afforded by intercrosses of the F_2 purples.

Intercrosses between different F_2 purples (from the cross purple X Sun-red)

Two F_2 purple plants were tested in F_3 and were also intercrossed. One, 370-1-75, a "B" type, in F_3 gave purple and sun-red in a ratio of 15 : 1 while the other, a "C" type, 370-1-15 produced only purple "C" in the F_3. The first one, therefore, was $R_1r_1R_2r_2$ from F_3 and backcross tests. The second one probably was $R_1R_1R_2r_2$ or $R_1r_1R_2R_2$. The result from the cross of these two plants gave 24 purple and 3 sun-red plants. From this cross, the progeny should be all purple by their assumed genotypes. The presence of three sun-red might be due to mechanical mixture either in sowing or at transplanting, although further tests of these plants are desirable.

In every case but one then, the intercrosses between F_2 purple color types and between purple color types and sun-red produced the expected phenotypes. The observed frequencies of the expected intensity phenotypes were not always in close agreement with the theoretical frequencies. Considering the difficulties in classification owing to the fact that there is continuous variation in the intensity of purple, one would expect only general correspondence between phenotypic separation and genetic constitution. The results bear out this expectation. In general, however, they do show that the deeper intensities are associated with a larger number of doses of R. This shows that there is a cumulative effect of R_1 and R_2. In certain irregular cases, modifying factors may have affected the intensity.

Crosses Involving Purple and Green.

F_1 and F_2 results

The same purple "D" type was studied in crosses with green

plants. As pointed out earlier, this green type has no pigment. The F_1 plant from this cross was intermediate in color. In F_2, in addition to the parental types, a sun-red class appeared. (see Table VII). The F_2 ratio is a fair fit to 9 purple: 3 sun-red: 4 green. A deviation as large as that observed might be expected through chance alone in about one out of two trials.

A single distinct magenta plant was found in the F_2 population. Its occurrence was most probably due either to a mechanical mixture of seed or to a mistake made during transplanting.

The F_2 results can be explained by the assumption that the parents differ in two factor pairs for color. A factor, G, is assumed necessary for tne development of any color. This is lacking in the greens, and present in the colored types. Another factor, which may be designated H intensifies the color when G is present. Then the phenotypic formulae may be set up as fallows:

G H = purple
G h = sun-red
g H = green
s h = green.

F_3 tests of the hypothesis were made.

Behavior of F_2 purples in F_3 from the cross purple x green.

Twelve purple plants from the F_2 of the cross purple x green were selfed and grown. The F_3 results are given in Tables VII and VIII. Assuming that purple color is due to the interaction of two factors,

Frequency	F_2 purple genotypes	F_3 behavior		
		purple	sun-red	green
1	GG HH	all		
2	GG Hh	3	1	
2	Gg HH	3		1
4	Gg Hh	9	3	4

we would expect to find four different genotypes in the F_2 purple plants. The frequencies of these four types and the color types which they will produce in F_3 are as follows:

Six F_2 purple plants produced purples, sun-reds, and greens. Four of these approximated 9: 3: 4 ratios similar to the original F_2. The plants, therefore, were heterozygous for both the G and H factors. The comparisons with expectation are given in Table VII.

Table VII. Data on F_2 progenies from the cross of purple x green cabbage; and F_3 results from F_2 purples which segregate all three types (similar to F_2).

Pedigree		Purple	Sun-red	Green	X^2	P	Odds
F_2 355—2	Obs.	61	18	19			
	Cal. (9:3:4)	55.08	18.36	24.48	1.8690	0.4055	1:1
F_3 355—1—18	Obs.	62	15	21			
	Cal. (9:3:4)	55.10	18.40	24.50	1.9922	0.3181	2:1
355—1—17	Obs.	13	8	5			
	Cal. (9:3:4)	14.63	4.87	6.50	2.5267	0.2854	3:1
355—1—13	Obs.	83	21	19			
	Cal. (9:3:4)	69.17	23.07	30.76	7.4472	0.0261	32:1
355—1—19	Obs.	67	6	25			
	Cal. (9:3:4)	55.10	18.40	24.50	10.9271	.01	99:1
355—1—15	Obs.	119	22	5			
	Cal. (9:3:4)	82.13	27.37	36.50	44.7902	.01	99:1
355—1—16	Obs.	49	3	1			
	Cal. (9:3:4)	29.83	9.93	13.24	173.3257	.01	99:1

Only two of the four cultures (355-1-17, 355-1-18) showed a good fit to a 9 : 3 : 4 ratio, odds being 2 : 1 and 3 : 1, respectively. (see Table VII.) In progeny 355-1-13, there is an excess in the purple class and a deficiency in the green class. The deviation from the 9: 3 : 4 ratio is significant.

The other three F_2 plants gave very poor agreement with the expected frequencies. A great deficiency of sun-reds occurred in culture 355-1-19. This might be due to difficulty in classification.

In several cases the sun-red character was not distinct. A slight indication of sun-red might be easily overlooked. In the last two progenies, 355-1-15 and 355-1-16, the ratios do not fit the hypothesis. Unless the deviation is due to a mechanical mixture in sowing or at transplanting, a modifying factor may be involved. The genotypic constitution of these two F_2 plants cannot be determined without further genetic tests.

Two of the F_2 purple plants from this same cross produced purple and sun-red in the F_3 in a ratio of approximately 3 : 1. The results are given in Table VIII. and show that the observed frequencies agree with the calculated ones very closely, odds being 4 : 1 and 3 : 1, respectively. On the basis of the hypothesis, they were GG Hh. The observed frequencies are compared with the expected ones as given in Table VIII.

Table VIII. Data on the segregation of F_2 purples in F_3 from the cross of purple x green.

Pedigree		Purple	Sun-red	X^2	P	Odds
355—1—11	Obs. Cal.(3:1)	22 22.5	8 7.5	0.0444	.80	4 ; 1
355—1—12	Obs. Cal.(3:1)	51 55.5	23 18.5	1.4595	.2320	3 ; 1

A single doubtful green plant found in the culture 355-1-12 is most probably a sun-red plant. This plant has been saved for further testing.

Another F_2 purple plant produced 57 purple and 18 green in the F_3. This is a good 3 : 1 ratio of purple and green, P equaling 0.80. This indicates that the F_2 purple plant must have been GgHH. This extracted green type, gg HH, when crossed with sun-red should give purple plants if the hypothesis is correct. This direct test has not been made.

Three of the F_2 purple plants produced only purple in the F_3 and therefore must have been GG HH genotypically.

The behavior of the F_2 purples in F_3 corroborates the theory that a difference of two factor pairs exists between purple and green. The frequencies of the different types of F_2 purples are close to calculated considering the small numbers. The comparison follows:

F_2 genotype	Obs.	Cal.	X^2	P	Odds
GG HH	3	1.33			
Gg HH	2	2.67			
GG Hh	1	2.67			
Gg Hh	6	5.33	3.3937	.3148	(2 : 1)

Further tests of the hypothesis were made by testing F_2 sun-reds in F_3.

F_3 from F_2 sun-red plants.

Four F_2 sun-red plants were tested. All produced sun-red and green plants in the F_3 (Table IX). With one exception the observed segregation shows a good fit to the expected ratio of 3 sun-red : 1 green. The comparisons are shown in Table IX.

Table IX. Data on the segregation of F_2 sun-reds in F_3 from the cross of purple x green.

Pedigree		Sun-red	Green	X^2	P	Odds
355—1—3	Obs.	18	7			
	Cal.(3:1)	18.75	6.25	.1200	.75	3 : 1
355—1—7	Obs.	35	15			
	Cal.(3:1)	37.5	12.5	.6678	.4311	1 : 1
355—1—8	Obs.	20	10			
	Cal.(3;1)	22.5	7.5	1.1110	.2934	2 : 1
355—1—4	Obs.	28	21			
	Cal.(3:1)	36.75	12.25	8.3333	.01	99 : 1

In progeny 355-1-4 there is a significant excess of green. This might be due to errors made in classification. The pure breeding

sun-red type was not obtained, possibly due to the fact that so few were tested.

F_3 from F_2 green plants.

Two F_2 green plants produced only green plants in F_3 populations consisting of 49 and 75 individuals. Even though F_2 green plants are expected to be different genotypically, they cannot be distinguished from each other by an F_3 test. One test of the hypothesis is to cross F_2 greens with sun-reds. There different types of progenies would be expected from such crosses as foillows:

F_2 green types		F_2 sun-red types
	GG hh	*Gg hh*
gg HH	all purple	1 purple: 1 green
gg Hh	1 purple: 1 green	1 purple: 1 sun-red: 2 green
gg hh	all sun-red	1 sun-red: 1 green

The above outlined crosses have not been made in the experiment.

To sum up, the breeding behavior in F_2 and F_3 substantiates the hypothesis that the purple and green parents differ by two factor pairs which may be designated Gg and Hh.

INHERITANCE OF FOLIAGE TYPE

Two foliage types, wrinkled and smooth, are to be found in cabbage varieties. The pure sun-red strain used in the plant color studies was wrinkled. The F_1 from the cross of wrinkled and smooth were all intermediate. In the F_2 generation, while both parental types were recovered, very few were as wrinkled as the grand-parental type. The majority of the plants fall in grades of wrinkling less than that of the wrinkled grand-parent. It is very difficult to separate the slightly wrinkled type from the smooth type. The F_2 are given in Table X. The F_3 results from F_2 plants which segregated wrinkled and smooth are also given in Tables X and XI. The F_2 data indicate a ratio of 9 wrinkled : 7 smooth, if the wrinkled, intermediate aud slightly wrinkled classes are grouped together. This would indi-

cate that the production of wrinkled foliage may be due to a complementary action of two factor pairs. The fits are fairly good, odds being 19 : 1. The comparison between the observed and calculated results is given in Table X.

Table X. Data from the F_2 progenies from the cross of wrinkled x smooth; and F_3 results which show similar segregation.

Pedigree			Wrinkled	Smooth	X^2	P	Odds
F_2	370—1	Obs.	258	212			
		Cal. (9:7)	264.6	205.4	.3767	0.55:0	1:1
	370—3	Obs.	123	72			
		Cal. (9:7)	109.67	85.33	3.7026	0.0561	17:1
	370—5	Obs.	101	96			
		Cal. (9:7)	110.83	86.17	1.9933	0.1670	5:1
	Total F_2				6.0726*	0.0487	19:1
F_3	370—1—122	Obs.	114	84			
		Cal. (9:7)	111.37	86.63	.0860	0.3960	2:1
	370—1—62	Obs.	112	83			
		Cal. (9:3)	109.67	85.33	.1121	0.7043	12:1
	370—1—123	Obs.	113	84			
		Cal. (9:7)	110.83	86.17	.0971	0.7608	3:1
	370—1—42	Obs.	119	78			
		Cal. (9:7)	110.81	86.19	1.3835	0.2455	3:1
	370—1—98	Obs.	128	66			
		Cal. (9:7)	109.16	64.84	7.4353	.01	99:1
	Total F_2 & F_3				15.1866	0.0520	18:1

If we designate as $\underline{W}$ and $\underline{S}$ the two factors which are necessary for wrinkled foliage, then there will be three genotypes of pure smooth-leaved plants, one being $\underline{W}\ \underline{s}$, another $\underline{w}\ \underline{S}$, and the third $\underline{w}\ \underline{s}$. In an F_2 involving both factors, these should occur in the ratio of 3 : 3 : 1. The hypothesis was tested in F_3 and in intercrosses of the F_2 types.*

*These values are the sum of the separate X^2.

Behavior of F_2 wrinkled plants in F_3.

F_2 individuals from the different classes of wrinkling were tested in F_3 and in intercrosses with smooth and with wrinkled. On the complementary factor hypothesis, we expect to find four genotypes among the wrinkled F_2 individuals. If *W* and *S* are not distinguishable then only three can be determined from F_3 tests. Their frequencies and F_3 behavior are indicated below.

F_2	F_2	F_2 behavior	
Frequency	Genotypes	wrinkled	smooth
1	W W S S	all	
2	W w S S	3	1
2	W W S s	3	1
4	W w S s	9	7

Seventeen F_2 wrinkled plants from the cross of wrinkled x smooth were grown and selfed. The F_3 results are given in Tables X and XI. The results are grouped according to the grade of wrinkling in F_2

F_3 behavior of F_2 plants showing an intermediate grade of wrinkling.

Five plants having wrinkling of intermediate degree produced in the F_3 wrinkled and smooth in a ratio of 9: 7 similar to the original F_2 ratio.(see Table X.) These F_2 plants, therefore, must have been heterozygous for both the W and S factors. With one exception all cultures showed a good fit to a 9 : 7 ratio. In this particular culture, 370-1-98, although there was an excess of wrinkled types, yet only a few plants were as wrinkled as the original wrinkled plants. In this respect it is no different from the others.

F_3 behavior of medium wrinkled F_2 plants.

In this group of plants, two types of segregation should take place. One should produce 3 wrinkled : 1 smooth, corresponding to

genotypes WW Ss or Ww SS. The other should breed true for wrinkling.

Results from twelve such F_2 plants are given in Tables X and XI. Nine of them produced ratios of approximately 3 wrinkled : 1 smooth. The F_2 parents, therefore, were either WW Ss or Ws SS. With two exceptions all cultures showed a good agreement between the observed frequencies and those calculated on the basis of a 3 : 1 ratio. The comparisons are given in Table XI.

Table XI. Data on the F_3 segregation of F_2 wrinkled-leaved plants from the cross of wrinkled x smooth.

Pedigree	—	Wrinkled	Smooth	X^2	P	Odds
370—1—12	Obs.	107	34			
	Cal. (3:1)	105.75	35.25	0.0590	.8100	4:1
370—1—1	Obs.	67	17			
	Cal. (3:1)	63.00	21.00	1.0159	.3190	2:1
370—1—115	Obs.	155	43			
	Cal. (3:1)	148.50	49.50	1.1380	.2891	3:1
370—1—73	Obs.	65	29			
	Cal. (3:1)	70.50	23.50	1.7163	.1930	4:1
370—1—78	Obs.	99	44			
	Cal. (3:1)	107.25	35.75	2.5384	.1163	7:1
370—1—22	Obs.	92	20			
	Cal. (3:1)	84.00	28.00	3.0476	.0850	11:1
370—1—12	Obs.	158	38			
	Cal. (3:1)	147	49	3.2925	.0742	12:1
370—1—83	Obs.	102	48			
	Cal. (3:1)	112.50	37.50	4.7023	.0336	29:1
370—1—121	Obs.	161	34			
	Cal. (3:1)	146.25	48.75	5.9504	.0156	63.1

In culture 370-1-83, there was a deficiency of wrinkled individuals, while there was an excess in culture 370-1-122. These deviations might be due to difficulty in classification.

The other three wrinkled F_2 plants in this group produced only

wrinkled plants in the F_3. They were probably homozygous for both the W and S factors. One of these cultures, 370-1-75, produced wrinkled individuals that were almost as wrinkled as the original wrinkled parent. The progeny were quite uniform. The other cultures, 370-1-69, 370-1-44 showed extreme variability in the amount of wrinkling. Since smooth individuals were absent, they must have been WW SS genotypically. The variability in amount of wrinkling might be due to specific modifying factors.

A comparison of the observed frequencies of the types of F_2 behavior in F_3 with the calculated frequencies shows a good fit,

F_2 genotypes	Obs.	Cal.	X^2	P	Odds
WW SS	3	1.88			
Ww SS WW Ss	9	7.56			
Ww Ss	5	7.56	1.7716	.4272	1 : 1

The behavior, therefore, of the F_2 wrinkled plants in F_3 agrees with the hypothesis that a difference of two factor pairs exists between the wrinkled and smooth parents.

Behavior of F_2 smooth plants in F_3.

Four F_2 smooth plants were tested in F_3. Each gave smooth plants only. This test told nothing about the genotypic constitution. This can be tested by intercrossing with each other or with wrinkled F_2 individuals.

Intercrosses of different F_2 wrinkled plants.

Nine of the F_2 wrinkled plants which were tested in the F_3 were intercrossed in the following combinations:

1. 370-1-122 x 370-1-12
2. 370-1- 98 x 370-1-12
3. 370-1-123 x 370-1-12
4. 370-1- 62 x 370-1-73

4. 370-1- 12 x 370-1-73
6. 370-1- 12 x 370-1-75
7. 370-1-121 x 370-1-12
8. 370-1- 78 x 370-1-12
9. 370-1-115 x 370-1-73

Four of these plants segregated 9 wrinkled : 7 smooth in the F_3; while five plants showed a segregation of 3 wrinkled : 1 smooth. One plant bred true for wrinkling in the F_3. The first four, therefore, probably were heterozygous for both factor pairs, Ww Ss as well as F_1. The second five, perhaps, were either WW Ss or Ww SS. The results of the first four intercrosses are given in Table XII (a) in comparison with the calculated.

Table XII (a) Intercrosses between two different types of F_2 wrinkled plants; one giving 9 wrinkled : 7 smooth in F_3, the other 3:1.

Grosses		Wrinkled	Smooth	X^2	P	Odds
370—1—122 x 370—1—12	Obs.	73	35			
	Cal. (3:1)	81	27	3.1605	.0564	17:1
370—1—98 x 370—1—12	Obs.	76	40			
	Cal. (3:1)	87	29	5.5632	.0200	49:1
370—1—123 x 370—1—12	Obs.	63	39			
	Cal. (3:1)	76.5	25.3	9.5294	.01	99:1
370—1—62 x 370—1—73	Obs.	27	16			
	Cal. (3:1)	32.25	10.75	3.4180	.0686	14:1

Two out of four crosses showed significant deviations from the expectation. In both cases there was an excess of smooth. This might be due to the fact that slightly wrinkled plants might be overlooked and classified as smooth.

In a progeny of 49 plants from the intercross of two of these same F_2 plants (370-1-12 x 370-1-73) all the plants were wrinkled. This indicates that the two plants were not heterozygous for the same fac-

tor. Had they been heterozygous for the same factor pair, a segregation of 3 wrinkled : 1 smooth would have been obtained in that cross.

In the fifth cross with an F_2 which bred true for wrinkling, only wrinkled plants were produced in a population of 18 individuals. This is as expected, since one parent should have been WW SS.

In the last three crosses, a segregation of 3 wrinkled : 1 smooth was obtained. This shows that plants 370-1-121, 370-1-1-78 and 370-1-12 are heterozygous for the same factor pair, being either Ww SS or WW Ss. The data from these tests are given in Table XII (b).

Table XII (b) Intercrosses between F_2 wrinkled plants which gave 3 wrinkled : 1 smooth in F_3.

Crosses		Wrinkled	Smooth	X^2	P	Odds
370—1—121 x 370—1—12	Obs.	31	17			
	Cal. (3:1)	36	12	2.8897	.0919	10:1
370—1—78 x 370—1—12	Obs.	39	21			
	Cal. (3:1)	45	15	3.2000	.0870	11:1
370—1—115 x 370—1—37	Obs.	68	30			
	Cal. (3:1)	73.5	24.5	1.6463	.2000	4:1

The fits are very good.

Intercrosses of F_2 wrinkled with F_2 smooth.

In the first intercross between wrinkled and smooth F_2 plants, plant 370-1-15 which had bred true for smooth in F_3 and plant 370-1-75 which had bred true for wrinkling were concerned. As expected this cross gave wrinkled plants with the exception of two smooth plants which might have been due to mechanical mixture. This cross does not tell anything about the genotypic constitution of the F_2 smooth plant.

Another intercross was made between F_2 wrinkled plants and F_2 smooth plant. Plant 370-1-12 segregated into 3 wrinkled : 1 smooth in the F_3 and plant 370-1-15 bred true for smooth. The cross showed a segregation of 1 wrinkled : 1 smooth. The comparison between

observed frequency and that of calculated is given in Table XIII.

Table. XIII. Intercross of F_2 wrinkled x F_2 Smooth

Cross		Wrinkled	Smooth	X^2	P	Odds
370—1—12 x 370—1—15	Obs.	59	66			
	Cal. (1:1)	62.5	62.5	0.3920	.5411	1:1

This shows that the smooth plants must have either ww Ss, Ww ss or ww ss genetically because the wrinkled F_2 plants were heterozygous for one of the two factor pairs (WW Ss or Ww SS).

Intercross between different F_2 smooth plants.

Two plants, 370-1-74 and 370-1-19 which in F_3 tests produced all smooth foliage, were intercrossed. This cross showed a segregation of 13 wrinkled : 15 smooth, or approximately of a ratio 1:1. The X^2 is 0.1428 with P .6938 and odds being less than 3:1. This is a very good fit although the numbers are very small. This cross, therefore, was either Ww ss x ww SS or WWss x ww Ss. On the hypothesis no other combinations of smooth can give this segregation. These different genotypes cannot be differentiated without further tests.

The behavior of the F_2 in F_3 and of the intercrosses between F_2 individuals substantiate the hypothesis that wrinkled foliage is due to the action of two complementary factor pairs. The variation in degree of wrinkling suggests that additional factors may affect the amount of wrinkling.

INHERITANCE OF PLANT HEIGHT

F_1 and F_2 Result

A study of the inheritance of such characters as yield, weight and size of plant is of much interest from a practical standpoint. It is well known that these quantitative characters are often very complex in their mode of inheritance. They are often so influenced by environmental conditions that the genetic differences are obscured.

East and Hayes (2), Emerson (3), and others, have furnished evidence in tobacco and in corn which shows that the inheritance of quantitative as well as qualitative characters can be explained on a genetic basis. Quantitative characters are interpreted on the basis of multiple factors. Studies on the inheritance of plant height in cabbage have not been reported by any previous worker.

The two pure strains of cabbage which were crossed for this study differ in type of growth as well as height. The one, "341". has a compact growth habit and a compact head. Its height was 8.00±.197 inches is the year 1931 and 7.99±.179. inches in 1932. The other strain, 1085-5-6, has loose foliage and a loose head but is a little taller. Its height was 9.36±.197 inches in 1931 and 9.18±.145 in 1932. In other words, the tall parent is about 15% taller than the short one. The height was measured from the surface of the ground to the tip of the head. The difference between these two parents is then 1.27±.279 and 1.19±.251 inches for the two years. Although the difference is small it is about five times the probable error. Crosses were made between these two strains and the F_1, F_2 and F_3 plants were measured. In 1932, P and F_1, F_2, and F_3 populations were all growing in the same plot. The results obtained in the two years are summarized in Table XIV.

The difference between the two years for the two parental strains is not significant, being .10±.267 inch for the shorter parent and .18±.245 inch for the taller parent.

The F_1 plants from the cross of the two strains show a marked increase in height, (see Plate I) head weight, (see Plate II) solidity of head, and in uniformity of maturity. This phenomenon is known as hybrid vigor and has been found in many species of plants. The means for the height of the F_1 plants are 10.28±.170 inches for the year 1931 and 10.75±.154 inches for 1932, as compared with 9.36±.197 and 9.18±.145 for the tall parent in the same years. This is an increase in height over the tall parent of 9.8% in 1931 and 17%

Table XIV. Frequency distribution of plant height in a cross of purple tall X sun-red dwarf, P_1, F_1, F_2 and F_3 results.

	F_2 Height	Year	Class centers in inches																											Total	Mean	σ	C. V.
			4.25	4.75	5.25	5.75	6.25	6.75	7.25	7.75	8.25	8.75	9.25	9.75	10.25	10.75	11.25	11.75	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75				
P_1 (341)		1931					3	3	4	12	9	8	4	2																	46	8.09±.197	0.921±.065	11.39± .811
		1932			1		1	3	4	17	10	4	5	2																	47	7.99±.179	0.868±.060	10.86± .765
F_1 (370)		1931										3	4	13	11	8	5	2	1	1											48	10.28±.170	0.862±.059	8.39± .570
		1932									1	3	3	8	13	15	20	13	3												79	10.75±.154	0.879±.047	8.18± .439
P_2 (1085)		1931						2	0	0	8	5	11	10	7	3	1	1													48	9.36±.197	0.996±.066	10.64± .740
		1932						1	2	9	6	14	16	22	12	3															85	9.18±.145	0.894±.044	9.73± .439
F_2		1931			1	0	3	14	23	36	58	72	92	71	47	29	14	6	1	1	0	0	1								469	9.12±.073	1.169±.026	12.69± .280
		1932					1	2	0	7	19	40	59	63	61	55	32	18	23	1	1	0	1	0	1						384	10.04±.085	1.200±.014	11.95± .140
F_3 370—1—75	6.0	1932				5	1	13	14	14	20	16	15	10	1	1															110	8.13±.150	1.097±.050	13.50± .625
370—1—48	6.8	1932				1	2	3	6	3	7	5	0	2																	29	7.80±.286	0.977±.087	12.52±1.127
370—1—69	6.8	1932				2	2	7	11	12	17	24	15	14	5	7	2	1													119	8.66±.152	1.220±.053	14.09± .628
370—1—12	7.6	1932			1	1	4	4	4	5	9	14	11	18	13	17	16	15	5	0	1	2									140	9.85±.229	1.678±.068	17.04± .707
—73	88.0	1932			1	2	2	5	4	11	13	22	12	12	5	3															92	8.58±.200	1.145±.057	13.35± .677
—19	8.2	1932		2	1	1	1	3	10	10	12	14	7	7	1																69	8.14±.239	1.158±.066	14.22± .833
—1	8.5	1932						2	4	5	10	13	27	19	13	7	10	0	3												113	9.47±.149	1.145±.051	12.09± .551
—83	8.8	1932					1	3	11	18	20	30	28	18	18	2	1														150	8.83±.109	0.982±.038	11.12± .439
—78	8.9	1932			1	0	2	2	3	2	9	7	18	12	26	23	16	3	3	1											128	9.89±.209	1.323±.049	13.38± .574
—22	9.0	1932							1	2	3	14	11	29	22	15	7	2	1												107	9.87±.119	0.901±.042	9.14± .421
—74	9.5	1932								2	5	1	12	5	10	9	1	1	2												48	9.83±.208	1.052±.072	10.70± .745
—115	9.3	1932							2	13	20	43	44	35	20	9	1	2	0	1											190	9.23±.086	0.876±.030	9.49± .328
—62	10.2	1932									2	4	14	19	34	31	39	28	10	7	5										193	10.85±.101	1.031±.035	9.50± .326
—123	10.5	1932					1	1	5	5	10	18	40	48	29	25	10	2													194	9.67±.106	1.003±.034	10.37± .359
—13	10.7	1932									2	18	17	41	34	30	21	12	13	5											193	10.37±.103	1.047±.036	10.09± .469
—122	10.8	1932				1	0	0	3	5	11	22	28	35	29	16	17	6	6	3	5	0	1								190	9.96±.131	1.321±.046	13.27± .467
—98	11.0	1932			1	0	0	2	2	2	4	12	24	26	28	36	32	14	6	3	1	1									194	10.31±.131	1.232±.042	11.94± .415
—121	11.0	1932					1	4	7	9	20	25	24	21	36	19	11	6	2	1											166	9.40±.145	1.312±.046	13.95± .498
—44	11.8	1932	1	0	0	0	1	0	0	1	2	0	2	4	3	2	1	0	1												18	9.33±.789	1.820±.205	19.50±2.273
—15	12.5	1932							1	0	0	3	2	2	2	1	10	5	12	18	20	28	36	23	14	6	3	2	0	1	189	13.55±.177	1.607±.056	11.86± .417
—42	14.0	1932									2	2	2	0	1	4	6	12	14	24	22	21	23	21	19	13	6	0	1	2	195	13.61±.182	1.672±.057	12.28± .426

in 1932. This increase in height is significant, the difference in every case being over three times its probable error, D/PE=3.53 for 1931 and 8.42 for 1932. The mean height decreased in the F_2. The means of the F_2 were 9.12±.073 and 10.04±.085 inches for the years 1931 and 1932. Comparison of the variability in F_2 with that in F_1 shows an increase in F_2. In 1931, the coefficients of variability are 8.39± 0.570 and 12.69±.280 for F_1 and F_2, respectively. In 1932, they are 8.18±.439 and 11.95±.140, respectively. This may be interpreted to mean that factors for plant height are probably segregating in F_2. The modal value in F_2 was about the same as that of the tall parent, but the range extended from values smaller than the extreme from the shorter parent, to values exceeding the extreme from the tall parent. This phenomenon has been called transgressive inheritance.

The data suggest that the inheritance of plant height can probably be best explained on a multiple factor basis. According to Jones, interpretation of such results, we may assume a series of dominant independent cumulative factors or genes favorable for growth and that each parent strain carried only part of these favorable factors. The increase in vigor in the F_1 would result if the two strains carried different groups of these factors. The F_1 would then carry all these favorable factors in heterozygous condition. It would be expected to show increased vigor. Segregation and recombination would give F_2 plants which would be taller than the tall parent and shorter than the short parent. If the assumption is true, then the taller individuals possess more of the dominant favorable growth factors. The distributions of the F_2 populations approach normal frequency curves. This might be said to indicate that the factors concerned in the inheritance of this character were of equal value and had a cumulative effect upon plant height. Owing to the complexity of the character no estimate of the number of factor pairs involved in the inheritance of height can be made. In order to show that segregation did occur, it is necessary to test F_2 segregates in F_3.

Behavior of F_2 in F_3

Twenty-one F_2 plants differing in height were selected for an F_3 progeny test. The results are summarized in Table XIV. The correlation between the height of the F_2 plant and the mean height of its F_3 progeny is high, the correlation coefficient being 0.958±.012 (see fig. 1 for the distribution).

Fig. I. Relation between plant height (in inches) of F_2 plants and mean height of their F_3 progenies.

F_2 Height	7.75	8.25	8.75	9.25	9.75	10.25	10.75	11.25	11.75	12.25	12.75	13.25	13.75	
6.25		1												1
6.75	1		1											2
7.25														0
7.75					1									1
8.25		1	1											2
8.75			1	1	1									3
9.25				1	1									2
9.75					1									1
10.25							1							1
10.75					2	1								3
11.25		1		1										2
11.75				1										1
12.25														0
12.75													1	1
13.25														0
13.75														0
14.25													1	1
	1	3	3	4	6	1	1	0	0	0	0	0	2	21

$r_{xy} = 0.958 \pm .012$

However, the numbers are very small. This indicates that tall F_2 plants give tall F_3, etc., and shows that the increased variability in F_2 was probably due to segregation of growth factors. The different F_3 families showed differences in the amount of variation, the coefficients of variability varying from 9.14±.421 to 17.04±.707, but their frequency distributions occupied different positions in the total spread between the F_2 heights with two exceptions. Differences in variability are expected since certain F_2 plants would be heterozygous for fewer factors than others. Whether any of the F_2 plants selected for F_3 test were

homozygous cannot be determined without further breeding from the F_3 plants. It seems probable that certain ones, 370-1-13 for instance, which showed a small range of variation, may be found to breed true.

INHERITANCE OF HEAD WEIGHT

F_1, F_2, and F_3 Results

In 1932, head weight was also studied in the same cultures used for the plant height studies. As noted above the F_1 showed a marked increase in head weight. The mean weights were 1.17±.054 pounds for the short parent ("341"), 1.14±.070 pounds for the tall parent (1085−5−6), and 3.15±.147 pounds for the F_1. (see Table XV.) The F_1 therefore is 169.2% heavier than one parent and 176.3% than the other. The mean of the F_2 heads decreased to 1.81±.067 pounds with the modal value at 1.25 pounds. (see Table XV.) The range of variation of the F_2 was much wider than in the F_1. The evidence that weight of head is inherited as a quantitative character is not complete, since F_2 head weights from which F_3 progenies were grown were not taken. It was found that a considerable number of the plants did not head in F_3. This was not found in F_2 but it might have been overlooked. No definite explanation of the lack of heading can be given at present.

LINKAGE DATA

Relation of Plant Color and Foliage Character

Up to the present, only a few cases of apparent linkage have been reported in Brassica. Malinowski according to Pease (9), was the first to point out a rigid association between heart and smooth leaf, and curliness and no heart in the cross of cabbage with curly kale. Later Pease (9) studied the association between different characters in Brassica. He obtained the following relationships:

(1). The recombination percentage between tallness and heading from a cross of F_1 (cabbage x curly kale) x cabbage was 30.41 per cent.

Table XV. Frequency distributions of head weight in a cross of purple x sun.red, P_1, F_1, F_2 and F_3 results(1932)

	Class centers for head weight in lbs.											Total	Mean	S.	C. V.
	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	4.75	5.25				
P_1 (341)		10	32	3								45	1.17±.054	.514±.037	43.86±3.673
F_1 (370)		2	2	5	9	17	14	20	12	1	1	83	3.15±.147	.901±.047	28.62±1.618
P_2 (1085—5—6)	5	35	30	17	4							91	1.14±.070	.479±.024	42.02±2.448
F_2	18	59	68	75	79	47	21	12	1			380	1.81±.067	.864±.021	47.63±1.407
370—1—122	19	46	51	35	21	9	1					182	1.32±.068	.680±.024	51.67±2.112
—78	7	11	25	38	27	12	2					122	1.70±.100	.678±.029	39.88±1.979
—115	14	56	43	20	6							139	1.06±.061	.496±.020	46.65±2.263
—121	13	34	25	14	3							89	1.02±.081	.514±.026	50.15±3.111
—1	4	10	22	35	24	10	4	1				110	1.78±.090	.697±.032	39.20±2.040
—12	32	37	28	20	10	3	2					132	1.08±.086	.714±.042	65.93±5.291
—19	22	15	15	7	7							66	0.96±.120	.657±.039	68.30±5.577
—44	1	4	4	4	4							17	1.43±.216	.617±.071	43.27±5.866
—83	37	40	40	7	1							125	0.83±.058	.470±.020	56.63±3.097
—98	32	62	40	22	3	1						160	0.95±.065	.525±.020	55.09±2.636
—123	21	39	41	52	35	5						193	1.39±.067	.667±.023	47.81±2.658
—13	40	42	43	20	4	5	0	0	1			155	1.01±.109	.677±.026	66.77±3.520
—62	20	42	58	31	13	8	0	1				173	1.26±.068	.660±.024	52.34±2.363
—74	4	17	16	7	3							47	1.12±.105	.510±.035	45.45±3.763
—15	45	49	17	5	0	1						117	0.69±.090	.454±.020	65.80±3.966
—22	1	8	11	32	36	8	4					100	1.92±.085	.601±.029	31.30±2.091
—73	12	22	31	14	3							82	1.09±.081	.518±.027	47.48±3.014

(2). An association between heading and curliness was found in a cross of cabbage with curly kale. The author states that "It is impossible to give a complete description of the association between hearting and smoothness, in the cross cabbage x curly kale, in terms of factors and crossover percentages. This much, however, we can say, that at least one of the curly factors is linked to one of the heading factors."

(3). There is evidence of possibly a slight association (41%) between tallness of plant and curliness of foliage in Pease,s cross of F_1 (cabbage x curly kale) x cabbage.

(4). In Kohlrabi, the linkage relationship between the color factor "D" and the bulb factor "B" has been studied in a cross of purple bulb x green stalk, green bulb x purple stalk and purple kohlrabi x green stem stalk. The data showed that the factor "D" is linked only with factor B_1 or B_2 which is the factor for bulb formation because in coupling phase the distribution of purple and green plants in the bulb class is not normal. The crossover value between D and B is 30 per cent.

My own studies give data which may be used to determine the possible existence of linkage between several characters.

The F_2 from the cross purple x sun-red was also the one segregating for wrinkled and smooth foliage, the cross being purple smooth x sun-red wrinkled.

In order to determine if any linkage exists between these characters, the following comparison was made:

	Obs.	Cal.	*Cal. for linkage	X^2	P	Odds
Purple wrinkled	460	454.23	269.91			
Purple smooth	365	353.85	284.34			
Sun-red wrinkled	22	30.33	53.34			
Sun-red smooth	15	23.59	54.41	5.7857	0.1290	7 ; 1

* Based upon 10% crossing over either $\underline{R_1}\ \underline{W}$ or $\underline{R_2}\ \underline{S}$.

The F_2 results give a very close fit to the calculated 135 : 105: 9 : 7 ratio, expected from independence of the duplicate genes for color and the two complementary factors for foliage type. This evidence indicates no close linkage between the factors. Linkage would have to be very close before it could be detected with certainty in such a cross.

Relation of Foliage Character and Plant Height.

The data on the relation of foliage character and plant height in the F_2 families grown in 1931 and 1932 are presented in Table XVI.

The data indicate that in 1932 the wrinkled-leaved plants were .296±.165 inches taller than the smooth ones, but in 1931 the smooth leaved plants were .284±.145 taller than the wrinkled ones. These differences are not significant, D/PE being only 1.79 and 1.69, respectively. Therfore, there is no evidence of linkage between the factors for plant height and those for foliage type.

Relation of Foliage Character and Head weight.

The data on the relation of foliage type and head weight in the F_2 generation grown in 1932 are presented in Table XVII.

The F_2 data presented indicate that the wrinkled-leaved plants have somewhat heavier heads than do the smooth-leaved ones. The difference is 3.75 times its P. E. More data are needed to determine whether such a differnce actually exists.

Relation of Plant Height and Head Weight.

The relation of plant height and head weight in the F_2 generation grown in 1932 is presented in the form of a double-entry in figure 2. The value of the correlation coefficient is 0.179 ± .034. The value is positive, but is very low. The value is statistically significant. It may be interpreted to mean that there is a slight tendency but only slight, for the heads from taller plants to be heavier than those from the shorter ones.

Table XVI. Data on the relation between foliage type and plant height-F_2 data from the cross wrinkled x smooth.

Foliage Character	Year	Frequency distribution for plant height in inches																					Total	Mean	Difference	D/PE	Odds
		5.25	5.75	6.25	6.75	7.25	7.75	8.25	8.75	9.25	9.75	10.25	10.75	11.25	11.75	12.25	12.75	13.25	13.75	14.25	14.75	15.25					
Wrinkled	1931	1	0	3	11	15	20	34	39	47	35	21	18	6	3	0	0	0	0	1			254	8.996±.106	0.284±.145	1.96	4.31:1
Smooth					4	7	13	25	32	45	37	26	11	8	3	1	1						213	9.280±.098			
Wrinkled	1932						2	11	17	34	34	35	25	21	11	14	1	1	0	1	0	1	208	10.197±.113	0.296±.165	1.79	3.45:1
Smooth				1	2	0	5	8	23	25	29	26	30	11	7	8							175	9.901±.119			

Table XVII. Data on the relation of foliage character and head weight

Foliage Character	Frequency distribution for head Wt. in lbs.									Total	Mean	Difference	D/PE	Odds
	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25					
Wrinkled	6	23	30	45	43	23	13	10	1	203	2.011±.085	.450±.120	3.75	87 : 1
Smooth	10	33	36	33	36	16	7	3		174	1.611±.085			

Table XVIII. Data on the relation between plant color and plant height in F_2 of the cross purple x sun-red.

