

中国太湖地区水稻土

中国科学院南京土壤研究所

THE PADDY SOIL OF TAI-HU REGION IN CHINA

NANKING INSTITUTE OF SOIL SCIENCE
ACADEMIA SINICA



中国太湖地区水稻土

中国科学院南京土壤研究所

徐 琪

陆彦椿 刘元昌 朱洪官

上海科学技术出版社

中国太湖地区水稻土

中国科学院南京土壤研究所

徐 琪

陆彦椿 刘元昌 朱洪官

上海科学技术出版社出版

(上海瑞金二路 450 号)

新华书店上海发行所发行 上海中华印刷厂印刷

开本 787×1092 1/16 印张 5 插页 22 字数 94,000

1980 年 9 月第 1 版 1980 年 9 月第 1 次印刷

书号: 16119·682 定价: 5.00 元

序 言

我国是广种水稻的国家,稻谷生产在粮食上占有很大的比重。所以,水稻土的研究在科学上和生产上都有极其重要的意义。

我国种植水稻的地区很广,南起热带的海南岛,北到寒温带的黑龙江,东自台湾省与滨海平原,西至新疆荒漠绿洲都有水稻栽培。从地形条件来说,由接近海平面的沼泽洼地和沿海潮田一直到海拔高达2700余米的漠北高原,甚至在青藏高原的峡谷地带都有水稻栽培。但由于气候和土壤母质的不同,地形和水文殊异,水稻土的剖面发育产生复杂的变化,因而促使我国土壤工作者在水稻土方面进行较多和深入的研究工作。

水稻土是在水旱交替耕作条件下形成的,主要的成土过程是氧化还原作用。由于土体构型不同,土壤水分状况各异,频繁的氧化还原过程使水稻土产生特殊的剖面形态,其最重要的诊断层是渗渍层。具有渗渍层的土壤才能称为水稻土,否则仍应属于种稻前原来的土壤类型。

有些地区由于不种水稻或只在积水洼地种稻,所以他们未能理解水稻土剖面的形态变化。太湖地区是我国水稻高产地区之一,水稻栽培历史悠久,水稻土剖面形态类型较多,而且发育较好,其形态变化虽不如南方红壤地区复杂,但已能反映水稻土形态变化的特点。

水稻土的剖面形态不仅反映不同的成土过程和不同类型的水稻土,也可据以判断土壤的肥力水平。例如爽水水稻土不仅含有丰富的养分,还有适量的渗透性和良好的物理性质,水肥气热比较协调;滞水水稻土和囊水水稻土,因渍水过多,土壤粘闭不透水,有机质不易矿化,一般肥力较低。

为了说明水稻土剖面形态的变化,我所水稻土生态研究组同志,在太湖地区对各种土壤类型拍摄了剖面彩色照片,并整理了有关资料编印成册。本书除对彩色剖面图谱作了简单的形态描述及附注了理化特性外,还附文介绍了太湖地区水稻土的发生、分类和改良利用。印制水稻土彩色剖面图谱在国内还是一个尝试,缺点错误在所难免,希读者指正。

熊 毅

1980年1月20日

Preface

Rice is almost cultivated all over the territory of China. The production of rice makes up a considerable proportion of the total grain output of the country. Therefore, the study of paddy soils is of great significance both in scientific research and agricultural practice.

In our country, the area of rice cultivation spreads from the tropical Hainan Island in the South to Heilongjiang Province of the frigid-temperate zone in the North, and from Taiwan Province and the coastal plain in the East to the oasis of desert in the West. As for topographical conditions, rice is cultivated not only in the marshy depression and coastal lowland approaching the sea level but also on the plateau in the North-West with an elevation above 2,700 metres, and even on the canyon benches of Qinghai-Xizang Plateau. Nevertheless, the development of paddy soils is greatly influenced by different climate, soil parent material, landform and hydrological conditions, which induce complicated variation of the profile. Hence, our soil scientists have the responsibility for studying paddy soils more comprehensively and thoroughly.

It should be emphasized that the paddy soils are formed under the farming condition of water-dryness alternation. The oxidation-reduction plays a dominant role in the soil-forming process of paddy soil. Due to the difference in patterns of soil constitution, water regime and the frequent oxidation-reduction, paddy soil has its unique morphology of soil profile. The redoxic (or perco-submergic) layer in the profile is the most important diagnostic horizon of paddy soil. Only the soil with redoxic layer can be called paddy soil while those soils without the layer should be regarded as their original soil type before being used for growing rice.

