**British oak galls / by Edward T. Connold.**



# BRITISH OAK GALLS

"Mihi contuenti se persuasit rerum natura nihil incredibile existimare de ea."

(*Pliny the Elder, Nat. Hist., XI, 2.*)

"The contemplation of Nature has convinced me that nothing which we can imagine about her is incredible."

FRONTISPIECE.

[PLATE I.]

Galls caused by DRYOPHANTA SCUTELLARIS on under-surface of leaves of *Quercus pedunculata*.

"THE CHERRY GALL."

*Adlard & Son, Impr.*

# BRITISH OAK GALLS

BY

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EDITOR OF 'BRITISH HYDROID ZOOPHYTES,'
FROM NOTES BY THE LATE P. J. RUFFORD, F.G.S., ETC.
(PUBLISHED POSTHUMOUSLY)

ILLUSTRATED WITH 68 FULL-PAGE PLATES, 21 INSETS AND 17 SMALL DRAWINGS

London
ADLARD AND SON
BARTHOLOMEW CLOSE
1908

PRINTED BY ADLARD AND SON
LONDON AND DORKING

# PREFACE

The British Oak is the abode of a vast concourse of dependents. Nearly five hundred different species of insects, and other creatures, find their needs amply supplied, mainly by the leaves. Of this number about two hundred are either parasites living upon the larvæ of fifty-four species of Cynipidæ which produce galls, or they are inquilines obtaining their nourishment from the tissues of the galls. The Oak is therefore of great importance to insect life.

The object of this volume is to describe and illustrate, in some measure, galls produced by the Cynipidæ and other causes of galls on the Oak. The insects, with their parasites and other occupants of the galls, have been fully described by various writers; several pages will, however, be devoted to a few interesting and unique features of the Cynipidæ. This volume is also the fulfilment of an intimation contained in the preface of my 'British Vegetable Galls,' explaining the reason why galls on the Oak were not described in that work.

I trust the information herein contained may be the means of assisting many students to a further understanding of the subject; that collectors of these most interesting and dainty galls will be enabled to identify any specimen obtained; and, that casual observers will find in the illustrations and the text, such as will influence them to pursue the study in a practical manner.

There is much more to be ascertained concerning

the growth of oak galls, and one purpose of the following pages will have been accomplished if they are the means of inspiring somebody to further unfold the subject.

I shall esteem it a pleasure to endeavour to identify any galls. *Specimens should always be sent in a tin box.*

I desire to acknowledge with much gratitude the kindness and help received from my aged friend, the Rev. E. N. Bloomfield, M.A., F.E.S., of Guestling Rectory, Sussex, without whose stimulation and encouragement I should probably never have studied galls.

To Mrs. M. J. M. Andresen of Hastings, I offer my heartiest thanks for translating various Continental treatises; and to my wife, for valuable assistance from the earliest contemplation of the work, and with the proof-sheets; to Sir Archibald Lamb, Bart., for his kindness in allowing me, at any time, to roam about in Beauport Park in search of specimens; to Dr. Alfred Nalepa of Vienna, for permission to reproduce Plate LXIV; to Mr. W. H. Hammond for the photo-micrographs divs. B and C, Plate XXXII; to Mr. A. W. Bawtree, F.L.S., for the insets on Plates XLVIII and XLIX; also to Mr. H. Stone, F.L.S., F.R.C.I., and Messrs. W. Rider and Son, Ltd., for permission to include Plate II; to Mr. E. W. Swanton, M.C.S., for specimens and notes of observations; and also to Mr. W. W. Midgley for a valuable specimen.

EDWARD CONNOLD.

1, St. Peter's Road,
St. Leonards-on-Sea
*July*, 1908.