Color types	Year	Frequency distribution for plant height in inches (F_2)																					Total	Mean	Difference	D/PE	Odds
		5.25	5.75	6.25	6.75	7.25	7.75	8.25	8.75	9.25	9.75	10.25	10.75	11.25	11.75	12.25	12.75	13.25	13.75	14.25	14.75	15.25					
Purple	1931	1	0	3	13	22	34	54	69	88	67	43	27	13	6	1	1	0	0	1			443	9.14±.074	.03±.103	0.291	1 : 1
Sun-red					1	1	2	4	3	4	4	4	2	1									26	9.17±.324			
Purple	1932			1	2	0	7	19	38	56	61	59	53	32	18	23	1	1	0	1	0	1	373	10.08±.087	.37±.307	1.21	1 : 1
Sun-red									2	3	2	2	2										11	9.71±.295			

Table XIX. Data on the relation between plant color and head weight in F_2 of the cross purple x sun-red,

Color type	Frequency distribution for head Wt. in lbs. class center									Total	Mean	Difference	D/PE	Odds
	.25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25					
Purple	15	55	63	76	77	47	20	11	1	365	2.04±.093	.06±.226	.026	1 : 1
Sun-red	1	1	2	2	2	1	0	2		11	1.98±.255			

Fig. 2. Relation of plant height and head weight (F_2population)

Inches	Weight in lbs. .25	.75	1.25	1.75	2.25	2.75	3.25	3.75	4.25	
6.75	1	1								2
7.25										0
7.75	2		1	2	1		1			7
8.25	2	5	4	2	4	1				18
8.75		8	10	9	8	5				40
9.25	2	11	12	12	10	3	3	3		56
9.75	2	4	11	14	16	11	2	2		62
10.25	3	7	13	11	10	8	6	2		60
10.75	1	9	4	13	12	11	3	1	1	55
11.25		4	2	8	7	5	1	2		29
11.75	1	1	3	3	5	1	4			18
12.25		5	5	2	5	2		3		22
12.75					1					1
13.25			1							1
13.75										0
14.25						1				1
14.75										0
15.25				1						1
	14	55	66	77	79	48	20	13	1	373

r_{xy} — .179±.034

Relation of Plant Color and Plant Height.

The data on the relation of plant color and plant height in F_2 families grown in 1931 and 1932 are presented in Table XVIII.

The data indicate that the purple plants were 0.37 ± .307 inches higher than the smooth ones in 1932, while 0.03 ± 0.103 inches shorter than sun-reds in 1931. These differences are not significant. Therefore, there is no evidence of linkage between the factors for plant colors and those for plant height.

Relation of Plant Color and Head Weight.

The data on the relation of plant color and head weight in F_2 families grown in 1932 are presented in Table XIX.

The data indicate that the purple plants had heads .06 ± .226 pound heavier than the sun-red ones. This difference is not significant, It is evident that no linkage exists between the factors for plant colors and those for head weight.

DISCUSSION

The results obtained from the two crosses, purple x sun-red and purple x green, differed from each other. In the purple x sun-red cross, the F_2 segregated for different intensities of purple. In the other cross this segregation for purple intensity was not as clear cut. This difference is difficult to explain. The purple parent which was used in the cross with sun-red and in the cross with green was from the same pure line. In the former case, a ratio of 15 purple : 1 sun-red was obtained; in the latter 9 purple : 3 sun-red : 4 green. In the latter cross (purple x green) considering only the pigmented classes. there were 225 purples and 50 sun-reds. This is a poor fit to a 3 : 1 ratio, X^2 equaling 7.0696, $P>.01$, odds being >99 : 1. Yet the fit to a 15 : 1 is much worse. It is possible that the sun-red type extracted from the purple x green cross is not the same as the pure snu-red strain used in the other cross. A cross between the two sun-reds should give some information on this point.

The failure to obtain magenta plants in both crosses indicates that the factor for production of magenta is absent in the purple plant. Therefore, this purple type must be different genetically from that which Magruder (7) obtained from the cross of sun-red x magenta. It is also a question whether the sun-red parent used in Magruder's cross is the same genetically as those used in these studies.

When two of the F_2 sun-reds which were obtained from the cross purple X sun-red were intercrossed, the progeny was all sun-red but showed more intense color. This increase in intensity of sun-red may be due to the presence of an intensifying factor brought in by the purple parent. This factor would show up more clearly in the cross, purple x sun-red than in the cross purple x green, since in the former cross, both parents carry the basic factor G for pigment production. In the backcross of F_1 (purple x sun-red) x sun-red

(from F_2) a few "C" types of purple were always obtained where only "B" and "A" types are expected. This might also be explained on the basis of an independent intensifying factor. In this case, only part of the F_2 sun-reds should be carrying this factor.

The nomenclature of purple and red has not been well standardized. If the term sun-red refers to the light red mid-vein type used by Kristofferson, then the result Kristofferson (6) obtained from a cross kale x light red vein cabbage is similar to that secured by the writer in the cross of one type of green with sun-red {gH x GH → F_1 Purple (dark red mid-vein) }. This result parallels that obtained by Allgayer (1). If the colored plants in my 9 : 3 : 4 ratio are grouped together, the ratio of 3 colored : 1 green will result.

The inheritance of wrinkled type of foliage can be explained by complementary factors though continuous variation occurs in the F_2 which is very much like quantitative inheritance. These factors at least show only partial dominance. The F_3 and intercross tests show that the complementary factor hypothesis is probably correct.

Difficulties were met with in classifying the different degrees of wrinkling. An attempt was made to set up arbitrary classes, but it did not help any. In interpreting the result, therefore, only two classes, wrinkled and smooth, are considered. The intermediate expression in F_1 was very distinct. In F_2 very few were as wrinkled as the grand-parental type. This latter observation was also made by Price (10) in crosses of savoy Drumhead variety x smooth Volga variety, by Kristofferson (6) in crosses of common cabbage varieties x kale and brussels sprouts x kale, and by Rasmusson (1932) in crosses of cabbage x savoy cabbage. They interpreted their results on the basis of a multiple factor hypothesis.

In my own studies, the progeny from F_2 wrinkled plants which were very much like the wrinkled grand-parent showed a variation in degree of wrinkling. This suggests that additional factors affecting the amount of wrinkling may be segregating.

The intercross of two F_2 smooth plants giving a segregation of 1 smooth : 1 wrinkled is the clearest evidence that wrinkling is due to complementary factors. The observation made by Tschermak (1906) (after Fruwirth) that curled leaf in kale was found to be dominant over the smooth leaf in cabbage and brussels sprouts also agrees with the present result.

In the plant height and head weight studies, marked hybrid vigor was noted in the F_1. The same result was noted by Rasmusson (12) for head weight in crosses of common cabbage x savoy cabbage. In my studies an increased variability in F_2 was noted with a decrease in mean weight.

The writer is well aware that the number of F_2 individuals selected for F_3 test was in many cases smaller than is desirable for full confirmation of the hypothesis involved. There are many mechanical limitations in handling cabbage in large numbers. Among these is the difficulty of keeping plants in storage over winter which is necessary in the region of Ithaca if the seed generation is to be grown in the field. If on the other hand, greenhouse is used for producing the seed generation, the amount of space available is a limiting factor. Also storage rots often reduce the numbers of plants and losses may occur in the green-house.

SUMMARY

A cross of deep purple x sun-red gave an F_2 ratio of 15 purple : 1 sun-red. The F_3 and intercross tests show that the assumption of two duplicate genes, $\underline{R_1}$ and $\underline{R_2}$ for purple will explain the result. Evidence shows the genes are cumulative in effect.

From the cross of deep purple x green, a ratio of 9 purple : 3 sun-red : 4 green resulted. The F_3 test fits the assumption that two factor pairs are concerned; $\underline{G}$ a basic factor for pigment which with $\underline{H}$ gives purple and with $\underline{h}$ gives sun-red.

It is pointed out that there are difficulties in reconciling the two above results, and that possibly the two sun-red types are different.

The wrinkled foliage type, apparently is due to two complementary factors, W and S with the possibility that accessory factors are involved which affect the degree of wrinkling.

There is no evidence of linkage between foliage type and plant color in the cross of purple x sun-red.

The plant height data may be explained on the basis of multiple factors. Hybrid vigor was noted in the F_1 and transgressive segregation in F_2.

Head weight also showed hybrid vigor in F_1.

There is no evidence of linkage between foliage type and plant height or between plant height and plant color. Also there is no linkage between plant color and head weight. The wrinkled-leaved plants had somewhat heavier heads than did the smooth-leaved ones. There was only a slight tendency for the taller plants to have heavier heads.

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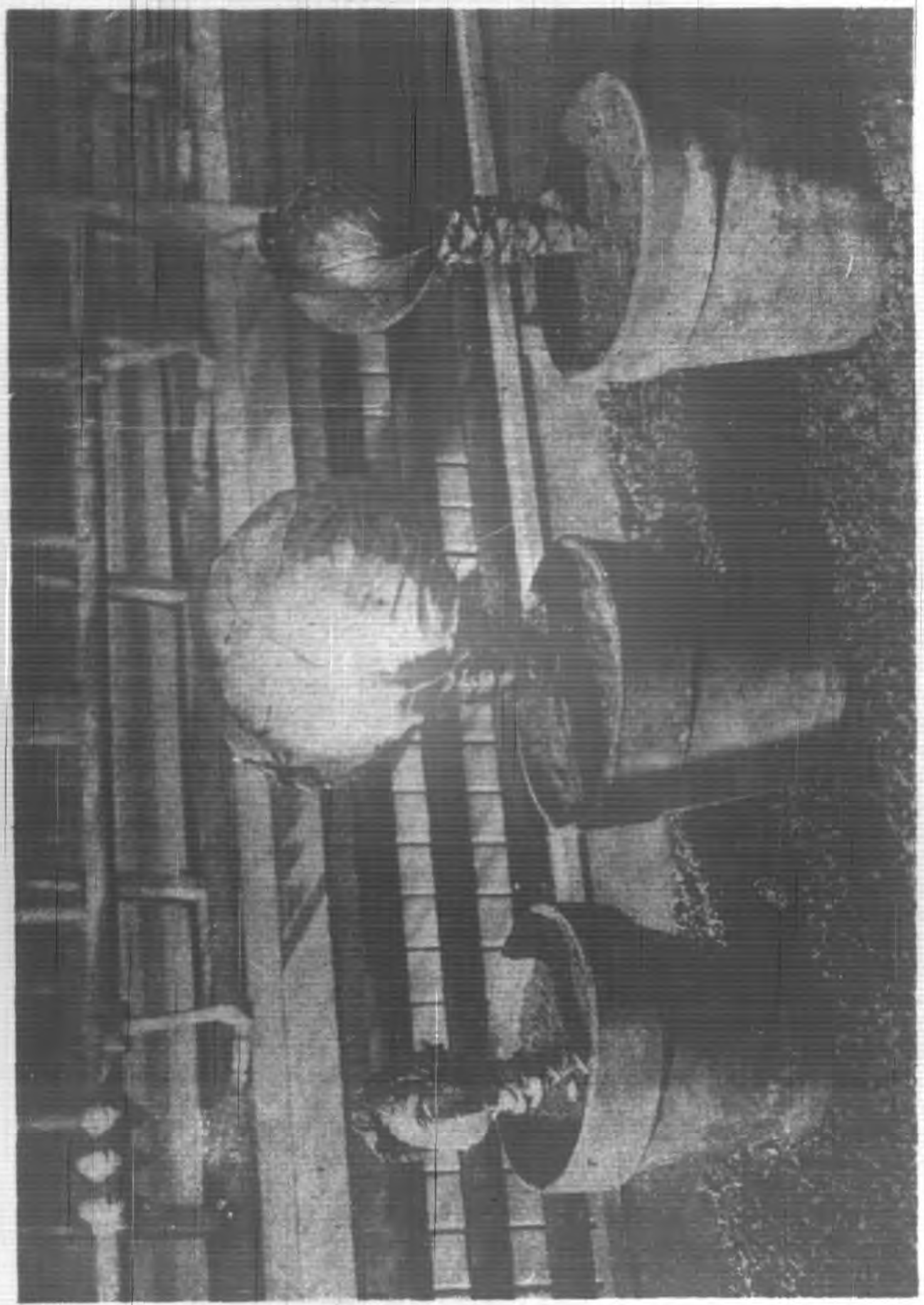


Plate I. Photograph showing the difference in plant height between F_1 and parent. F_1 in middle, parents on either side.

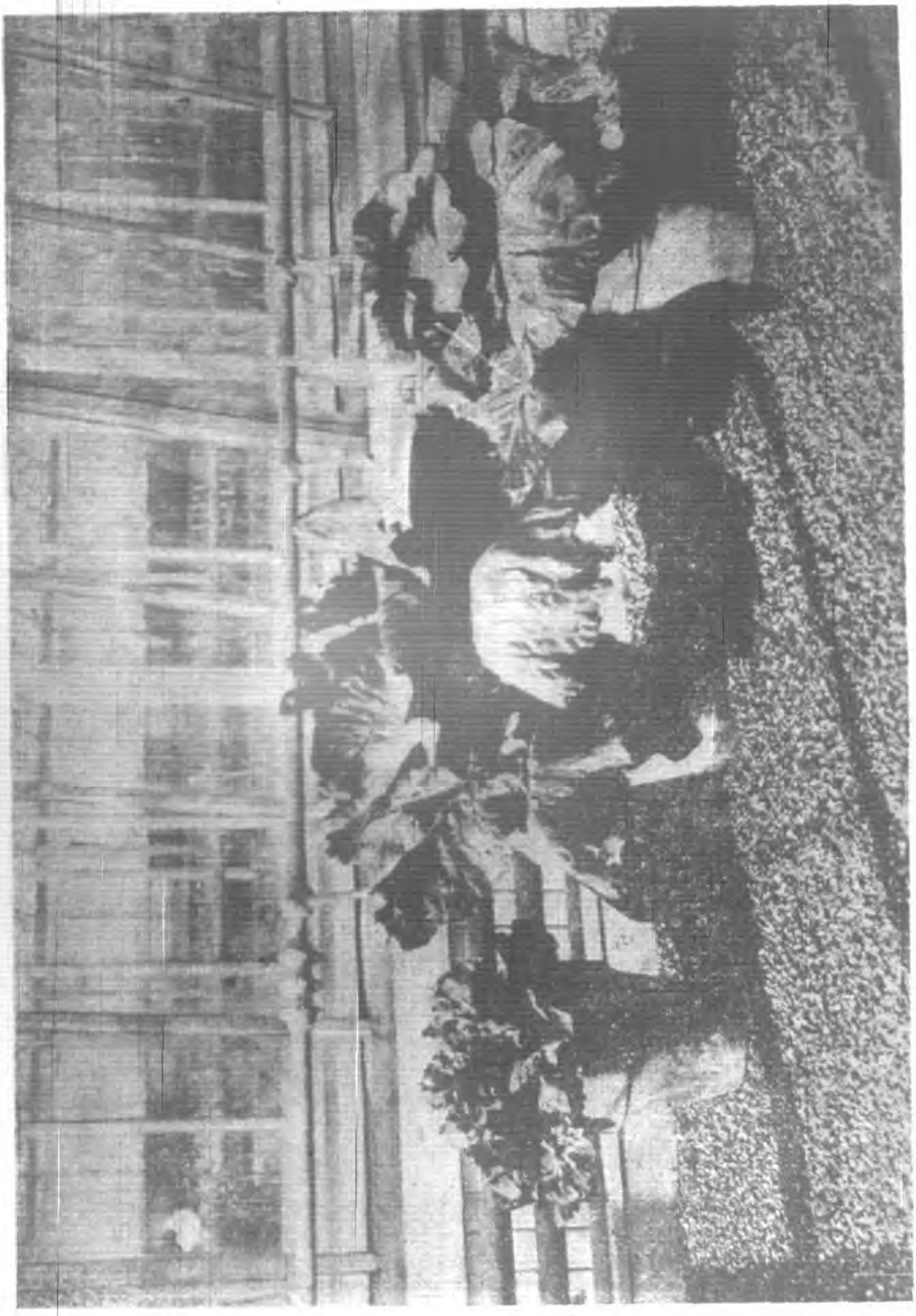


Plate II. Photograph showing hybrid vigor in F_1. F_1 in the middle, parents to left and right.

甘藍數種性狀遺傳研究

提　要

本篇報告甘藍性狀，如植株色澤，葉型，植株高度及球之重量等之遺傳研究結果，對於植株之色澤及葉型兩種性狀之研究尤爲注意。

I. 植株色澤遺傳

以紫色（"1085—5"）× 日光色（"341"）及紫色（"1085—5"）綠色（"342"）爲研究植株紫色遺傳之材料，茲將所得結果分別簡述之：

紫色（"1085—5"）× 日光色（"341"）雜交所產生之雜種第一代植株，均爲紫色，但其色澤較紫色（"1085—5"）淺，較日光色深，似爲中間性，雜種第二代產生826株紫色與37株日光色，所得比率與15:1頗相符合，此即表示植株紫色之遺傳由於二對重複因子而成。但祇根據雜種第二代植株之比率爲不可靠，須以雜種第三代之遺傳證明之，倘15:1爲可靠，雜種第三代之植株須分離15紫色:1日光色或分離3紫色:1日光色。此種結果在雜種第三代植株中均得之。此足爲紫色由於重複因子而成之明證。著者爲更進一步之試驗，將雜種第一代與日光色回交之結果證明之，如植株之紫色爲由於重複因子，則此回交所得者爲 3 紫色:1日光色。試驗所得結果與理論的恰相符合。

假定顯性因子R_1或R_2產生植株之紫色，倘無R_1或R_2則產生日光色，但重複因子有累積之影響，即植株所含R_1或R_2愈多則色澤愈深。如雜種第二代植株色澤之深度不同，因植株所含之成形型R_1或R_2因子不同，故

雖爲紫色，然亦有四種深淺不同色澤之植株。據種第二代紫色之各種等級，可由雜種第三代自交之結果知之，根據試驗所得之結果證明色澤愈深所含R_1與R_2因子愈多，是卽重複因子之影響。

紫色("1085—5")×綠色("342)雜交所產生之雜種第一代植株，如中間色澤，雜種第二代植株中除親代紫色與綠色外得一種日光色，其比率爲9紫色：3日光色：4綠色。根據分離結果，可知紫色由於二對因子而成，假定G爲產生顏色的基本因子，如與H同在一植株，則產生紫色，如與h同在，則產生日光色。如植株所含之因子爲g則爲綠色。雜種第二代紫色植株自交後，在第三代分離二種比率，卽9紫色：3日光色：4綠色，與3紫色：1日光色。雜種第二代日光色植株自交後，在第三代分離爲3日光色：1綠色

雜種第二代與雜種第三代分離現象，足以證明紫色親代與綠色親代含有兩對不同遺傳因子Gg與Hh

至于有色類中，紫("1085—5")×日光色，("341")與紫色("1085—5")×綠色("342")雜交結果，大不相同。在紫×日光色雜交，雜種第二代有紫色深淺植株分離。而在另一雜交，紫色深淺植株分離不顯明。此種不同現象不易解釋因兩種雜交之紫色親代爲同一純系。在紫×日光色雜交所得比率爲15紫：1日光色，而另一雜交其比率則爲9紫：3日光：色(4綠色)。雖然，紫×綠雜交之雜種第二代分離爲225紫：40日光色，與3:1比率相差不遠，而與15:1比率則相差更甚矣。故唯一解釋爲從紫×綠所得之日光色植株與第一雜交所用之純系日光色親代，其遺傳因子或不相同。

依據馬氏(Magruder)研究結果，在日光色×洋紅雜交可得紫色。但著者兩種雜交中均無洋紅植株分離，是可知所用紫色親代中無產生洋紅因子存在，或有其他阻止產生洋紅因子，其所有遺傳因子與馬氏所用者異。

II, 葉型遺傳

皺葉×平葉雜交所產生之雜種第一代爲中間性,雜種第二代得428皺葉:380平葉之分離,頗近9:7之比率。故皺葉性狀由于兩對互補因子而成雜種第三代與各個雜種第二代互交之結果,證明此種解釋。雜種第二代皺葉之植株自交後其雜種第三代則得9:7與3:1兩種比率。雜種第二代兩個平葉互交後,其下代則分離皺葉與平葉。以上各種結果,皆足爲皺葉性狀由于兩對互補因子而成之明證。茲假定顯性因子W與S以表之。根據試驗之結果,皺葉因子與紫色因子無連繫遺傳之關係。

III. 植株高度及球之重量遺傳

植株高度及球之重量似爲數量遺傳,雜種第一代健全優勢甚爲顯著,雜種第二代之變異性較雜種第一代更加增大。就植株高度而言,雜種第二代植株中有高于高的親代矮于矮的親代分離,此種現象謂之 transgressivn 分離。高的雜種第二代植株,產生高的雜種第三代,可知雜種第二代高度與第三代相關係數甚大,即0.958±0.012。從試驗結果,可知植株高于數多累積顯性因子相互作用而成,而每一親代各有此等顯性因子之一度遺傳由部分。其雜種第二代分離情形,頗似正態頻數曲線,此即各個顯性因子對于植株高度有同等之價值,因高度性狀遺傳非常複雜,故因子數目尚不能估定。

球之重量性狀爲數量遺傳,但不能臆斷。因雜種第二代各個球重未曾權衡,故雖有雜種第三代之記錄,亦不足以證明。

植株色澤與植株高度或球之重量爲獨立遺傳,非連繫遺傳。植株高度與葉型遺傳無關,惟皺葉性狀與球之重量稍有連繫遺傳之指示,即皺葉植株所結之球較平葉重也。

柑橘貯藏試驗(一)

金陵大學農學院教授

陳錫鑫

我國柑橘之生產額，年約一千餘萬元，產量之多，列世界第三位(6)，除缺乏檸檬外，種類極爲豐富。增加生產，尙有充分之餘地。但每年尙由國外輸入，橘子一項民國廿一年輸入額爲1,405,005海關金，較之前二年並未減少(10)，輸入國首爲日本，次爲美國，前者推銷於華北，後者於華南，1930美國加州大學之 Crocheron, Norton 兩氏(3)及 Overholser 氏(12)曾在中國作大規模之菓蔬市場，調查與運輸試驗，對於我國產菓實之豐美甚爲驚嘆，並謂推銷於我國市場之花旗牌（Sunkist）鮮橘乃不列等之屑果(Cull)，殊有損花旗之聲譽。廣東產柑類橙類其風味與國外品比較，有過無不及，嗜柑者皆知之，雖外觀鮮美稍遜，此甚容易改進，目前問題，乃不能週年供給。

南京市場柑橘之來源，僅限於浙江廣東福建等省，利用水運經上海而來者，每年十一月起，有浙江黃巖產早橘，本地早，朱橘，繼爲溫州產本地橘，福建產紅橘及廣東產有柑，新會橙雪柑等，最後爲廣東之蕉柑(上海稱暹羅蜜橘)與浙江溫州產帶苦味之瓯柑。(蘇州洞庭產之早紅十月已上市爲數甚少)一月與二月中各處柑橘紛至沓來，四月以後則跡絕市場，自五月至十月之七個月中，販賣者消費者乃不得不仰給於國外之貯藏品。

註一　本試驗得上海水菓地貨行業同業公會寄贈材料，病源菌之鑑定得俞大紱博士助力謹誌簡頭致謝

閩粵浙三省生產地調查所及，尙無良好貯藏方法，採後有用竹簍堆積家中，待價出售者，時間稍久，腐蝕續出，冬季高溫之處，損失尤大。南京之氣候冬春季用普通貯藏法(Common storage or dry storage)，五個月之期間，決非難事。春末夏初正值鮮菓青黃不接之時，國外貯藏品充溢市場，國產苹果，額量尙不足供消費，此期間鮮菓之供給，自宜以柑橘爲中心。盛夏之貯藏，則需要冷藏庫之設備，但浙江柑橘之採期爲十一月，廣東爲一二月，採下卽收入冷藏庫，延至盛夏所費甚大，單就成本而言，亦須兼用普通貯藏互相連續，較爲經濟。

材料及試驗方法

早橘，本地早，朱橘三種，民國廿二年十一月廿一日在浙江黃巖縣南門外西林園內，選發育均等之樹共六株，樹齡十三年，該園之管理在當地爲最進步者，但採收前一月內未撒布藥劑，剪果裝箱運輸均由筆者與同行者動手，務使果皮不受傷疵，果梗修理平整，本地早，朱橘採下各分一半用5%溫硼砂液（液溫40°—32°c）浸過五分鐘，作防黴(Penicillum)試驗，他一半留作對照。包裝用黃巖常用之木箱(照片三)，大小爲1.5×1.0×.08尺，容重約四十斤，裝果用直線包裝法(Straight packing style)，果梗側向安置，廿六日到南京，運輸中氣溫爲23°—17°c，廿八日入庫。

廣東產柑橘三種卽有柑，雪柑，蕉柑，由上海水菓同業公會寄贈，採期及各種處理均不明，用以代表現在市場上之商品，到後加以選擇，收入庫內，又在南京下關水菓行於三大木桶內(每木桶容重200斤)選廣東產雪柑百顆供試。

腐敗果之摘出每週兩次，發病日期，病源菌，罹病數目，均詳加記載。

貯藏中主要成分變化之調查，每品種選大小相同之果實藏於庫內，二

月以前每兩週一次，以後三週一次 取出試驗。酸量之測定，取果汁5c.c.用氫氧化鈉(NaOH)之十分之一當量溶液滴定，全酸量換算作枸櫞酸(Citric acid)。可溶性固形物之測定，取果汁220c.c.用六英寸之 Balling 比重計量過，再用Schultz及Osterman之麥酒抽出液表檢索100c.c. 內之克量。然後計算其酸固形率(Solids acid ratio)。由上海水菓公會寄贈之柑橘，因採期及樹齡不明，故每次多取顆數榨出果汁300c.c.左右供試。黃岩產柑橘每次十顆至十二顆。供此試驗之顆數，概未計入貯藏總數內。

重量之檢查每品種選二十顆，每七日秤其重量，中途腐爛者，概未算入平均內。

貯 藏 庫

地下貯藏庫之構造，在金陵大學園藝系斜坡之桃園內，擇高爽處，掘深2.6m.寬及長3.2m之地下室，四隅離室底60cm.高處埋直徑18cm 之土管，出於地上，管口罩以鍍鐵製之風筒，供換氣時之用，使沉下之CO_2亦易

圖一 貯藏庫之外觀

排出；門厚 10cm. 中實以乾燥鋸屑。地下室上部蓋厚木板一層，中間能開閉。屋頂用木板與厚蘆葦葺成。屋頂四壁，有三個二重窗，換氣時與土管同時開放。方位北向，南方爲建築物，西南有傾斜，容易排水，室內設架棚，每層均置90×74×15cm.之木製果棚，柑橘卽排列其中，未用紙包。

庫內換氣，冬季於清晨或晚間開放三小時，春季徹夜開放，每週一次至兩次，四月以後因外溫過高，選擇涼夜開放。

庫內溫度，濕度，庫外溫度，及1m.深之地溫，列於第一表內。

第一表　庫內外溫度濕度及一m深之地溫表

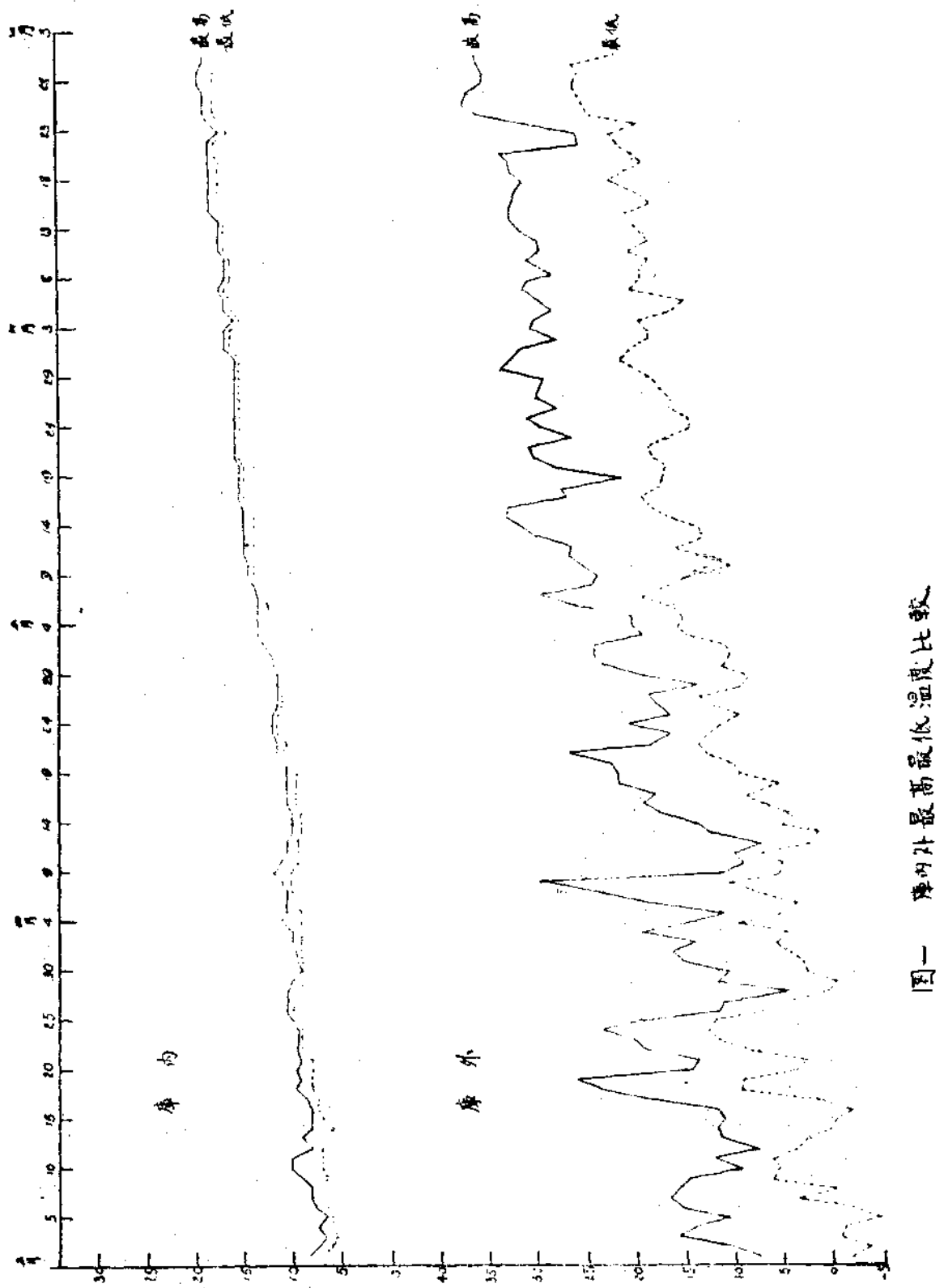
（每週平均）

日　期	庫內溫度c°	庫外溫度c°	地溫（一公尺深）c°	庫內濕度%
十一月廿七日至十二月三日	11.33	9.61	14.36	92.71
十二月四日至十日	11.13	10.54	12.71	92.71
十二月十一日至十七日	9.90	6.21	11.64	93.43
十二月十八日至廿四日	9.04	5.39	11.00	92.14
十二月廿五至卅一日	10.46	7.50	10.29	93.00
一月一日至七日	7.30	1.21	10.00	91.86
一月八日至十四日	6.26	0.71	8.43	91.79
一月十五日至廿一日	4.74	0.99	8.21	91.86
一月廿二日至廿八日	4.84	0.10	7.64	91.00
一月廿九日至二月四日	6.53	2.56	6.93	91.43
二月五日至十一日	6.84	4.11	8.29	91.43
二月十二日至十八日	7.39	6.37	7.71	92.21
二月十九日至廿五日	7.54	4.76	7.57	92.21
二月廿六日至三月四日	7.76	6.24	7.71	92.57
三月五日至十一日	7.64	7.76	8.29	87.57
三月十二日至十八日	8.10	7.93	8.43	92.29

三月十九日至廿五日	9.74	13.91	8.64	92.43
三月廿六日至四月一日	9.67	7.39	9.29	92.79
四月二日至八日	10.50	12.67	9.07	93.00
四月九日至十五日	10.50	7.99	9.00	92.86
四月十六日至廿二日	11.13	15.39	9.50	93.14
四月廿三日至廿九日	12.20	14.29	10.50	94.00
四月卅日至五月六日	12.79	18.06	11.50	93.29
五月七日至十三日	14.20	20.77	13.29	93.29
五月十四日至二十日	15.20	23.10	15.07	93.86
五月廿一日至廿七日	15.83	23.07	16.00	93.71
五月廿八日至六月三日	16.40	25.00	16.43	94.29
六月四日至十日	16.83	24.26	17.64	94.57
六月十一日至十七日	17.43	25.53	18.43	94.57
六月十八日至廿四日	18.09	25.74	18.86	94.57
六月廿五日至七月一日	18.97	30.64	18.86	94.14

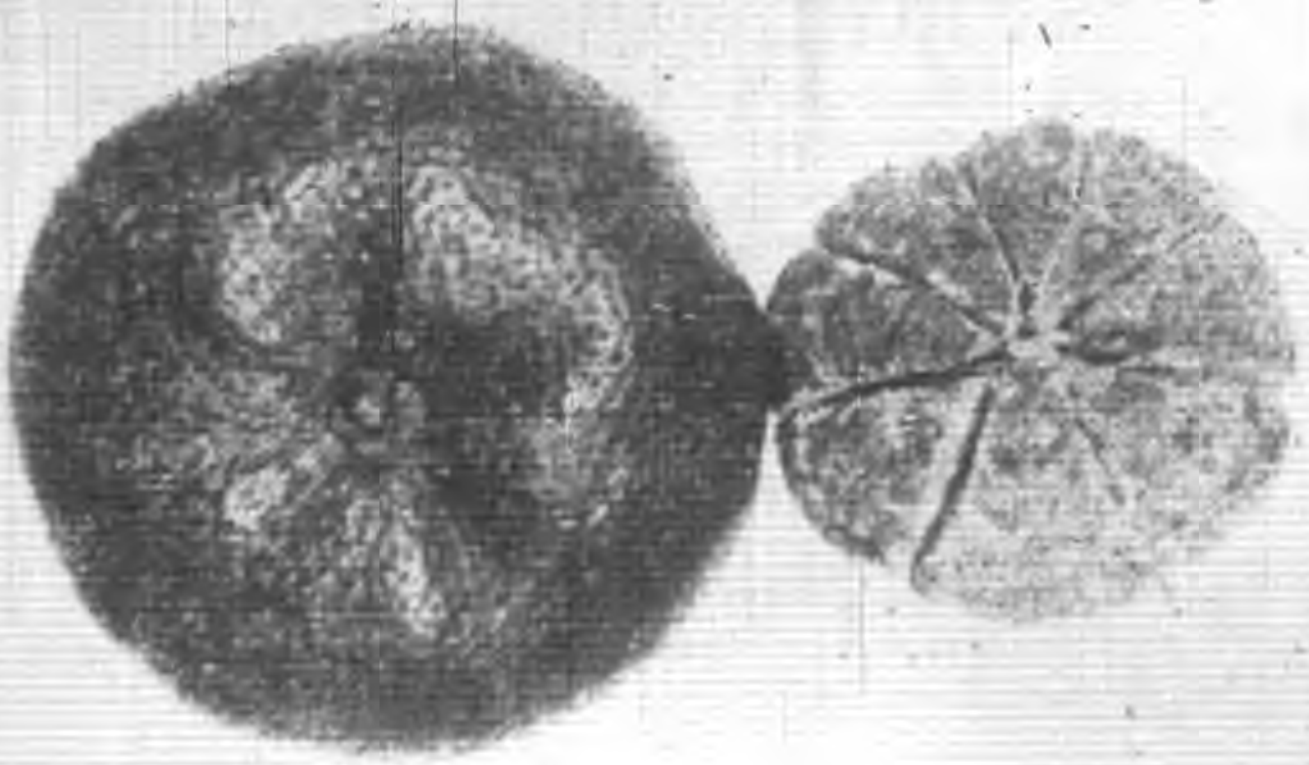
每週平均溫度,三月以前庫溫較外溫高,三月以後庫溫較外溫低。地下貯藏室之溫度受外溫之影響小,受地溫之影響大(9)。1m. 深之地溫,測定以供對照。三月至七月每月庫內外最高最低溫度如圖一。外溫雖急劇增高,庫內所受之影響較微,其昇高狀況,亦甚規則,每日最高最低之相差亦小。柑橘採於冬季,春季貯藏,無凍冷裝置之地上貯藏室及地下貯藏室均可利用,但前者易受外溫之影響,春季庫溫之保持,牆壁須施絕緣。置裝所費較大。地下貯藏室除屋頂門戶之絕緣與防過濕外;建築較爲簡單。地下室之濕度亦易保持,第一表內均在90%以上,防果皮萎縮之效果甚大。(照片二)

柑橘原產於熱帶,貯藏溫度不能與苹果同視。若果皮健全,稍高溫,反較低溫能耐久。Ramsey(13)謂柑橘不能貯藏於32°F,圓橙類(Orange)冷



圖一　庫內外最高最低溫度比較

藏適溫爲38—42°F，檸檬爲 42°F，葡萄柚(Grapefruit)爲45—50°F。貯藏溫度過高，反易發生種種生理的病害(11)。



圖二　經過二百日貯藏之早橘果肉乾縮果皮仍新鮮未變

貯藏中腐爛狀況

貯藏病害之發生與果園之管理及採果後種種之處理，有密切關係。由上海水菓公會寄贈之柑橘，入庫前曾嚴加選擇，入庫不久，卽病害迭出（第二表一B）。有柑僅藏廿二日，已腐敗至30%以上，其時庫溫爲7.3—6.2°C.，雪柑二十七日已腐爛至53.10%其時庫溫爲7.8—7.6°C。蕉柑與南京所購之雪柑，經兩個月之貯藏，亦發病至30%以上。黃岩產之朱橘與本地早（第二表－A）由筆者所運輸者，閱五個月之貯藏後，累積腐敗率始至30%。市場上之商品，其貯藏之困難於此可見。

貯藏病之調查，曾延至七月十六日，全腐爛中各種病害之百分率，列於第三表內。由上海水菓公會寄贈之有柑雪柑蕉柑，腐爛之原因，大部分由於黴類（Penicillum）青黴病（Penicillum italicum）之發生已占全腐敗果之60%與58%以上。各種重要病害發生之經過，列於第四表。有柑，雪