Consequently, the morphological variations of paddy soils are not quite known by those in the districts where no rice is cultivated or where it grows only in submerged depression. Tai-hu district in the delta of the Yangtze River is one of the high-yield rice regions in our country. In this district, rice has been grown for a long period; and there are a good many patterns of morphological profile of well developed paddy soils. Though the paddy soils in this district do not comprise so many morphological patterns as those in the red earth area of southern China, they have enough to reflect the most important morphological characteristics of paddy soils.

The morphology of paddy soil profile not only reflects its soil-forming process and its soil type, but also indicates the level of soil fertility. The permeable paddy soil always contains abundant nutrients and has moderate permeability and proper physical properties; therefore, the water, nutrient, aeration and thermal conditions in the soil are well coordinated. Both the stagnant paddy soil and the submerged paddy soil, under a long-standing waterlogging condition, are sticky, puddling and impermeable. The organic matter in the soils are not liable to be mineralized, so their fertility is low.

In order to illustrate the variation of the profile morphology of paddy soils, the comrades of the Research Group of Paddy Soil Ecology of the Institute of Soil Science, Academia Sinica, prepared a series of colour photographs of various types of paddy soil in Tai-hu district. These photographs will be printed and bound in a volume, with an introduction on the genesis, classification, amelioration and utilization of the soils. Besides the concise description of morphology, there is also a brief interpretation of physical and chemical properties of the soil under each photograph. Publication of such a book being our first attempt, errors and shortcomings might be unavoidable. So we would appreciate it very much if the reader would give us criticisms and suggestions.

Heung Yi

January, 1980

目 录 (CONTENTS)

序言 Preface

原色图版 (Photo No.)1~36

第一章 (Chapter I) 太湖地区的自然条件与农业生产特点 (Natural Conditions and Characteristic Features of Agricultural Production)

- 一、自然条件概况 (Natural Conditions)37
 - 1. 气候 (Climate)37
 - 2. 植被 (Plant Cover)37
 - 3. 土壤 (Zonal Soils)38
 - 4. 母质与地形 (Parent Materials and Geomorphology)38
 - 5. 湖泊水系 (Lakes and Water Systems)38
- 二、农业生产特点 (Characteristic Features of Agricultural Production)38
 - 1. 土地利用方式 (Forms of Land Utilization)39
 - 2. 耕作制度 (Cropping Systems)39

第二章 (Chapter II) 太湖地区水稻土的形成条件 (Conditions under Which Paddy Soils are Formed)

- 一、母质、地形对水稻土形成的影响 (Influence of Parent Material and Geomorphology on the Formation of Paddy Soils)41
 - 1. 低山丘陵地区母质、地形对水稻土的影响 (Rolling Hills)41
 - 2. 平原地区母质、地形对水稻土的影响 (Plains)42
 - 3. 沿江平原地区母质、地形对水稻土的影响 (Alluvial Plains)42
 - 4. 湖泊洼地母质、地形对水稻土的影响 (Lake Depressions)42
- 二、耕作制度对水稻土形成的影响 (Influence of Cropping Systems on the Formation of Paddy Soils)43
 - 1. 轮荒阶段 (Shifting Stage)43
 - 2. 沤田阶段 (Water-logging Stage)43
 - 3. 稻麦两熟阶段 (Rice-Wheat Stage)44
 - 4. 三熟制阶段 (Rice-Rice-Wheat Stage)45

第三章 (Chapter III) 太湖地区水稻土的形成特点 (Characteristics of Paddy Soil Formation)

- 一、氧化还原作用 (Oxidation-reduction)46

二、白土形成作用 (Formation of White Bleaching Paddy Soil)	47
1. 关于双层母质的问题 (On the Double Layers of Parent Material).....	48
2. 关于白土是否还在形成的问题 (On the Current Process of White Bleaching)	48
3. 关于侧向淋洗的问题 (On the Process of Side Bleaching)	49
4. 白土形成过程探讨 (On the Process of White Bleaching In Stagnating Paddy Soil)...	49
三、鳝血形成作用 (Formation of Iron-humic Coating).....	50

第四章 (Chapter IV) 太湖地区水稻土的发生及分类 (Classification of Paddy Soils In Tai-hu Region)