# CONTENTS


PAGE

PREFACE . . . . . v

LIST OF FULL-PAGE PLATES . . . . . ix

LIST OF SMALL ILLUSTRATIONS . . . . . xi

INTRODUCTION . . . . . xiii

CHAPTER I

THE PRINCIPLES OF OAK GALL FORMATION . . . 1

CHAPTER II

SOME FEATURES OF OAK GALL GROWTH . . . . 9

CHAPTER III

THE NUMERICAL ASPECT OF OAK GALLS . . . 20

CHAPTER IV

THE CYNIPIDÆ AFFECTING THE OAK . . . . . 26

CHAPTER V

THE BRITISH OAK . . . . . 33

CHAPTER VI

HINTS ON COLLECTING AND MOUNTING OAK GALLS . . 40

TERMS EMPLOYED IN THE SYNOPTICAL TABLES . . . 46

TABLE OF ALTERNATE GENERATIONS . . . . . 49

PAGE

The Genus **Andricus** . . . . . 50
„ **Aphilothrix** . . . . . 73
„ **Biorhiza** . . . . . 98
„ **Cynips** . . . . . 102
„ **Dryophanta** . . . . . 108
„ **Neuroterus** . . . . . 117
„ **Spathegaster** . . . . . 126
„ **Teras** . . . . . 137
„ **Trigonaspis** . . . . . 139
**Cynips** *tinctoria* . . . . . 141
„ *calicis* . . . . . 143
Cupules of *Q. Ilex* . . . . . 144
Other Galls on the British Oaks not caused by Cynipidæ—
**Asterolecanium** *variolosum* . . . . . 146
**Diplosis** *dryobia* . . . . . 147
**Dichæna** *quercina* . . . . . 148
Parasites and Inquilines Mentioned in the Volume . 150
A Table of Months in which the British Oak Galls Illustrated in the Volume may be Found . . 153
A List of Mid-European Oak Galls . . . . 155
Description of Plate XXXV . . . . . 159
„ of Plate XXXVI . . . . . 160
„ of Plates XXXVII and XXXVIII . . 161
Index . . . . . 163

# LIST OF PLATES


PLATE

I.—Frontispiece, "The Cherry Gall," *Dryophanta scutellaris.*

II.—Sections of Oak Wood.

III.—Fruit and Leaves of *Q. pedunculata* and *Q. sessiliflora.*

IV.—Fruit and Leaves of *Q. cerris* and *Q. Ilex.*

Galls Caused by—

V.—*Andricus Æstivalis.*
,, ,, *amenti.*
,, ,, *circulans.*
,, ,, *clementinæ.*
,, ,, *gemmatus.*
,, ,, *lucidus.*

VI.— ,, *curvator.*

VII.— ,, ,,

VIII.— ,, *glandium.*

IX.— ,, ,,
,, ,, *noduli.*

X.— ,, *glandulæ.*

XI.— ,, *inflator.*

XII.— ,, *noduli.*

XIII.— ,, *nudus.*
,, ,, *pilosus.*

,, *Aphilothrix quadrilineatus*

XIV.—*Andricus ramuli.*

XV.— ,, *solitarius.*

XVI.— ,, *testaceipes.*

XVII.— ,, *albopunctata.*

XVIII.—*Aphilothrix callidoma.*

XIX.— ,, *corticis.*

XX.— ,, *fecundatrix.*

XXI.— ,, ,,

PLATE

XXII.—*Aphilothrix fecundatrix, A. corticis.*

XXIII.—*Aphilothrix Malpighii.*
,, ,, *globuli.*
,, ,, *autumnalis.*

XXIV.— ,, *marginalis.*
,, ,, *seminationis.*

XXV.— ,, *quadrilineatus.*

XXVI.— ,, *radicis.*

XXVII.— ,, *Sieboldi.*

XXVIII.— ,, ,,

XXIX.— ,, ,,

XXX.— ,, ,,
,, ,, *radicis.*

XXXI.—*Biorhiza aptera.*

XXXII.— ,, ,, ova, &c.

XXXIII.— ,, ,, roots of tree.

XXXIV.— ,, *renum.*

XXXV.—*Cynips Kollari*, ridges, papillæ, etc.

XXXVI.—*Cynips Kollari*, aberrant examples.

XXXVII.—*Cynips Kollari*, geometrical groups.

XXXVIII.—*Cynips Kollari*, conglomerated clusters.

PLATE

XXXIX.—*Cynips Kollari*, attacked by *Phoma gallorum*, parasites and inquilines.