柑，蕉柑入庫後，黴類之發生甚速，當時庫溫並不甚高，而雪柑於四十一日中已發生至55.86%，與同表內筆者所運輸之本地早朱橘比較，黴類之被害狀況，頗堪注目。

黴病之胞子在舟車倉庫店頭，到處飛散，但侵入果皮，多由傷口，苟果皮新鮮健全，不易被其侵蝕。Fawcett & Lee(4)引用 Ramsey 之報告，謂青黴病綠黴病之豫防，自採果以至販賣種種經過與處理最爲緊要，不可使果皮受黴傷，果皮受傷之原因，如採果之剪刀，殘留之果梗，橘樹之刺，採果梯與果實之摩擦，工人之指甲，採果裝箱時果實之擲入，容器內之砂礫釘頭，用無彈簧之卡車運搬，採後選果洗滌乾燥時之不注意，裝貨時之粗魯等等無時不可開黴病侵入之門戶，關於工作時之注意，兩氏列引二十九

照片三　各處柑橘之容器(於南京市場)

(一)廣東雪柑　(二)廣東蕉柑　(三)新會甜橙　(四)黃岩早橘本地早　(五)美國花旗牌鮮橘

注意　花旗牌鮮橘之容器裝重不過雪柑容器四分之一且每箱內又分兩隔

大條,以爲豫防黴病唯一之有效方法。

廣東方面栽培地,採果以及種種處理方法,筆者未曾親自調查,不知其詳。但民國廿二年一月曾在南京檢查各處運柑橘容器,(照片三)廣東雪柑盛於大木桶內,容重約200斤,顆數500,果梗長留,裝果無一定排列,開桶後三大木桶之果實,內已有25%被壓壞刺傷,不易着目之微傷,尙未計算在內,雪柑果梗直下之組織,較爲柔軟,桶內載重過甚,下層之果實,其果梗部多被壓平或皺折。

黴病之發生,與溫度固有關係,但Brook and Cooley(1)謂苹果之青黴病(Penicillum expansum),如其胞子已侵入果內發芽,卽在32°F.之低溫,亦能繼續生長。柑橘之冷藏適溫,須在32°F. 以上,故將來各處縱有冷藏庫之設備,苟現在之包裝運輸方法,不加改良,能否發揮冷藏之效果,當屬疑問。

黃岩產本地早朱橘之貯藏病,以炭疽病(Colletotrichum gleosporioides) 與果腐病(Alternaria Citri)爲最多,但其發生最劇時期在五月以後,以風味而言,此兩種柑橘之貯藏不能過四月,故此次試驗,並未蒙其大害。

黴病之防止,Fulton and Bowman(5)1924年發表,將柑橘在5%之硼砂液內,浸過一次,頗爲有效,以後尙有多數試驗者之報告,關於液溫濃度,浸液時間,亦有種種,浸過者均較無處理罹黴病少。實用上則尙有試驗之餘地。本試驗中之朱橘與本地早(第三,四表)浸過硼砂液者與無處理比較,黴病之發生曾減少,然朱橘之果腐病,本地早之炭疽病,則較無處理增加數倍,此兩病之增加與浸硼砂液有無關係,一回試驗,無從判斷。但40°F之液溫,浸後常有使果梗花蕾枯萎者,頗堪注意。

第二表—B　上海寄贈廣東產各種柑橘之腐爛狀況

種類	碰柑			雪柑(上海)			雪柑(南京)			蕉柑		
入庫日	民國二十二年十二月二十三日			民國二十三年二月十四日			民國二十三年一月三十一日			民國二十三年二月七日		
入庫總數	82顆			145顆			78顆			271顆		
調查日月	貯藏日數	腐敗果累積數	腐敗果百分率	貯藏日數	腐敗果累積數	腐敗果百分率	貯藏日數	腐敗果累積數	腐敗果百分率	貯藏日數	腐敗果累積數	腐敗果百分率
一月一日	9	2	2.44	—	—	—	—	—	—	—		—
一月十五日	23	28	34.15	—	—	—	—	—	—	—	—	—
一月廿九日	37	32	39.02	—	—	—	—	—	—	—	—	—
二月十二日	51	40	48.78	—	—	—	13	0	0	6	0	0
二月廿六日	65	48	58.56	13	5	3.45	27	2	2.56	20	0	0
三月十二日	79	59	71.95	27	48	33.10	41	12	15.38	34	22	8.12
三月廿六日	93	60	73.17	41	93	64.83	55	22	28.21	48	52	19.19
四月九日	107	67	81.71	55	105	72.41	69	28	35.90	62	69	25.46
四月廿三日	121	71	86.59	69	125	86.21	83	54	69.23	76	91	33.58
五月七日	135	74	90.24	83	129	88.97	97	66	84.62	90	109	40.22
五月廿一日	149	74	90.24	97	133	91.73	111	68	87.18	104	112	41.33
六月四日	163	78	95.12	111	134	92.41	125	72	92.31	118	119	43.91
六月廿五日	184	79	96.34	132	134	92.41	146	72	92,31	139	147	54.24
七月二日	191	79	96.34	139	137	94.48	153	75	96.15	146	175	64.58
七月十六日	205	81	98.78	153	139	95.86	167	75	96.15	160	214	78.97

第二表—A：　黃岩產本地早與朱橘之腐爛狀況

種類		本地早（浸硼酸）		本地早（無處理）		朱橘（浸硼酸）		朱橘（無處理）	
入庫日		民國二十二年十一月二十八日		民國二十二年十一月二十八日		民國二十二年十一月二十八日		民國二十二年十一月二十八日	
入庫總數		267		390		353		200	
調查日月	貯藏日數	腐敗果累積數	腐敗果百分率	腐敗果累積數	腐敗果百分率	腐敗果累積數	腐敗果百分率	腐敗果累積數	腐敗果百分率
民國二十二年十二月十七日	21	0	0	0	0	0	0	0	0
民國二十三年一月一日	35	0	0	2	0.51	0	0	0	0
一月十五日	49	2	0.75	8	2.05	8	2.27	3	1.50
一月廿九日	63	3	1.12	11	2.82	8	2.27	3	1.50
二月十二日	77	3	1.12	12	3.08	8	2.27	3	1.50
二月廿六日	91	4	1.50	14	3.59	9	2.55	6	3.00
三月十二日	105	6	2.25	20	5.13	15	4.25	11	5.50
三月廿六日	119	12	4.48	23	5.90	22	6.23	11	5.50
四月九日	133	19	7.11	27	6.92	52	14.73	14	7.00
四月廿三日	147	36	13.48	42	10.77	84	23.80	20	10.00
五月七日	161	52	19.48	50	12.82	114	32.29	31	15.50
五月廿一日	175	64	23.97	62	18.46	126	35.69	39	19.50
六月四日	189	109	40.82	78	20.00	158	44.76	60	30.00
六月廿五日	210	151	56.55	103	26.41	175	49.58	74	37.00
七月二日	217	185	69.29	124	31.79	205	58.08	105	52.50
七月十六日	231	213	78.78	161	41.28	248	70.25	132	66.00

第三表　全腐爛果中各種病害之百分率

	早橘	朱橘(浸硼酸)	朱橘(無處理)	本地早(浸硼酸)	本地早(無處理)
青黴病 Penicillum italicum	32.31%	9.70%	31.69%	17.28%	49.11%
綠黴病 Penicillum digitatum	1.54	0.37	2.82	0.83	2.37
黴病 Penicillum sp.	4.62	2.99	3.52	3.70	4.14
炭疽病 Colletotrichum gleosporioides	12.31	40.30	39.44	53.50	21.89
果腐病 Alternaria Citri	27.69	32.84	9.15	13.58	10.06
蒂腐病 Diplodia natalensis	3.08	1.49	2.12	2.47	1.18
酸腐病 Oospora citri-aurantii	1.54	0.75	——	——	——
赤腐病 Cephalothecium roseum	——	——	0.70	3.70	——
Fusarium sp.	——	3.73	4.93	3.70	1.78
未決定	16.92	7.84	5.63	1.23	9.47

第三表——續

	布柑	雪柑(南京)	雪柑(上海)	蕉柑
青黴病 Penicillum italicum	60.87	68.83	65.06	58.67
綠黴病 Penicillum digitatum	5.43	——	2.41	1.78
黴病 Penicillum sp	2.17	5.19	12.05	7.56
炭疽病 Celletotrichum gleosporioides	17.39	16.88	7.83	17.78
果腐病 Alternaria Citri	4.35	1.30	1.81	4.44
蒂腐病 Diplodia natalensis	1.09	——	——	0.44
酸腐病 Oospora citri-aurantii	——	——	1.81	0.80
Fusarium sp.	2.17	——	2.41	0.44
未決定	6.52	7.79	6.63	8.00

第四表 各種重要病害之

種類	種										
								柑	雪		
調查日月	病名 / 貯藏日數	黴類		炭疽病		果腐病		病名 / 貯藏日數	黴類		
		累積數	百分率	累積數	百分率	累積數	百分率		累積數	百分率	
一月一日	9	2	2.44	0	0	0	0	—	—	—	
一月十五日	23	25	20.49	1	1.22	1	1.22	—	—	—	
一月廿九日	37	26	21.70	4	4.88	1	1.22	—	—	—	
二月十二日	51	33	40.24	6	7.32	2	2.44	—	—	—	
二月廿六日	65	41	50.00	7	8.54	2	2.44	13	5	3.45	
三月十二日	79	49	59.76	9	10.97	2	2.44	27	41	28.28	
三月廿六日	93	50	60.97	9	10.97	2	2.44	41	81	55.86	
四月九日	107	56	68.29	9	10.97	3	3.66	55	97	66.90	
四月廿三日	121	58	70.73	10	12.20	3	3.66	69	121	83.45	
五月七日	135	58	70.73	10	12.20	3	3.66	83	122	84.14	
五月廿一日	149	60	73.17	13	15.85	3	3.66	97	124	85.62	
六月四日	163	63	76.83	16	19.54	3	3.66	111	130	89.66	
六月廿五日	184	63	76.83	16	19.54	3	3.66	132	130	89.66	
七月二日	191	63	76.83	16	19.54	3	3.66	139	132	91.03	
七月十六日	205	63	76.83	16	19.54	4	3.66	153	132	91.03	

*各種病害發生百分率中,每一橘發生二種病害者,亦分別計算在內。

發生經過*

(上海) 柑 炭疽病		柑 果腐病		蕉 柑 貯藏日數	蕉 柑 黴病		蕉 柑 炭疽病		蕉 柑 果腐病	
累積數	百分率	累積數	百分率		累積數	百分率	累積數	百分率	累積數	百分率
—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	6	0	0	0	0	0	0
0	0	0	0	20	0	0	0	0	0	0
1	0.69	1	0.69	34	18	6.64	0	0	2	0.74
10	6.90	2	1.38	48	43	15.87	0	0	2	0.47
11	7.59	3	2.07	62	57	21.03	3	1.12	2	0.74
13	8.97	3	2.07	76	77	28.41	3	1.12	3	1.12
13	8.97	3	2.07	90	84	31.00	3	1.12	3	1.12
13	8.97	3	2.07	104	97	35.79	4	1.48	3	1.12
13	8.97	3	2.07	118	103	38.01	5	1.85	3	1.12
13	8.97	3	2.07	139	125	46.13	9	3.32	4	1.48
13	8.97	3	2.07	146	136	50.18	23	8.49	5	1.85
13	8.97	3	2.07	160	154	56.83	40	14.76	10	3.69

第四表

種類		本地早（浸硼酸）						本地早（無			
病名		黴類		炭疽病		果腐病		黴類		炭疽病	
調查日月	貯藏日數	累積數	百分率	累積數	百分率	累積數	百分率	累積數	百分率	累積數	百分率
民國廿二年十二月十七日	21	0	0	0	0	0	0	0	0	0	0
民國廿三年一月一日	35	0	0	0	0	0	0	2	0.51	0	0
一月十五日	49	0	0	2	0.75	0	0	2	0.51	3	0.77
一月廿九日	63	0	0	3	1.12	0	0	3	0.77	5	1.28
二月十二日	77	0	0	3	1.12	0	0	4	1.03	5	1.28
二月二十六日	91	1	0.37	3	1.12	0	0	5	1.28	5	1.28
三月十二日	105	1	0.37	4	1.50	1	0.37	10	2.56	5	1.28
三月廿六日	119	3	1.12	4	1.50	2	0.75	11	2.82	6	1.54
四月九日	133	4	1.50	4	1.50	3	1.12	12	3.08	7	1.79
四月廿三日	147	13	4.86	10	3.75	8	3.00	20	5.13	7	1.79
五月七日	161	16	5.99	17	6.37	9	3.37	24	6.15	8	2.05
五月廿一日	175	19	7.11	27	10.11	15	5.62	35	8.97	8	2.05
六月四日	189	27	10.11	63	23.60	20	7.48	42	10.77	16	4.10
六月廿五日	110	34	12.73	93	34.83	24	8.99	62	15.90	17	4.36
七月二日	117	46	17.23	116	43.45	30	11.61	82	21.03	20	5.13
七月十六日	131	53	19.85	130	48.69	33	12.36	94	24.10	37	9.49

——續

處理)		朱橘(浸硼酸)						朱橘(無處理)					
果腐病		黴類		炭疽病		果腐病		黴		炭疽病		果腐病	
累積數	百分率	累積數	百分率	累積數	百分率	累積數	百分率	累積數	百分率	累積數	百分率	累積數	百分率
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0.51	1	0.28	6	1.70	2	0.57	3	1.50	1	0.50	0	0
2	0.51	1	0.28	6	1.70	2	0.57	3	1.50	1	0.50	0	0
3	0.77	2	0.57	6	1.70	2	0.57	4	2.00	1	0.50	0	0
5	1.28	2	0.57	6	1.70	5	1.41	7	3.50	2	1.00	1	0.50
5	1.28	4	1.13	6	1.70	9	2.55	7	3.50	2	1.00	1	0.50
6	1.54	6	1.70	15	4.25	20	5.67	8	4.00	2	1.00	2	1.00
12	3.08	11	3.12	23	6.52	44	12.46	12	6.00	3	1.50	4	2.00
12	3.08	13	3.68	29	8.22	57	16.15	16	8.00	3	1.50	5	2.50
14	3·54	14	3.96	39	11.05	64	18.41	26	13.00	6	3.00	6	3.00
15	3.86	20	5.67	48	13.60	74	20.96	33	16.50	13	6.50	10	5.00
16	4.10	23	6.52	55	15.58	80	22.66	38	19.00	19	9.50	11	5.50
16	4.10	29	8.22	78	22.10	86	24.36	48	24.00	38	19.00	12	6.00
17	4.36	36	10.20	108	30.59	88	24.93	54	27.00	56	28.00	13	6.50

貯藏中主要成分之變化

果汁之風味,並非一二成分所能決定,精密之表示,須將果實所有之成分一一分析,非闡明其本質與配合狀態不可,此乃極困難之工作,常用檢查法,乃取與風味最有關係之可容性固形物(Soluble solid)與含酸量作標準。可溶性固形物內,最多量存在者爲糖分,糖分以外,酸 Pectin 等均在內,故其數值常較糖分爲高,但其消長,卽用以代表糖分之增減,貯藏中各種柑橘主要成分之變化列表於下:

第五表 朱橘之成分變化

調查日期	貯藏日數	供試果重量	果皮重量%	果肉重量%	果汁100c.c.中枸橘酸克量	果汁100c.c.中固形物克量	酸固形率
十二月二日	5	586.4	25.31	74.69	0.736	14.68	19.94
十六日	19	487.8	25.51	74.49	0.646	14.31	22.14
三十日	33	516.9	26.29	73.71	0.668	16.05	24.02
一月十四日	47	450.9	27.76	72.24	0.600	15.32	25.53
二十六日	59	399.2	27.45	72.55	0.490	15.97	32.59
二月十九日	83	490.0	28.51	71.49	0.446	14.87	33.34
三月八日	100	507.8	30.15	69.85	0.437	14.84	33.96
三十日	122	454.8	33.40	66.60	0.303	14.59	48.15
四月廿一日	144	479.8	32.58	67.42	0.245	14.98	61.14
五月十四日	167	477.8	32.28	64.71	0.205	15.20	73.54

第六表　本地早之成分變化

調查日期	貯藏日期	供試果重量	果皮重量%	果肉重量%	果汁100c.c.中枸橼酸克量	果汁100c.c.中固形物克量	酸固形率
十二月四日	7	684.7	23.09	76.91	0.487	14.68	30.14
十八日	21	574.5	23.68	76.13	0.464	13.77	29.68
一月一日	34	563.7	25.67	74.33	0.317	13.90	43.86
十五日	48	487.6	26.35	73.65	0.317	14.46	45.62
廿九日	62	540.7	——	——	0.245	14.42	58.86
二月十九日	83	576.3	26.04	73.96	0.206	13.77	66.84
三月十四日	106	657.8	26.04	73.96	0.147	13.64	92.79
四月四日	127	547.3	27.01	72.99	0.127	13.53	106.54

第七表　早橘之成分變化

調查日期	貯藏日期	供試果重量	果皮重量%	果肉重量%	果汁100c.c.中枸橼酸克量	果汁100c.c.中固形物克量	酸固形率
十二月二日	5	923.8	23.67	76.33	0.476	11.91	25.02
十二月十六日	19	669.0	23.82	76.18	0.464	13.17	28.38
卅日	33	546.2	26.22	73.78	0.390	12.43	31.87
一月十三日	46	580.4	26.69	73.31	0.368	13.66	37.11
二月二日	66	583.9	28.53	71.47	0.304	13.66	44.93
廿四日	88	552.1	27.77	72.23	0.215	12.91	60.05
三月十八日	110	517.4	30.74	69.21	0.176	14.59	82.90
四月七日	130	504.9	29.87	70.13	0.166	13.94	83.98

第八表 碰柑之成分變化

調查日期	貯藏日期	供試果重量	果皮重量%	果肉重量%	果汁100c.c.中枸橘酸克量	果汁100c.c.中固形物克量	酸固形率
一月十二日	20	633.2	25.57	74.43	0.889	17.16	19.30
二月二日	41	670.5	29.37	70.63	0.695	15.88	22.84
廿三日	62	599.4	28.16	71.84	0.431	16.05	37.24
三月十八日	85	590.1	29.16	70.84	0.470	17.28	36.77

第九表 雪柑(南京)之成分變化

調查日期	貯藏日期	供試果重量	果皮重量%	果肉重量%	果汁100c.c.中枸橘酸克量	果汁100c.c.中固形物克量	酸固形率
二月六日	17	785.0	24.64	75.36	0.719	15.88	22.09
二月廿八日	39	722.5	24.95	75.05	0.465	16.55	35.59
三月廿三日	62	526.0	27.70	72.30	0.617	16.22	26.69
四月十三日	83	510.2	23.54	74.46	0.470	16.02	34.08
五月一日	101	482.2	24.51	75.49	0.460	16.27	35.37

第十表 蕉柑之成分變化

調查日期	貯藏日期	供試果重量	果皮重量%	果內重量%	果肉100c.c.中枸橘酸克量	果汁100c.c.中固形物克量	酸固形率
二月十二日	5	638.4	35.56	64.44	0.499	16.09	32.24
三月五日	26	496.8	34.46	65.54	0.494	16.27	32.94
三月廿六日	47	492.8	35.49	64.51	0.519	17.20	31.56
四月十六日	68	609.7	36.21	63.79	0.421	16.38	33.14
五月七日	89	507.6	36.37	63.63	0.362	16.38	45 25
五月廿八日	110	557.8	34.13	65.87	0.352	17.94	50.97

第十一表　雪柑(上海)之成分變化

調查日期	貯藏日期	供試果重量	果皮重量%	果肉重量%	果汁100c.c.中枸橘酸克量	果汁100c.c.中固形物克量	酸固形率
三月二日	17	494.2	32.70	67.30	0.925	17.20	18.59
三月廿二日	37	534.1	32.45	67.55	0.656	16.30	24.85
四月十九日	58	535.4	30.20	69.80	0.597	16.42	27.50
五月十六日	85	470.2	33.05	66.59	0.543	17.94	33.04

第五表至第十一表之六種柑橘，時日經過，酸量之減少甚爲顯著。固形物雖稍有增減，頗不顯明。酸固形率(Solids－acid ratio)因酸之減少，數字日益增大。Hawkins(F,8)研究葡萄柚(Grapefruit)貯藏中之變化，謂高溫貯藏(55°—80°F)含糖量減少，而酸度增加，32°c之冷藏，則結果相反，卽酸量減少，而全糖量無甚變化，酸度與可溶性固形物之變化亦相同。同氏推論謂高溫與低溫中變化之不同者，因呼吸作用之材料不同，高溫中所用者爲糖類，低溫所用者爲酸類。

貯藏中含酸量既日漸減少，故酸量多者甘味漸增，以達最良之風味，含酸量少者味漸淡泊，僅覺微甘，雖外觀無損，內容已失去柑橘原有之風味，故貯藏種須加選擇。黃巖縣產本地早朱橘早橘三種，採期相近，朱橘之含酸量較其他二者特高，而固形物之相差甚少，故酸味特强，稍經貯藏，味乃轉良，採下卽刻出售，價格亦較本地早早橘爲賤，故以貯藏爲利。新舊年關出貨最爲適當。此次試驗延五四月，味亦堪啖。早橘與本地早乃早熟種，閩粵柑橘尚未上市以前，獨占市場，貯藏之味日漸變淡，0.200 以下之酸量，已完全失去原有風味，短期貯藏，供黃岩鄉近消費或不無利，但除廉價

以外，其品質自不足與廣東所產柑橘競爭。

有柑雪柑蕉柑酸量高，同時固形物含量亦高，故味濃厚。蕉柑雪柑用普通貯藏法至五六月間亦無損於風味，蕉柑爲柑類（Mandarin orange group）中之最晚熟種，採期在一二月，果皮粗厚，剝皮容易，其品質之良佳，早已膾炙人口，爲有希望之貯藏品種，雪柑熟期亦在一二月，採下卽刻出售，正值柑橘供給豐富時期，殊爲可惜，緊皮之橙類，冷藏至夏季，獲值當更高。

貯藏中果肉與果皮之重量變化，以上各表中，緊皮之雪柑其果皮果肉百分率無顯著之差異。剝皮容易之柑類與橘類，果皮之百分率日漸增加，而果肉之百分率日漸減少，兩者之失重，並不均齊，濕度高之庫內，果皮之凋萎小，而果汁之減輕甚速。

貯藏中重量之減輕

果實採收後，熟度仍漸次進行，因呼吸作用消耗其物質，果皮果肉之水分則由表皮蒸發，表皮組織內所含之精油漸次逸散，故重量日益減輕。減輕之程度，依柑橘之種類與個體而不同，受環境之影響尤大，我國柑橘之賣買，不以等級箱數爲單位，多衡其重量，故重量之損失，直接卽影響於貯藏者之利害。本試驗中各種柑橘減量經過，列表於次：

第十二表　貯藏中各柑橘平均每個重量減輕百分率

品種		朱橘	本地早	早橘	雪柑(南京)		有柑	
		13個重 661.2g.	14個重 944.6g.	14個重 1304.9g.	12個重2112.6 g.		11個重1767.0g.	
調查日期	貯藏日數	減量百分率	減量百分率	減量百分率	貯藏日數	減量百分率	貯藏日數	減量百分率
民國廿二年十二月七日	11	2.75	2.05	1.87	—	—	—	—
十二月十四日	18	4.68	3.73	3.43	—	—	—	—
十二月廿一月	25	6.49	5.13	4.96	—	—	—	—
十二月廿八日	32	7.69	6.49	6.05	—	—	—	—
民國廿三年一月四日	39	9.20	7.72	7.41	—	—	12	1.11
一月十一日	46	10.90	8.91	8.68	—	—	19	3.10
一月十八日	53	12.90	10.80	10.26	—	—	26	5.04
一月廿五日	60	14.77	12.55	11.93	—	—	33	7.84
二月一日	67	15.57	13.46	12.79	—	—	40	8.67
二月八日	74	16.59	14.35	13.68	9	0.63	47	9.53
二月十五日	81	17.91	15.53	14.91	16	1·36	54	10.77
二月廿二日	88	18.66	16.41	15.58	23	1.72	61	11.77
三月一日	95	19.56	17.27	16.44	30	2.27	68	12.75
三月八日	102	20.80	18.29	17.92	37	3.00	75	14.12
三月十五日	109	21.88	19 50	18.91	44	3.65	82	15.48
三月廿二日	116	23.10	20.50	19.71	51	4.23	89	16.37
三月廿九日	123	23.59	21.02	20.36	58	4.44	96	17.10
四月五日	130	24.93	22.23	21.67	65	5.02	—	—
四月十二日	137	25.17	22.44	22.25	72	5.24	—	—
四月十九日	144	25.86	22.97	23.21	—	—	—	—
四月廿六日	151	26.39	23.51	24.14	—	—	—	—
平均每週減量		1.26	1.12	1.19		0.52		1.32

第十二表——續

蕉柑 12個重1487.1gr.

日期	二月十九日	廿六日	三月五日	十二日	十九日	二十六日	四月二日
日期貯藏	13	20	27	34	41	48	55
減量百分率	1.61	2.74	4.54	5.57	6.38	7.18	7.63

九日	十六日	廿三日	卅日	五月七日	十四日	廿一日	廿八日	每週平均
62	69	76	83	90	97	104	111	0.87
8.15	8.62	9.10	9.67	10.10	10.82	11.12	13.03	

朱橘藏至三月底，每個平均減量已達20%以上，本地早朱橘亦同。有柑雪柑蕉柑入庫時期，與上三種不同，且係一次試驗，各品種間減輕程度之差異，難於判斷。但早橘朱橘本地早，個體較蕉柑雪柑爲小，重量較輕，朱橘(十三個平均)每個平均重量爲50.86克，早橘(十四個平均)爲81.29克，本地早(十四個平均)爲67.47克，每個20%以上之減量，影響於果肉甚大。鬆皮橘類之減輕，以果汁較爲迅速，已如前述。三月底以後，此三種橘之果肉，卽漸有乾縮者。其發生無一定方向，最初一二瓣，漸至全橘，果皮並不萎縮，外觀毫無異狀，剝皮後卽所謂"金石其外敗絮其中"，已失商品之價值(照片二)。生理上之原因，尙屬不明。五月以後，蕉柑亦漸有發生。緊皮之雪柑，此次試驗中，並未發見。

結　論

南京春冬之氣候，利用地下貯藏室，延長柑橘之供給至五六月，並不困難。但先決問題，卽各地採果包裝運搬等處理法之改良。現在市場上之商品，入庫後徹病發生特甚，損害甚大。採果後各種處理之粗放，果皮受

傷，爲黴病侵入之大原因。將來縱有冷藏庫之設備，恐亦難發揮冷藏之效果。

浙江黃岩縣產之本地早早橘，酸量與固形物之含量均較少，貯藏之味漸淡泊。朱橘含酸量高，採下味甚酸，貯藏之可矯正其風味，但仍不足與同時上市之蕉柑雪柑等比較，且三月底以降，果肉常易乾縮。本試驗中之六品種柑橘，以廣東產之蕉柑雪柑最適於貯藏，其採期亦遲，在一二月間。黃岩縣爲早熟橘類之栽培區域，現在栽培最多之品種爲本地早早橘朱橘三種，熟期均在十一月，他處柑橘尙少上市以前，利用早熟，獨霸市場，貯藏非重要問題，將來方針宜延遲廣東產柑橘之供給，提早黃岩縣產柑之成熟，務期國產柑橘，週年供給不斷。

Storage of Citrus Fruits I.

Summary

1. An investigation of the keeping qualities of the following six varieties of citrus fruits in storage was undertaken:

Loose skinned orange: Chu-chieh(朱橘)Tsao-chieh(早橘), Pen-ti-tsao(本地早),

Mandarin orange: Pong-Kan(冇柑), Sheo-kan(蕉柑),

Round orange: Hsueh-kan(雪柑).

The cellar is 3.2 m. wide x 2.6 m. high, a temperature of 5-12° C. and a relative humidity of 90% or above were maintained from January to May 1934.

2. The most serious storage rots were green mold *(Penicillum*

*italicum)*anthracnose*(Colletotrichum glaeosporioides)* and Alternaria rot*(Alternaria Citri)*.

3. Careful handling of the fruit reduced the per cent of penicillum rot. Carefully handled fruits of Chu-chieh and Pen-ti-tsao showed only 10 to 27 per cent rot while the roughly handled fruits of Pong-kan, Sheo-kan and Hsueh-kan showed 70 to 90 per cent rot.

4. In storage, the acid content of the fruit decreased. The amount of soluble solids varied slightly. The green weight of the peel of the loose skinned and mandarin oranges (expressed in percentage) increased, while the green weight of the pulp decreased rapidly.

5. Tsao-chieh and Pen-ti-tsao, which were low in acid content, could not be stored due to the steady decrease in acid content. After a period of 4 months in storage, they became incipid. in flavor.

6. Sheo-kan and Hsueh-kan, thick skinned oranges with high acid and solid content, had good keeping qualities. The picking season of these oranges is January and Februray.

7. Soaking the fruit in 5% borax solution (40°-32 °C.) for 5 minutes right after picking reduced the penicillum rot, but produced certain injuries of the calyx and the stem ends.

8. Loose skinned oranges, after a period of 5 months in storage, had dried and shrunken pulp. The peel remained normal

in appearance.

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蓖麻葉殺蟲之研究

總理陵園

葉 培 忠

民國十七年，廣西柳慶墾荒局在柳城沙塘新闢苗圃百餘畝，播種杉木種子四畝，苗床東西並行，床之南邊，蒔種蓖麻子，俾其長大後蔭蔽幼苗發芽。當時苗頗整齊，惜出土未久，即遭害蟲，致幼苗日漸減少，其時蓖麻子亦已發芽，而同樣受害。惟在被害之小蓖麻下，發見僵死小蟲，俗名夜摸蟲，英名 June bettle 學名 Apagonia. 嗣後聞工人云，老農有以蓖麻葉殺蟲者，但不知所殺者係何種害蟲及其効力如何。因命工人採集蓖麻葉，以行試驗，於午後五時半將蓖麻葉撒於被害之苗床上，至八時許提燈至苗圃檢查 則見蓖麻葉旁已有僵死之蟲，且有正在走向蓖麻葉者，次日清晨復詳細檢查，見僵死之蟲，均朝天仰臥，尾端帶青屎一粒，茲將最初四天所放蓖麻葉之數量及每晚所殺之蟲數列表於后：以資參考。

日　　期	蓖麻葉撒放處數	殺鞘甲蟲數目		未殺鞘甲蟲之處數
		總　　數	每處平均殺蟲數	
四月十日	22	259	11.80	2
四月十一日	157	745	4.74	2
四月十二日	111	922	8.31	16
四月十三日	256	3200	12.07	20

尋常夜摸蟲食後潛伏土中，故在被害植物之下可掘得害蟲，爰將土中掘得之害蟲，於特製之木匣中，更作試驗、用紗布就中間隔爲甲乙二室，各

室放十個害蟲,甲室之蟲飼以蓖麻葉,乙室之蟲不結食料,次日甲室之蟲盡皆朝天僵死,尾端帶青屎一粒,其結果與圃場試驗相同。然經三天後,漸漸甦醒,復能活動,故知圃中僵臥之蟲,尙非眞死,乃因其食蓖麻葉後,麻醉而失其知覺,在圃場中所以不能復活者,則因無力入土爲太陽所殺死者也,若遇陰天,則能維持數日不死,且有復活者,殺蟲之効因而大減,又依試驗之結果,知同時爲害之十餘種甲蟲,其性質各不相同,非用蓖麻葉均能殺滅,就中僅 Apagonia 一種有顯著之効果,其他種類均難見効。

蓖麻葉不能治之甲蟲,如絨蛂,赤絨蛂,黑蛂,金龜子等,常於晚間吃油桐,刺槐,柳,楊,梨,李等之木葉及幼芽此類害蟲,可用杜荆木葉誘捕之法取杜荆木葉以十數枚爲一束,縛於竹桿上,竹高四五尺,日落後插於苗圃之區路上,每隔十尺或五尺插一個,多少則視木葉之多寡及面積之大小而定,至晚七八點鐘時,則可見多數害蟲歇於木葉上,自數十至數百餘個不等,蟲之多少,因氣溫而異,通常涼少暖多,捕蟲時每三人爲一組,一人提燈,一人張大口布袋,一人拔取竹桿將木葉投入袋中,劇烈搖撼,令蟲落於袋中,搖落後木葉復插於原處,依次巡視一週,如天暖蟲多,再巡第二次,經二次捉捕後,大抵蟲漸稀少,空氣亦漸涼,蟲類潛伏土中,不能爲害矣。木葉枯乾後卽失効用,須每尺更新,如材料缺乏則可於早晨太陽未起時,將木葉拔起置於蔭處,至晚再用一次,捉捕之蟲,可用熱水殺之以喂鷄也,其中有 Odoretus 一種對於以上諸法均不見効。

乙醚(Ethylene)氣在園藝上之效用研究

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章文才

一　問題之概要

用化學藥品以促進植物生長之方法，由來久矣；歐洲在十九世紀中葉，即有一般植物生理學家，用$KMnO_4$, $ZnSO_4$, $MgSO_4$, $MgCl_2$, Glucose等養化或培養藥劑，以促進種子之發芽生長，或插條之發根，例如德人Richards, Raulin等，用$ZnSO_4$可以增加產量；M. Popoff教授用$MgCl_2$ $MgSO_4$及$Mg(NO_3)_2$，以促進種子之發芽。美人 Curtis 教授用 $KMnO_4$，促進插條根之生長，均係效果顯著者。甚至有用藥品，直接注射至植物體內，以促進植物之生長作用者，我國古時有夢中哭筍之故事，蓋亦人類腦筋中之以人工方法而促進植物成熟作用之想象也。晚近世界各國之科學家，對於此種植物上化學刺激作用 (Chemical Stimulants)之研究，不遺餘力，德國方面，且有德文專刊，按期發表關於此種研究所得之結果，將來人類能用人工方法，左右植物之生長速率，亦未始非意料中事也。

近世紀人類滋生繁衍，都市方面，日形榮盛，對於果實蔬菜花卉以及其他食用作物之供給，兢兢焉惟求其速而多，早熟之品種，價值昂貴，銷路暢達，因此育種家求其得早熟之品種，栽培家求其得促成之方法，鉤心鬥角，互相研究；惟因限於氣候之影響，生長期之過短，或使用上方法之不經濟，以致所得反不能償其所失；爲滿足此種人類之慾望，當設法尋求一更

簡易而更經濟及不受氣候影響之方法，以促成植物之生長，用化學上乙醚(Ethylene)或同樣之 Gas 即其方法之一也。

乙醚在園藝上之功用，已經各國學者之證明者，約略有下列諸端：

(1)果實之着色：例如柑桔檸檬或檬果蕃茄等之本屬青綠色，果皮上帶有多量之葉綠素者，用乙醚氣燻蒸，即可將葉綠素脫去，而顯現其固有之橙紅色或黃色。

(2)果實之脫澀及後熟：例如柿香蕉洋梨萬壽蒲 (Carica papaya)等，使果實在短期內將所含之 Tannin，可以由增加其呼吸作用而養化凝固，澀味因之而全脫，或使果實在短期內可以後熟，甜味香氣因之而增加，然後可以供食。

(3)縮短球根宿根或其他植物之休眠期：例如馬鈴薯洋水仙鈴蘭等，使其原有之休眠期縮短，而生長提早；亦有得生長期提早而增多其產量之結果者。

(4)蔬菜之軟化：R.B.Harvey 氏曾在一九二五年研究得可以用乙醚氣軟化芹菜，結果甚佳。

(5)促成植物之生長：B. M. Duggar 氏在一九一一年發表，用 Ether 可以使鈴蘭早開花四五星期，惟其餘各學者尚未能證明此功用；最近Mack及 Livingston 在一九三三年夏季發表，謂在小麥抽芽之時，用乙醚灌入，結果反使小麥芽停止生長，其原因大抵因小麥幼芽內細胞之 Metabolism 作用甚弱，而所灌入之氣過濃也。

二　歷來乙醚氣對於園藝植物上所作研究報告

乙醚(Ethylene) 可以使用於植物上者，由於二三十年前二三學者對

於Ether之使用而來，一九〇六年，北歐Johannsen教授，曾用Ether促成丁香花(Syringa vulgaris)及檳樹(Acacia mimosa)之生長使之在三星期至六星期即可開花，彼用30—40grams之Ether置入100 litres之箱內，經過一晝夜至二晝夜之時間，即取出而置於平常之空氣中；俟後W.L. Howard氏，在一九一〇年於美國之Missouri州，用七十種之落葉性觀賞樹木，例如紅楓杜鵑紅莖木山楂等，用Ether燻蒸，結果枝條之生長甚速，一九一一年，美人 B.M.Duggar，復用 Ether 燻蒸鈴蘭百合洋水仙鬱金香等，使之開花能提早四五星期；C. O. Appleman 等，復於一九一四年發表，用 Ethyl-Bromide 可以促成馬鈴薯之發芽，是謂乙醯促成植物生長之先聲。

十年以後，E.M. Chase及 F.E.Denny 二氏，在一九二四年發表謂用乙醯可以使柑桔着色，同年 F.E.Denny 氏發表，謂用乙醯可以使檸檬着色；至此乙醯遂成爲實際上之重要應用，蓋因檸檬在實際上必須人工着色，而其他人工着色方法，不如用乙醯之簡便經濟也；彼等用 1—1000 至1—200,000之氣之濃度，使綠色之檸檬，在五日至八日變爲橙黃，溫度以70°—80°F時成績最佳，氣體過濃，或溫度低至45°F以下即阻止着色。

一九二五年，R.B.Harvey 氏在美國 Minnesota 州試驗，用乙醯可以軟化芹菜，彼將芹菜品種(Self-Blanching)一類，在溫度65°F之室內，用乙醯1—1000至1—10,000之濃度中，可以在五六日後脫去葉莖上之葉綠素，而呈黃白色，質脆而嫩；同年J.T.Rosa 氏，用乙醯後熟綠色之番茄，在溫度65°—75°F濕度80%—90%之室內，用乙醯1—1000之濃度，可以使綠色之番茄，在四五日後，顯現美麗之紅色，Rosa氏，試驗用其他同樣之Gas，如 Propylene 其所得之結果亦佳。