一、水稻土的概念及其分类概况 (Conception and Classification of paddy Soils) 53	
1. 关于水稻土的概念 (On the Concept of Paddy Soils).....	53
2. 水稻土分类的研究概况 (A Review of the Classification of Paddy Soils)	53
二、太湖地区水稻土的诊断层与土体构型 (Diagnostic Horizon and Profile Patterns)	54
三、太湖地区水稻土的发生分类 (Classification of Paddy Soils In Tai-hu Region)	56
1. 水稻土分类命名原则 (Principles of Classification of Paddy Soils)	56
2. 水稻土分类系统 (Classification System of Paddy Soils)	57
四、太湖地区水稻土类型的基本性状 (Characteristics of Main Types of Paddy Soil in Tai-hu Region)	58
1. 爽水水稻土 (Permeable Paddy Soils).....	58
2. 侧渗水稻土 (Side-bleaching Paddy Soils)	58
3. 滞水水稻土 (Stagnating Paddy Soils).....	60
4. 囊水水稻土 (Water-logged Paddy Soils)	62
5. 漏水水稻土 (Percolating Paddy Soils)	62

第五章 (Chapter V) 太湖地区水稻土的肥力特点及改制后的变化 (Fertility of Paddy Soil and Its Changes after Alteration of Cropping System)

一、水稻土形态与物理性质的变化 (Changes of Morphological and Physical Characters)	65
1. 土壤通透性变差与犁底层滞水 (The Variation of Soil Permeability and the Stagnating Water Of Plow Pan)	65
2. 耕层变浅与结构性变差 (Thinning of Plowed Layer and Deterioration of Soil Structure)	65
二、水稻土养分状况的改变与合理施肥 (Nutrient Status of Paddy Soils and Reasonable Fertilization)	66
1. 养分含量及改制后的变化 (Soil Nutrients Content and It's Variation After Changing to Triple Cropping System)	66
2. 氮肥有效利用与磷钾的协调供应 (Efficient Use of Nitrogen Fertilizer and Coordina-	

tion of Supply of Phosphorus and Potassium)	70
---	----

第六章 (Chapter VI) 太湖地区水稻土的利用分区 (Reasonable Utilization of Paddy Soils in Differential Regions)

一、丘陵低山土区 (Hill-mountain's Soil Region)	72
二、太湖平原土区 (Plain's Soil Region)	74
三、冲积平原土区 (Alluvial Plain's Soil Region)	76
四、低洼圩田土区 (Polder's Soil Region).....	77
英文提要 (Abstract).....	81
参考文献 (References).....	94
后记 (Acknowledgements)	98

原色图版目次 (Photo No.)

图版 (Photo) 1	太湖农业地区的农业景观 The agricultural landscape in Tai-hu plain.....	1
图版 (Photo) 2	太湖农业地区的农业景观 The agricultural landscape in Tai-hu plain.....	1
图版 (Photo) 3	杭嘉湖地区的农业景观 The agricultural landscape in Hung-jia-hu region.....	2
图版 (Photo) 4	阳澄湖地区的农业景观 The agricultural landscape in Yang-cheng-hu region.....	2
图版 (Photo) 5	前洲圩区的农业景观 The agricultural landscape in Qian Zhou polder region.....	3
图版 (Photo) 6	丘陵地区的农业景观 The agricultural landscape in hill region.....	3
图版 (Photo) 7	冲积平原地区的农业景观 The agricultural landscape in alluvial plain.....	4
图版 (Photo) 8	滨湖洼地的农业景观 The agricultural landscape in shore depression.....	4
图版 (Photo) 9	爽水水稻土(黄泥土) Permeable paddy soil (huang ni tu).....	5
图版 (Photo) 10	爽水水稻土(乌黄泥土) Permeable paddy soil (hu huang ni tu).....	6
图版 (Photo) 11	爽水水稻土(白底乌黄泥土) Permeable paddy soil (bai de hu huang ni tu).....	7
图版 (Photo) 12	侧渗水稻土(白土头) Side bleaching paddy soil (bai tu tou).....	8
图版 (Photo) 13	侧渗水稻土(板浆白土) Side bleaching paddy soil (ban jiang bai tu).....	9
图版 (Photo) 14	侧渗水稻土(小粉土) Side bleaching paddy soil (xiao fen tu).....	10
图版 (Photo) 15	侧渗水稻土(马干土) Side bleaching paddy soil (ma gan tu).....	11
图版 (Photo) 16	滞水水稻土(小粉白土) Stagnating paddy soil (xiao fen bai tu).....	12
图版 (Photo) 17	滞水水稻土(小粉白土) Stagnating paddy soil (xiao fen bai tu).....	13