XL.—*Dryophanta agama.*

XLI.— „ *disticha.*

XLII.— „ *divisa.*

XLIII.— „ *longiventris.*

XLIV.— „ *scutellaris.*

XLV.— „ „

XLVI.—*Neuroterus fumipennis.*

XLVII.— „ *læviusculus.*

XLVIII.— „ *lenticularis.*

XLIX.— „ *numismatis.*

L.— „ *ostreus.*

LI.—*Spathegaster albipes.*

LII.— „ *aprilinus.*

„ „ *similis.*

„ „ *Taschenbergi.*

LIII.— „ *baccarum.*

PLATE

LIV.—*Spathegaster tricolor*

LV.— „ *vesicatrix.*

LVI.—*Teras terminalis.*

LVII.— „ „

LVIII.—*Trigonaspis crustalis.*

LIX.— „ „

LX.—*Neuroterus fumipennis.*

„ *Cynips tinctoria.*

LXI.— „ *calicis.*

„ Cupules of *Q. Ilex.*

LXII.—*Asterolecanum variolosum.*

LXIII.—*Diplosis dryobia.*

LXIV.—*Epitrimerus cristatus.*

LXV.—*Dichæna Quercina.*

LXVI.— „ „

LXVII.—*Q. pedunculata* at Guestling.

LXVIII.—*Q. pedunculata* at Guestling.

# LIST OF SMALL ILLUSTRATIONS


FIG. PAGE

1.—A pair of Nippers . . . . . 45

2.—A Pruner . . . . . 45

3.—A Fern-trowel . . . . . 45

4.—Mm., Cm., and Inch Scale . . . . . 48

5.—Galls caused by *Andricus glandulæ*: A, young × $2\frac{1}{2}$; B, mature × $2\frac{1}{2}$; C, section × $2\frac{1}{2}$ . . . . . 62

6.—Galls caused by *Andricus testaceipes* on petiole and mid-rib of leaf . . . . . 72

7.—Galls caused by *Aphilothrix albopunctata*, illustrating variability in situation, form, and marking . . . . 74

8.—Galls caused by *Aphilothrix collaris*: A, *in situ*, nat.; B, enlarged, × 4; C, scales removed, × 4 . . . . 80

9.—Galls caused by *Aphilothrix Malpighii* . . . . . 88

10.—Galls caused by *Aphilothrix Sieboldi*, typical shapes and situations . . . . . 98

11.—Sections of galls caused by: A, *Dryophanta agama*; B, *D. disticha*; C, *D. divisa* . . . . . 109

12.—Three aspects of the same specimen of *D. disticha*: A, side; B, top; C, end . . . . . 111

13.—Sectional aspect of specimen of *D. longiventris*: A, cross; B, longitudinal; C, transverse . . . . . 114

14.—Galls caused by *Neuroterus læviusculus* on upper-surface of leaf; variations in form, etc. . . . . 119

15.—Diagrammatic sections of *N. lenticularis*, *N. fumipennis*, *N. læviusculus* . . . . . 121

16.—Section of gall caused by *N. lenticularis* . . . . 121

17.—Galls caused by *Spathegaster verrucosus* . . . . 135

# INTRODUCTION

The beautiful colours, diversity of sizes, and the peculiar shapes of many British oak galls impart an unusual interest and charm to their study. It, however, possesses an additional interest to the student of Natural History. The gall-makers, with the numerous Parasites, Inquilines, and other creatures which emerge from the galls, invite the student to extend his research in another direction, and when he does so Entomology becomes inseparably associated with Botany.

Collecting oak galls is a most fascinating occupation. It does not require a greater amount of time than is devoted to gathering material for an herbarium.

The principal British oak gall-producing insects are the Cynipidæ, a family of the Hymenoptera. Flies with two wings, or Diptera, are represented by a few species; there is also one species of Coccus, and one Fungus.

A few species of flies producing galls on other plants, are of medium size. *Tephritis bardanæ*, and *Urophora solstitialis*, which produce galls in the seed-heads of common burdock, and in thistle stems respectively, are typical examples. The alar extent of these species is about 8–10 mm. But the majority of gall-flies (including those on the oak) are very diminutive, many species not measuring 2 mm. To these the name of gall-gnats, or gall-midges, may appropriately be given. They produce galls in a great

variety of forms on numerous plants. One form is illustrated on Plate LXIII, and others are referred to elsewhere.