一九二六年，E. S. Haber 氏用乙醚促成玉葱幼球之長大，彼用1—100至1—200之乙醚濃度，將玉葱幼球(Onion Sets)燻蒸二十四小時，可以促進其生長，并可使球根之生長較大，其後在一九二七至一九二八兩年，研究者愈衆，其顯著者如 E. M. Chase, C.G.Church, R.B.Harvey, G.A.Vacha及L.O.Regeimbal 諸氏，不但對於果實之後熟，植物休眠期之縮短，與以更深切之證明，且對於乙醚在植物或果實體內所發生之影響，亦與以精密之試驗；L.O.Regeimbal 及 G.A.Vacha 氏試驗，得乙醚能在果實內增加 CO_2 之發出量至 150%，經過二十分鐘至半小時以後，發出 CO_2之呼吸作用，漸漸低減，俟第二次之通氣後，再行增加，氏等並證明在果實中之糖量，通乙醚氣後可以較其餘之方法後熟者增加20—25%；R.B Harvey氏亦得同樣之效果，謂用乙醚燻蒸後，果實之糖量及香氣，俱見增加。

F.E.Denny氏在一九二七年，在美國之Jour. of Botany 雜誌上發表在潮濕空氣中促成馬鈴薯之發芽，以 Ethylene Chlorohydrin ($ClCH_2CHCH$)爲最佳，彼用 Ethylene Chlorohydrin 40% 之液體½—1gal:，置於一千立方呎之空室內，使馬鈴薯可以在七日至十日發芽生長；一九二九年，Ora Smith氏亦有同樣之證明，是爲以 Ethylene Chlorohydrin 代替Ethylene 之先聲，俟後 H.O. Werner氏在美國之 Nebraska 州一九三一年發表用 5% Ethylene Chlorohydrin 浸馬鈴薯，然後藏入緊閉之箱內，二十四小時浸種之種薯，發芽數較多，且較未曾浸種者，增加產量至 17.5—62.0%; W. B. Davis 及 C. G. Church 二氏。復於一九三一年試驗，用乙醚氣可以將柿果實脫澀，後熟而變爲紅色，且所得之果實品質極佳。

三　乙稀之製作

乙醚屬氣體，在外國有裝就之鋼管，(Compressed Cylinder)可以隨處購得，我國各處市上，尚不能購得，惟須用化學方法以製造之，製造之方法亦甚多，通常有下列諸種：

(1)乙醚C_2H_4可由$C_2H_4Br_2$中，用較重之金屬原質代替而出；普通以用鋅加入灼熱而成，如以下之公式所示：

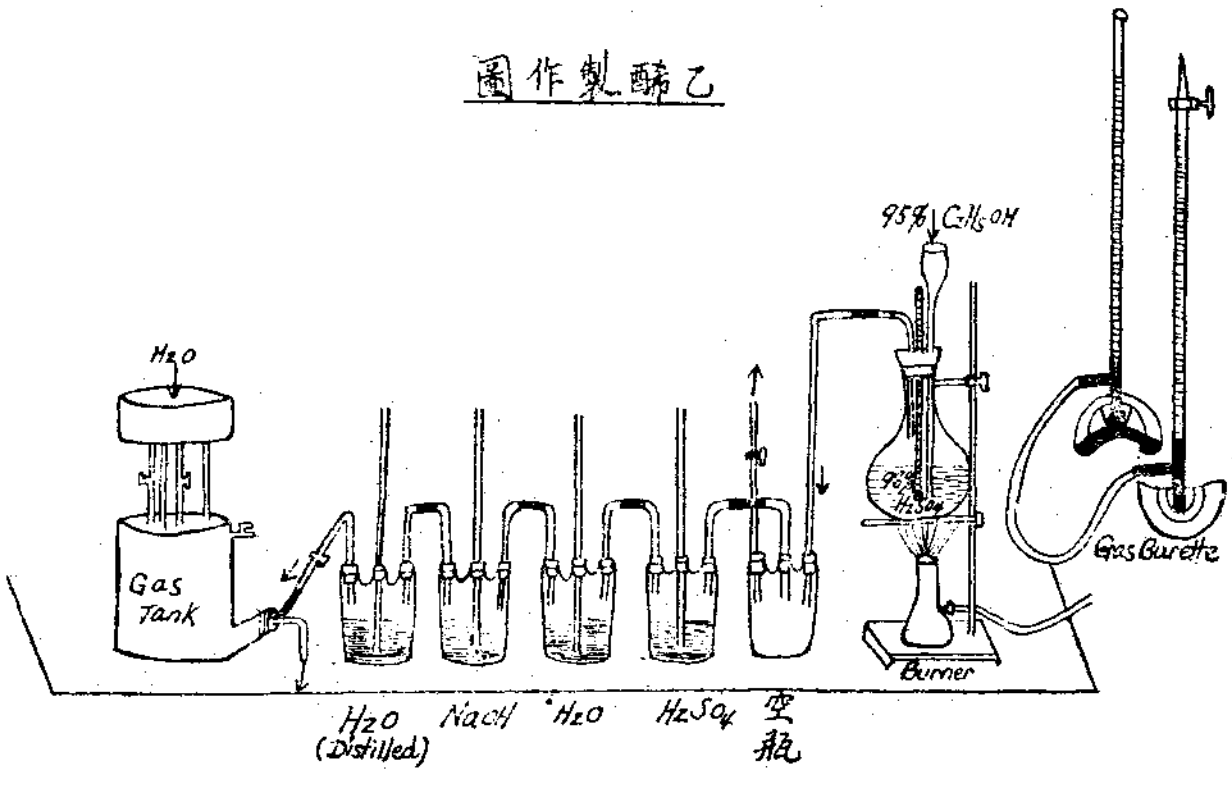
$$C_2H_4Br_2 + Zn = C_2H_4 + ZnBr_2$$

(2)乙醚亦可由C_2H_5Br中，用含酒精之鹼水，如KOH，加熱發生，如以下公式：

$$C_2H_5Br + KOH(in\ Alcohol) = C_2H_4 + KBr + H_2O$$

(3)普通製造較大量之乙醚時，可用濃硫酸150c.c.加酒精25c.c.，灼熱而製成；濃燐酸亦可應用，因濃硫酸及濃燐酸均係去水劑(Dehyd-

乙醚製作圖



rating agent) 加熱至 150°—170°C 時，即能將酒精中之輕養原素提出，而成爲硫酸乙醯(Ethyl Sulfuric acid)；硫酸乙醯$C_2H_5HSO_4$ 係不固定，即當分離而成爲乙醯與硫酸，如下公式所示：

$$C_2H_5OH + H_2SC_4(濃) = C_2H_5HSO_4 + H_2O$$

$$C_2H_5HSO_4 \longrightarrow C_2H_4 + H_2SO_4$$

發生之乙醯氣體，當通過濃硫酸及水，以除去其未化合之水氣，二養化炭及其他雜質；再通入淡NaOH或KOH之水中，以除去不能溶解在水中之二養化硫等雜氣，使之純淨；乙醯極不易溶解於水中，故可避免其損失，爲明瞭起見，茲繪圖示明之如左：

四　實驗之經過

本篇用濃硫酸及酒精所製成之乙醯氣，首先於民國二十年春季在福建廈門集美農林專科學校，開始試驗；該處位北緯二十三度左右，氣溫較高，故實驗所得之結果頗佳，惟以設備上不足，缺乏裝氣用之 Gas Tank，及量氣用之Gasmeter或 Gas Burettes；因此各種試驗均係隨時製就後，當即灌入，所得之結果，亦尙有興味，茲先將在廈門所作之試驗，分別記述其結果如下：

(1)香蕉之後熟試驗：——該處產香蕉甚多，惟採收以後，必須用竿香燻烟，後熟後方堪供食，此次取方從枝上割下之已成熟而尙呈深青色之香蕉，(爲該校校園所產)，分成十二組，每組有香蕉五條，分別放入悶氣之抽箱內，抽箱之容積約三立方尺，然後通入製成之乙醯，經過蒸溜水及KOH水而通入放香蕉之抽箱中，以時間之長短，而定氣之濃厚，該時室內溫度約70°F，茲錄結果如下：

香蕉後熟試驗結果(品種係漳州香蕉)

抽箱號數	處理方法	成熟所需日數	備註
1	不通氣	八日後稍熟	尙帶澀味
2	加水於果上通氣五秒鐘	七日成熟	
3	加水於果上通氣十秒鐘	七日成熟	
4	加水於果上通氣三十秒鐘	五日成熟	
5	加水於果上通氣一分鐘	四日成熟	
6	加水於果上通氣三分鐘	三日成熟	果皮帶紅芝麻點
7	加水於果上通氣五分鐘	三日成熟	果皮帶粗芝麻點
8	乾果通氣一分鐘	六日成熟	
9	乾果通氣三分鐘	四日成熟	
10	乾果通氣五分鐘	四日成熟	果皮帶粗芝麻點
11	乾果通氣十分鐘	三日成熟	果皮發黑
12	燻烟(竿香)	八日成熟	係該處通用方法

經過用乙醚通氣而後熟之香蕉，色澤較爲鮮麗，且較燻煙後熟者爲香甜。

(2)芋發芽生長試驗：——該處產芋極多，而尤以檳榔芋之栽培，較爲有益，惟因夏季收獲之芋子，冬季尙不易發芽，如在春季下種，則每因生長期過短，而所生之芋頭不大，產量因之而大減，如能將其在發芽時較速，生長較快，則可於春季下種，秋季水稻收割以後，尙有一季之豌豆或芥菜，可以栽種，經濟上可以增多不少；此次試驗，係在三月一日舉行，該時室溫約 70°F，取花盆二只，中盛洗過三次之粗砂，再選定大小均勻之芋子六枚，植於花盆中，每盆三枚，然後用較花盆稍小之玻鐘(Bell Jar)蓋上，每盆用一曲玻管通入土中，以便按日灌入等量之水，二盆均同樣處理，一盆再通入一曲玻管，玻管口在玻鐘

中向上，以備灌入乙醚氣；第一次氣灌入五分鐘，再過十五日後，又灌入五分鐘，三十日後，計算二盆內各株芋子之芽長，根數，及根重；茲將其結果記述之如下：

芋發芽生長試驗結果(品種檳榔芋)

	灌入乙醚氣二次者				未灌氣者			
	一號	二號	三號	平均	四號	五號	六號	平均
芽長度 (cms.)	二四・五	二四・五	二一・二	二三・四	五・九	五・七	三・四	五・〇
根數	二五	三九	九三	五二・三	二六	八	八	一四
根重 (grs.)	〇・九	一・一	一・七	一・二三	〇・四五	〇・一	〇・七五	〇・四三

灌入乙醚後之芋子，其生長上較未灌氣之芋子，計芽之長度增加468/100，根之數目增加374/100，根之重量增加286/100。

(3)千日紅(Gomphrena globosa)之促成生長試驗：——以上二試驗係證明果實之後熟作用，及促成發芽效果，對於促進生長方面，不能完全示明，故同時取用千日紅大小相彷，並各具葉五片者六株，栽種二盆，每盆三株，均用洗淨之粗砂，各罩以玻鐘，如前芋子樣，按日灌入等量之水，一盆通入乙醚三次，每次隔一星期，通入量每次五分鐘，三月一日至四月一日，將盆連玻鐘置於露天日光下，至四月一日，檢查其大小如下表：

千日紅(Gomphrena globosa)之生長試驗

量度	株數	莖之長度			全株之重量		
		原長 (cms)	生長後長 (cms)	生長實長 (cms)	原重 (grs)	生長後重 (grs)	生長實重 (grs)
灌入乙	1	五・二	一八・三	一三・一	一・四	四十二	二・八

醚氣者三次	2	五·五	二一·五	一六·〇	一·六	五·一	三·五
	3	五·〇	一九·七	一四·七	一·一	四·八	三·七
	平均	五·二	一九·八	一四·六	一·四	四·七	三·三
未灌氣者	4	五·一	一一·一	六·〇	一·三	三·五	二·二
	5	五·〇	一〇·四	五·四	一·二	二·八	一·六
	6	五·三	一五·五	一〇·二	一·四	三·五	二·一
	平均	五·一	一二·三	七·二	一·三	三·三	二·〇

灌入乙醚後之千日紅幼苗，雖所得日光水分及土壤，均相彷彿，而其莖之平均長度，較未灌氣者約增加203/100，其全株之重量，較未灌氣者增加165/100。

作者再於二十二年秋，在杭州浙江大學農學院作同樣之試驗，用馬鈴薯，廈門水仙，鬱金香，風信子，碧桃，豆芽菜，黃岩早桔，及柿子等材料；此次所試係用Gas Tank 先將乙醚灌入，然後用 Gas Burrettes 量氣入內，希望能獲得所需乙醚氣體之濃度，以爲標準，所得結果均尙佳，惟以大部均尙在試驗中，詳細結果，須待下季刊印時，再行公諸大衆，以求指正；茲先將桔子及柿子之着色，及脫澀結果，報告之如下：

(1)黃岩早桔之着色試驗：——今秋十月間，在市上水果舖，滿置自黃岩運來之綠色未熟早桔，農民商人均未用人工着色法，使之變紅，對於販賣上影響價值不少；當時卽購得綠色相同之桔子三十枚，分爲三組，每組十枚，第一組放入之1/1000乙醚氣，第二組放入1/10000之乙醚氣，均用 Gas Burretts 量過，經過四十八小時後，再取出置於平常空氣內，第三組置於平常空氣中，三日後同時檢視之，通過1/1000之乙醚者，已完全紅色，極美麗，通過1/10000之乙醚者，顯橙黃色，尙

微帶綠色斑紋,惟未通氣之果實,尙現深綠色,並未有如何之變色。

(2)柿之脫澀試驗:——柿之脫澀,亦係果實之後熟作用,因柿在後熟時經呼吸作用之養化,使果實中之 Tannin,變成不溶解性,乙醯氣可以增進果實之呼吸作用速度,自同時可以脫去柿果實中之澀味也。本試驗由同學李蘭芬女士作成,茲錄其結果於後。

第一次係斷定柿脫澀之乙醯濃度,柿之品種係著者從五雲山上之野山柿樹上採得,本種野山柿(Diospyros Kaki),果實小而堅,澀味極强,採下時青綠色,普通均用之做柿澀用,採下第三日,卽分別放入 1/100, 1/200, 1/1000, 及 1/5000, 之乙醯氣濃度中,另用一組,置於普通空氣中,作爲比較,經過四十八小時後,同時取出,放於普通空氣中,三日後,所有經過乙醯燻氣之四組果實,均已脫澀,且顏色鮮紅,味極甜,未經通氣之一組,經過十六日後,始脫去澀味。

第二次係斷定通氣後置於乙醯氣之時間長短影響,本次係用本校植物園所產之油柿 (Diospyros sp.),澀味亦極强,分爲四組,每組通入1/100之乙醯氣,經過 48, 72, 96, 120 小時,每組按時檢查其澀味。

通氣後置48小時者	八日後脫澀
通氣後置72小時者	四日後脫澀
通氣後置96小時者	三日後脫澀
通氣後置120小時者	二日後脫澀

此試驗似證明通氣時間愈長者,則脫澀愈快, R.B.Harvey 氏,謂在香蕉上通氣後,經過十五至二十小時,其果實之呼吸作用卽減弱,須待第二次之通氣,以促進之,此說似尙成疑問也。

五　乙稀氣在果實及植物上所發生之生理作用解釋

綜觀以上如學者之報告，及著者對於本題試驗之結果，可以證明乙醚氣C_2H_4，及同樣性質之氣體，例如 Propylene(C_3H_6)或 Ethylene chlorohydrin ($ClCH_2CHOH$) 等，均能促成植物之生長，縮短植物之休眠，及促進果實之後熟作用，通入乙醚後，究於植物體內發生何種之生理變化，而使以上作用可以實現，理論方面，有申述之必要，茲舉重要學說數端，以說明之：

(1)果實體內Enzyme之變化，改變蛋白質(Protein)之消化力，因之增加；Regeimbal 及 Harvey 氏證明在鳳梨上，經過乙醚1/1000燻過後，果實內之 Proteoclastic Enzymes，較未燻過之果實爲多：凡燻過乙醚之果實，其組織內澱粉及蛋白質之消化量變速，同時還原糖之數量增加，故果實變甜，且香味大增。

(2)乙醚在果實上，能增加有機物之養化作用(Catalytically oxidization Effect)，使之後熟或脫澀。

(3)乙醚能影響植物體內之原生汁之滲透力 (Permeability of Protoplasm)，使植物體內細胞之生長及繁殖較速。

(4)增加植物或果實之呼吸作用(Respiration)，增進二養化炭之發散率，故增加植物或果實之代謝作用(Metabolism)，而促進其成熟或增加其生長，此點影響，似最屬重要；R.B.Harvey 氏曾在香蕉上，試驗得經過乙醚1--1000釀之香蕉，其呼吸作用及 CO_2 氣之排出量，較未經燻過者約多二倍至三倍；F. E. Denny 氏在檸檬上，謂經過燻氣之檸檬，其呼吸量約較未經燻過者，增加三倍，彼曾計算其

CO_2之排出量如下表：

檸檬果實之呼吸作用比較(Milligrams of Co_2 per Kg. per Hour)

	第一日量	第二日量	第四日量	第六日量	第八日量
爐過乙醚1—10,000	一〇·五	二一·〇	二二·〇	四一·一	三〇·六
爐過乙醚1—200,000	一一·三	一五·四	二九·八	二八·八	三二·九
未經燻氣者	一一·五	九·一	八·七	一二·五	九·六

呼吸作用既形增加，則細胞之新陳代謝作用較速，植物之生長或果實之化學變化，亦當隨之而增速矣。

六　繼續研究之必要

我國果實須要經濟方面着色者，如柑桔，檸果，及萬壽蒲等，須要脫澀者，如柿，香蕉，鳳梨，及酥梨等，蔬菜方面，須要軟化者，如芹菜，韭芽葫蔥等，諸如此類，不勝枚舉，栽培者或販賣者均墨守舊法，或因方法之不良，而損及果實蔬菜之品質，或因手續之麻煩而增加後熟軟化之費用，以上各試驗，既證明用乙醚處理，不但簡捷，且頗經濟，故目前問題，自宜擴大試驗，做成大規模農業上或商業上可以利用之方法，美國之檸檬包裝公司，現在大規模應用者，在我國果實上，似亦宜仿傚之。

再如蔬菜花卉之促成栽培上，將來能否應用乙醚之促成，以及菜圃或溫室中之使用方法，當如何方爲妥善，諸問題更待有深切之試驗，方可得一最完妥及最經濟之應用，俾世界人類，對於園藝植物之享受上，增多一分機會，願國內同志，共努力圖之。

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目錄

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NOTES ON THE STORAGE AND MARKET DISEASES OF FRUITS II.

Diplodia Stem-end Rot of Citrus Fruits

(*DIPLODIA NATALENSIS* Evans)

T. F. Yu.

In cooperation with the Department of Horticulture, attempts have been made to measure quantitatively the fruit rots caused by various fungi in the market here at Nanking. As a result of two years investigation on citrus fruits, attention has been drawn to the *Diplodia* Stem-end rot, which, according to the data available, is widely distributed in China. This paper presents the results of two years study of this disease with special reference to (1) its occurrence (2) its mode of infection and (3) its pathogenicity on the various citrus fruits commonly found on the market.

History: Stem-end rot of citrus fruits, caused by *Diplodia natalensis* Evans, was first reported by Evans (8) as a rot of lemon fruit in Natal, South Africa. From 1911 to 1913, Fawcett, (9, 10, 11) while connected with the Florida Agricultural Experiment Station, Florida, U. S. A., made studies of the organism both on oranges and grapefruit. The disease is now known to be widely distributed throughout the world. (1, 2, 3, 5, 15, 17, 20).

In addition to causing damage in the citrus grove, the fungus is known to cause a serious rot during storage and transportation (3, 13, 14). Fawcett (11) first isolated the fungus from oranges shipped to Porto Rico. Horne (17) called attention to this rot on grapefruit during transit. Hills and Hawkings (16) reported

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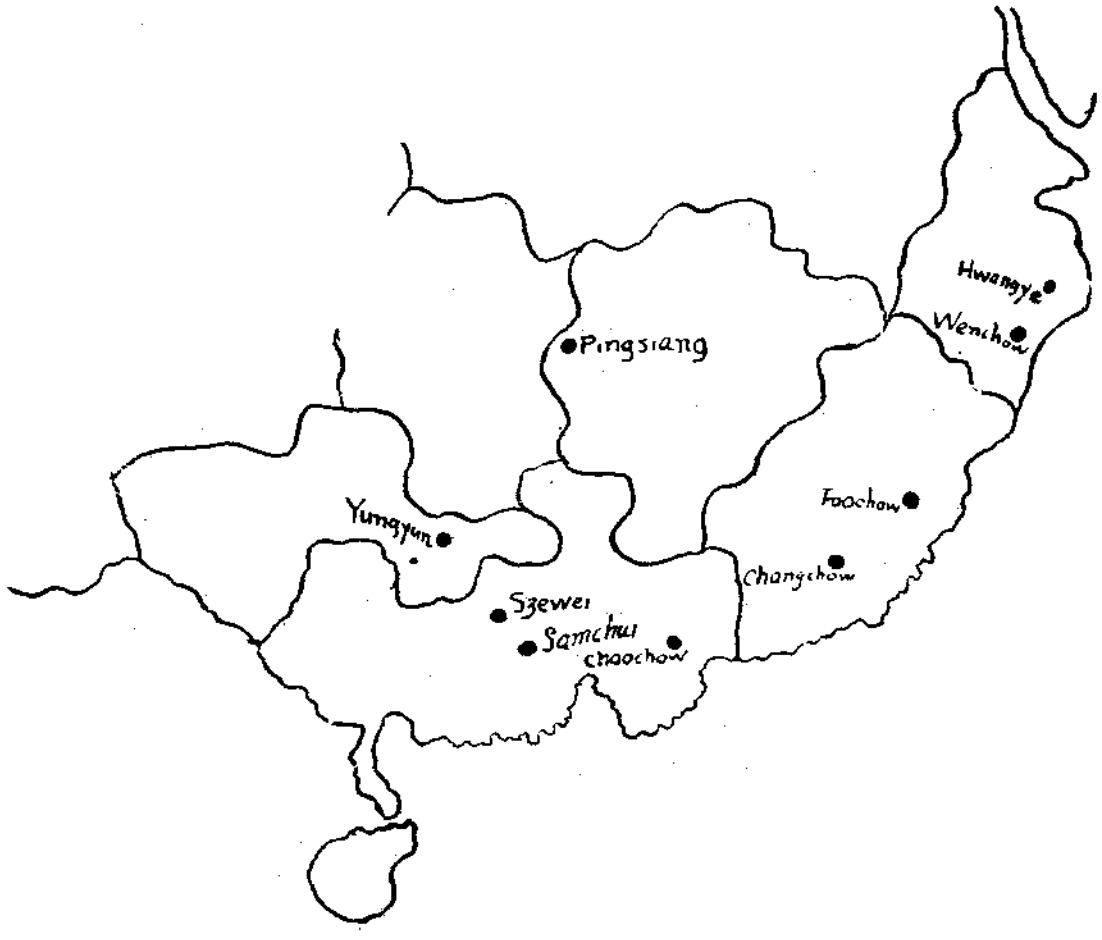
* Contribution No. 31 from Plant Pathology Laboratory, Department of Botany University of Nanking, Nanking, China.

damage produced by *Diplodia natalensis* on citrus fruits when transported without ventilation. In Palestine, Reichert and Littauer (20) found that 8 per cent of the citrus fruits in one of the shipping experiments had shown *Diplodia* Stem-end rot. The annual lose produced by this disease, according to them, was about 25000 pounds.

According to Burger (4), *Diplodia natalensis* also produces the foot rot of nursery stock and young peaches. Miller and Harvey (18) found it associated with the collar and root rots of peanut caused by *Bacterium solanacearum*. However, artificial infection experiments with the organism failed to produce the disease. The fungus has also been found on Hibiscus and Panax in Hawaii (23).



A map showing the distribution of Diplodia Stem-end rot of Citrus fruits in China.

Occurrence in China: Detailed records pertaining to the distribution of *Diplodia* Stem-end rot on Citrus fruits in China is still lacking. However, examination of diseased oranges received directly from various citrus growning regions reveals the fact that this disease is widely distributed in China. Citrus fruits* infected with *Diplodia natalensis*, have been received from the following places: Hwangyen (黃巖), Wenchow (溫州), Chekiang (浙江); Foochow, (福州) Changchow (漳洲) Fukien (福建); Szewei, (四會) Samshui, (三水) Chaochow, (潮州) Kwangtung (廣東); Yungyun, (容縣) Kwangsi (廣西); and Pingsiang, (萍鄉) Kiangsi, (江西). The places mentioned above are the principle citrus production centers in China (See map).

Occurrence on the market. Estimation of the diseased fruits in storage and on the market was made by actual count of the diseased and healthy fruits in the boxes immediately after unpacking. Of 7431 oranges shipped in from Hwangyen (黃巖) 0.4—2.5 per cent decidely showed *Diplodia* infection. It is interesting to note that there were many more fruits of the early varieties (*Citrus nobilis* Lour. and *C. nobilis* var. *deliciosa* Swingle) infected with *Diplodia natalensis* than the later varieties. In certain boxes, the diseased fruits might be as high as 7.5 per cent; while, on the other hand, they might contain not a single diseased fruit. Of the later varieties, only 0.23 per cent of 1646 fruits showed *Diplodia* infection. Examination of 2742 fruits of *Citrus tankan* Hayata, a late variety from Swatow did not disclose a single *Diplodia* infected fruit.

In the boxes, it has been found that the partially or completely rotted fruits might give rise, usually through the stylar or stem end to a mycelial growth which serves as a source of infection to healthy fruits whenever the latter come in contact with it. This kind of infection, though occurring rarely, has been actually traced in many

* Pure cultures of *Diplodia natalensis* have beed obtained from these fruits. The writer wishes to cxpress his appreciation to Professors H. H. Hu and S. H. Chen for furnishing the materials.

boxes, in which the *Penicillium* rot was destructive, where a comparatively high moisture and temperature condition existed. The improper packing as well as the poor transportation facilities are doubtless responsible for the rapid rotting of the fruits during transportation.

The percentage of *Diplodia* infected fruits in the store was much lower than that in the boxes. Throughout the whole season, 11425 early and 3948 late oranges showed respectively 0.8 and 0.2 per cent of diseased fruits. These figures do not indicate the actual loss produced by the disease as the dealer ordinarily discards all the discolored fruits immediately after unpacking.

Isolation: Orange fruits which showed a brownish discoloration on the surface were superficially disinfected with flaming alcohol and then cut open by means of sterile scapels. A bit of the diseased tissue underneath the discolored area was transferred to an agar plate. Pure cultures of the fungus were readily obtained. A still simpler method is to transfer a bit of mycelium grown in the hollow space inside of an orange into agar tubes. By means of both of these methods, pure cultures may be obtained.

In the winter of 1932 and spring of 1933, 196 isolations made from diseased oranges which had only shown the light discolorations either on the rind or at the stem end, yielded the following species of fungi:

	No. of fruits	% of Total
Colletotrichum gloeosporioides Penz.	105	53.51
Penicillium species.	42	21.42
Alternaria citri Pierce	22	11.32
Diplodia natalensis Evans.	11	6.12
Fungi not determined	16	8.32

These fruits were isolated when brown discolorations of various kinds appeared which were not supposed to be caused by Penicilla. In general, rots of citrus fruits caused by Penicilla are by far the most common both in storage and on the market. The results do

not, therefore, stand for the actual prevalence of these rots in the market. Furthermore, not all the citrus varieties showed the same kinds of rot. For instance, those coming from Kwangtung (*Citrus suhoiensis* Tanaka) were usually badly infected with *Colletotrichum gloeosporides* Penz. and those from Chekiang (*Citrus nobilis* Lour. and *C. nobilis* var. *deliciosa* Swingle) with *Alternaria citri* Pierce.

Symptoms: Under storage conditions, the disease appears either as a small brown discolored area at or near the stem end; or as big brown area extending from the stylar or the stem ends to the whole fruit surface. In rare cases, the fruits become completely decayed and blackened. At this stage, deep grēenish mycelial growth is seen on the fruits.

When the fruits are inoculated either with conidia suspension or a bit of mycelium through the wounds or at the stem end, there appears, at first, a small discolored area on the rind. This water soaked area turns first light and finally dark brownish in color, while the infected tissue becomes leathery pliable. The surface of the diseased fruit gives out juicy exudations. Further development of the disease results in the blackening both of the rind and the internal tissues. The whole fruit soon becomes watery and soft.

In most of the loose skinned oranges, such as *Citrus nobilis* Lour., the fungus grows very rapidly in the empty space inside the skin. (Plate I, Fig. 1) As a result, wide bands on the surface corresponding to the divisions of the segments within appear on the surface. On most of the oranges which are not of the loose skin type, this band formation on the fruit surface occurs less frequently. In both cases, the brown discolored area enlarges and extends over the whole fruit surface.

The fungus grows very rapidly from the stem to the stylar end. This is especially true when the center of the fruit is hollow. In many cases, a whitish fungous growth, as a result of stem end inoculation, comes out through the stylar end before the appearance

of any detectable symptoms on the rind.

Under moist conditions, the infected fruits become softened with tufts of mycelial growth coming out from the rind. They are whitish at first and then turn deep green. When exposed to light, they become pinkish in color. The diseased fruits when kept in a dry condition become blackened and mummified.

In the early stage of the disease, the whitish and greenish mycelial growths are found inside of the fruits. The juicy vesicles become deep green in color. In the later stage, the juicy vesicle and the rind become blackened and soft.

Artificial inoculation of lemons (*Citrus Limon* (Burm) Tanaka) at the stem end produces an almost inperceptible watery soaked area which enlarges and soon turns blackish in color. On pumelo (*Citrus grandis* Osbeck), the disease progresses just as on oranges except that the discolored area is deeper in color and the tissues are less watery in texture. The fungus grows rapidly on the peel, in the vascular cord, and on the surface of the juicy vesicle. All of the tissues become blackened and stiff. (Plate I, Figs. 3 &4) In *Citrus mitis* Blanco (金橘) the disease starts as a water-soaked area. It becomes light brown and extends over the entire fruit surface. The infected fruits are soft, watery and shrunkened.

The causal organism. The cultures isolated from the diseased citrus fruits which came from various places seem to be a single species and all are identical to *Diplodia natalensis* Evans.

Pycnidia are produced on the diseased orange kept for a considerable length of time in the laboratory. They are papillated, mostly in clusters and measure from 124-163×157-210 u. At first they are submerged but later break out. (Plate II, Fig. I) In the pycnidia, there are numerous immature spores which are single celled, hyaline, and thick walled. (Plate II, Fig. 3). They require a long time to reach maturity. The mature spores are dark colored with straight bands on the surface (Plate II, Fig 2). It was found upon examination

of 6 cultures grown in sterile orange juice vesicles for 106 days that not more than 2 per cent of the spores had matured

Culture No.	Immature spores	Mature spores	Total	Per cent of immature spores	Percent mature spores
1	501	21	522	95.98	4.02
2	165	2	167	98.81	1.19
3	441	3	444	99.33	0.67
4	742	10	752	98.67	1.33
5	429	3	432	99.31	0.69
6	2278	39	2317	98.40	1.60
				Average.	1.58

In the same pycnidium, spores of various ages are found. There are (1) the immature, hyaline, non-septated spores; (2) immature, hyaline, one-septated spores; (3) immature, light brown, non-septated spores; and (4) the mature, dark colored, one-septated spores with straight bands. The diamensions of the mature spores are given below: (211 measurements)

	Range	Mean	P. E. of Mean	Standard deviation
Length	21.3-33.6	27.28	±0.05	3.03
Width	13.5-22.7	16.23	±0.02	1.3

Under laboratory conditions, the pycnidia and the spores are formed only in the cultures after a period of time. They are produced both in natural and artificial media. Their formation in various cultural media after 123 days is listed below:

Potato stab	++*
Potato dextrose agar	++
Beet Extract agar	—
Corn meal agar	+
Steamed rice	+
Onion decotion agar	+
Beef decotion agar	—
Nutrient broth	—
Gelatin stab	—

Citrus acid agar	−
Steamed onion bulb	+
Orange peel	+ + +
Nutrient beef broth	−
Lima bean agar	+
Quaker oat agar	−
String bean agar	−
Orange seed	+ +
Orange juicy versicles	+ + +

* The number of plus signs indicate the relative abundance of pycnidia. The minus signs indicate the absence of pycnidia.

Spore germination The immature spores germinate much more readily than the mature spores in distilled water. Immature spores in distilled water for 6 hours at 30°C. and for 24 hours at 17°C. gave respectively 6.1 and 59.2 per cent of germinating spores; the matured spores under the same conditions of time and temperature did not have a single germinating spore. At 25°C. for 24 hours or more, a few mature spores germinated by producing one or two rarely three germ tubes (Plate II, Fig. 2).

The germ tubes from the immature spores may come out from any place on the spores. At first, there is a small protrusion seen inside of the cell wall which soon elongates rapidly (Plate II, Fig. 4) The germinating spores give arise, in general, one to two germ tubes which either come out apically or laterally. However, the number of germ tubes per single spore is very variable. Spores producing as many as 7 germ tubes have been seen (Plate II, Fig.5) The place of emergence of the tubes may be constricted or may form an enlarged vesicle-like body (Plate II, Fig. 4).

Mycelia in the host: Mycelia in the host tissues are intercellular and richly branched (Plate IV, Fig. 1-5). The young hyphae are hyaline, with or without septation and measure about 5.1-8.5 u in width (Plate III, Fig. 1-a) .Sometimes there is an enlarged portion in the

hypha (Plate III, Fig I-b). Short, lobed and non-septated hyphae are frequently seen. (Plate III, Fig. 1-f). The old hyphae are granulate, septated, brown or olivaceous green in color and measure 13.3-22.1 u in width (Plate III, Fig. 1 c & d). Branching of hyphae may be terminal or lateral. The place of branching is usually slightly constricted, and may or may not be septated from the main hypha (Plate III Fig.1 d). The tips of the hyphae especially of the young hyphae, may be slightly enlarged. (Plate III, Fig. 1 e)

Old mycelia, especially those in the white rind, are deep green or brown, septated, branched and heavily granulate. Dark colored, thick-walled cells occur intercalarly either single or in chains of the main hyphae. They measure from 8.1-17.5×6.9-10.6 u in size. From them new hyphae may arise (Plate III, Fig. 2a-i). Plate III, Figures 2 j, k and e show the new hyphae coming out from these thick walled cells in a drop of distilled water kept under 25°C. for 41 hours. The mycelia in the host may also grow out radially from a common center made of thick walled cells (Plate III, Fig. 1 g&. h).

The aerial mycelia are present both on the fruit surface and inside of the hollow centered fruits. They are at first whitish and turn gradually to green and then to dark brownish green. The young hyphae are hyaline, usually non-septate and measure 3.5-6.8 u in width; while the old ones are brown, septated, granulated and measure 13.6-18.7 u wide.

Cultural characteristics: The fungus grows rapidly and vigrously on most of the natural and artificial cultural media, while sporulation takes place only in certain kinds of media after a period of time.

On potato dextrose agar (1% dextrcse), aerial growth is abundant and white: surface growth smooth and green.

On corn meal agar, aerial growth is less abundant: surface growth smooth and green.

On orange decoction agar (300 grams of juicy vesicle, 10 grams

dextrose, 20 grams agar and 1000 cc. distilled water) aerial growth is white, abundant, and forms a light olivaceous to dark green, velvety layer about 2 mm. in thickness; surface growth, black above, and green underneath, mycelia deep green, granulate and measurs 5.6-17.3 u in width.

On citric acid agar (15 grams citric acid, 20 grams agar, and 1000 cc. distilled water), aerial growth is absent, surface growth smooth and dark green to almost black, growth in substratum, deep green. Mycelia greenish brown to brown, and measures 6.8-8.5 u in width. Intercalary thick walled cells occur singly or in chains, brown to greenish brown and measure 6-17.5 x 10.3-17.7 u.

On orange skin: scanty mycelial growth on the cuticular side, grayish aerial mycelial growth about 1-3mm. long on the white rind, mycelia, dark green to brown in color, granulate, septate, branched and measuring 6.8-8.5 u in width. The fungus avoids growing on the yellow ring at least in young cultures.

On orange seeds: aerial growth, white, about 1-2 mm. in thickness, seeds blackened, with a layer of dark mycelial growth on the seed coat, growth inside of the seeds absent, mycelia light to dark green or brown and measuring 13.6-17.1 u in width, thick walled cells not present.

On sterile orange juice vesicles: aerial growth dark green, juicy vesicle becoming a dry black mass. Immature pycnidia produced in abundance.

Temperature in relation to the growth of Diplodia natalensis. *Diplodia natalensis* is a fast growing fungus. Thus during the period of the second twenty-four hours growth on one percent potato dextrose agar under a temperature of 27°-28°C., the average diameter of ten colonies increased from 7 to 10 mm. tevery five hours. Fawcett (12) found that the optimum temperature for the growth of the fungus during the second twenty-four hour period was 27.5° C. and

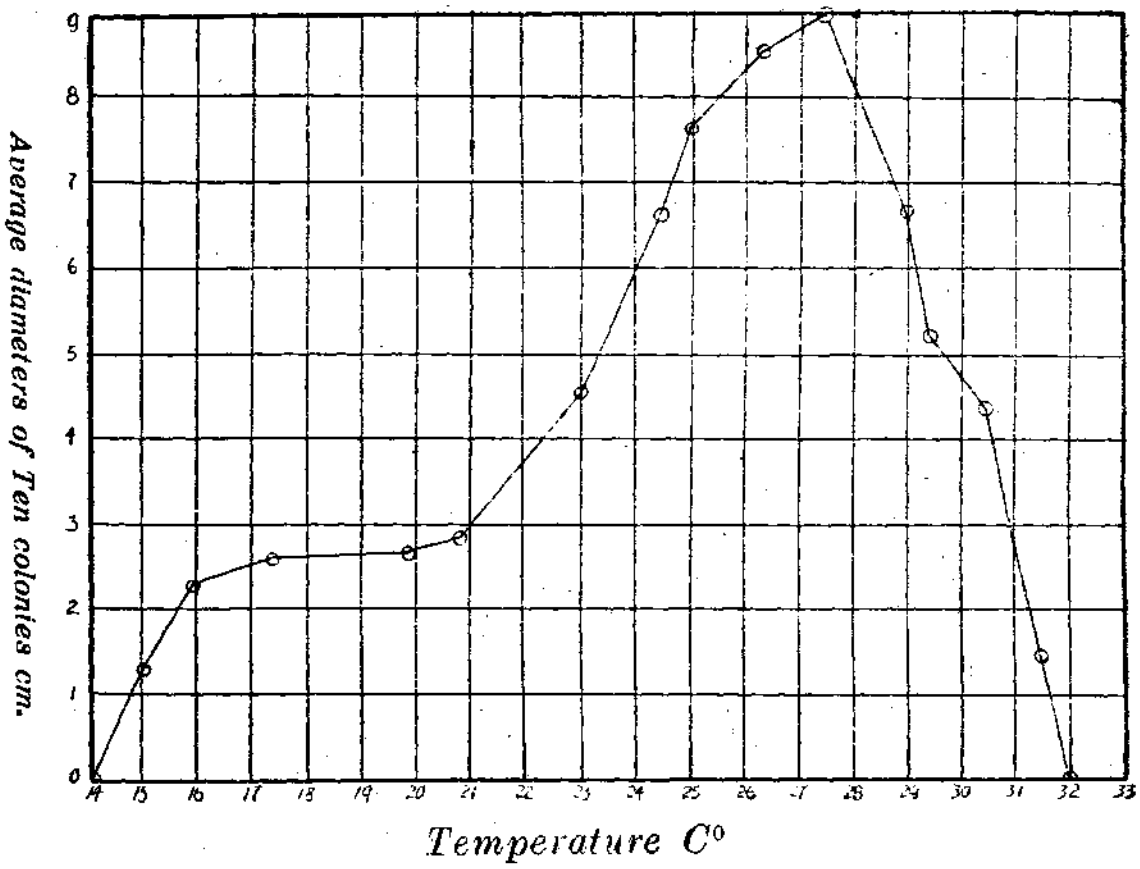
the maximum temperature was 36.5°C. Some growth was made at as a low temperature as 7.5°C. The writer inoculated a bit of mycelium in a moist chambers containing 30 cc. cf one per cent potato dextrose agar at the bottom. The chambers were put up side down in an incubator of 28-30° C. On the third day, the aerial mycelia which had grown geotropically measured 5-7 cm. in length. This explains, at least partially, why citrus fruits with hollow centers usually rot more quickly than those with solid centers.