图版 (Photo) 18	滞水水稻土(黄泥白土)	
	Stagnating paddy soil (huang ni bai tu)	14
图版 (Photo) 19	滞水水稻土(青黄泥土)	
	Stagnating paddy soil (qing huang ni tu)	15
图版 (Photo) 20	囊水水稻土(沙青土)	
	Waterlogged paddy soil (sha qing tu)	16
图版 (Photo) 21	囊水水稻土(青紫泥)	
	Waterlogged paddy soil (qing zhi ni)	17
图版 (Photo) 22	囊水水稻土(青泥白土)	
	Waterlogged paddy soil (qing ni bai tu)	18
图版 (Photo) 23	囊水水稻土(乌栅土)	
	Waterlogged paddy soil (hu san tu)	19
图版 (Photo) 24	囊水水稻土(粘乌栅土)	
	Waterlogged paddy soil (nian hu san tu)	20
图版 (Photo) 25	囊水水稻土(沙底青泥土)	
	Waterlogged paddy soil (sha de qing ni tu)	21
图版 (Photo) 26	囊水水稻土(灰炉底)	
	Waterlogged paddy soil (hui lu de)	22
图版 (Photo) 27	囊水水稻土(竖头乌栅土)	
	Waterlogged paddy soil (shu tou hu san tu)	23
图版 (Photo) 28	漏水水稻土(乌沙土)	
	Percolating paddy soil (hu sha tu)	24
图版 (Photo) 29	漏水水稻土(乌泥土)	
	Percolating paddy soil (hu ni tu)	25
图版 (Photo) 30	漏水水稻土(乌泥土)	
	Percolating paddy soil (hu ni tu)	26
图版 (Photo) 31	漏水水稻土(狗头沙土)	
	Percolating paddy soil (gou tou sha tu)	27
图版 (Photo) 32	漏水水稻土(黄夹沙)	
	Percolating paddy soil (huang jia sha)	28
图版 (Photo) 33	漏水水稻土(沙夹黄)	
	Percolating paddy soil (sha jia huang)	29
图版 (Photo) 34	漏水水稻土(小粉沙土)	
	Percolating paddy soil (xiao fen sha tu)	30
图版 (Photo) 35	冲积土	
	Alluvial soil	31
图版 (Photo) 36	侵蚀黄棕壤	
	Strongly eroded yellow brown soil	31
图版 (Photo) 37	耕种沼泽土	

	Cultivated bog soil	32
图版 (Photo) 38	鳝血的形态特点 Morphological features of Fe-humic coatings	32
图版 (Photo) 39	鳝血的微形态 Micromorphology of Fe-humic coatings	33
图版 (Photo) 40	爽水水稻土的渗渍层 Percosubmergic layer of permeable paddy soil	33
图版 (Photo) 41	侧渗水稻土的渗渍层与侧漂层 Percosubmergic layer and side bleaching layer of side bleaching paddy soil	34
图版 (Photo) 42	滞水水稻土的渗渍层 Percosubmergic layer of stagnating paddy soil	34
图版 (Photo) 43	囊水水稻土的潜育层 Gley layer of waterlogged paddy soil	35
图版 (Photo) 44	囊水水稻土的渗渍层 Percosubmergic layer of waterlogged paddy soil	35
图版 (Photo) 45	漏水水稻土的渗渍层 Percosubmergic layer of percolating paddy soil	36
图版 (Photo) 46	沼泽土中的管状铁锰结核 Tubular Fe-Mn concretions in bog soil	36

图版号 (Photo №) 1

摄影日期 (Date) 1979, 4.

地点 (Location) 江苏省吴县金山公社

Jin Shan Commune, Wu County, Jiang Su Province.



说明 (Explanation)

土地利用方式之一，小麦、紫云英与秧田。

One of the intensive land-use patterns in spring, wheat field, green manure (*Astragalus*) field and rice seedling bed.

图版号 (Photo №) 2

摄影日期 (Date) 1979, 4.

地点 (Location) 江苏省无锡县东亭公社

Dong Ting Commune, Wu Xi County, Jiang Su Province.

说明 (Explanation)

土地利用方式之一，小麦与秧田。

One of the intensive land-use patterns in spring, rice seedling bed and wheat field.





图版号 (Photo №) 3

摄影日期 (Date) 1979, 5.

地点 (Location) 浙江省吴兴县苕南公社
Tiao Nan Commune,
Wu Xing County,
Zhe Jiang Province.

说明 (Explanation)

土地利用方式之一，稻田与桑园。

One of the intensive land-use patterns in spring, rice field and mulberry garden.

图版号 (Photo №) 4

摄影日期 (Date) 1979, 4.

地点 (Location) 江苏省常熟县白茆公社
Bai Mao Commune, Chang Shu
County, Jiang Su Province.