Of the Cynipidæ there are many species. They attack various plants, but they are found principally on the oak. They have four wings, and to distinguish them from other gall producers may correctly be known as gall-wasps, and henceforth they will be referred to as such. They are briefly described in Chapter IV.

While the Diptera are comparatively free from the attacks of other insects, the gall-wasps are not; they are extensively preyed upon by parasites, and hyper-parasites, and the gall tissue around the larva is often the welcome abode of a host of other creatures which play the parts of inquilines, commensal tenants, or casual occupants. They seldom cause the death of the rightful inhabitant except in the case of inquilines living gregariously around the larval cell of *Cynips Kollari*. The number of lodgers in oak galls is very great (more than 180), a good many occurring in several kinds of galls. *Eurytoma rosæ* occurs in fourteen different galls, *Megastigmus dorsalis* in eleven, *Synergus facialis* in ten, *S. vulgaris* in nine, and five other parasites each in eight galls. There are many more of similar habits.

It will be found that thirteen species are without alternate generations, viz.: *Andricus æstivalis*, = *amenti*, = *clementinæ*, = *glandium*, = *glandulæ*, = *lucidus*, = *solitarius*, *Aphilothrix albopunctata*, = *marginalis*, = *quadrilineatus*, = *seminationis*, *Dryophanta agama*, and = *disticha*. At present these are unknown; and of two other species there is yet some doubt. In this, however, our British species are not alone. According to Beyerinck the sexual generations of twenty-six continental forms are unknown (p. 152).

A very large number of oak galls occur in Mid-European countries. The various species and varieties of oak are also numerous, consequently a great many

of the galls cannot be expected to occur in England, and several of our English forms do not appear in those countries. It is not improbable, however, that some of the continental species do occur in England, and that they will be found when more workers are engaged upon the subject. I have therefore prepared a list of Mid-European oak galls with fullest details obtainable, as a guide to the collector. The list must not be regarded as complete (pp. 155–158).

The history of British oak galls dates from a very early period.

The word "gall" appears first in English literature in 'Trevisa,' Barth., De P. R., XVII, civ (Tollem MS.), where the following occurs: "The mall (Mandragora) haþ white leuse . . . and apples groweþ on þe leues, as galles groweþ on oaken leues." In 1481 Caxton uses the word "gall." Turner, in his 'Herbal,' ii, 109 (1562) describes a gall as "the fruite of an oke, and especially of the leve." In 1616 Surfl. and Markh., in 'Country Farme,' p. 28, remark: "He shall know a fruitfull and fertile yeare if he see the Oke apples, commonly called Gals."

In the last case the reference is to the oak-apple, *Teras terminalis*. Probably very few other oak galls had then been observed. In 1668, however, several kinds were recorded. In a volume published in 1902, ('Notes and Letters on the Natural History of Norfolk, more especially on the Birds and Fishes; from the MSS. of Sir Thomas Browne, M.D. [1605–1682],' by Thomas Southwell, F.Z.S.), there are two references of much value in showing the circumstances under which these galls were introduced to literature. The fact is also revealed that Sir Thomas was aware of galls on foreign oak trees.

"The fourth letter to Dr. Merrett, Decemb. xxix (1668). (Fol. 42 verso) . . . .

"A paragraph might probably be annexed unto Quercus. Though wee hawe not all the exotic oakes, nor their excretions, yet these and probably more

supercrescences productions or excretions may bee obserued in England.
Viscum—polypodium—Juli pilulæ—
Gemmœ foraminatæ (formicatæ ?) foliorū—
excrementum fungosum verticibus scatens—
excrementum Lanatum—
Capitula squamosa jacææ æmula.
Nodi—melleus Liquor—Tubera radicum
vermibus scatentia—Muscus—Lichen—
Fungus—varæ querinæ."

In the volume the Rev. E. N. Bloomfield, M.A., of Guestling Rectory, Sussex, suggests the following explanatory notes :

"1. Viscum, is doubtless the Mistletoe.