In studying the temperature relation to the rate of growth of this fungus, uniform discs of media bearing hyphae of the fungus were placed in the center of Petri dishes containing 10 cc. of sterile potato dextrose (1%) agar. The plates were kept in incubators at various temperatures from 5°. to 37°C. The diameters of the colonies were computed daily. The average diameters of 10 colonies for each temperature are presented in Table I.

Table 1. Temperature in relation to the growth of *Diplodia natalensis* Evans.

Temperatures degrees-Centigrade	Days after inoculation				
	1	2	3	4	5
	cm.	cm.	cm.	cm.	cm.
5—7	—	—	—	—	—
7—9	—	—	—	—	—
9—12	—	—	—	—	—
12—14	—	—	—	—	0.2
14—16	—	0.7	1.3	2.0	2.4
16	—	1.0	2.3	3.0	3.9
17—18	0.3	1.3	2.6	3.5	3.9
19—21	0.3	1.5	2.7	4.3	5.5
20—22	0.3	1.7	2.9	4.0	5.3
22—24	0.7	2.8	4.5	6.0	7.9
24—25	0.9	3.0	6.6	7.5	
25	0.9	3.1	7.6	8.1	
26—27	1.5	4.3	8.6		
27—28	1.7	4.8	9.0		
28—29	1.2	4.2	6.6	8.6	
29—30	1.2	2.1	5.2	7.4	8.3
30—31	0.8	2.7	4.3	5.9	7.7
31—32	0.2	0.8	1.5	2.7	3.6
32—34	—	—	—	0.4	0.7
35—37	—	—	—	—	—

Cultures kept either in the ice box (3°C.) or in a high temperature incubator (40°C.) produced no growth for a period of seven days. When taken out and incubated again under a temperature of 25°C., the fungus resumed its vitality.



Influence of temperature at end of three days on mycelial development of Diplodia natalensis Evans. grown in pure culture on potato dextrose agar.

As shown in the chart, the optimum temperature for the growth of *Diplodia natalensis* lies between 27°-28°C. Neither the maximum nor the minumim temperatures have been accurately determined.

The relation of pH to the growth of the fungus. Bits of agar about 4 mm. square having mycelia growth, were inoculated in 150 cc. Erlenmeyer flasks containing 100 cc. of cultural fluid (300 cc. of orange juice, 700 cc. distilled water and 10 grams dextrose). The pH of the fluids was adjusted by the Quinhydrone electrode method with the addition of HCl and NaOH. After five days incubation under a temperature of 25°C., the mycelial growth was washed and dried as

in the ordinary procedure. The dry weights of the mycelia were computed. In another experiment, discs of agar bearing the mycelia were put in the centers of Petri dishes containing 10 cc. of nutrient agar (1% dextrose, 1% peptone, 1.5% agar and 1000 cc. distilled water.) The pH value of the medium was adjusted by adding either HCl or NaOH and compared colorimetrically with the standard pH tubes. The plates were incubated for 5 days under a temperature of 28°C. The diameters of the colonies were computed. The results of these two experiments are given in Table 2.

Table 2. Hydrogen ion concentration in relation to the growth of *Diplodia natalensis* Evans. *

pH	Cultural fluid	pH.	Nutrient agar
	Dry weight (gm) of mycelia		Diameter (cm.) of colonies
2.0	0.0000		
2.5	0.0000		
3.5	0.0945		
4.1	0.1162	4.3—4.5	4.2 X 4.5
4.6	0.1301	5.0—5.3	6.1 X 6.3
5.6	0.1533	5.3—5.9	6.6 X 6.9
6.0	0.1706	6.1—6.3	7.6 X 7.8
6.2	0.1886	6.4—6.6	6.9 X 7.0
7.7	0.1492	7.5	4.9 X 5.0

* average of ten cultures.

The fungus can grow in a wide range of pH values from 3.5 to 7.7. The optinum pH value according to the above data, lies somewhere between 6.0 and 6.6. It is interesting to note that the fungus does not thrive well in pH 3.5 to 4.1, a limit within which the pH values of most of the fruits tested in the laboratory fall.

Inoculation experiment. The pathogenicity of the fungus of various kind of citrus fruits has been studied under laboratory conditions. The inoculum consisted of either vigorous mycelial growth of the fungus obtained from pure cultures or conidia suspension containing both immature and mature spores.

The fruits, under a temperature of 28°-30°C., decayed very rapidly when they had been artificially wounded and inoculated with mycelia.

The discolored area at the wounded place enlarged and soon involved the whole fruit surface on the third or fourth day after the inoculation On the unwounded fruits, the mycelial growth covered a considerable portion of the fruit surface accompanied by the softening and discoloration of the rind underneath. In general, the rate of decay was slower in the normal than in the wounded fruits. Inoculation of the fruits at or near the stem end usually brought about a rapid decay of the fruits.

When inoculated with spores, it usually takes a longer period for the appearance of the disease as well as the rotting of the whole fruit. The symptoms however, do not differ essentially from those produced as a result of mycelia inoculation.

On account of the fact that not all the citrus fruits come on the market at the same time, experiments to compare their reactions to the organism carried at the same time and under the same condition are almost impossible. In spite to this fact, the difference in the rate of decay on the various kinds of citrus fruits was strikingly apparent. From time to time inoculations of fruits were conducted with conditions as nearly uniform as possible. The healthy fruits, after being superficially disinfected with 95% alcohol, were wounded, by means of a sterile needle, making a hole of 2 mm. in diameter and 4 mm. in depth. A drop of spore suspension was introduced into the hole. The inoculated fruits were then kept in moist chambers under 28°C. The rate of decay as seen on the fruit surface, was recorded. As the rate of complete decay for all fruits was not equal, only the average number of days that is required for complete decay of all of the fruits was recorded for comparison. Based on the results of 74 inoculations, the following list is given.

Citrus nobilis Lour.

早橘	~~+~~+++
本地早	++++
乳橘	++++

溫州橘 ++++

C. nobilis var. *deliciosa* Swingle

朱紅 ++++

早紅 ++++

紅橘 ++++

C. nobilis var. poonensis Hayata

椗柑 +++

槾 +++

C. suavissima Tanaka

甌柑 ++

C. tankan Hayata

焦柑 ++

C. suhoiensis Tanaka

四會橙 ++

C. sinensis Osbeck

臍橙 ++

甜橙 ++

雪柑 ++

C. medica Linn.

柚 +

C. lemon (Burm.) Tanaka

檸檬 ++

C. mitis Blanco

金橘 ++

C. grandis Osbeck.

香櫞 +

The plus sign after the name of the fruits indicates the rate of decay. Those having one plus sign took the longest time for complete decay while those having four plus signs took the shortest time.

The rate of decay of these fruits showed no correlation with the acidity of the fruits. The pH of the citrus fruits, determined by the standard Quinhydrone method at intervals of ten days, are given below.

Name of the Citrus fruits		pH Determinations		
		I.	II.	III.
Citrus nobilis Lour.	朱紅	2.97	3.13	3.75
C. nobilis Lour.	本地早	3.26	3.88	3.95
C. nobilis Lour.	早橘	3.62	3.71	3.42
C. nobilis var toonensis Hayata	桁柑	3.58	3.61	3.42
C. tanaka Hayata	焦柑	3.91	4.08	4.13
C. suhoiensis Tanaka	新會橙	4.14	4.10	4.13
C. sinensis Osbeck	雪柑	2.07	3.01	3.14

Although the pH values of the fruits given above were not determined at the time when the inoculation experiments were made, it is quite obvious that the rate of decay, as indicated by the list on the previous page, bears no relation to the acidity of the fruits. Thus, *Citrus sinensis* Osbeck (雪柑) and *C. Tanaka* Hayata (焦柑) both decayed more slowly than *C. nobilis* while the pH value of one is higher, and of the other lower than that of *C. nobilis*. According to the unpublished data of Prof. S. H. Chen, the acid content of *Citrus nobilis* Lour. (朱紅), expressed in terms of citric acid, and under common storage conditions(storage temperature varied from 4^0-11^0C.) during a period of 79 days from Dec. 2 to Feb. 19, dropped from 0.736 to 0.466 per cent; while that of *C. sinensis* Osbeck from Feb. 6 to 28 dropped from 0.723 to 0.467 percent Inoculation experiments conducted bythe writer from November, 1933 to March, 1934 on different varieties of Citrus fruits showed, however, that *C. sinensis* Osbeck always took a longer period of time for complete decay than *C. nobilis* Lour.This indicates that the acid content in a fruit does not influence the rate of the stem end rot caused by *Diplodia natalensis*.

In as much as the real physiological differences between these citrus varieties is not understood, the writer is inclined to believe that the morphological characters of these fruits may affect, at least partly, the rate of decay according to the experimental results. All of the loose skin type citrus fruits, such as *Citrus nobilis* Lour. and

C. nobilis var. deliciosa decayed much faster than the firm skin types such as *C. suhoiensis*. This is due to the rapid and vigorous growth of the fungus in the hollow spaces in the fruits. The average number of days that were required for the complete decay of two varieties of citrus which were incubated under 26°C., although not at the same time is given as follow:

	Days for complete decayings of	
Experiment	*C. nobilis*	*C. suhoiensis*
I	3-4	5-9
II	3-5	8-9
III	3-7	7-9
IV	3-5	4-7
Aver.	3-4.3	6-8.5

Citrus nobilis is a loose skinned orange with a hollow center and *C. suhoiensis* is a firm skinned type with a solid, cortical center. In all of these experiments, the former took a shorter period of time for complete decay than the latter. The growth of the fungus in these two different varieties of fruits is shown in Plate I, Figures 1 and 2.

In addition to the citrus fruits, the fungus, when artificially inoculated with mycelial growth, may also induce a rot on other host plants. Eddings (7) reported that the fungus caused a dry rot of ears of corn when artificially inoculated in the dough stage. It also produces rot on sweet potatoes and watermelons.

When artificially inoculated in the laboratory with mycelial growth through needle wounds, the following hosts developed rot.

Pyrus ussuriensis Maxim.
Malus pumila var. *domestica*
Punica granatum L.
Dioscorea japonica Thunb.
Solanum tuberosum L.
Raphanus sativus var *longipinnatus* Bailey
Sagittaria sagittifolia L.
Lactuca sativa L.
Daucus carota L,
Brassica caulorapa Pasq.

Brassica Rapa L. *Oenanthae stolonifea* DC.

Temperature in relation to the development of Diplodia stem-end rot of Citrus fruits

Healthy fruits of *Citrus nobilis* Lour. were superficially disinfected with 95% alcohol and inoculated by inserting a bit of vigorous growing mycelia through needle punctures. Ten fruits were put in each moist jar incubated at different temperatures ranging from 3°C. to 35°C. The results of the experiment are given in Table 3.

Fruits incubated under 25° to 30°C., showed symptoms twenty four hours after inoculation. Three to four days were required for complete discoloration of the fruit surfaces.

The disease started, as a rule as a small discolored area around the needle holes. Not all the fruits under the same temperature rotted at the same rate. Some fruits were completely discolored one to two days ahead of the others. Under 25° to 30°C., this difference is less significant than under a lower temperature.

The optimum temperature for the development of rot is 28°-30°C. The rate of decay becomes slower when the temperature either fall to 20° or goes up to 35°C. Fruits kept under 30°C. for 55 days did not show any sign of disease; while those under 5°-8°C. developed small brown spots about 4-5 mm. in diameter after an incubation of 25 days. Although these spots enlarged very slowly, the fruits, at the end of the experiment, became softened and showed a tendency to decay. It is obvious that the disease could be checked by storing at a temperature below 8°C.

Pathogenicity: The mode of infection of *Diplodia natalensis* Evans on *Citrus nobilis* Lour. was studied by inoculating the fruits, with spore suspension. The infected rinds showing the various stages of development of the disease, were fixed in uric acid alcohol for 2 to 3 days (19). Sections were prepared by the ordinary paraffin method and stained with safranin and cotton blue. The fungus stained blue.

Table 3. Temperature In Relation to The Development ot Diplodia Stem End Rot on Citrus nobilis Lour.

Temperature C°	Days after inoculation: 1	2	3	4	6	9	11	13	24
3	—	—	—	—	—	—	—	—	—
5—8	—	—	—	—	—	—	—	—	—
12—13	—	—	—	—	—	Slightly discolored areas around the needle holes.	Brown soft areas 2x5 mm. around the needle holes.	Brown soft area 7x9 mm.	About 2/5 of the fruit surfaces rotted
15—16		whitish mycelial growth coming out fm needle holes		Soft, light yellow to brown area about 2mm wide around the wounds	Brown soft area 8x12 mm.	Brown soft area 15x19 mm.	Disease areas, deep brown 4.x5cm.	Completed rotted	
20—22		light-yellowish area around needle holes	Brown area about 4x5 mm.	Brown soft area about 1 cm.	Brown soft area 3.3 x 3.8 cm	completely rotted			
25—27	Slightly yellowish discoloration around needle holes	Brown discolored area 34x45 mm.	1/3 fruit surface involved	Completely decayed					
28—30	light to deep brown colored area 4x5 mm.	½ fruit surface involved	Completely discolored						
35	—	Slightly discolored area around needle holes	Discolored area about 2x2 mm.	Brown area 5x9mm.	4/5 fruit surface involved	Completely rotted			

Immediately after germination, the germ tubes of the spores may penetrate the cuticle directly (Plate V, Fig. 2-5) or grew on the rind surface without any indication of infection. In the later case, the germ tubes were branched and spread over the fruit surface. The mode of penetration of the cuticle could not be accurately seen. However, it is very evident that the fungus does not dissolve its way through the cuticle into the host. After entering the cuticle, the mycelia grew either perpendicular or parallel to the cuticle (Plate V, Fig. 7, 8, 10, 12, 13,& 14) In the latter case, it results in the swelling of the cuticle. The tips of the germ tubes are usually slightly pointed (Plate V, Fig. 3). In many instances, they may enlarge to form a vesicle-like body (Plate V, Fig. 4). The hyphae penetrate intercellularly the epidermal and subepidermal cells (Plate, IV, Fig. 1-5). Under moist conditions, the fungus grows rapidly just underneath the cuticle which swells up and separates from the epidermal cells (Plate V, Fig. 11 & 15).

The fungus avoids the attack of oil bearing tissues. The retardation of the growth near the oil gland is shown in Plate IV, Fig. 2. Passing through the yellow ring, the fungus grows vigorously in the white rind. The growth is intercellular (Plate IV, Fig. 1) and produces thicked walled cells as shown in Plate III, Fig. 2. As soon as the fungus comes out from the rind tissue, whitish cottony mycelial growth appears in any hollow space in the fruits It grows in between the juicy vesicles and causes softening and blackening of the latter. Heavy, thicked celled, dark colored hyphae are found on the surface but rarely inside of the juice vesicle. In the hollow center of the citrus fruit the whitish green aerial growth is similar to that produced by *Alternaria citri*, except that no black spore masses are present. Under favorable conditions, this whitish growth, as a result of stem-end inoculation with spore suspension, can be seen growing out at the stylar end two or three days after inoculation. In the case of fruits with a solid cortical center, the fungus also grows

much faster in it than in the yellow rind.

On the stem, the fungus attacks both the parenchymous cells and the vascular rings but rarely the pith. In the xylem tissues, it grows both inter-and intracellularly. The most favorable tissue for its development however is the parenchymous cell, (Plate IV, Fig. 5) in which, it grows rapidly in the intercellular spaces and soon reaches the center of the fruits without meeting any oil bearing tissues.

SUMMARY

1. The Stem-end rot of citrus fruits caused by *Diplodia natalensis* Evans. is commonly observed on the market.
2. This disease has been found on the citrus fruits coming from Wenchow, Hwangyen, Chekiang; Foochow, Changchow, Fukien; Samshui, Sze Wei, Chaochow, Kwangtung: Junghsien, Kwangsi- and Pinghsien, Kiangsi. This shows that it is widely distributed in China.
3. Morphological and physiological studies of the fungus have been made.
4. The optimum temperature for the development of the rot on *Citrus nobilis* in the laboratory lies between 28^0-30^0C.
5. The rate of decay varies on different citrus fruits, *C. nobilis* rots faster than other citrus fruits such as *C. suavissima* Tanaka, *C. tankan* Hayata, *C. suhoiensis* Tanaka, *C. sinensis* Osbeck, *C. medica* Linn.. *C. lemon* (Burm) Tanaka *C. mitis* Blanco and *C. grandis* Osbeck. The differences in the rate of rotting do not correlate with the pH values of the fruits. However, the fruits with hollow centers usually rot faster than those with solid compact centers.
6. The mode of infection of the fungus on *C. nobilis* and its growth in the host have been briefly described in this paper.

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Plate I

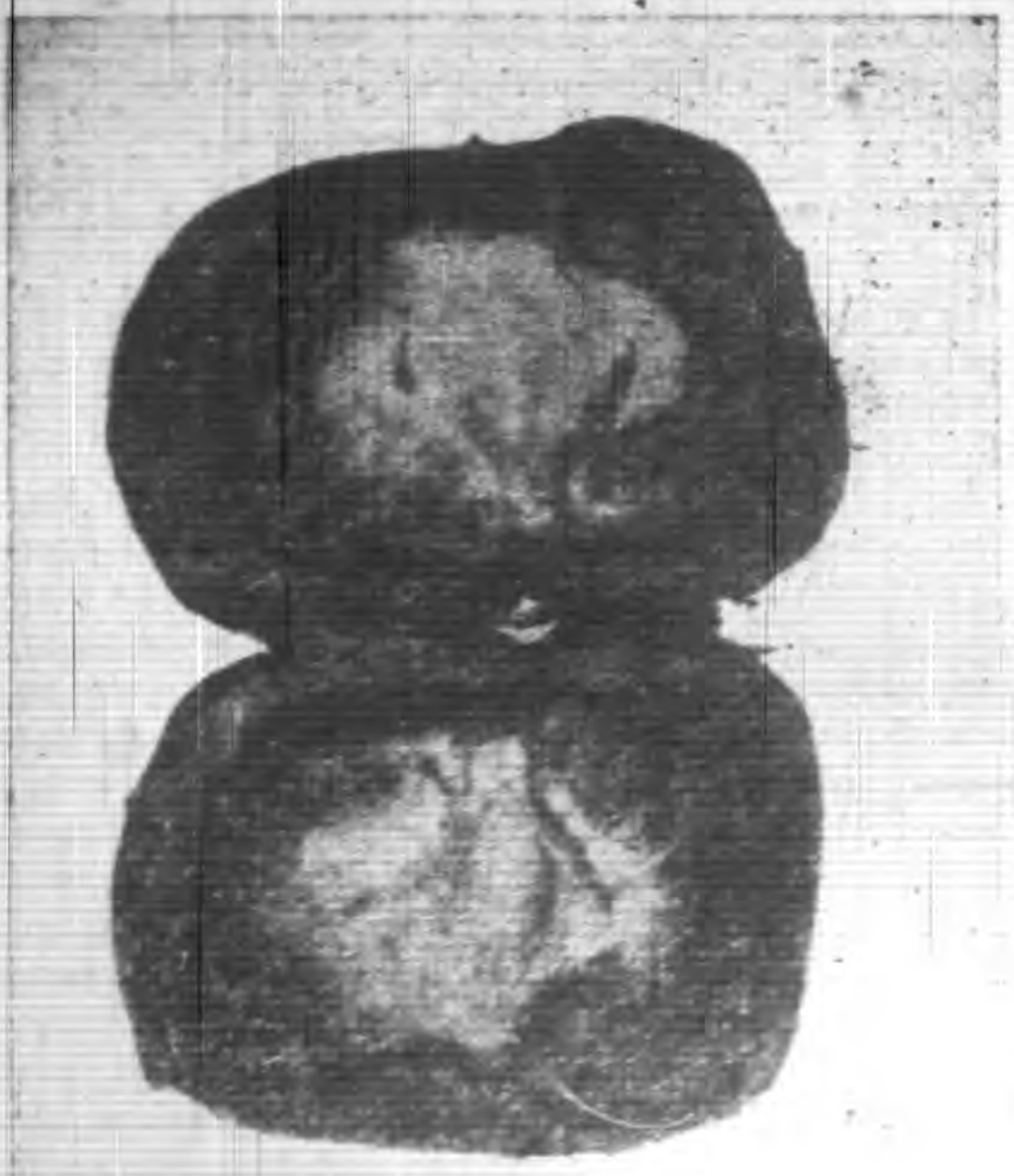


Fig 1. Section through a diseased citrus fruit (*Citrus nobilis* Lour) showing the fungous growth in the hollow space.

Fig 3. Section through a diseased pumelo

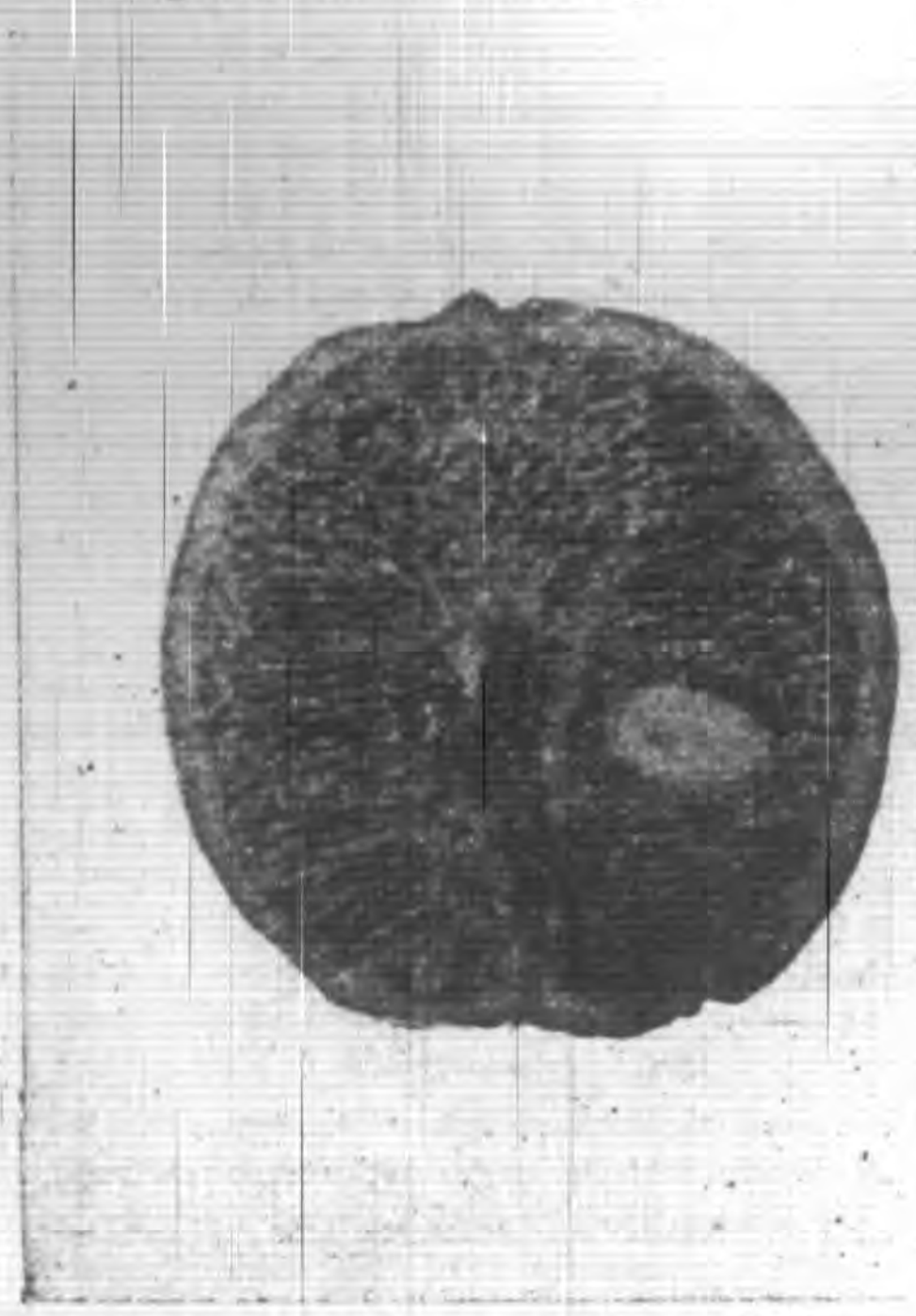


Fig 2. Section through a diseased citrus fruit (*Citrus suhoiensis* Tanaka) showing the discoloration

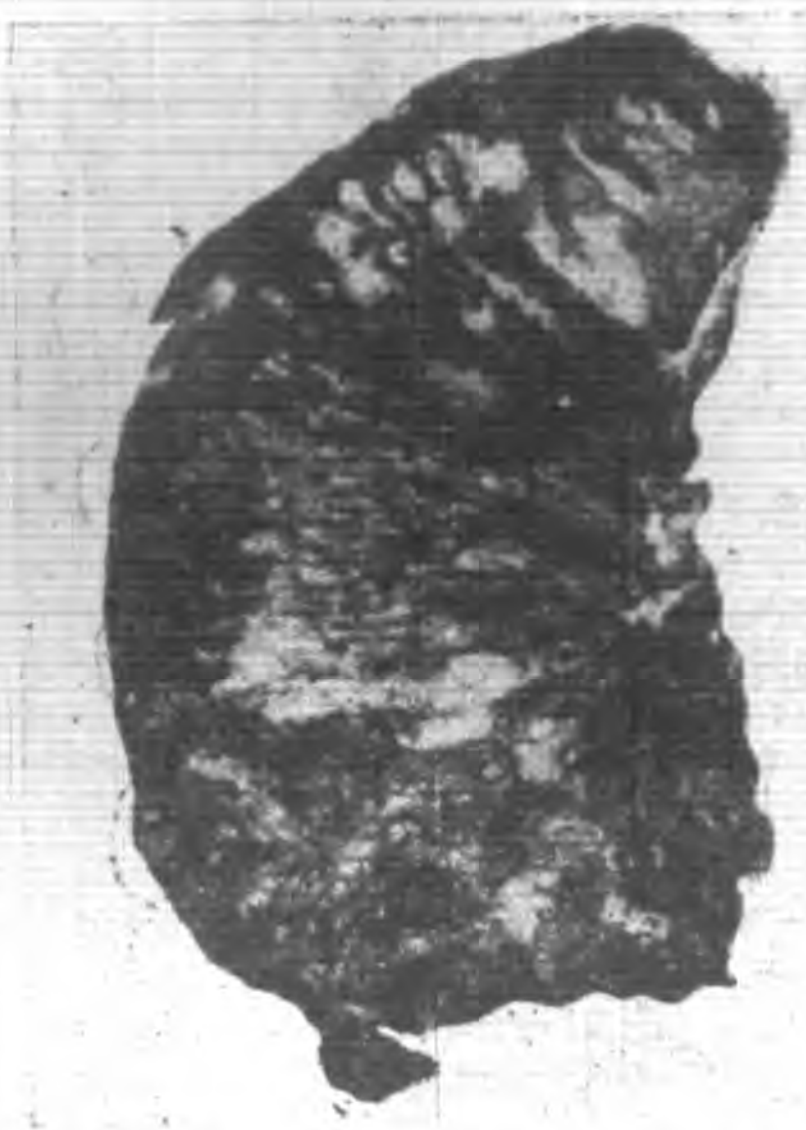


Fig 4. Rotted juicy versicle of pumelo

Plate II

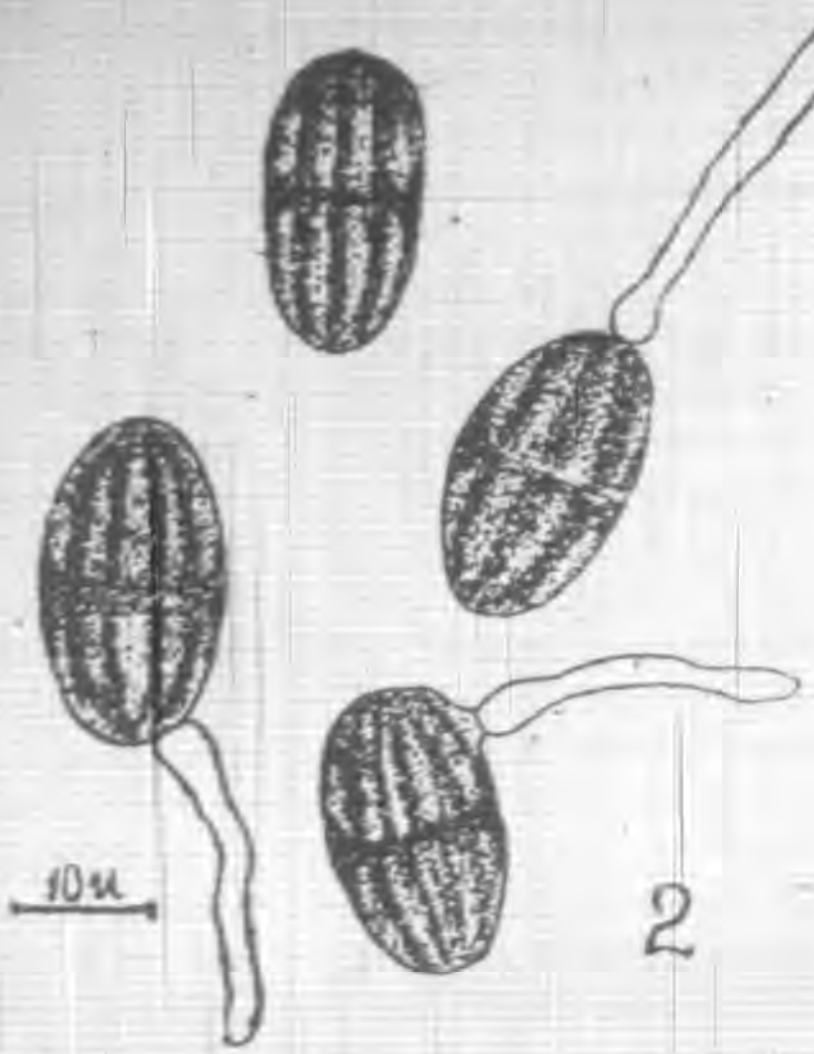


Fig. 2. Mature pycnospores

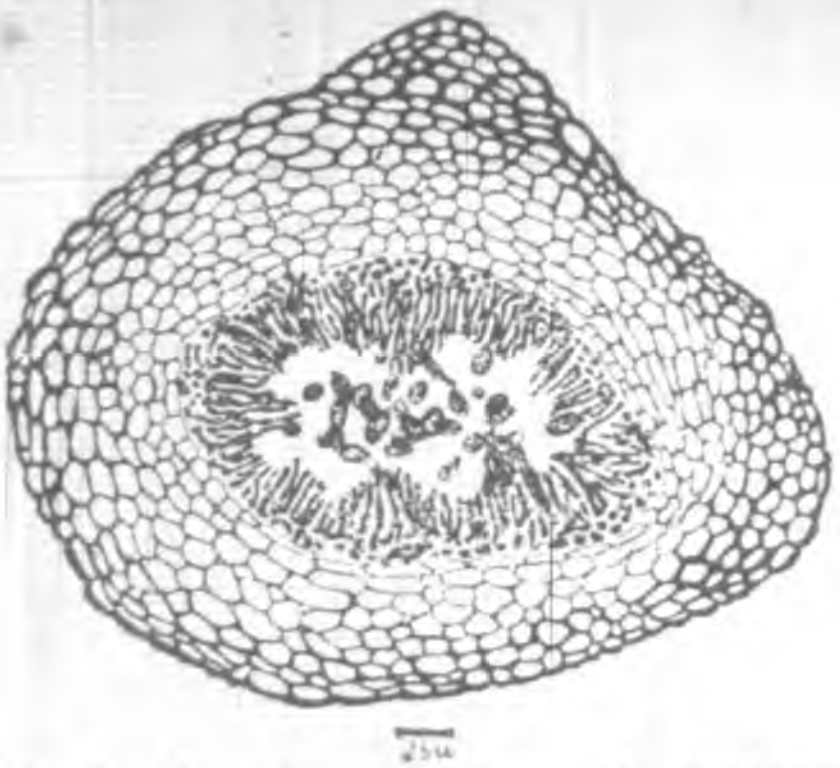


Fig. 1 Young pycnidium of Diplodia natalensis Evans.

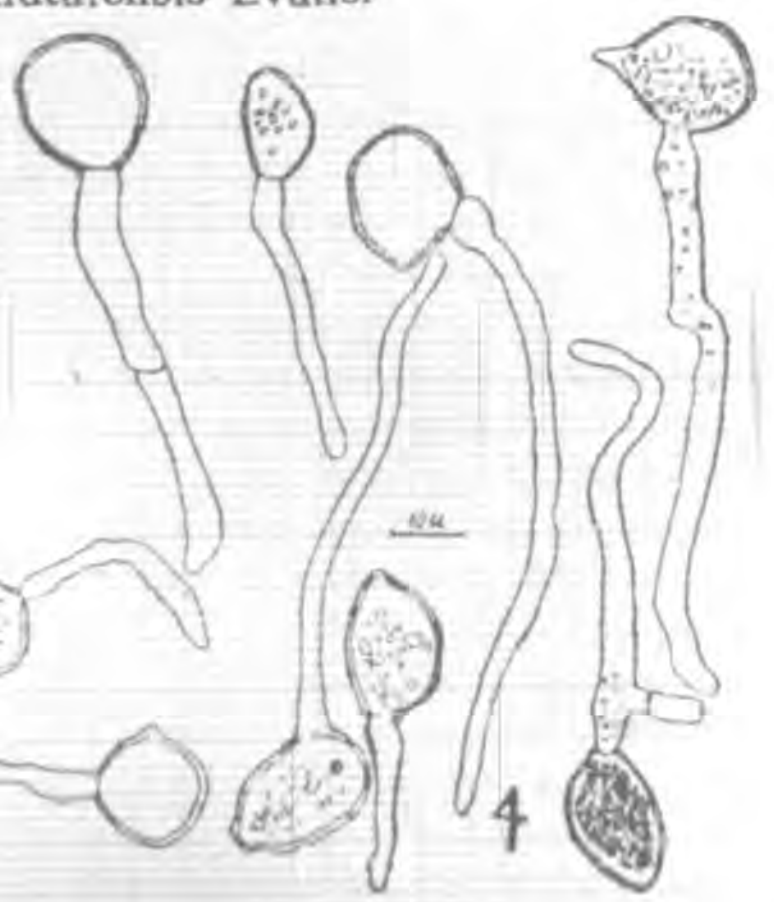


Fig.4.Germinating immature pycnospores.

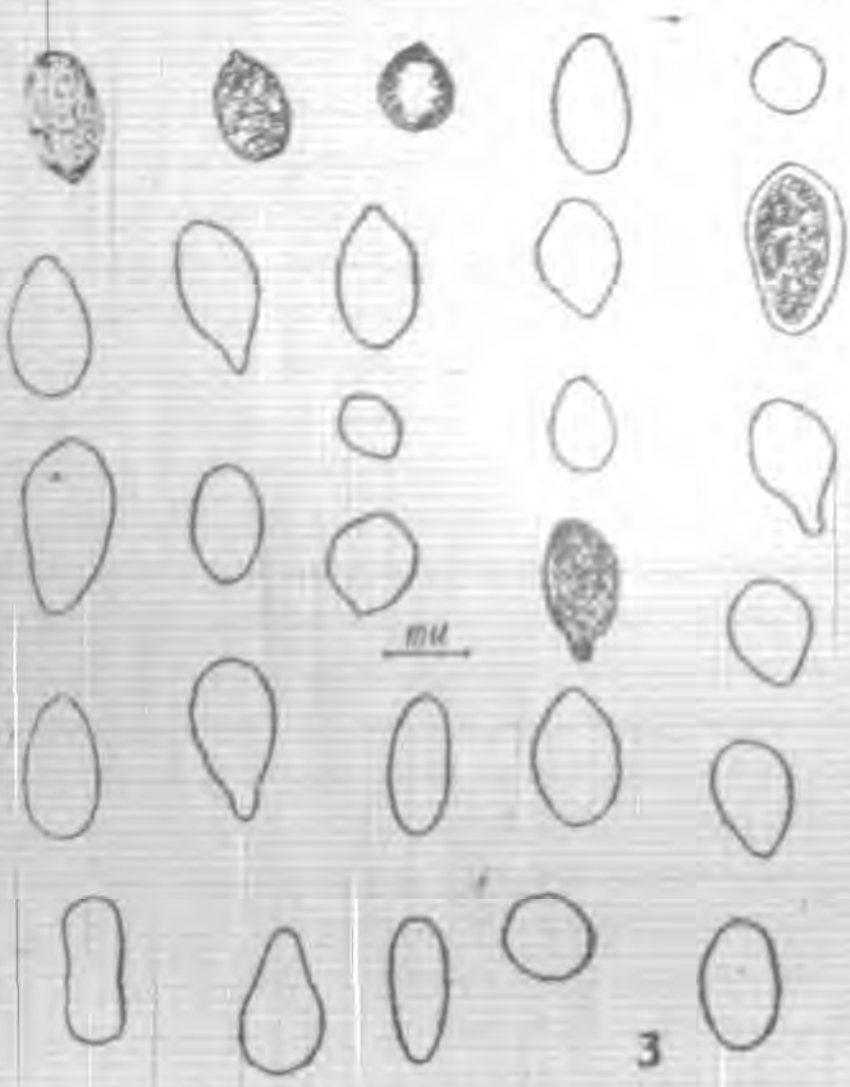


Fig. 3. Immature pycnospores.