说明 (Explanation)

用地与养地相结合，小麦，紫云英与积草塘泥。

Land-use with proper soil management-combination of cultivation and manuring in spring. Wheat field, the traditional manuring resouces: green manure and manure composted with mud.



图版号 (Photo №) 5

摄影日期 (Date) 1979, 4.

地点 (Location) 江苏省无锡县前洲公社

Qian Zhou Commune, Wu Xi County, Jiang Su Province.



说明 (Explanation)

油菜、饲料、小麦田与猪舍。

Rape field, forage field, wheat field and pigpen.

图版号 (Photo №) 6 摄影日期 (Date) 1979, 4.

地点 (Location)

江苏省宜兴县善卷公社

Shan Juan Commune, Yi Xing County, Jiang Su Province.

说明

(Explanation)

丘陵地区的梯田。

Terraced field in hill region.



图版号 (Photo №) 7

摄影日期 (Date) 1979, 4.

地点 (Location) 江苏省沙洲县后塍公社

Hou Cheng Commune, Sha Zhou County, Jiang Su Province.



说明 (Explanation)

利用方式之一，麦棉间种套作。

One of the intensive land-use patterns in spring. First season, drilling of wheat and cotton seedling bed. Next season, wheat intercropped with cotton.

图版号 (Photo №) 8

摄影日期 (Date) 1979, 4

地点 (Location)

江苏省吴县洞庭公社

Dong Ting Commune, Wu County, Jiang Su Province.

说明 (Explanation)

圩区土地利用方式之一，桑基鱼塘。

One of the intensive land-use patterns in polder, mulberry cultivation combined with fish culture.



爽水水稻土（黄泥土）

(Permeable paddy soil)

地 点 (Location) 江苏省吴县农科所

Agriculture Institute of Wu

County, Jiang Su Province.

图 版 号 (Photo №) 9

摄影日期 (Date) 1979, 4.

海 拔 (Elevation) 4 米(m)



暗灰黄，多鳃血与锈纹。
2.5Y5/3, considerable Fe-humic coatings and rust streaks.

暗灰黄，稍紧实，少鳃血，有锈纹。
2.5Y5/3, slightly compact, a few Fe-humic coatings and rust streaks.

灰黄，结构体表面灰色胶膜，内多锈斑点。
2.5Y5/4, gray coatings on ped surface and rust mottles inside ped.

淡灰黄，结构体表面灰色胶膜，小结核状锈斑点。
2.5Y6/3, gray coatings on ped surface, small concretionary mottles.

黄白色，潜育斑，多量小结核状锈斑点。
2.5Y4/4, gleyey spots, considerable small concretionary mottles, Cg.

物理化学分析 (Physical-Chemical Analysis Data)*

发生层 (Horizon)	各级颗粒含量百分数 (Particle size) (%)							质 地			
	1—0.25 mm	0.25—0.05 mm	0.05—0.01 mm	0.01—0.005 mm	0.005—0.001 mm	<0.001 mm	<0.01 mm	(Texture)			
A	0.7	2.8	32.9	16.4	18.2	29.0	63.6	轻粘土 (light clay)			
P	0.3	1.5	31.6	17.1	17.4	32.1	66.6	轻粘土 (light clay)			
W	0.3	1.3	30.7	19.4	17.7	30.6	67.7	轻粘土 (light clay)			
Bg	0.4	1.8	28.9	24.1	17.5	27.3	68.9	轻粘土 (light clay)			
Cg	0.3	0.8	29.7	13.9	18.5	36.8	69.2	轻粘土 (light clay)			

发生层 (Horizon)	pH (H ₂ O)	有机质 (OM) (%)	N (%)	C:N	P ₂ O ₅ (%)	K ₂ O (%)	代换量 (CEC) (me/100g)	容 重 (V) (g/cm ³)	非毛孔隙 (Pn) (%)	毛管孔隙 (Pc) (%)	总孔隙 (Pt) (%)
A	5.7	2.82	0.148	11.1	0.250	1.71	21.25	1.25	3.4	52.8	56.2
P	6.6	2.05	0.122	9.8	0.225	1.84	20.69	1.28	0.9	53.1	54.1
W	7.5	0.80	0.054	8.6	0.138	1.73	17.42	1.43	3.05	42.5	45.6
Bg	7.3	0.83	0.054	8.9	0.129	1.76	18.62	1.45	2.75	42.8	45.7
Cg	7.5	0.80	—	—	0.054	1.48	16.58	1.46	1.7	46.1	47.8

Pn—non capillary porosity.

Pc—capillary porosity.

Pt—total porosity.

V—volume density.