"2. Polypodium, the Common Polypody Fern.

"3. Juli pilulæ, 'little balls on the flower catkins,' the Currant Gall (*Neuroterus baccarum*, which is the spring form of *N. lenticularis*, Oliv.).

"4. Gemmæ foraminatæ (formicatæ ?) foliorum, 'pimple-like buds on the leaves.' Leaf-galls such as the Silky Button, *N. numismatis*, Oliv., and the common Spangle, *N. lenticularis*, Oliv.

"5. Excrementum fungosum verticibus scatens, 'a spongy secretion bursting out from the ends of shoots.' The Oak Apple, *Biorhiza terminalis*, Fab.

"6. Excrementum lanatum, the Woolly Gall, *Andricus ramuli*, L., a somewhat rare gall, resembling a ball of cotton wool.

"7. Capitula squamosa jacææ æmula, 'little scaley (or imbricated) heads resembling the heads of Jacea' (Black Knapweed). The Artichoke Gall, *Andricus fecundatrix*, Htg.

"8. Nodi, probably swellings of any sort, whether caused by insects or not.

"9. Malleus liquor, honey-dew, a secretion of Aphides.

"10. Tubera radicum vermibus scatentia, 'swollen tubers on the roots containing grubs'; without doubt the Root-gall, *Andricus radicis*, Fab. Polythalamous

Galls, often very large at the roots or on the trunk near the ground.

"How wonderfully observant Sir Thomas Browne must have been to distinguish the various galls, etc., and to point them out so distinctly.—E. N. B."

The second reference is:

"Letter No. 5. Dr. Browne to Merrett (Dr. Christopher Merrett). . . . .

"I made enumeration of the excretions of the oake which might bee obserued in england because I conceived they would bee most obseruable if you set them down together, not minding whether there were any addition by excrementum fungosum vermiculis scatens I only meant an vsuall excretion, soft and fungous at first and pale and sometimes cowered in part with a fresh red growing close vnto the sprouts, first full of maggots in little woodden cells which afterwards turne into little reddish browne or bay flies. of the tubera indica vermiculis scatentia I send you a peece, they are as bigg as good Tennis-balls and ligneous."

The Oak-apple and the Truffle-gall are the kinds here referred to.

It was not until Withering's 'British Plants' was published (1776–1796), that galls were again definitely treated of. In Edition 3, vol. ii, p. 388, it is stated that "the balls or galls upon the leaves are occasioned by a small insect with four wings." It would appear from this that the galls of *Spathegaster baccarum* and others were well known to botanists, and the cause of their origin understood.

In 'The Entomologist' for the years 1874–1878 there appeared a translation from Dr. G. L. Mayr's 'Die Mitteleuropaischen Eichengallen,' with numerous wood-cuts of the galls. Francis Walker, E. A. Fitch, and others, added notes as to the occurrence or otherwise of the species in Britain, and a most valuable compilation was thus made of the knowledge of those days.

Several interesting and informative papers on the same subject have been published in various Transactions, etc.

But the study of the causes of oak galls remained greatly neglected, and although several British entomologists worked out the life-history of some of the Cynipidæ it was not until Peter Cameron published vol. iv of his excellent 'Monograph of the British Phytophagous Hymenoptera' (Ray Society, 1892) that there was a comprehensive account in the English language of the gall-producing species.

In 1894 Charles R. Straton, M.D., translated from the German Dr. Hermann Adler's 'Alternating Generations' ("A Biological Study of Oak Galls and Gall Flies"), and himself added many pages of very valuable information.

In drawing up the descriptions of some of the galls I have added extracts from these works; the characteristics of the specimens are so excellently described by these authors that I feel sure the student will be grateful for their reproduction. In addition I have incorporated the results of fifteen years' practical research in the field and in the study. I am also glad to be able to describe several galls not mentioned in any other English publication.

With a very few exceptions the illustrations are entirely new and original, and are my own production. The specimens were collected expressly for this work, and great care has been exercised in their selection and arrangement that they may as far as possible be representative.