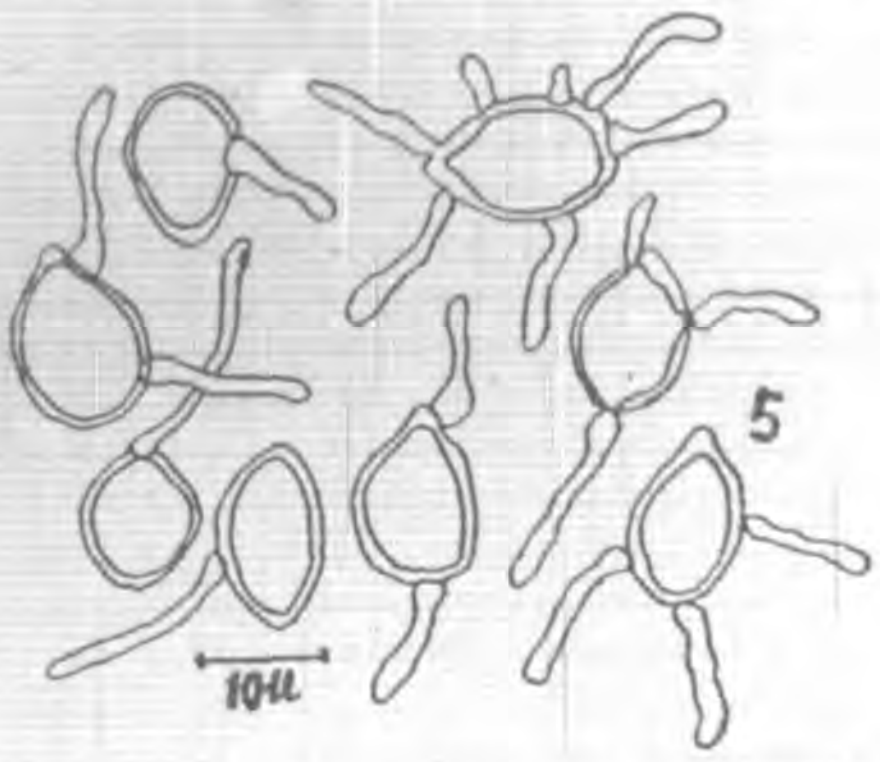


Fig. 5. Immature pycnospores showing the number of germ tubes.

Plate III

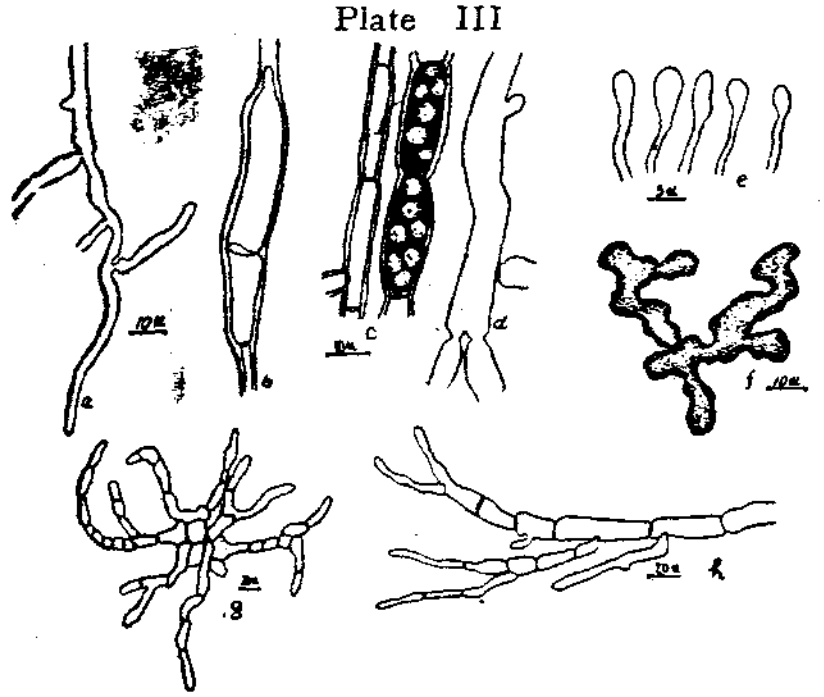


Fig. I. Mycelia of Diplodia natalensis Evans in host tissue (Citrus nobilis, Lour.)

(a) Young mycelium (b) same, showing an enlargement of the main hyphae (C) old mycelium (d) The branching of hyphae (e) The enlargements of hyphae tips (f) short, lobed & non-septated hyphae(g)and(h) mycelial growth from thick walled cells

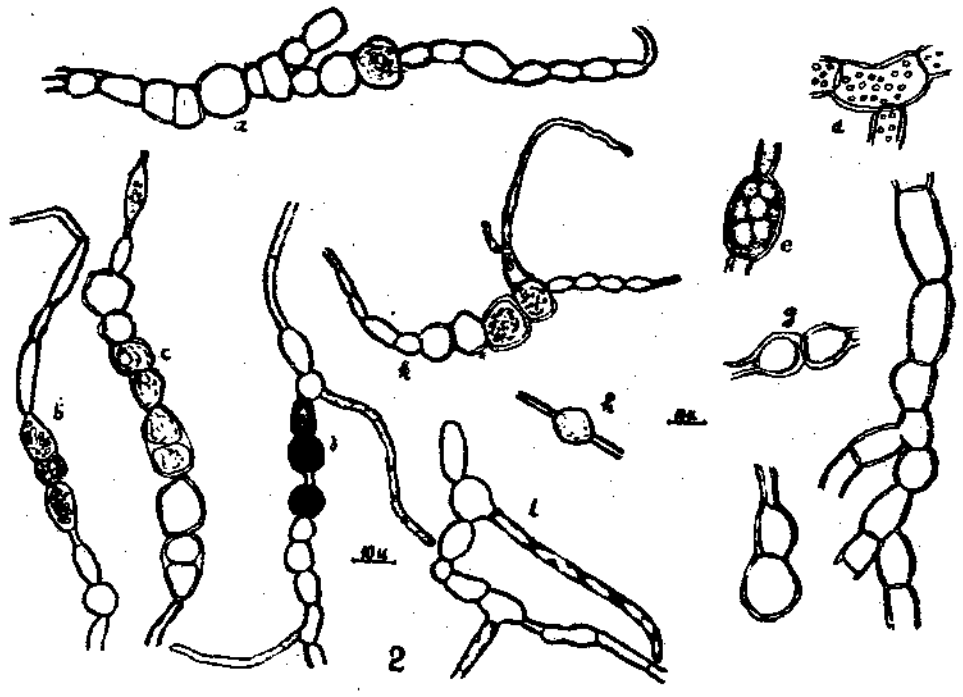


Fig. 2. Mycelia and thick walled cells of *Diplodia natalensis Evans* in host tissues (Citrus nobilis Lour) a-i the thick walled cells of the mycelia, j. l. and k, new hyphae coming ont from the thick walled cell.

Plate IV

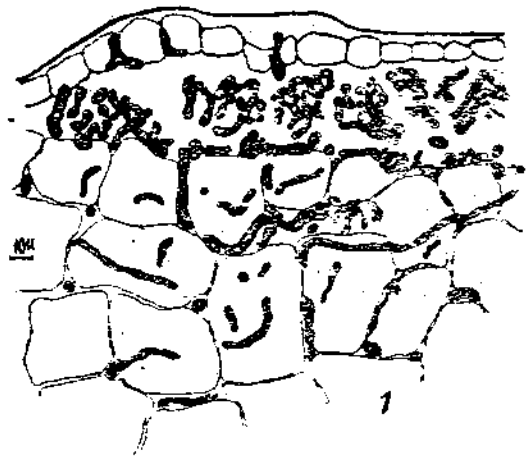
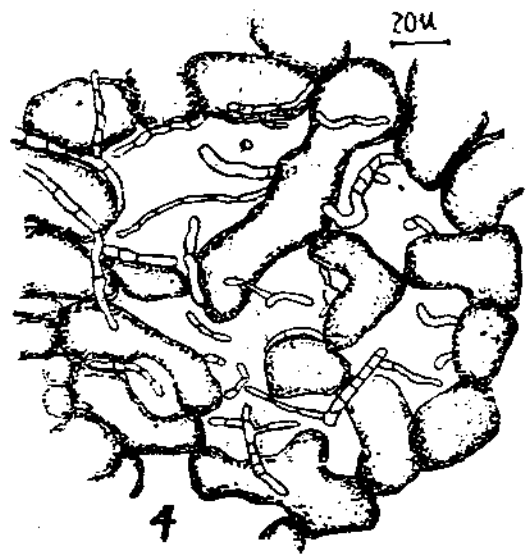


Fig. 1 A cross section of the rind of Citrus nobilis Lour. showing the fungeous growth.



g.iF 4. Intercellular mycelial growth in the white rind of pumelo.

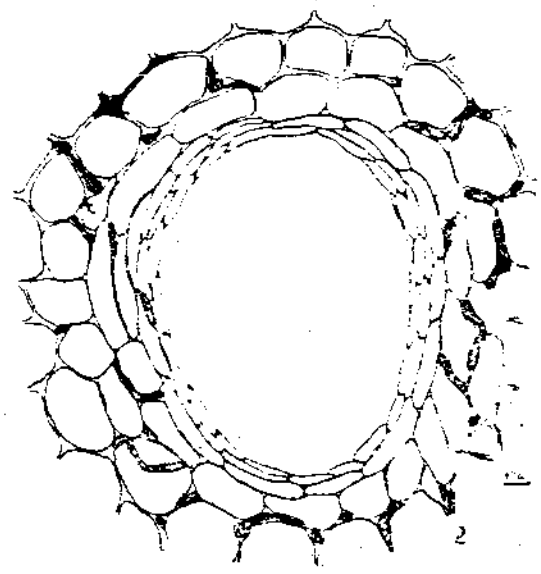


Fig. 2. A cross section of the same showing the retardation of the mycelial growth in the oil glands

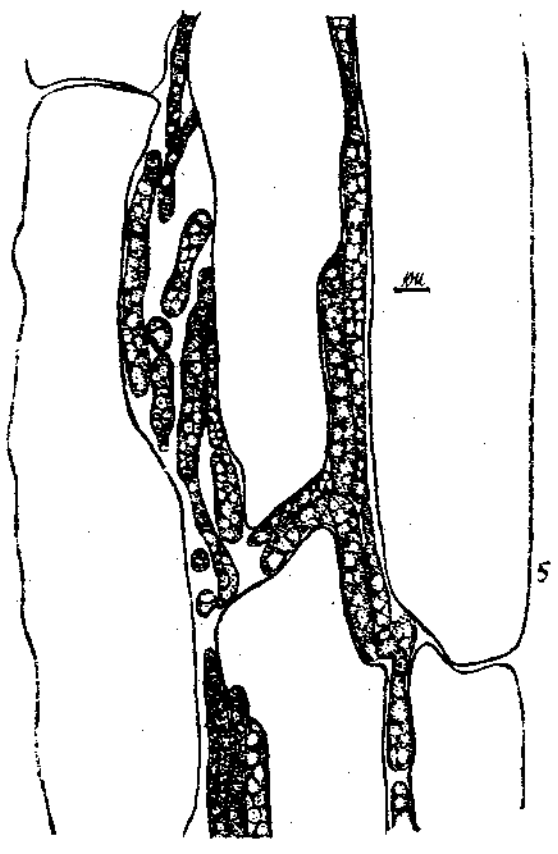


Fig. 5. Mycelial growth in parenchymous cells of the stem of Citrus nobilis Lour.

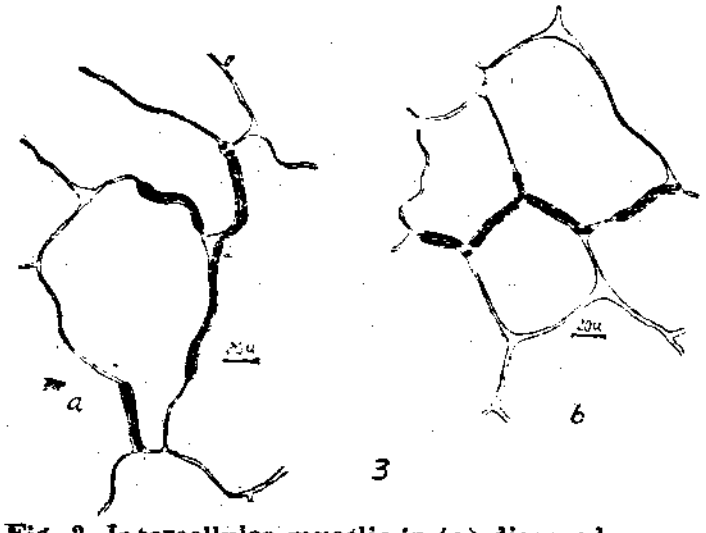
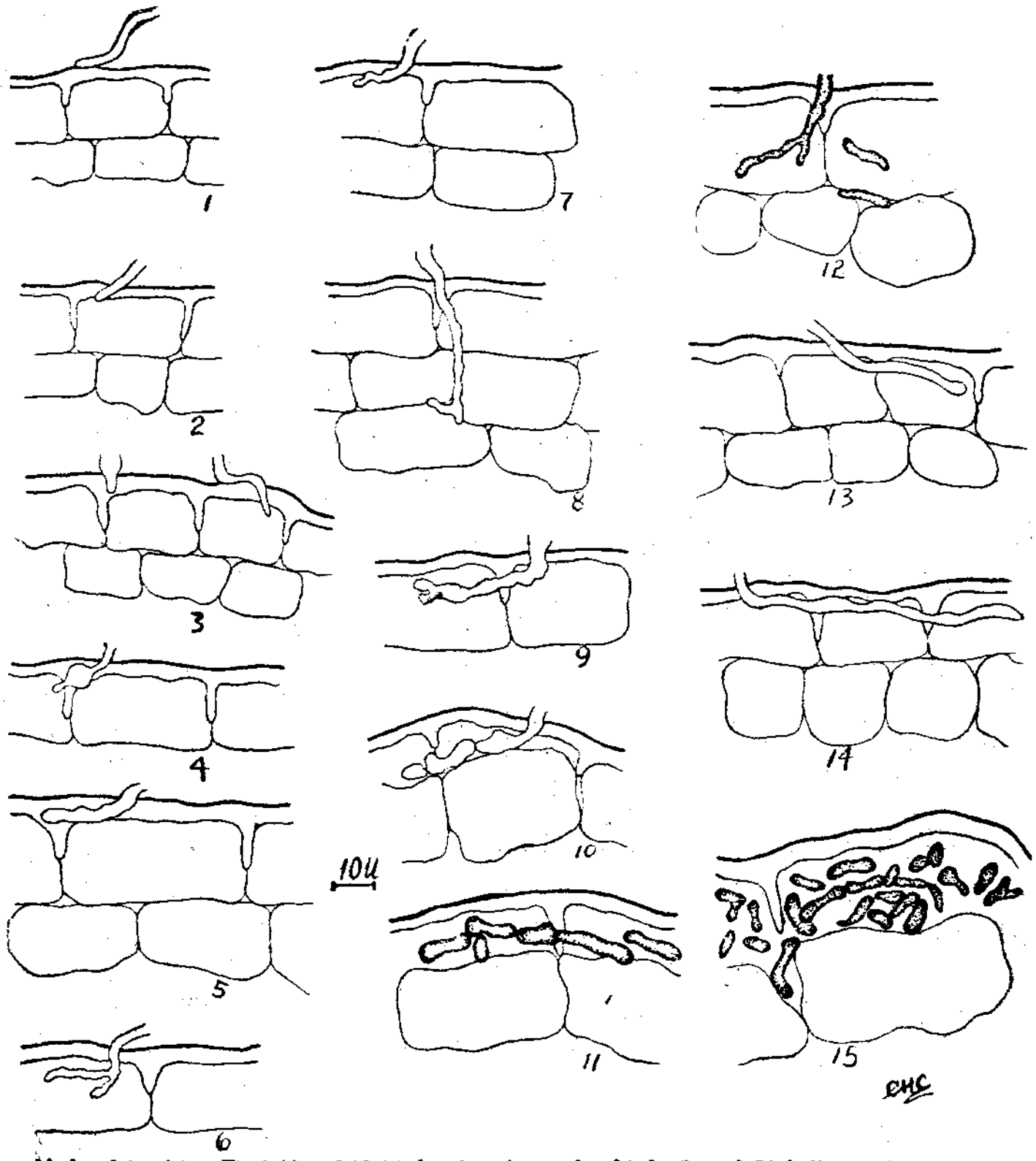


Fig. 3. Intercellular mycelia in (a) diseased pear and (b) diseased apple

Plate V



Mode of inteition: Fig 1-10 and 12-14 showing the mode of infection of Diplodia natalensis, Evans, to Citrus nobilis, Lour.

Fig 11 an15p showing the growth of the fuugus underneath the cuticles.

貯藏中及市場上水菓之病害(其二)

柑橘之Diplodia蒂腐病

提　要

俞大紱

(一)*Diplodia natalensis* Evans 所致之蒂腐病，爲柑橘普通病害之一，在南京市場上受害病菓實平均約百分之0.2至0.8，而在貯運中約百分0.4至2.5，最多者竟達百分之7.5，此病在中國分佈甚廣，如由浙江之黃岩，溫州，福建之福州，漳州，廣東之四會，三水，潮州，廣西之容縣，及江西之萍鄉，所得之病橘，皆發現此病。

(二)最初之病徵，爲橘實之蒂或近蒂處，發生黃褐色之病斑，漸次擴大延及全橘，有時此病斑隨橘瓣排列而滋長，故實之外皮上呈深褐色帶紋，由蒂部直達他端，病菓之外皮常分泌黏着水汁，病部由淡黃變作深黃而黑變，若置於高濕之處，則有白色菌絲由菓皮長出，此菌絲漸變爲深綠色，菓實軟而易腐裂，漸漸黑變，若置於乾燥處，則全實乾縮成爲黑色菓屍，受病菓實之內部，最初軟腐而多水汁，凡空處，皆長有深綠色菌絲，橘瓣，皮，筋，最後皆黑變。

(三)病原菌在培養基或病實上，須經過長久時間，始產生分生胞子器，分生胞子器生於寄主組織內，最後始裂出，其形圓或扁圓，有短頸口，叢生，124—163×157—210u.，未成熟之分生胞子，倒卵狀，厚膜，無色，透

明，成熟之分生胞子長卵形，二細胞，深褐色，外膜上有縱條紋，16.2×27.3u.萌芽時於胞子之一端或兩端產生一或二個萌芽管，未成熟之分生胞子較易萌芽，萌芽管之數目，有多至七枚者。

（四）此菌生長最適宜之溫度爲27—28°C，最適宜之酸度爲 pH6.0至6.6 之間。

（五）根據接種試驗，各種橘類之感病性，頗有差異，如橘類（Loose skin orange group）與紅橘類（Tangerian group）皆極易腐爛，茲將所試驗之橘實排列於下：

符號表示其感病性，最多者最易腐爛

早橘	＋＋＋＋	焦柑	＋＋
本地早	＋＋＋＋	四會橙	＋＋
乳橘	＋＋＋＋	臍橙	＋＋
溫州橘	＋＋＋＋	甜橙	＋＋
朱紅	＋＋＋＋	雪柑	＋＋
早紅	＋＋＋＋	柚	＋
紅橘	＋＋＋＋	檸檬	＋＋
柘橘	＋＋＋	金橘	＋＋
槾橘	＋＋＋	香櫞	＋
甌橘	＋＋		

（六）柑橘之感病性與其酸度之高低無關係，但菓實中多空隙者，較易腐爛。

（七）在溫度28至30°C之間，菓實腐爛最速，在20°C以下，或35°C以上較慢。而在5至8°C之間，則不易腐壞。

(八)分生胞子之萌芽管與菌絲，皆由傷口或直接侵入菓實．菌絲滋長於細胞中間、在黃色皮層中，生長較慢，且不能侵入油腔，但在白色皮層，筋及蒂中，則生長甚速，而尤以在薄膜細胞間 (Parenchymous cell) 中爲甚。

南京金陵大學植物病理究研室

A DRY ROT OF POMEGRANATE FRUIT CAUSED BY ZYTHIA VERSONIANA SACC*.

F. L. Tai and C. C. Cheo

A dry rot of pomegranate fruit (*Punica granatum* L.) was brought to the attention of the senior writer in 1925. Pressure of other duties prevented him from making any study on this disease until 1927 when an organism was isolated from the internal host tissue of the dried fruits collected that year. Mr. T. H. Wang(王清和)in 1930, and the writers in 1931 succeeded in isolating again the same fungus, and in infecting the blossoms and fruits of the pomegranate by artificial inoculation. The results of studies made on this disease since 1931 are given in this paper.

Economic Importance.

The loss due to this disease varies with different varieties of the host plant and with different climatic conditions. With the variety under cultivation in Nanking the loss was more than thirty per cent in 1931. Certain varieties are very susceptible such as Funpi (粉皮), forty nine per cent of its total number of fruits being diseased in 1933. The percentage ranges from 4 to 22 in the same year for the other varieties, Yushihtze (玉石子) being the most resistant with only four per cent infection.

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*Contribution No. 35 from Plant Pathology Laboratory, Botany Department, The University of Nanking, Nanking.

Symptoms.

The disease affects only flowers, fruits and fruit bearing stalks. The diseased fruits dry up and remain on the tree throughout the fall and winter. On these fruits minute, densely aggregate, yellowish dots are present. These are the pycnidia of the causal organism. Symptoms first appear on the petals or stamens of the flower which become discolored. From these the infection may extend down into the receptacle. Brown and somewhat sunken areas appear within a short time, first on the lower part of the calyx lobes or usually near the base of the cleft of the calyx lobes, and finally involve the whole receptacle. (Plate 1 Fig. 1 & 2) Flowers and young fruits when heavily infected usually fall to the ground but infected fruits which have attained three-fourth of the size of mature fruits usually remain on the tree. As the diseased fruit gradually dries up, numerous minute elevations appear on the affected parts. When such dried fruit is opened. minute black fruit bodies of the causal organism may be found on the seeds and other internal parts of the host. (Plate 1 Fig. 3) The fruit bearing branches may also become affected and show small black fruit bodies on them. A serious storage disease caused by the same fungus has also been observed.[1]

The Fungus.

Isolation Isolations were made from pericarp, seeds, and internal parts of diseased fruits and also from diseased fruit-bearing branches. More than one hundred isolations were made. On the average ninety four per cent of all these isolations yielded the same fungus.

Cultural characteristics Growth is good on ordinary media such as potato, potato dextrose and oatmeal agar. The rate of growth is

1 Yu, T. F. Notes on the storage and market diseases of fruits 1. Jour. Agr. Assoc. of china. No. 123: 16-27 1934

about the same on potato dextrose and oat meal agar, but pycnidia are produced earlier and more abundantly on oatmeal agar. Zonations are often produced in plates on these media. In all these media the mycelium adheres to the substratum, no aerial mycelium being formed. Scanty aerial mycelium is sometimes produced on the margin of the tube slant when the medium gradually dries up. On sterilized cowpea pods, however, profuse aerial mycelium develops on the surface of the substratum.

Pycnidia are produced witnin one week to ten days. When the plates are contaminated with molds, pycnidia are produced around the mold growth in a much shorter time than normally.

Germination of pycnidiospores The pycnidiospore germinates in distilled water at 24°C. within twenty-four hours. Potato decoction is a more favorable medium for germination than distilled water. The spore first increases in size. Germ tubes are produced laterally near the end of the spore. It rarely germinates terminally from both ends. The germ tubes are stouter when the spores germinate in water in which a bit of the pericarp of the pomegranate fruit is added. A yellowish fluid is usually secreted and accumulated on the apical portion of the young hyphae. Anastomosis by tubes from one spore to the germ tube of the other spores has often been observed. Appressorium-like structures are sometimes produced at the end of the germ tube and of its branches. The shape and size of these structures vary greatly, sometimes reaching a large size. Occasionally the spore become bicellular just before germination (Plate II, Fig.4&2).

Temperature in relation to growth of the fungus Discs of plate culture of this fungus of uniform size were planted on dextrose agar plates and incubated at different temperatures, six plates forming a set for each temperature. The diameter of the fungous growth was then measured at intervals of time. The results are tabulated below;

Table I. Growth of the fungus at different temperatures

Temp.° C.	Av. diameter of fungous growth in cm.			
	3 days	5 days	7 days	9 days
12.5	0.0	0.6	1.7	—
14	0.6	1.5	2.5	—
19	1.3	3.6	5.3	6.4
21	2.4	5.4	7.2	8.2
24	3.2	6.4	8.5	9.2
26	3.9	7.4	9.2	—
28	3.5	7.4	9.1	—
30	2.4	5.9	7.1	9.2
32	2.5	3.4	3.9	—
35	0.6	1.5	1.8	1.8

The optimum temperature for the growth of the fungus was found to be between 24° and 28°C. At 35°C. and 12.5°C. there was little or no growth at the end of three days. The average maximum and minimum air temperature in May and June in 1933 at Nanking, for instance, was 27°C and 16.2°C. in May, and 28.4°C. and 20.1°C. in June. This probably accounts for an outbreak of the disease at Nanking in May and June.

Tannin tolerance In the germination tests it was observed that tannin in the pomegranate fruit seemed to have some stimulating effects on the germination of the spores. A synthetic medium* was prepared with tannic acid ($C_{14}H_{10}O_9$) added to the following concentrations: 1-1000, 2-1000, 1-100, 2-100, 3-100, 4-100, 6-100 and 7-100, medium without tannin serving as check. Discs of uniform size from culture plates were introduced into the tubes, four tubes making a set for each concentration. These were incubated at 24°C. for one week. At the end of one week mycelial weft that was produced at the top of the medium was taken out from the tubes and dried in a dessicator. After being thoroughly dried they were weighed. The results are presented in the following table:

* see page 207.

Table II. Results of experiment in tannin tolerance

Concentration of tannin	Dry weight in milligrams of mycelial weft
Check	0.8
1—1000	10.5
2—1000	12.1
1—100	15.9
2—100	16.7
3—100	21.9
4—100	7.2
6—100	0.86
7—100	0.0

In the above table it is of interest to note that the organism made a feeble growth in medium in which no tannin was added. The growth was best in tannin-containing medium at the concentration of 3-100. Growth was inhibited by 7% tannin.

Cook and Taubenhaus[2] have found that in many cases tannin has a tendency to retard or inhibit the germination and growth of fungi. In the present case, on the contrary, tannin was found to promote the growth of the fungus, as growth was much poorer in the medium to which tannin was not added than in those containing tannin below 6% concentration.

Pathogenicity Pathogenicity of this organism has been proved by inoculation. Surface-disinfected pomegranate fruits with and without punctures were inoculated with pure cultures of the organism and then placed in moist chambers. In the case of those fruits on which punctures had been made the area around the punctures became discolored on the third day after inoculation, while infection did not take place on fruits that had no punctures on them.

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* H_2O 1000cc.
Dextrose 25 gms.
$MgSO_4$ 2.5 ,,
KH_2PO_4 2.5 ,,
NH_4NO_3 2.5 ,,

2 Bul. 91. Delaware Coll. Agri. Exp. Station, 1911.

Flowers were also inoculated by spraying a spore suspension of the organism on them, and then kept in bell jars. Two days later petals of the inoculated flowers became discolored and some of them were detached from the receptacle. Discolored areas first appeared near the calyx lobes, and gradually extended to the whole receptacle. In one experiment, flowers with petals removed were inoculated by applying spore suspension only on the stamens. On the second day after inoculation, all the inoculated stamens became discolored Scanty white mycelium appeared on them after three days and the calyx also began to turn brownish. Four days later the whole receptacle was involved and numerous minute elevations began to make their appearance. In another experiment, flowers with both the petals and stamens removed were inoculated by applying the spores only on the stigma. The upper part of the pistil became discolored on the second day but the infected area did not extend further downward and the receptacle remained healthy.

In all the experiments checks were used. They all remained healthy. Re-isolations from the infected flowers and fruits all yielded the same and original fungus.

From what has been stated, it will be seen that the fungus can infect its host only through tender tissues or wounds. This explains why discolored areas always appear near the calyx lobes as has been observed in the field.

Description of the fungus The pycnidia are densely aggregate. They are at first covered, but finally erumpent, globose and measuring 56-144 by 62-131 u. The pycnidium is "pirite yellow"[3] in color, provided with a protruding ostiole, 4-5 u in diameter. The pycnidiospores are fusoid and hyaline, measuring 13-19 by 3-5 u. The sporophore is slender, 19-25 u long. (Plate I. Fig 4. and Plate II. Figs 1 and 2)

3 Ridgway-Color standards and nomenclature

Identity The above description and measurement agree closely with those of *Zythia versoniana* Sacc. [4] which was originally discovered in Northern Italy on immature fallen fruits of pomegranate.

Associated perfect Stage The junior writer collected on July 5, 1931 in the University Garden from one of the trees of the variety called Chien-tsen(千層) one diseased fruit which bears superficially brownish, globoid or discoid fruit bodies. On microscopic examination these proved to be perithecia. A search was subsequently made in other places for such specimens, none was found. But on April 14, 1932 the junior writer on examining diseased specimens which had been collected on December 24 of the previous year from different places, and kept indoors since, found also the same perithecia on all of them.

The perithecia are superficial and densely gregarious. They are globose or discoid, brownish and provided with a beak, measuring 166-227 u in diameter. The beak is 44 to 65 u long. Periphyses are present along the wall of the beak. The ascus is fusoid or clavate, thickened apically and opening by a pore, measuring 42-53 by 8-11 u. It is sessile or sometimes shortly stalked, aparaphysate, eight-spored and biseriate. The ascospore is one-celled, hyaline, granular and fusoid, measuring 11-14 by 4-6 u. The above description compares favorably with that of *Nectriella versoniana* Sacc. and Penz. [5] found originally on immature fallen pomegranate fruits in Italy and frequently associated with *Zythia versoniana.* It seems to be the same fungus (Plate II Fig 3 Plate III Fig 1&2)

In order to determine the generic relationship between *Zythia versoniana* and the associated perfect stage, attempts have been made to secure a culture of *Nectriella versoniana* but without success. The ascospores did not germinate in the different media tried, nor when subjected to low and high temperatures. The germination tests

4 Saccard-Syll. Fung. 3:614.

5 Saccards-Syll. Fung. 2: 449.

were first made in July 1932 and again in April 1933 using the same material in the hope that the ascospores would germinate after a period of rest, but all efforts to make them germinate failed.

Experiments tried with the pycnidiospores to obtain the perithecial stage have also resulted in failure. One of the experiments consists of first growing the fungus in potato decoction, and then transferring the mycelial weft from the decoction on to moistened filter paper in sterilized petri dishes. Scanty growth of mycelium appeared and after about twenty days a few pycnidia were produced. Perithecia did not make their appearance. Another experiment was conducted by planting single spore isolations in different combinations on various media; the sexual stage was not produced.

Overwintering experiments In December of 1931 two sets of experiments on the overwintering problem of the fungus was started by the junior writer. One set of dried fruits was hung outside the window sill and the other set was shallowly buried in the ground. Germination tests were made in April and May in 1932. The spores from the fruits buried in the ground did not germinate, while those from the fruits hanging outside the window sill germinated at the following percentages: 9.3 in April and 10.5 in May.

Table III. Results of germination tests of pycnidiospores in overwintering experiment, 1931-32.

	Average percentage of germination	
	April 18	May 3
Hanging outside of window sill	9.3	10.5
Buried in the ground	0	0

The original aim of the overwintering experiment was simply to determine whether the spores are still viable when the host plants are in bloom. It was, however, contrary to expectation to find in this experiment that the percentage of germination of the spores,

instead of decreasing, was greater in May than in April. This curious fact led the senior writer to conduct again in the fall of 1933 another experiment by hanging dried diseased fruits collected in September, 1933 on the top of a tree, and by storing another set of fruits in the laboratory for comparison. Germination tests were made of the spores from these two sets of fruits from December 1933 to May 1934 at various intervals.

Table IV. Results of germination tests of pycnidiospores in overwintering experiment from December 1933 to May 1934.[x]

	Average percentage of germination				
	Dec. 28	Feb. 20	Mar. 28	April 30	May 31
Kept indoors	60	54	23	38	48
Hanging on top of trees	—	23	9	55	57

[x]The spores were germinated in potato decoction at about 23°C.

From the above table it will be seen that there was a rapid decrease in viability of the spores from both sets of fruits from February to March, more so with those kept outdoors. But from April to May the percentage of germination of the spores of both sets, as in the experiment of 1931-32, was on the increase. The rate of increase was most striking in the case of fruits hanging on trees. It is hard to believe that spores which had already lost their viability could recover and germinate again. It might be suggested that chilling outdoors may have some relation to the increase in the percentage of germination of the spores. The reason for the nongermination of many of the spores might be due to the lack of fulfillment of conditions for the best germination, and not due to the loss in viability. But how shall we account for the same phenomenon in the other set that was stored in the laboratory? This rather seems to indicate that at the inception of favorable temperature and on absorption of moisture in April the dormant mycelium in the tissues of the dried

fruit became active again. Pycnidia were produced. Pycnidiospores from these new pycnidia account for the increase in the percentage of germination in April and May. The second set of fruits that were stored in the laboratory were put in paper bags. These bags would not prevent the stored fruits from absorbing enough moisture for the dormant mycelium to start its activity again. Hence the percentage of germination of the latter set also increased from 23 in March to 48 in May, although the increase was not so great as in the other set. In other words, the dried fruit hanging on the tree is an important source of primary infection.

Control Measures.

In the spring of 1933 a preliminary control experiment was carried out. Six varieties of pomegranate were used: Tachinpi (大青皮), Chientsen (千層), Yushutze (玉石子), Malao (瑪瑙), Funpi (粉皮) and Tiehpi (鐵皮). Half the number of trees of each variety was not sprayed, serving as a check. The other half was sprayed with Bordeaux mixture (4-6-50) on May 16, 24 and June 10. Unfortunately each variety consisted of only two to six trees, so the data obtained is not conclusive, but it gives some indication that the disease can be checked by spraying. The results of the spraying experiment are tabulated below:

Table V. Results of spraying experiment in 1933.

Variety	No. of trees		Average percentage of diseased to total no. of fruits	
	Sprayed	Check	Sprayed	Check
Yush utze	3	3	1.3	3.9
Tachinpi	1	1	2.4	(blown off by wind)
Funpi	1	2	21.5	48.6
Malao	1	1	1.8	17.4
Tiehpi	1	2	1.6	10.4
Chientsen	2	1	3.3	22.2

Readings were taken on August 4, 1933.

It will be seen from the above table that the percentage of diseas-

ed to total number of fruits varied with different varieties, but the fact that the disease was considerably reduced by spraying was quite evident in susceptible plants. Since the dry diseased fruit hanging on the tree is an important source of primary infection it should be removed and destroyed in the fall. The disease will be kept in check if removal and destruction of the dried fruits from the trees is accompanied by spraying. The difficulty in the spraying lies in the fact that the most critical period for controlling this disease is when the trees are in full bloom, but at that time fungicides should not be applied. Only resistant varieties should be planted.

SUMMARY

1. A dry rot of pomegranate fruit caused by *Zythia versoniana* Sacc. inflicts heavy loss on the growers at Nanking every year.

2. Pathogenicity has been proved by successful inoculation and re-isolation.

3. The causal organism has been tentatively identified as *Zythia versoniana* Sacc., and the associated perfect form as *Nectriella versoniana* Sacc. & Penz., The relationship between the imperfect and perfect forms has not yet been definitely determined.

4. The optimum temperature for the growth of the causal organism was found to be between 24°C. and 28°C.. the minimum and maximum somewhere around 12.5°C. and 35°C. respectively.

5. Tannin was found to promote the growth of the fungus. Growth was best in the 3% tannin-containing medium.

6. The dried fruit hanging on the trees is an important source of primary infection. Although the spores decrease rapidly in their viability in the early spring, the dormant mycelium in the dried fruits seems to become active again in April and produces crops of new pycnidia.

7. The disease was greatly reduced by spraying with Bordeaux mixture in 1933.

8. Yushutze, one of the varieties of pomegranate, is found to be resistant to the disease, while Funpi very susceptible.

Plate I

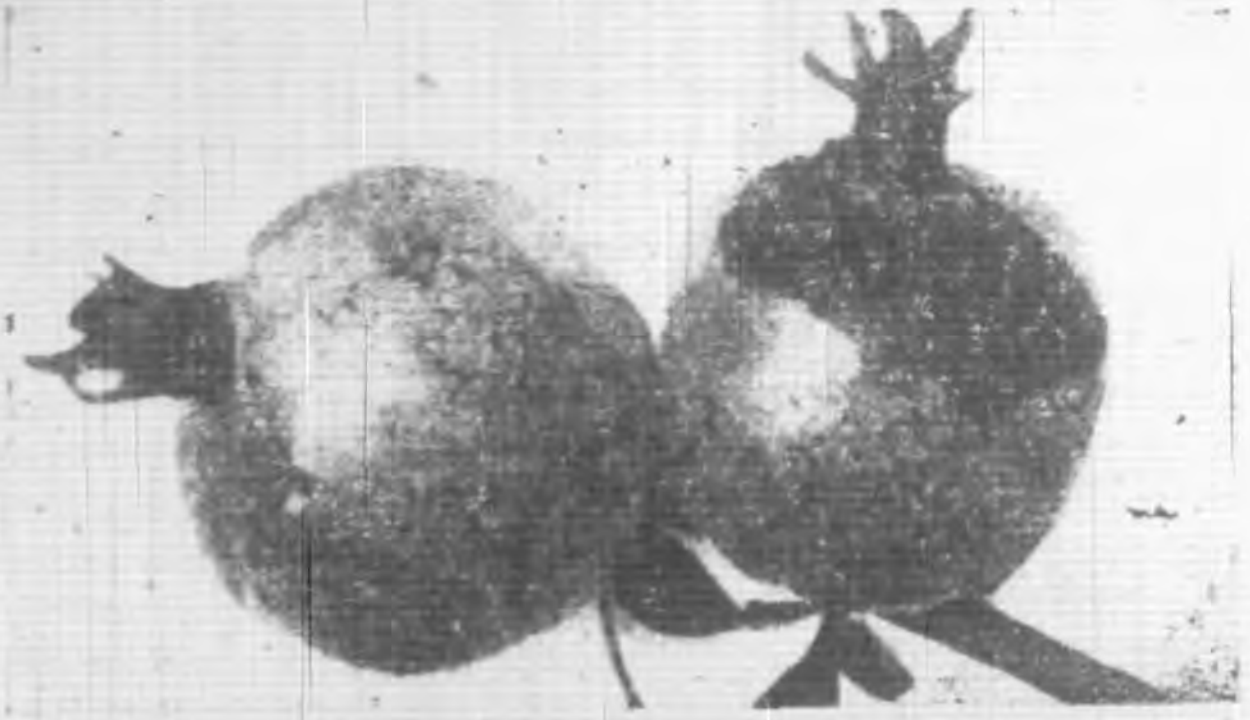

Fig 1. Diseased fruits. Note the discolored areas.

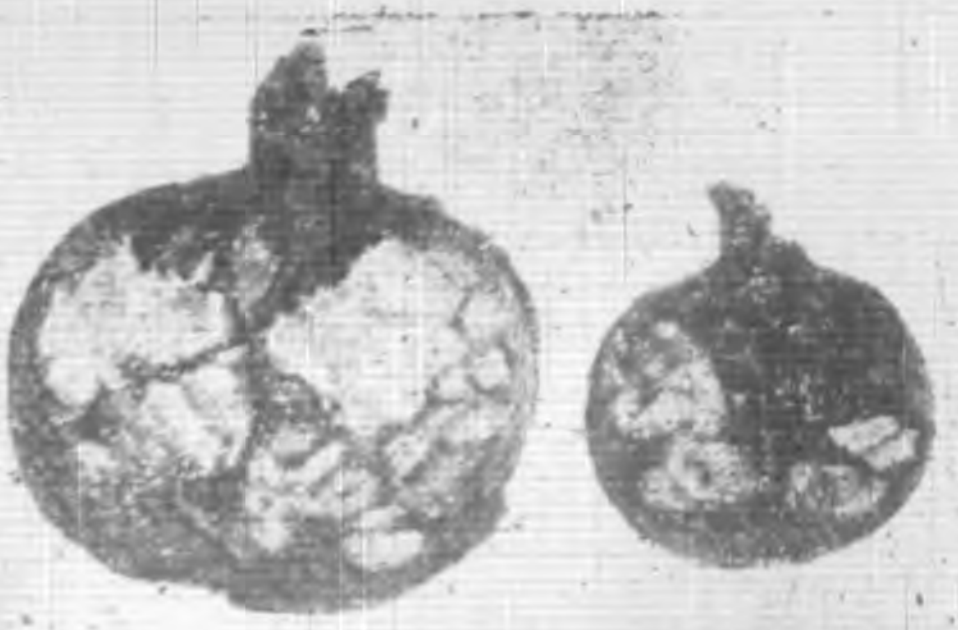

Fig 2. Sections of diseased fruits

Fig. 3. Seeds of pomegranate fruit covered with many pycnidia

Fig. 4 Protruding ostiole of the pycnidium

Plate III

Fig 1 Section through a perithecium of *Nectriella Versoniana.* *with a lateral beak*

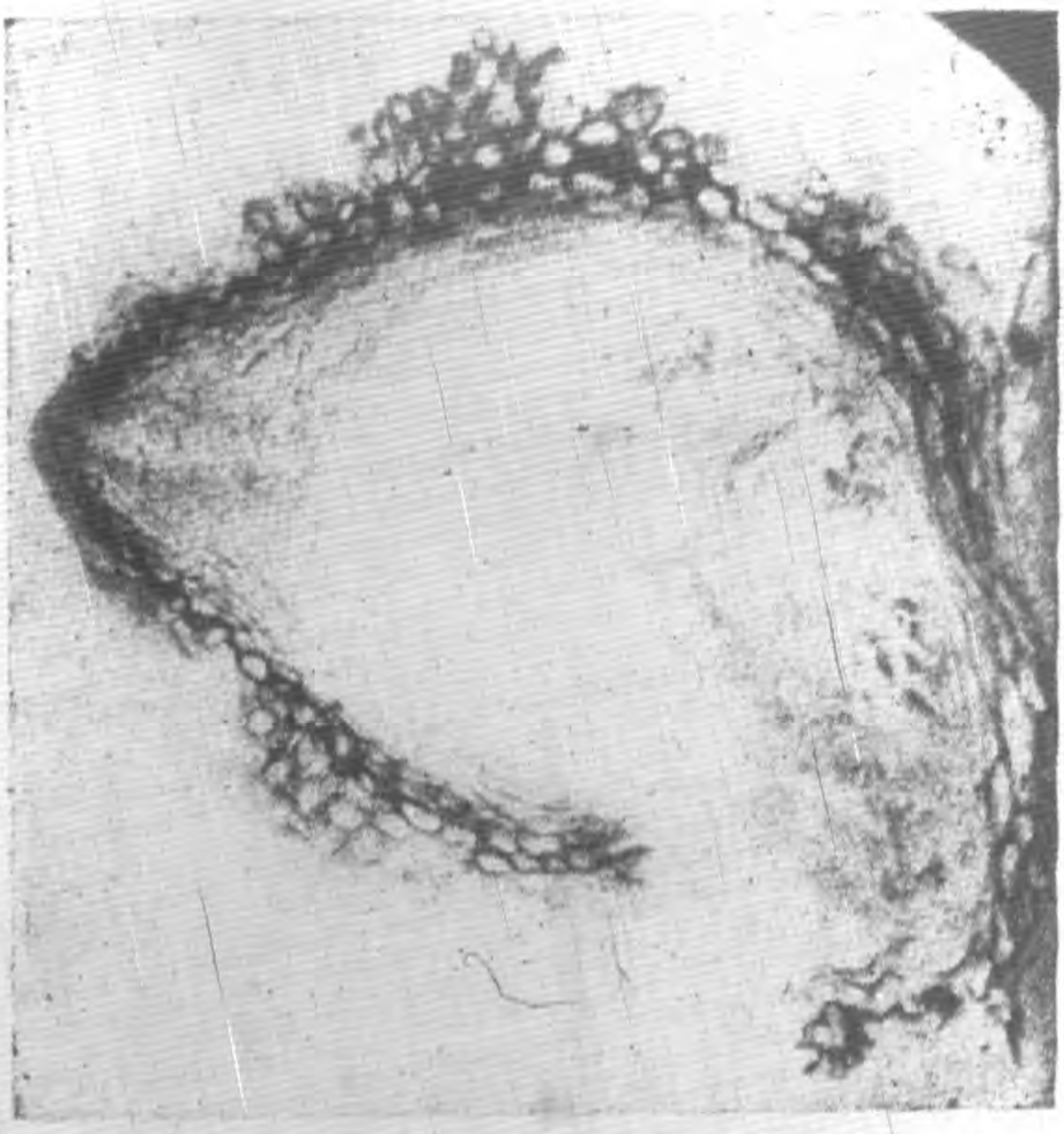

Fig. 2 Section through a Perithecium of *Nectriella Versoniana*

Plate II

Fig 1 Section through a pycnidium of *Zpthia Versoniana.*

Fig 2 Pycnidiospores of *Zpthia Versoniana.*

Fig. 3 Asci of *Nectriella Versoniana.*

Fig. 4 Germination of spores in medium with a bit of the pericarp of the pomegranate added.

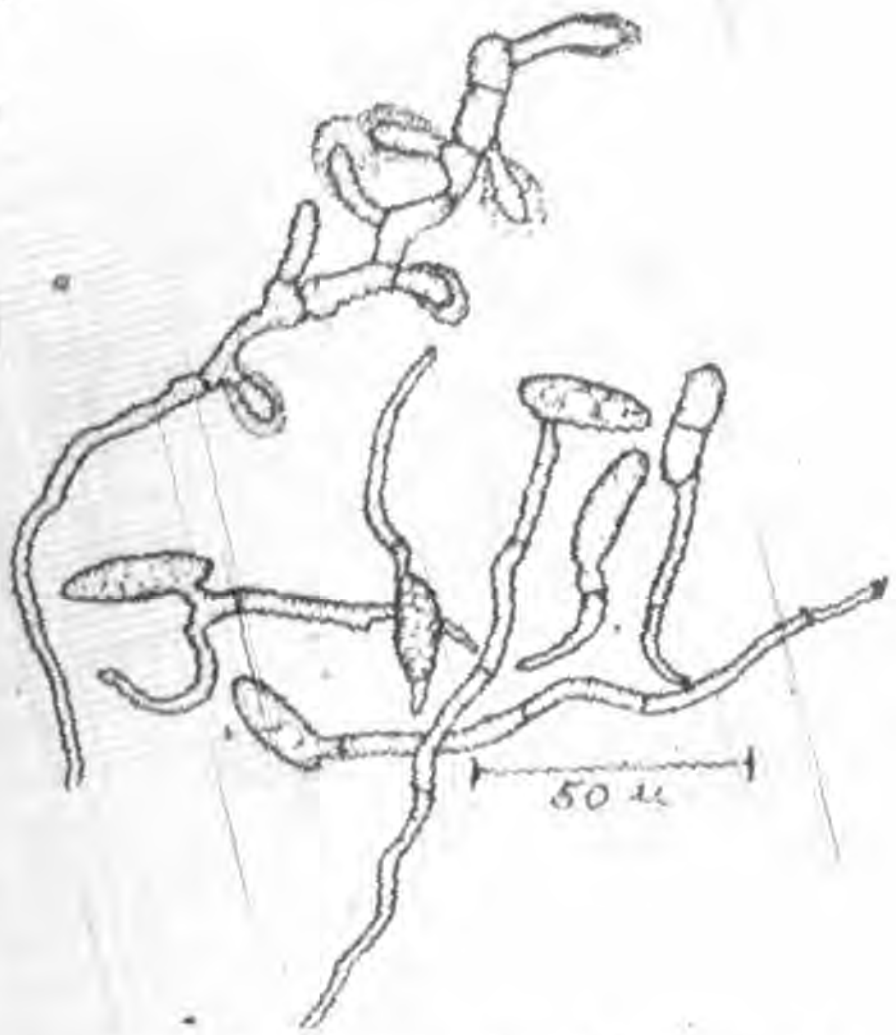

Fig. 5 Germination of spores in potato dextrose and tip of young hyphae

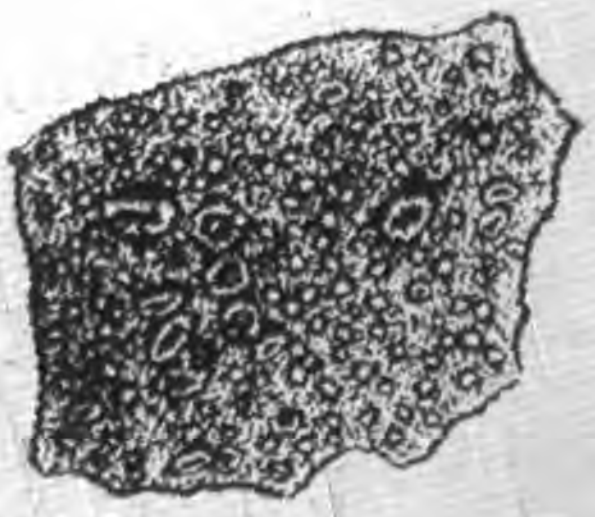

Fig. 6 Perithecia of *Nectriella Versoniana* to the naked eye

石榴乾腐病

戴芳瀾　　周家熾

提　要

此病每年在南京一帶爲害甚烈，病徵發現於花，果實及果梗，在石榴花開時卽發現，花托幼果被害特甚，最初花瓣被侵，變褐色，病部下延至花萼，更蔓延而使全花托成褐色，數日後褐色部發生甚多小形粒狀物，此卽病原菌之分生胞子器，被害果實逐漸乾枯，留掛枝頭，果梗亦有被害者，受害部發生分生胞子器。

此病之病原菌與 *Zythia versoniana* Sacc. 極類似。另一有性世代之菌則與 *Nectriella versoniana* Sacc. & Penz, 極類似，前二菌昔人認爲一種菌之二世代，其關係雖曾試行確定，因種種困難，未獲結果。

病原菌之致病性，曾經試驗證明，此菌生長之最適宜之溫度，（氣溫）在攝氏24與28度之間，最低與最高溫度，約在12.5與35度左右。

丹甯（tannin）有增進此菌生長之效能。在含有3%丹甯之培養基中，長生最良。

懸於枝頭之乾果，爲次年之重要病源。乾果上之分生胞子，雖在早春時逐漸失去萌發能力，但在陽曆四月時，乾果之休眠菌絲似重行活動，發生新分生胞子器。

此病在民國二十二年曾用波爾多液試行防治，大爲減輕，試驗時，用石榴六種，其中以玉石子較有抗病性，而粉皮最易感染。

南京金陵大學植物病理研究室

本報第一二八期目錄

本會第十七屆年會論文專號

論文

紀事

本期定價每册大洋五角

A PRELIMINARY STUDY ON BACTERIAL SOFT ROT OF BRASSICA PEKINENSIS AND OTHER VEGETABLES IN CHINA[1][2]

L. Hwang

Bacterial soft-rot is one of the most common and wide spreading diseases of vegetables. Some strains of bacteria cause soft rot in fleshy vegetables and others in ordinary herbaceous plants. They attack especially the fleshy stems, roots, fruits, and other parts of the plants that consist largely of succulent parenchymatous tissue. There is no data indicating the actual loss due to the disease, available in this country but a survey made in the fall of 1930 showed its destructiveness To vegetable crops here at Nanking. In 1929, about 10% percent of *Brassica pekinensis Rupr* (Shantung cabbage), a common vegetable in China, was lost due to the occurrence of the organism in the farmers' fields. In the University Garden, heavy loss of cabbage was recorded in the spring of 1932. This disease is of great economic importance in this part of China, not only in the field, but also in storage and during transportation.

The causal organisms of bacterial soft rot have been described by Jones (5) as *Bacillus carotovorus*, and by Townsend (22) as *B. aroidcae*. Recently it was reported that some vegetables were affected by the former and some by the latter. A preliminary study of the disease was therefore undertaken with the hope of determining which of the causal organisms of bacterial soft rot is responsible for the disease in China.

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(1) This work was done during the period from the fall of the 1930 to spring of 1934.

(2) Contribution No. 27 from the Plant Pathology Laboratory, Botany Dept., University of Nanking, Nanking, China.

REVIEW OF LITERATURE

In 1896, C. F. Stewart (5) in New York made successful inoculation experiments using bacteria isolated from diseased cabbage and produced the soft rot as it appeared in cabbage fields. Later on, he determined experimentally that a destructive soft rot could be produced under proper conditions by the inoculation of a pure culture. In 1898, L. R. Jones (5) isolated an organism which produced soft rot in carrots and other vegetables. It was described by him in 1901 under the name of *Bacillus carotovorus*. In the summer of 1899, he also proved that the soft rot of cabbage was a disease closely allied to carrot rot. In 1902 van Hall (16) in Holland described an organism which he isolated from iris bulbs under the name *Bacillus omnivorus*. At the same time, Harrison (16) described *Bacillus oleraceae* as a cause of soft rot in cauliflower and related plants. Townsend (22) in 1904 published a description of a soft rot organism found in calla lily, which he named *Bacillus aroideae*. Giddings (4) published a paper on a bacterial soft rot of muskmelon and named the organism *Bacillus melonis* in 1910. This organism was found not only destructive to muskmelons but also capable of producing rot in some other plants.

In 1909, Harding and Morse (5) made the first comparative studies of the soft rot organisms. Their studies included four species namely: *Bacillus carotovorus* Jones, *B. oleraceae* Harrison, *B.omnivorus* van Hall, and *B. aroideae* Townsend. Thirty nine additional strains were isolated from various soft rot hosts, such as cabbage, cauliflower and turnip. All these 43 strains were alike in the 38 classificatory features studied, except in their manner of common sugar fermentations. They were classified in three groups. The first group, including *Bacillus carotovorus*, *B. oleraceae*, *B. omnivorus* and 30 unnamed strains, showed the production of acid and gas during the fermentation of dextrose, saccharose and lactose. The second group, which showed the characteristic of acid fermentation of these three sugars

without gas formation, included *Bacillus aroideae* and three unnamed strains. The third group which included six other unnamed strains, was just intermediate between the above two groups and varied in the fermentation of these sugars, some with acid and gas production from one sugar and others from two. This difference was not, however, sufficient to classify them as distinct species, and a study of the pathogenicity of these cultures was needed. Harding and Morse (13) questioned *Bacillus carotovorus* and *B. aroideae* being distinct species, and they recognized that their pathogenic behavior might separate them more distinctly.

Sherbakoff (19) in 1916 proved that soft rot of pepper fruit was caused by *B. carotovorus*.

Smith (20) in 1920 thought that *B. aroideae* and *B. melonis* were identical.

In 1923, Richardson (18) reported that he had isolated 36 organisms from soft rot of iris from various sources and their pathogenicity was proved by inoculation. Among them two of the isolated organisms which reacted in a similar manner, appeared to be forms of *Bacillus carotovorus*.

In 1924 Wingard (24) proved that bacterial soft rot of tomato was caused by *B. aroideae* and that the disease was responsible for severe losses in Virginia. In the same year Massey (13) published a paper showing that a bacterial soft rot of tomato was caused by *Bacillus aroideae*, and made comparative studies of *B. aroideae* and *B. carotovorus*. The studies indicated that these two forms were closely related, but they might be readily differentiated by laboratory cultures and pathogenicity or by a combination of the two.

Lacey (8) in 1926 published a paper reporting that three species of *Bacillus* had been isolated from various hosts, and made cultural, pathological, and serological tests, showing that a close relationship existed between the three species, *B. carotovorus*, *B. solanisaprus*, and *B. phytophthorus*, and that they could be differentiated culturally.

Ciferri (2) in 1927, after inoculating with a strain of *B. carotovorus* which was isolated from rotted rhizomes of yautia *(Xanthosoma sagittifolium Schott.)*. concluded that *B. carotovorus* and *B. aroideae* might be identical.

Link and Taliaferro (11) in 1928 reported that *B. aroideae* and *B. carotovorus* were found to be closely related serologically, but the existence in each of specific antigens was considered sufficient justification to retain them as distinct species.

In 1930 Johnson (6) reported that cabbage maggot was often associated with the soft rot of cabbage and other vegetables, and that the control of the cabbage maggot should be considered in planning measures of controlling the soft rot of cruciferous plants. In the same year Leach (9) published a paper concluding that blackleg was simply a form of soft rot of potato and was caused by a strain of *B. carotovorus*.

Johnson and Valleau (7) in 1931 found that soft rot of potatees and carrots was produced by the tobacco blackleg pathogen which was considered to be identical with *B. aroideae*. In the same year Leach (10) regarded the causal organism of blackleg disease of potatoes as identical with *B. carotovorus*. and from a comparative study of allied organisms, *B. oleraceae*, *B. omnivorus* and *B. apiovorus* were found to be synonymous with *B. carotovorus*. Matsumoto and Okabe (14) in 1931 reported that a bacterial rot of an orchid *(Phalaenopsis aphrodite, Reichb.)* was caused by *B. carotovorus* type B. In the same year Matsumoto and Somazawa (15) reported that the soft rot of peh-tsai *(Brassica pekinensis)* was caused by a *Bacillus* which was morphologically similar to *B. aroideae*, and that some soft rot organisms from various hosts resembled *B. aroideae* and others were similar to *B. carotovorus*.

SYMPTOMS

The first indication of infection is the appearance of watersoaked

translucent areas. Later, it progresses into a soft mushy or slimy rot but the epidermis remains intact. Color changes vary from gray clay-like to brown, or black accompanied by a disagreeable odor. On cabbage and other crucifers, the rot frequently begins just below the head, causing a wilting of the outer leaves (Figure 1), and finally the rotting of the stem. Then the head falls off, or may easily be pushed over, leaving a stump, thus the name "Stump rot." Both stump rot and ordinary rot occur most frequently in the spring when the plants approach maturity. When rot takes place on the mother seed plant, the floral stalk wilts and dies. The rot under field conditions begins first in or on the base of the older leaves and then invades the center of the head. After reaching the head, the entire head gradually becomes a mass of rotten tissue with the core completely decayed (Figure 2). The rot occurring in storage is similar to that in the field. In an advanced stage of infection, though the epidermis in many cases remains intact, the rotten part shrinks and exudes a grayish sap filled with bacteria. The symptoms on various hosts are similar to those on Shantung cabbage (*Brassica pekinensis*). Infection generally comes through the wounds or is brought about by insect transmission, regardless of

Figure 1. Cabbage naturally infected by the rot organism showing the wilting and dropping of outer leaves.

Figure 2. Cabbage head naturally infected by the organism showing the soft rotted appearance at the center.

the parts which are infected.

ISOLATION

The diseased specimens collected from various places in the vicinity of Nanking were isolated in accordance with the following methods. The diseased host was first thoroughly washed with tap water and then sterilized with(1:1000) mercuric chloride.

1. Take a small piece of the slightly infected tissue directly from surface sterilized part and put it into the nutrient agar plate.

2. Select a piece of partially infected tissue from the sterilized part and isolate it by the ordinary dilution method.

3. Take one piece of partly decayed tissue directly from the sterilized part and put it into a tube of nutrient broth.

Twenty-five isolations were made from four different species of rotten *Brassica* from various sources. Based on the physiological and cultural characters and pathogenicity, they fall into two strains.

INOCULATION EXPERIMENTS

The inocula for the experiment consisted of two strains of bacteria. Culture No. 1 was isolated from the rotten Shantung cabbage and culture No. 3 from the rotten stem of cauliflower. The inoculation experiments were carried on both in the green house and in the laboratory.

I. *Green house experiments*

Plants to be inoculated were grown in pots. They were inoculated by puncturing the stem just above the soil surface with a sterile needle. By means of a sterile pipette, 24-hour old beef culture was introduced into the punctures. The results of the experiments made during March, April, and May 1931 were as follows:

Cabbage: After seedlings were inoculated with cultures No. 1 and No. 3, one set of each was placed in a moist chamber in the green house while a second set was left in the green house.

Five to seven days after inoculation, the seedlings inoculated with No. 3 gave no signs of disease while those with No. 1 showed discoloration and soft-rot around the needle puncture. The results were similar in both sets despite slightly different conditions.

Brassica chinensis, L. (Peh Kan Tsai), a kind of Chinese cabbage: Both young seedlings and old plants were used for inoculation throughout this experiment. Six days after inoculation, there was a slight appearance of discoloration near the root but without any further decay in the first experiment. In the second experiment all plants showed rotten areas around the needle puncture and the plants died ten days after inoculation except those inoculated with culture No.3.

Brassica narinosa, Bailey (Piao Er Tsai), another kindof Chinese cabbage: Six days after it was inoculated with culture No. 3, the seedlings were rotten around the needle puncture near the root. They did not however, show any signs of discoloration and decay with culture No. 1.

Iris: Several days after the green leaf was inoculated with culture No. 3, a very slight discoloration and decay appeared. When placed in a moist chamber, there was a general breaking down of the leaf tissues around the needle puncture. In a severe case the leaves were bent down and died seven days after inoculation. Inoculation with culture No. 1 did not cause any signs of the disease.

Hyacinth: The bulbs after inoculation were put immediately into a moist chamber in order to secure a high humidity. Two days after inoculation with the cultures mentioned above, sap was given off from the puncture. Ten days later these bulbs were completely decayed and the decay spread to the adjacent leaves.

Day-lily: Two to five days after inoculation with culture No. 1, there was a slight discoloration and decay around the needle puncture and there was a further development of the infected area. With culture No. 3 under similar conditions,no infection took place.

II. *Laboratory experiments*

The materials used for inoculation in the laboratory were secured from the market and the University Garden.

1. *General method:* This method had been used by Jones and is now generally used in studying wound parasites. The whole material was thoroughly cleaned, sterilized, and put into a moist chamber and then inoculated by puncturing with a sterile needle. The size of the moist chamber varied with the material used. Each experiment should have several replications and checks. The results of this experiment will be given in Table I: Twenty-two inoculations with culture No. 1 for each host showed that the small round radish and green pepper fruit required the shortest time for complete decay, while carrot, onion bulb, Shantung cabbage (*Figure 3*) and parsnip required the longest time for complete decay. No infection was

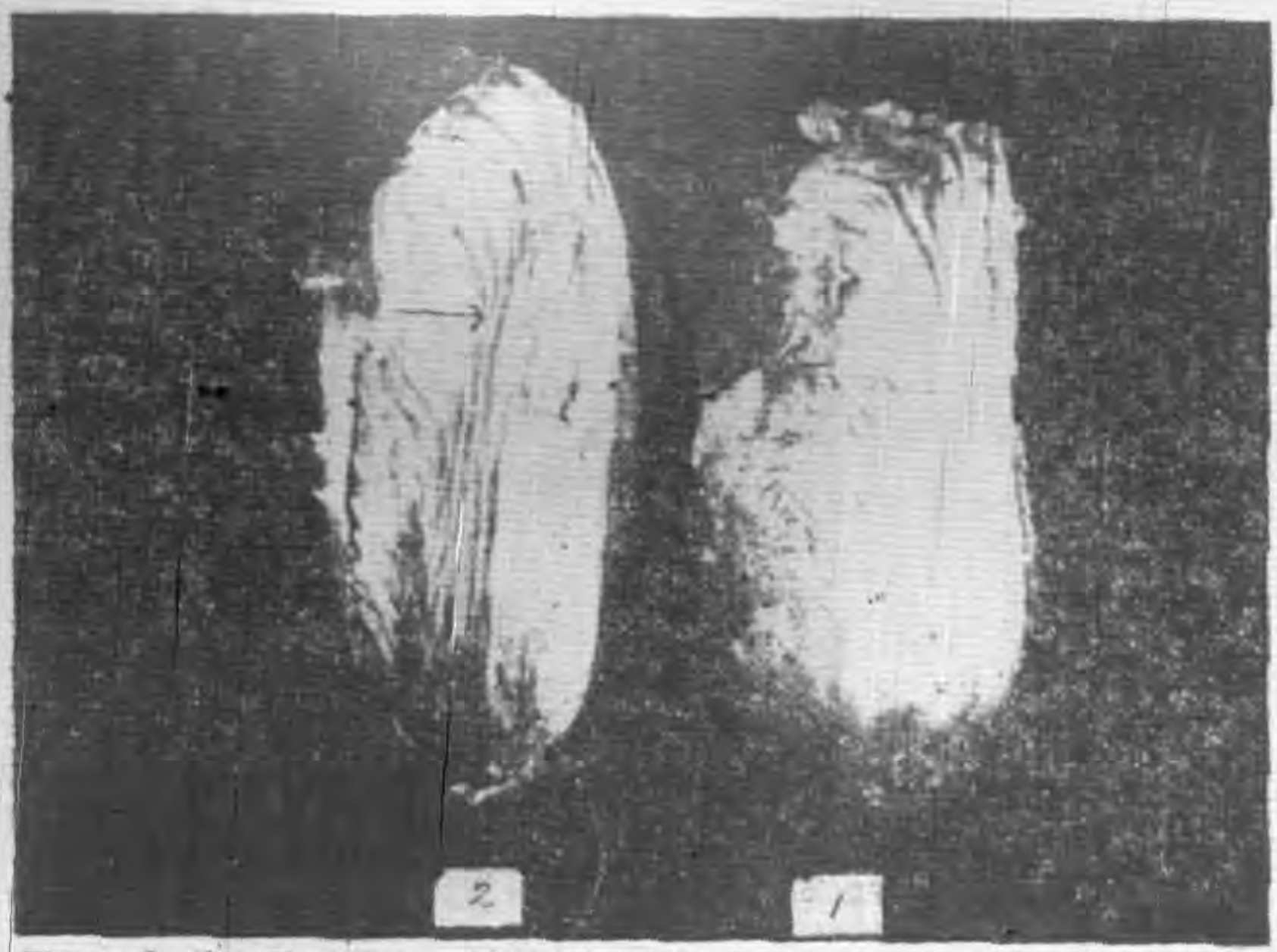

Figure 3. (2), Shantung cabbage inoculated with the organism by needle-pricks (culture No. 1), showing the water-soaked appearance and discoloration along the veins, (1), check punctured with sterile needle, entirely sound.

Table I. Results of inoculation of soft rot organisms

(Experiments were made in moist chambers in the laboratory at 20-25°C. on March, April, May, August and September of 1931; December of 1932; and January, July, August, and September of 1933.)

Host	Culture No. 1		Culture No. 3	
	lst. appearance of disease	days for complete decay	ist. app. of disease	days for complete decay
Apple, fruit	No infection	——	No infection	——
Asparagus lettuce	1 day	7 days	No infection	——
Banana, green	No infection	——	,, ,,	——
Cabbage stump	2 days	——	,, ,,	——
Balsam-pear	3 ,,	——	,, ,,	——
Carrot	1 ,,	13 days	Not significant	——
Beet root	3 ,,	partly decay	No infection	——
Celery	2-7 ,,	,, ,,	Not significant	
Cucumber	1 ,,	11 days	No infection	——
Eggplant	3 ,,	10 ,,	,, ,,	——
Ginger	No infection	——	,, ,,	——
Field pumpkin	,, ,,	——	,, ,,	——
Irish potato, tuber	2 days	——	,, ,,	——
,, ,, young stem	No infection	——	,, ,,	——
Kolhrabi	2 days	7 days	,, ,,	——
Lettuce	2 ,,	——	5 days	——
Muskmelon	1 ,,	5-6 days	No infection	——
Onion bulb	1-2 ,,	13-15 days	Not significant	——
Orange	No infection	——	No infection	——
Oriental pickling melon (Tsai-kua)	No infection	——	,, ,,	——
Parsnip, stem	2 days	14 days	,, ,,	——
pepper fruit, green	1 ,,	3-5 ,,	,, ,,	——
Radish, long red	1 ,,	11-12 days	,, ,,	——
,, red skin	1 ,,	7 days	Not significant	——
,, small round	1 ,,	4-6 ,,	No infection	——
,, white skin	1 ,,	——	Not significant	——
Shantung cabbage	1 ,,	1-2 weeks	,, ,,	——
Sweet potato	3 ,,	——	No infection	——
Tobacco, stem & sucker	No infection	——	,, ,,	——

Tomato, young stem	,, ,,	—	,, ,,	—
Vegetable sponge	,, ,,	—	,, ,,	—
Watermelon	1-2 days	5-6 days	,, ,,	—
Zizania aquatica	No infection	—	,, ,,	—

found to be significant when culture No. 3 was used even when tried twelve times with the same materials under similar conditions.

6. *Townsend's method:* The plant tissue was disinfected in advance and slices were placed in sterile petri dishes; then each slice was cut into four parts aseptically. Two pieces opposite each other were taken as a check and the surface of the remaining two pieces were inoculated with drops of 24-hour old beef broth culture and then these drops were stabbed through with a sterile needle. Cultures No. 1 and No. 3 were used as inocula in this experiment. According to Massey's (13) opinion, there are two objections to this method; (a) "The chances of autolysis of the plant tissue are greatly increased over that of the small wound caused by a needle puncture, hence the bacteria find simpler compounds at hand than those which occur naturally in the tissues"; (b) "The addition of a liquid culture to the wounded surface gives a chance for a saprophyte to appear parasitic since it is possible for the extra cellular enzymes to bring about hydrolysis of the compounds of the tissues". For

(Results of the experiments: January & March, 1931)

Host	Culture No. 1	Culture No, 3
	Days for complete decay	Days for complete decay
Cabbage stump	10 days-partly decay	Not significant
Carrot, root	11 days	,, ,,
Cauliflower stump	9 ,,	,, ,,
Kohlrabi	9 ,,	No infection
Radish, long green	7 ,,	,, ,,
Radish, red skin	7 ,,	,, ,,
Radish, white skin	7 ,,	7 days-partly decayed

these reasons, inoculation experiments of this sort have been made a few times only. The results are tabulated as follows:

Table II. Results of inoculations of floral plants, fruits tobacco and vegetables with soft rot bacteria, in comparison with previous work O=no soft rot developed; + = diseased developed; blank spaces = no report or inoculation not made.

Host	Bacillus carotovorus			B. aroideae		Culture 1	No. 2
	Jones	Smith	Massey	Townsend	Massey	Author	Author
Apple, ripe	O		O	O	O	O	O
Asparagus lettuce						+	O
Balsam-pear						slight	O
Banana, mature	O		O	O	O	O	O
Banana, green			O		O	O	O
Beet root	O		O		+	+	O
Brassica narinosa						O	+
B. chinensis						+	O
Cabbage	+		+	+	+	+	O
Carrot, root	+	+	+	+	+	+	slight
Cauliflower	O		O	+	+	+	O
Celery	+		+	+	+	+	slight
Cucumber		+	+	+	+	+	O
Daffodil						+	O
Day-lily						+	O
Eggplant fruit	+		+	+	+	+	O
Field pumpkin						O	O
Ginger						O	O
Hyacinth			+		+	+	+
Iris, leaf						O	+
Irish potato, tuber	O	+	+	+	+	+	O
,, ,, stem	O		O		O	O	O
Kohlrabi			O		+	+	O
Lettuce		+	+			+	+
Muskmelon		+	+	+	+	+	O
Oriental pickling melon (Tsai-kua)						+	O
Onion bulb	+		+	+	+	+	slight

Onion young leaf	+		○	○	○	○	○
Orange, ripe						○	○
Parsnip	+		+	+	+	+	○
Pepper, fruit	+		+	+	+	+	○
Pieplant				+			
Radishes	+		+	+	+	+	slight
Salsify	+		+	+	+		
Shantung cabbage						+	+
Sweet potato, tuber	○		○		+	+	○
Tobacco, stem			○		+	○	○
,, sucker			○		+	○	○
Tomato, fruit	+		+	+	+	+	○
Tomato young stem	○		○	○	○	○	○
Turnip, root	+		+	+	+		
Vegetable sponge						○	○
Watermelon						+	○
White gourd						+	○
Zizania aquatica						○	○

According to the above results, culture No. 13 in most cases is not pathogenic.

In addition to the above experiments, a number of inoculations were made in the plants for the purpose of comparison. The results, which were shown in Table II, were similar to those which had been reported by previous investigators.

HOST RANGE

In 1901, L. R. Jones (13) reported the results of inoculation of twenty kinds of hosts with *Bacillus carotovorus,* and twelve of them were found to be susceptible. In 1904, C. O. Townsend (22) reported that 15 out of 19 kinds of hosts were infected by *B. aroideae* under laboratory conditions. E. F. Smith (13 and 20) in 1920 reported that five different hosts inoculated with *B. carotovorus* showed the disease. In 1924, A. B. Massey (13) reported the results of inoculation with three organisms. Eighteen out of 34 different hosts inoculated with *B. carotovorus,* were rotten; 23 out of 33 different hosts inocu-

lated with *B. aroideae* were found to be infected; and 21 out of 32 different hosts inoculated with tomato strain were susceptible. The writer conducted this experiment from the fall of 1930 to 1933. Forty kinds of hosts were inoculated both in the green house and in the laboratory and 29 of them were found to be infected. These 29 hosts were distributed in eight families namely: *Cruciferae, Umbelliferae, Cucurbitaceae, Compositae, Liliaceae, Solanaceae, Convolvulaceae* and *Chenopodiaceae.* The results obtained by previous workers and by the writer are summarized in Table II.

CAUSAL ORGANISM

I. MORPHOLOGY

The morphological characters of the organisms were studied in one to two-dayold nutrient broth and agar cultures (cultures No. 1 and No. 3).

1. *Form.* A short, nearly round rod, occasionally long, with rounded ends and occurring generally as a single cell, sometimes in short chains of two or rarely in long chains.

2. *Size.* Organism from a 24-hour old beef-broth culture at about 23°C. and stained with carbol-fuchsin or gentian violet. Culture No. 1 measured from 0.5-0.9 μ in width and 1.1-3.5 μ in length, average 0.8 by 2.2μ. The average size of culture No. 3 was 1.0 by 2.4 μ. The sizes of the bacteria computed by various workers and the writer are tabulated in Table III.

3. *Staining reaction.* Gram negative. Stained readily with the usual bacterial stains.

4. *Endospores.* No endospores found in artificial media or in the diseased tissue.

5. *Flagella.* Organism from nutrient broth or agar slant cultures 16-18 hours old stained by Loeffler's or Moore's (21) method. Peritrichic flagella not distinctly visible in prepared slides.

6. *Capsules.* No capsules found.

Table III. Comparative size of bacteria.

Name	Width	Length	Age and kinds of media
Gidding's *B. melonis*	0.5-0.8 μ	0.9-1.5 μ	36 hrs. in broth or agar
Harding & Morse *B. carotovorns*	0.7-1.0 μ	1.5-5.0 μ	1-3 days in agar slope
Townsend's *B. aroideae*	0.5 μ	2.0-3.0 μ	24 hrs. in beef broth
Writer's Culture No. 1	0.5-0.9 μ	1.1-3.5 μ	24 hrs. in beef broth
Writer's Culture No. 3	0.8-1.1 μ	1.6-5.5 μ	24 hrs. in beef broth

7. *Involution forms*. Absence of involution forms.

II. PHYSIOLOGY

The cultural and physiological characters of cultures No. 1 and No. 3 were quite similar in most media and treatments. They are given under the same description unless there are some differences between them. Their differences are described separately.

A. *Cultural characters*. Cultures No. 1 and No. 3 were used throughout this experiment.

1. *Nutrient broth* (A. P. H. A. 1925)+15 Fuller's scale. Six to twenty hours after transferring, a moderate to strong clouding with a slight ring formation and a small amount of sediment were noted but no pellicle was seen in culture No. 1 tubes. A similar result was obtained but with a heavy pellicle in No. 3 tubes.

2. *Nutrient agar* (A. P. H. A 1925)+15 Fuller's scale. It consists of:

(a) *Agar slant*. The growth, distinctly visible within twenty-four hours at 20-25°C., was filiform to spreading. It was raised, wet-shining, smooth and of a white or opaque to opalescent color.

(b) *Agar stab*. After twenty-four hours incubation at 25°C.,

a filiform growth along the line of puncture, and a convex layer on the agar were observed.

(c) *Agar plates*. The growth was rather rapid within the first 24 hours. Generally the surface colonies were round with a wet-shining white to slightly opalescent color. The surface was smooth, elevation raised to convex, the edge entire, and the internal structure granular. The buried colonies were fusiform or round in shape, and much smaller than the surface colonies. (Figure 4)

(d) *Litmus lactose agar*. Two sets of experiments were made. The first set was transferred to the ordinary agar stab. Four days to one week after the transfer, the color was entirely bleached. The second set was an ordinary agar slant. Three days later, it was entirely bleached.

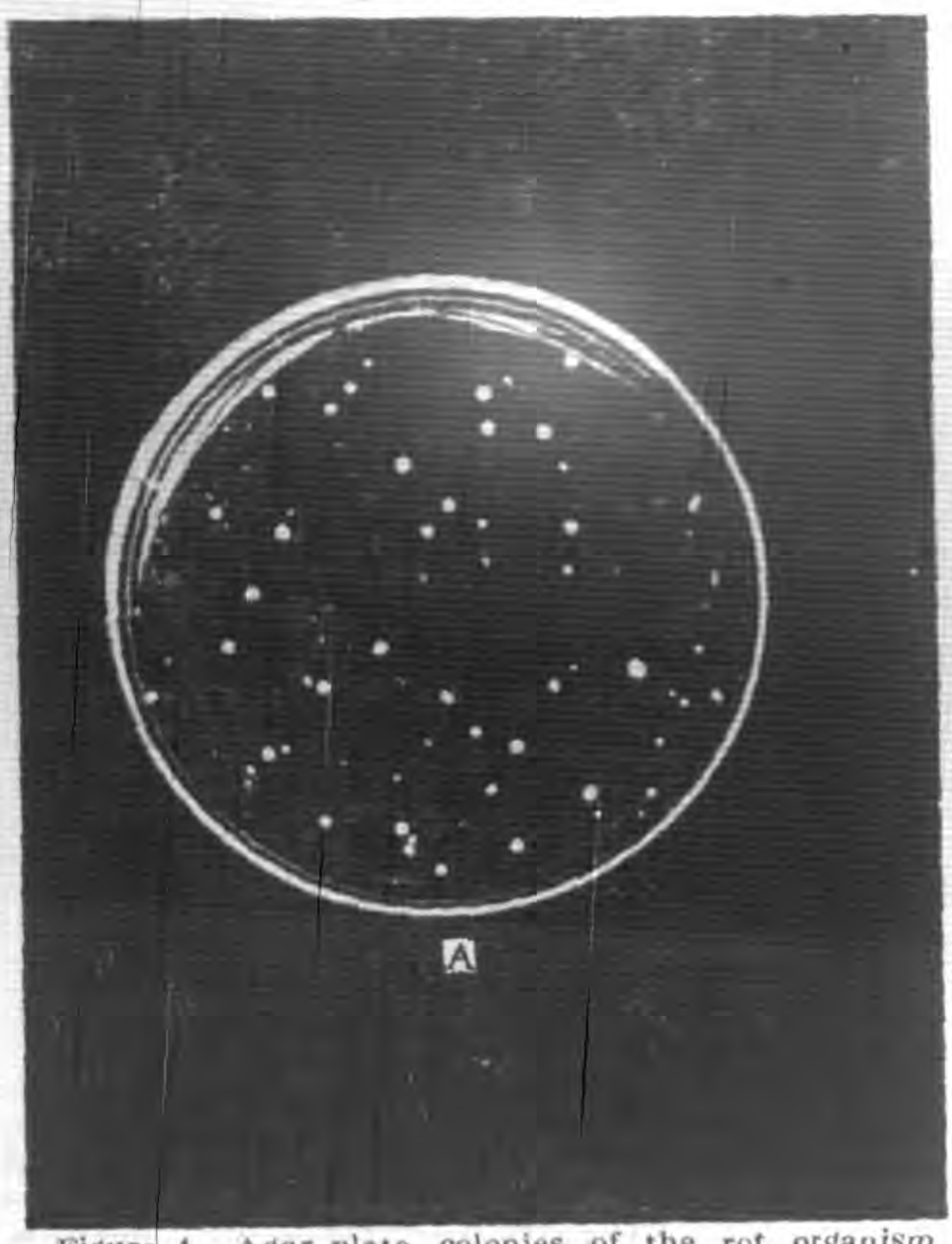

Figure 4. Agar plate colonies of the rot organism (culture No. 1) two days old at 25°C., then kept for 5 days at about 10°C. showing both surface and buried colonies.

3. *Gelatin:*

(a) *Gelatin plates*

Growth was apparent within twenty-four hours at 18-20°C. The forms of the colonies were punctiform to round with an entire edge at first. A few hours later, liquefaction began in the form of a saucer, the edges at this time being floccose.

(b) *Gelatin stab.* This growth was also apparent within twenty-four hours at 18-20°C., and was best at the top and filiform along the line of puncture. Liquefaction began on the second day. The liquefaction was crateriform to infundibuliform.

4. *Litmus milk.* It coagulated within five days after inoculation at 25°C. Two to three days after inoculation, the litmus was reduced, and 5 days later the medium was entirely changed to a reddish color.

5. *Fermentation broths.* These were prepared by using the standard nutrient broth plus 2% sugars in Smith's fermentation tubes. After sterilizing, each set of the experiment was inoculated with 24-hour old beef broth cultures of the organisms. Then the tubes were placed in two incubators at 25°C. and 30°C. The results are shown in Table IV. The details of each trial might be stated as follows:

(a) *Saccharose broth.* The growth was more rapid at 30°C. than at 25°C. Twenty-four hours after transferring, a very good growth was found in the open arm and a slight growth in the closed arm. There was acid aud no gas produced in culture No. 1 tubes while with culture No. 3 slight gas and acid were produced within twenty hours at 30°C.

(b) *Maltose broth.* The growth was similar to that in saccharose but more gas was produced in the case of culture No. 3.

(c) *Lactose broth.* The growth was quite similar to that in saccharose but no acid was produced in the case of culture No. 3.

(d) *Glucose broth.* The growth was similar to that in saccharose but with a smaller amount of gas produced by culture No. 3

(e) *Mannite broth.* The growth was somewhat similar to that in saccharose but the growth between closed and open arms was slightly different, i. e. the growth in the closed arm was much more abundant than in other broths, and more gas was produced than in saccharose at 25°C.

(f) *Glycerine broth.* The growth was very similar to that in

saccharose except that more gas was produced in culture No. 3.

(g) *Urea broth*. There was nearly no growth in the closed arm, but growth in the open arm occurred as in other cases. Neither gas nor acid was produced by either culture No. 1 or No. 3.

6. *Milk in fermentation tubes*. Skimmed milk was placed in Smith's fermentation tubes and treated in the same manner as the fermentation broths. Five days after inoculation, the milk in all tubes, except the checks coagulated. Abundant gas and acid were produced in culture No. 1 but without gas in No. 3 at 25°C. and 30°C.

Table IV. The results of gas and acid fermentation given by previous workers and the writer (Experiments made in January, April, and May, 1931).

	B. carotovorus				B. aroideae		B. melonis		Cult. 1		Cult. 3	
	Gas		acid		Gas	acid	Gas	acid	Gas	acid	Gas	acid
	Jones	Smith	Jones	Smith	Townsend		Giddings		Writer		Writer	
Glucose	+	+	+	+	○	+	○	+	○	+	+	+
Glycerine	○	○	+	+	○	+	○	+	○	+	+	+
Lactose	+	+	+	+	○	+	○	+	○	+	+	base
Maltose					○	+	○	+	○	+	+	base
Mannite	+	+	+	+	○	+	○	+	○	+	+	+
Saccharose	+	+	+	+	○	+	○	+	○	base	+	+
Urĕa							○	+	○		○	base
Milk	○	○	+	+	+	+	+	+	+	+	○	+

According to the above table, culture No. 1 was identical with *B. aroideae* and *B. melonis*, while culture No. 3 was similar to *B. carotovorus*.

7. *Fermi's solution*. Slight growth appeared on the following day but it was quite covered with a pellicle three days after inoculation at 25° C.

8. Cohn's solution. No growth was found in any culture.

9. Alcoholic broth. (pH 7.2) Six days after inoculation with culture No. 1, there was slight growth but without acid and pellicles in 5% alcoholic broth, while that with culture No. 3 showed abundant

growth, pellicles and acid (pH 5.9) formation. However, there was neither growth nor acid in 8% and 10% alcoholic broths within two weeks. The results agreed with those reported by Massey (13).

10. *Dunham's solution with 1% Methylene blue.* This consisted of two preparations:

(a) *Without glucose.* One to two days after transferring, the color of the medium became very light blue, but after shaking the original color was restored:

(b) *With 1% glucose.* Five days after transferring, the color of the solution became Benzol green (Ridgway), while the check tubes retained the original color (Italian blue). The green color of the inoculated tubes could not be restored by shaking.

11. *Dunham's solution.* Two days after transferring, the solution became turbid with a pellicle and slight sediment.

12. *Uschinsky's asparagin medium (Giltner).* Twenty-four hours after inoculation, good growth appeared in the two cultures at 25° C. A pellicle was produced in culture No. 3 tubes but none in the case of culture No. 1. However, pellicle formation was found in all cultures at the end of one to two weeks.

13. *Cooked potato.* Twenty-four hours after inoculation there was moderate filiform growth which was slightly effused. It was creamy yellow in color and the odor of the inoculated potato was decided and disagreeable.

B. Physiological characters. Cultures No. 1 and No. 3 were used as the inocula in the following experiments.

1. *Gas and acid production.* Cultures were made in Smith's fermentation tubes of nutrient broth containing different kinds of carbohydrates as has been stated under the topic of fermentation broths. The tubes were under observation for three weeks. Acid was formed in most of these sugar broths, except urea which produced alkali, and no gas was produced in any of the tubes inoculated with culture No. 1 but gas and acid were produced in milk tubes. In those tubes

inoculated with culture No. 3 gas and acid were produced in most of the sugar broths but no gas was produced in urea and in milk. The results are shown in Table IV.

2. *Indol production.* Cultures were made in Dunham's solution and put in the incubator at 25-30° C. Four to fifteen days after inoculation, the cultures were tested for indol. Negative results were obtained at the end of 15 days.

3. *Nitrate reduction.* Nitrate broth cultures were inoculated with these organisms and then incubated at 24-30° C. Two to five days after inoculation the cultures were tested by placing several drops of nitrite test reagents A and B in each tube. In the tubes inoculated with culture No. 1, abundant nitrite was produced at the end of two days and seemed to increase steadily. Slight nitrite was produced in culture No. 3 within 15 days. The tubes were tested in the same manner but gave no nitrite production. This indicated that the nitrates in the broth were reduced to nitrites by the growth of the organisms.

4. *Optimum pH for growth.* A series of nutrient broths ranged from pH 3.6 to pH 10. The growth appeared within 24 hours at 25° and 30° C. in pH 4.25 to 9.7. Growth was best in pH 6.3 to 8.35, weak in pH 5.75 and in 8.5, and very weak in pH 4.25 and in 9.7. At the end of one week, growth appeared in pH 10. In comparing these with Quirk and Fawcett's (17) results, - "the greatest degree of acidity tolerated by any organism tested wast+44 Fuller's scale (pH 4.3) in *Bacillus* sp. from iris and *Bacterium marginatum*, and the greatest degree of alkalinity was−22 Fuller's scale (pH 9.4) in *B. aroideae, B. apiovorus, B. carotovorus and Bacterium malvacearum*",- the range of pH value for the growth of the organisms was slightly different, namely from pH 4.25 to 9.70.

5. *Temperature relations:*

(a) *Thermal death point.* This was interpreted to be the high temperature at which the life of the organism would be destroyed when

a young culture was exposed to that temperature for 10 minutes. Nutrient broths incculated with 24-hour old cultures were used. The results showed that the thermal death point of culture No. 1 was 51° C. which was slightly different from that of Townsend's (22); while that of culture No. 3 was 50° C.

(b) *Optimum temperature.* Fresh cultures of nutrient broth and agar were inoculated with 24-hour old cultures and placed in incubators of 21-22° C., 24-25° C., 29° C., 30-31° C., 33° C., 35°C., and 37.5°C., respectively. The results showed that the growth appeared in 5-6 hours at 29°C., 30-31°C., 33°C., and 35°C.; growth began in 7-8 hours at 21-22°C. and 24-25°C.; and very slight growth within 24 hours at 37.5°C. Therefore the optimum temperature was 29-35° C. which was quite close to the temperature at which *B. aroideae* grows best, as reported by Brierley (1)

(c) *Minimum temperature.* After the fresh cultures were made, they were placed in a ice box regulated at 1-3°C. and at 4-6°C. Two and half days after inoculation slight growth appeared in broth cultures No. 1 and No. 3 at 4-6°C., while at 2-3°C. very slight growth was found in culture No. 1 at the end of six days. The result was quite similar to that for *B. carotovorus* as shown by Brierley (1).

(d) *Maximum temperature.* The fresh cultures were inoculated in the manner described under optimum temperature. Then they were placed in the incubators at 38°C., 39°C., 40°C., 41°C., 42°C., 43°C., 44°C., and 47°C. Slight growth appeared at 39°C. within 10 hours and no growth above 39°C.

6. *Direct sunlight.* Agar cultures were poured into petri dishes. One-half of each dish was covered with black paper and then exposed to the direct sunlight at mid-day in January. Some of the dishes were removed from the direct sunlight at the end of 5, 10, 15, 30, 60 minutes, one and half hours and 2 hours. These dishes were then incubated at 25°C. In those dishes which were exposed for 5 and 10 minutes, colonies were found within 20 hours, while in those exposed

for 15 minutes, only a few colonies were formed. In the rest of the dishes exposed from 30 minutes to two days, no colony appeared within 20 hours, but 48 hours later most of them showed growth along the edge of the plate.

7. *Growth over chloroform.* Cultures were made in 5% chloroform in nutrient broth and kept at 25°C. There was a very slight growth in 24 hours but abundant growth in 48 hours. This meant that chloroform had a slight effect on the growth of the organism.

8. *Toleration:*

(a) *Hydrochloric acid in nutrient broths* having reactions of +10, +15, +20, +25, and +30. Twenty-four hours after inoculation moderate growth was visible in the broths having reactions of +10, +15 and +20 but none in the other two.

(b) *Oxalic acid.* Nutrient broth was acidified to +45, +47, and +52. There was no growth in any of the reactions until three days after inoculation.

(c) *Sodium hydroxide.* Nutrient broths having reactions of −6, −7, −10, −11, −15, −18, −20, −25, −30, −35 were made. Twenty-four hours after inoculation abundant growth was formed in −6 broth, moderate growth in −7 and −10 broths. Slight growth appeared in the broths having reactions of −11, −15 and −18 in twenty-four hours but moderate growth appeared in −20 and −25 broths two days after inoculation, and the growth was visible in −30 and −35 broths within six days

(d) *Sodium chloride.* Nutrient broths containing 1%, 3%, 6% 8% and 10% were used for the tests. There was abundant growth in 1% and 3% broths in 24 hours but no growth in any other broths containing more than 3% sodium chloride. Seven days later, moderate growth appeared only in broths containing 6% sodium chloride.

9. *Effect of germicides:*

(a) *Phenol.* Ordinary broths containing 0.02%, 0.05%, 0.08%, 0.11%, 0.18% and 0.44% of phenol were tried. The growth was

apparent in the broths containing 0.02%, 0.05% and 0.08% on the third day, but no growth appeared in the broths containing more than 0.08%.

(b) *Formalin.* Broths containing 0.005%, 0.02%, 0.05%, 0.2%, 0.5% and 1% commercial Formalin were used. There was no sign of growth during a period of from one day to several weeks in any of the above dilutions.

10. *Desiccation.* Twenty four hour old nutrient broth cultures were transferred to sterile cover slips with a sterile platinum needle, and put into a sterile petri dish. These were then allowed to dry at a room temperature of about 20°C. For the sake of testing the viability of the organisms under such conditions, two of these cover slips were transferred with sterile forceps to broth tubes at the end of a period of 5 minutes, 30 minutes, 5 hours, 10 hours, 24 hours, 48 hours, 3 days, and one week. Twenty-four hours after transferring, growth was apparent in broths containing cover slips which had been dried from 5 minutes to 24 hours, but none in those dried for 48 hours to 7 days even three days after inoculation.

III. PATHOGENICITY

The pathogenicity of the 25 isolations of the bacteria made from various vegetables affected with soft rot in the vicinity of Nanking was thoroughly tested by inoculation and only one of them was found to be pathogenic, and one weakly pathogenic, as shown in the foregoing paragraphs. Inoculation made with culture No. 1 was shown to be pathogenic, while that with culture No. 3 was weakly pathogenic or in most cases, nonpathogenic.

On account of the close relationship between *B. carotovorus* and *B. aroideae*, Massey (13) in 1924 made comparative studies and accordingly proposed a scheme for differentiation. The scheme may be summarized as follows:

1. *Cultural and fermentation characters:* For *B. aroideae:* agar

colonies in thinly sown plates were amoeboid; fermentation of dextrose, lactose, galactose, saccharose, mannitol, etc. produced acid without gas; action in ethyl alcohol media produced no acid or gas, no pellicle and slight growth. For *B. carotovorus:* agar colonies were round entire: fermentation broths produced acid and gas; in ethyl alcohol media, acid without gas, heavy pellicle and abundant growth were found

2. *Pathogenesis;* In inoculation of calla, kohlrabi, cauliflower and iris. with *B. aroideae*, the first three hosts were found to be rotted and the last one intact. With *B. carotovorus* opposite results were obtained, i.e. positive results on iris and negative results on the remaining three.

Townsend reported that *B. aroideae* produced acid without gas in fermentation broths but produced acid and gas in milk. Jones and Smith showed that *B. carotovorus* produced acid and gas in fermentation broths but acid and no gas in milk. The results have been summarized in Table IV.

According to the data on fermentation characters shown in Table IV, cultures No. 1 and No. 3 gave the same results obtained by previous workers, Referring to the data on alcoholic broths, slight growth, no acid or pellicle were found in culture No. 1 tubes. Inoculations made with culture No. 1 on kohlrabi and cauliflower showed positive results but negative results on *Iris* sp. These results were quite similar to *B. aroideae* as shown by Massey.

Inoculations made with culture No. 3 on kohlrabi, cauliflower, radishes, etc. gave negative results but appeared weakly pathogenic to *Iris* sp. and *Brassica narinosa*. Thus, culture No. 3 was rather similar to *B. carotovorus* culturally and physiologically, but usually it was nonpathogenic. Therefore this culture may not be the cause of the soft rot but is probably a very weak strain of *B. carotovorus*.

By comparing Townsend's (22) original description and Massey's (13) results, it is found that the bacteria isolated from *Brassica pe-*

kinensis (culture No. 1) is probably the bacteria which has been named *Bacillus aroideae* Townsend.

SUMMARY

1. Two very closely related strains of a *Bacillus* have been isolated from *Brassica pekinensis*, Rupr. and other vegetables which were infected by soft rot bacteria in the vicinity of Nanking. One of them has proved to be *Bacillus aroideae* Townsend and the other is a very weak strain of *B. carotovorus* Jones.

2. About 10% loss of *B. pekinensis* was due to this disease in 1929 and heavy loss of cabbage was due to the same disease in 1932.

3. Artificially inoculated, *B. aroideae* infects the following hosts: carrot, radishes, cucumber, parsnip, kohlrabi, pepper fruit, cabbage, balsam-pear, beet root, celery, eggplant, potato, asparagus lettuce, lettuce, muskmelon, onion bulb, oriental pickling melon, sweet potato, vegetable sponge, watermelon, tomato fruit, white gourd, cauliflower, Shantung Cabbage, *Brassica chinen is*, daffodil, day-lily, and hyacinth.

4. Morphological, cultural and physiological characters of the organisms are given in this paper.

ACKNOWLEDGEMENT

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中國結球白菜及其他蔬菜軟腐病之初步研究

提　要

南京金陵大學植物病理研究室

黃　亮

1.南京附近,結球白菜及其他蔬菜軟腐病之病原菌,經作者加以分離後;認爲有二種:其中一種證明係 Bacillus aroideae Townsend;其他則係 B.Carotovorus Jones 致病力甚弱品系之一。

2.民國十八年,南京附近栽種結球白菜區域,受本病侵害之損失約百分之十。民國廿一年,甘藍之受其害者亦甚重。

3.將分離所得之病原菌(B.aroideae),作多次之接種試驗,證明下列各寄主均能受害:胡蘿蔔,各種蘿蔔,黃瓜,蒲芹蘿蔔,球莖甘藍,辣椒之果實,甘藍,苦瓜,紅菜頭,芹菜,茄子,馬鈴薯,萵苣,生菜,香瓜,洋葱頭,菜瓜,甘藷,絲瓜,西瓜,番茄,冬瓜,花椰菜,結球白菜,白梗菜,洋水仙,金針,風信子。

4.本病病原菌之形態,培養及生理特徵均曾詳述。

本 會 記 事

(一)事務所日記摘要

民國二十三年七，八月份

七月二日　覆李秉權葛鴻琛諸先生關於介紹新會員入會手續及應繳會費

三日　函催特約「森林專刊」稿件

五日　安徽省立茶業改良場匯繳機關會費十元當覆函致謝

八日　駐日留學生監督函覆本會關於介紹會員留學有所解釋

十日　河北省農學院孫醒東先生托本會介紹教授數位茲就其所需要專門科學之教授開具名單函徵前途意見

十二日　中山大學農學院院長鄧植儀先生來函報告將代表廣州分會來京出席年會

同　日　第一二五期會報由南京藝新印書館承印

十五日　山西趙嘉禮先生由李秉權會員等介紹請求入會

十六日　開發西北協會在綏遠開年會柬請本會派代表出席。

十七日　本會年會會員減價乘車事本日鐵道部批覆到會准予照辦

十八日　通告出席年會會員一切赴會手續並附發會員證乘車證等件

十九日　發表本會年會消息一則送各報館登載

廿三日　結付上海華豐印刷費洋陸百式拾元

廿四日　發寄第一二三期會報約千餘份

廿五日　結付京華印刷第一二三期費洋一百三十五元

廿六日　南通學院農科函請本會代爲招生當覆函允爲照辦

廿八日　內政部批覆本會關於發行叢書呈請審查事

同　日　領到教育部補助年會經費洋壹百元

三十日　通函會員徵求年會論文

八月一日　呈請教育部派員指導本屆年會

二日　南通李永振先生來函報告代收會費情形

四日　官熙光沈梓培兩先生請求入會

五日　函請新中國農學會會員出席本會年會

同日　呈請南京市黨部派員指導年會

六日　廣州分會來函報告分會最近舉行年會情形並匯到代收會費一批

九日　教育部頒發農業病蟲害進口特許證請求書格式到會令仰遵照

十二日　李啓田程復新兩先生請求入會附繳會費

十五日　教育部批覆到會令派黃司長出席本會年會

十六日　本日起編造本會一來會務概況以備大會時分發各會員

十八日　下午六時在本會開年會籌備委員會議對於年會應行注意事項有所決議

十九日　分函本京各機關略謂本會來京參加年會之各會員將往各該機關參觀

廿一日　重慶分會來函報告籌設分會經過並請備案

同　日　廣西農林局函請加入本會爲機關會員並附繳會費三十元當覆函致謝

廿二日　通告本京出席年會會員關於赴會乘車時間等事

廿四日　本日開理事會議到鄒樹文等十餘理事決議要案甚多(詳見另錄)

同　日　發表年會消息一則分送京內外報館刊登

廿五日　本會第十七屆年會在京假中央農業實驗所舉行本日起開始註冊明日正式大會後日參觀遊覽(詳見本報第一二八期年會大事紀)

(二)本會本年第二屆理事會議決議案紀錄

日　期　民國二十三年八月二十四日

地　點　本會

出席者　湯惠蓀　朱鳳美　鄒樹文(陳方濟代)　唐啓宇　許　璇(劉運籌代)　蔡邦華

錢天鶴　梁　希　胡昌熾　陳方濟　董時進(唐啓宇代)　劉運籌

主　席　劉運籌　　記　錄　湯惠蓀

決議案　(一)許理事長聲請辭理事長案　議決　一致挽留

(二)根據上屆理事會議決案建築冀氏紀念堂一案業已於本京安仁街秋元坊覓定準式

住宅一幢正價言定四千二百元連中用及登記等費約五千元左右是否有當請公決

議決 通過

(三)新會員三十人入會 審查通過

(四)各分會經去函催詢報告會務去後均無回信究應如何辦理請公決 議決 由本會分函各地分會對於各分會情形限期報告來會以資整理如分會中有逾期無報告到會者則由理事會改推地方幹事

(五)民國二十二年份經常費報告業經梁理事審查無誤請予追認案 議決 通過

(六)根據上屆理事會議決案添建廚房一間原交費氏紀念堂建築工程委員會會併辦理今該項紀念堂已在進行購置添建廚房一案究應如何辦理請公決案 議決 建築廚房二間約需二百五十元左右由本會基金項下撥用

(七)重慶分會業經組織成立茲函送會員錄一份請求備案應如何辦理請公決案 議決准予備案但須補送分會章程到會審查

(八)本會預備出版之園藝專號業已編就即可付印惟該期編輯先生意見擬用本會暨中國園藝學會兩名義出版對於紙張擬用道林紙印刷費約需六七百元此事究應如何辦理請公決案 議決 園藝專號仍用本會名義發行紙張照舊惟於會報內須敘明該刊與園藝學會合編園藝學會可另印複本惟於複本內須敘明該刊爲某期中華農學會報之園藝專號其排版費由兩會依比例分配複本印刷及紙張費由園藝學會自行担任

(九)廣西農林局請加入爲本會機關會員案 議決 通過

(十)新中國農學會會員參加年會案 議決 歡迎參加

(十一)本屆年會主席團職務分配如左

1. 開會式 鄒樹文
2. 宣讀論文 梁 希 蔡無忌
3. 報告會務及選舉司選委員 錢天鶴
4. 討論農業問題 譚熙鴻 湯惠蓀 馮澤芳
5. 對各機關公宴發言 劉運籌 董時進

(十二)本屆年會開會秩序單(見本報第一二八期年會大事紀)

(十三)推定陳方濟主持本屆年會文書事宜　議決　通過

(三)會費收入報告

民國二十三年七,八月份

1. 入會費　趙嘉禮　吳德洪　黎燿垣　何　亮　項霖葆　李啓田　官熙光　沈梓培　程復新　盧德明　陳兆騮　梅籍芳　趙雲夢　李順卿　劉凝福　孫仲逸

以上各繳到二十三年入會費二元

2. 常會費　謝　鏞　章恢志　孫祥復　趙嘉禮　鄒則榮　王　業　吳德銘　王烜之　吳德洪　張福達　沈厚和　溫文光　林亮東　關乾甫　黃菩荃　程樹勳　黃體昭　黎耀垣　方繼祥　何　亮　唐熙年　陳頌碩　馮子章　項霖葆　懷桂琛　李啓田　陳煥章　劉　業　程復新　宋鏡寰　盧德明　陳晰昶　孫尚貞　陳兆騮　彭逸羽　周季豪　李寶仁　梅盛琳　夏道湘　張　灝　段兆麟　鄭崇實　陳性元　王正朝　孫文郁　喬啓明　陳啓華　王錫祥　盧守耕　梅籍芳　郝欽銘　周明懿　蔣瑾春　秦　嗣　陳襄伯　沈梓培　官熙光　趙雲夢　單昌祺　周繼先　唐志才　陸費埏　梁　華　邵德馨　李順卿　馮澤芳　羅清生　張　復　顧　復　尹諾鼎　邵德棣　傅志章　吳昌濟　孫仲逸　夏振鐸　鄒景衡　沈霈曜　劉凝福以上各繳到二十三年度常會費三元

王　業　王烜之　利　寅　懷桂琛　胡學文　梅盛琳　鄭崇實　陳性元　孫文郁　喬啓明　郝欽銘　陸費埏　梁　華　俞筠鐫　夏振鐸　沈霈曜　李德毅　毛　鵬　以上各繳到二十二年度常會費三元

楊度春　胡學文　鄭崇實　喬啓明　郝欽銘　梁　華　俞筠鐫　李德毅　葛敬中　以上各繳到二十一年度常會費三元

章恢志　張延年　顧　鎏　邵德棣　葛敬中　以上各繳到二十四年度常會費三元

顧　鎏　繳到二十五年度常會費三元

周明懿　單昌祺　以上各補繳二十二度常會費一元

傅息儒　補繳二十三年度常會費二元　管相桓　先繳二十二年度常會費二元

葛敬中　補繳十九,二十兩年常會費六元

3. 永久會費　黃履陸　譚熙鴻　戴　弘　以上各繳到第一期永久會費二十元

方希立　馮紫崗　吳福楨　毛宗良　以上各繳到第一期永久會費十元

葉元鼎　藍夢九　孫逢吉　以上各繳到第三期永久會費十元

許康祖　繳到第二期永久會費十元

陳　植　繳到第四期永久會費十元

湯錫祥　繳到第二期永久會費二十元

4. 機關會費　安徽省立茶業改良場　繳到二十三年度機關會費十元

河南大學農學院　繳到二十三年度機關會費十元

廣西農林局　繳到二十三年度機關會費三十元

(四)收支報告

民國二十三年七月份

月	日	摘　要	收　方	月	日	摘　要	支　方
7	31	收六月底會計處結存	126,551	7	31	支印刷費	764.500
	,,	收六月底結存南京浙江興業銀行	1489.950		,,	支薪水	77.500
	,,	收入會費	2.000		,,	支酬勞	4.000
	,,	收常年會費	32.000		,,	支紙張	.520
	,,	收永久會費	20.000		,,	支郵電	18.300
	,,	收機關會費	20.000		,,	支書報	.700
	,,	收維持費	44.000		,,	支電話	8.000
	,,	收補助費	100.000		,,	支電燈	5.250
	,,	收售報	67.810		,,	支茶水津貼	6.400
	,,	收廣告費	5.000		,,	支證金發還	1.000
	,,	收雜項	20.304		,,	支雜費	3.845
	,,	總計	1927.615		,,	總計	890.015
				7	31	本月底結存南京浙江興業銀行	749.450
					,,	本月底結存會計處	285.600
					,,	生活書店本月結欠	2.550
			1927.615				1927.615

民國二十三年八月份

月	日	摘　要	收　方	月	日	摘　要	支　方
8	31	收七月底會計處結存	285600	8	31	支印刷費	49250
	,,	收七月底結存南京浙江興業銀行	749450		,,	支薪水	77590
	,,	收入會費	30000		,,	支酬勞	4000
	,,	收常年會費	313000		,,	支文具	4273
	,,	收永久會費	150000		,,	支紙張	6900
	,,	收機關會費	30000		,,	支郵電	17970
	,,	收維持會	29000		,,	支書報	700
	,,	收第十七屆年會費	351000		,,	支電話(未來收)	
	,,	收售報	60500		,,	支電燈	2730
	,,	收廣告費	7000		,,	支開會費	14070
	,,	收雜項	16000		,,	支茶水津貼	4900
	,,	收生活書店匯到代定報費	5150		,,	支裝修	500
	,,	總計	2026700		,,	支年會開支	363533
					,,	支劃存基金	25000
					,,	支津貼分會	18000
					,,	支雜費	19309
					,,	總計	608635
				8	31	本月底結存南京浙江興業銀行	1391450
					,,	本月底結存會計處	26615
			2026700				2026700

(五)收到出版物

民國二十三年七，八月份

本國之部	科　學　(第十八卷六期)	上海中國科學社
	四川農學院院刊(第二期)	成都四川農學院
	進展月刊(第一至三期)	北平進展月刊社

交通雜誌(第二卷八至九期)	南京交通雜誌社
鎭　　蠶　(第十二期)	鎭江女子蠶業學校
江蘇農行月刊(第二至三期)	鎭江農民銀行
中華職業教育社社務月報(二十三年六月份)	上海中華職教社
海　　王　(第二九至三三期)	塘沽海王社
合作訊(第一〇八期)	北平華洋義賑會
湖南合作訊(第九至十期)	長沙華洋義賑分會
蠕　　突　(第一卷二期)	上海蠕突社
浙江合作半月刊(第二四至二五期)	杭州浙江建設廳
農村合作(第五八至五九期)	江西農村合作委員會
社會經濟月刊(第一卷六期)	上海社會經濟調查所
農村旬刊(第二三至二八期)	上海立達農場
民間半月刊(第一卷五至七期)	北平民間社
建設週刊(第一百至一〇二期)	安慶建設廳
國立山東大學週刊(第七八至八二期)	濟南山東大學
綏遠農村週刊(第八期)	綏遠農村週刊社
大　　夏　(第二九至三〇期)	上海大夏大學
農　　報　(第一卷十一至十五期)	南京農報社
浙江省建設月刊(第八卷一期)	杭州建設廳
農林新報(第十九至二三期)	南京金陵大學
福建民衆(第十二至十九期)	福州民教館
新農村(第一卷四期)	杭州農業改良總場
中央時事週報(第三卷二五至三一期)	南京中央日報館
東方雜誌(第三十一卷十三至十六號)	上海東方雜誌社
醫事公論半月刊(第十八至二一期)	南京中國醫事改進社
經濟旬刊(第二卷十七,十八期)	江西經濟委員會
農業周報(第三卷十六至二四期)	南京農業周報社

四川農業(第一卷五期)	重慶中心農場
湖北省立教育學院院刊(第十四期)	湖北教育學院
氣象季刊(第三卷二期)	無錫教育學院
中行月刊(第九卷一期)	上海中國銀行
林　　聲　(第三號)	歙縣函圖
合作月刊(第六卷六至七期)	南京中國合作學社
科學的中國(第四卷一至四期)	南京中國科學化運動協會
上海郵工(第七卷一至二期)	上海郵務公會
瓊　　農　(第五至六號)	廣州中大農學院
時代公論(第三卷十四至二〇期)	南京時代公論社
實　　業　(第一九四至一九五期)	長沙湖南實業雜誌社
寒　　圃　(第十一至十三期)	紹遠農業學會
湖南農事試驗場季刊(第二期)	湖南農事試驗場
實業公報(第一七五至一八〇期)	南京實業部
蜂蜜新報(第九至十二期)	湖南養蜂協會
工　　程　(第九卷四號)	上海中國工程師學會
農村復興委員會會報(第二卷二號)	南京農村復興委員會
農情報告(第二年七期)	南京中央農業實驗所
科學世界(第三卷六期)	南京中華自然科學社
工商半月刊(第六卷十三至十五期)	上海商品檢驗局
中行月報(第三卷六期)	上海中央銀行
農業世界(第二卷二三至二五期)	廣州中大農學院
社會科學雜誌(第五卷二期)	北平社會調查所
新中華(第二卷十三至十五期)	上海中華書局
開發西北(第二卷六期)	南京開發西北協會
中國經濟(第二卷七至八期)	南京中國經濟研究會
上海市水產經濟月刊(第三卷五至六期)	上海市漁業指導所

昆蟲與植物(第二卷十九至二二期)	杭州浙江昆蟲局
北平民衆旬刊(第十五至二十期)	北平第一社會教育區
地政月刊(第二卷六期)	南京中國地政學會
國　訊 (第七二至七五期)	上海國訊社
國際貿易導報(第六卷七期)	上海國際貿易局
農牧月報(第二卷六期)	常州生生農牧場
皐　農 (第四卷四期)	如皐縣農業推廣所
鄉村建設(第四卷一期)	山東鄉村建設研究院
首都電廠月刊(第四一至四二號)	首都電廠
勞工月刊(第三卷七至八期)	南京勞工月刊社
民　訊 (第十二號)	北平市黨部
求　實 (第一卷十期)	北平求實月刊社
鑛業週報(第二九二至二九八號)	南京中華鑛學社
河南大學校刊(第三七至四九期)	開封河南大學
農民教育(第四卷六期)	湯山農民教育館
學　藝 (第十三卷四號)	上海中華學藝社
浙江蠶種技術改進會月刊(第二卷六至七期)	杭州浙江蠶種改進會
新青海(第二卷六至七期)	南京新青海社
瓊崖實業月刊(第八至九期)	瓊崖實業局
汗血月刊(第三卷四至五期)	上海汗血月刊社
政治成績統計(二十三年四五月份)	南京中央統計處
統計月報(第十八號)	國民政府統計局
人　文 (第五卷五期)	上海人文月刊社
陝西建設公報(第二〇至二六期)	陝西建設廳
上海物價月報(第十卷五至六號)	上海國定稅則委員會
中國養蜂月刊(第六卷六期)	北平中國養蜂月刊社
中國養蜂雜誌(第七至八期)	上海中國養蜂雜誌社

農業推廣(第六期)	南京中央農業推廣委員會
蘇農畢業紀念刊	蘇州農校
二十三年害虫防治概況	杭州浙江昆虫局
天虫生活史及其製絲方法	廣東農林局
兩年來之江蘇教育林	南京江蘇教育林
中國棉產統計	上海中華棉產改進會
新村月刊(創刊號)	北平民衆教育館
改進中國農業計劃草案	南京中央農業實驗所
浙江昆虫局十年大事記	杭州浙江昆虫局
廣東土壤提要	廣州土壤調查所
研究報告(第一至三號)	南京中央農業實驗所
農情報告彙編	仝上
研究彙報(第三卷　別册一至三號)	上海自然科學研究所
教育研究(第五十二期)	廣州中山大學
農情報告是什麼	南京中央農業實驗所
治蝗淺說	仝上
浙江實驗農校標本實驗室報告(一至五號)	金華浙江實驗農校
地文研究叢刊(第一至四號)	上海自然科學研究所
物　理　(第二號)	仝上
細　菌　(第一,四號)	仝上
病　理　(第八號)	仝上
藥　物　(第一,一號)	仝上
生　物　(第二至三,五至七號)	仝上
皖西各縣之茶業	安徽省立茶業改良場
皖浙新安江流域之茶業	安徽省立茶業改良場
南海縣土壤調查報告	廣州土壤調查所
廣西年鑑	廣西統計局

	白松產地之今昔觀	河南百泉植物研究所
	推廣金大二十六號小麥報告	嘉定農業推廣所
	建設救災	北平華洋義賑會
外國之部	林學會雜誌(第十六卷七號)	日本東京林學會
	大日本農報(第二四三至二四四號)	日本大阪大日本農報社
	農　業　(第六四四至六四五號)	日本東京大日本農會
	日本蠶絲總覽(第五卷六至七號)	日本長野蠶絲科學研究會
	農　友　(第二三二至二三三號)	日本福島農事講習同窗會
	蠶業新報(第四二卷七至八號)	日本東京蠶業新報社
	病虫害雜誌(第二一卷七至八號)	日本東京植物愛護會
	帝國農會報(第二四卷七號)	日本東京帝國農會
	瑞　穗　(第八十號)	全上
	理化學研究所彙報(第十三輯七至八號)	日本東京理化學研究所
	日本作物學會紀事(第六卷二號)	日本東京作物學會
	中央園藝(第三七七號)	日本東京中央園藝會
	大原農業研究所報告(第六卷一期)	日本東京大原農業研究所
	營養研究所報告(第六卷二號)	日本東京營養研究所
	園藝報告十八號	日本靜岡園藝研究所
	Exp't. Station Record (Vol. 70, no. 5)	U. S. Dep't. of Agriculture