For several reasons it has been found desirable to arrange the species in alphabetical order. In departing from the classification set forth in my other work, 'British Vegetable Galls,' I have been animated with the desire to present the subject in as simple a form as possible.

# BRITISH OAK GALLS.

## CHAPTER I.

### THE PRINCIPLES OF OAK GALL FORMATION.

The part of the tree from which the material is supplied to build up the substance of a gall is that known as the cambium layer or the cambium region. "The cambium itself is a clammy secretion, formed in the spring; a highly viscous fluid elaborated by the internal organs serving to nourish several parts of the plant" (Henslow, 'Dict. Bot. Terms,' p. 32).

"The cambium layer is a tissue in which a very vigorous formation of new cells is carried on" (Kerner and Oliver, 'The Natural History of Plants,' vol. i, p. 475). It may also be described as "a series of formative cells lying outside of the wood proper and inside of the inner bark. The growth of new wood takes place in the cambium, which is very soft" ('Webster's International Dictionary,' p. 207). The cells of which it is composed form a complete thin cylinder concentric to the pith throughout the whole of the plant, but separated from the pith by the xylem inwardly, and from the cortex, by the phloëm outwardly.

The xylem is that portion which has developed, or will develop into wood cells; the phloëm is that portion

of fibro-vascular bundles which corresponds to the inner bark.

The activity of the cambium layer begins in the spring and increases throughout the summer, the cells dividing continually, until by the autumn the layer is ten or twelve times thicker than at the commencement of activity. The result of the multiplication of these cells, which are formative, is to produce a new ring of xylem on its inner and a new layer of bark on its outer surface. The whole life of the plant springs from this cambium layer; it is the part in which active metabolism takes place, and it alone possesses the necessary conditions for gall production.

One essential condition for gall formation is that the egg must be laid in, or in closest contact with, the cambium layer. Another condition is the birth and growth of the larva.

It should be borne in mind that the act of oviposition, *i. e.* a wound caused by a simple puncture, does not of necessity give the impetus to gall formation. There are, however, exceptions to this. They are supplied by several species of the aculeate Hymenoptera. To name but one instance, the gall caused by *Aulax hypochæridis* in the flower stalk of the Cat's-ear (*Hypochæris radicata*, L.) is well developed before the larvæ hatch.

It is somewhat difficult to understand why this should be so. If it were merely a question of providing a sufficiency of food for the larvæ before they hatch, then the same reason would be expected to hold good with regard to the gall of *Aphilothrix radicis*; the more so, because the number of larvæ of the latter species (normally about sixty), is about five times greater than that of the former.

But as regards galls on the oak, it is only when the larva emerges from the egg that active metabolism begins and the seat of increase of plant tissue is manifested. Both Cameron and Adler, the two principal writers on galls, whose works are in English, are very

definite on this point. "What is the first factor in gall formation? This, the growth of the larva, as has already been pointed out. The second is that the egg must be laid in, or in contact with, the cambium layer" ('Brit. Phyto. Hymen.,' vol. iv, p. 21). "When a gall-fly has inserted its egg into the neighbourhood of this (cambium ring) tissue, what follows? In the first place the act of oviposition itself has no effect. . . . I am convinced that the simple prick of the gall-fly does not set up gall formation; this, I hold, only begins when the larva emerges from the egg" ('Alternating Generations,' p. 99).

In comparison with the opinions of such specialists, supported by those of recent observers, and confirmed by many who have devoted years of research to the subject, the theories of gall origin advanced by very early writers have but little value. They must not, however, be entirely omitted. It was thought by several of the early observers that the production of cell activity was caused by a glandular secretion of an irritating nature, introduced with the egg at the time of oviposition. Others advanced a theory that the action of oviposition caused irritation to the plant. Another suggestion was made, viz. that the egg possessed a higher temperature than that of the plant, and thus the cells were warmed into activity. Several writers have also maintained that infection, in the form of disease, was the sole cause of galls.

That a secretion of some kind emanates from the gall-wasp when ovipositing is well known, and it can be seen, especially if a number of imagines develop from galls kept in a glass bottle or glass-topped box. They will place their eggs on the glass, and at the same time the minute drop of fluid can be seen also. *Andricus nudus* will provide a good example. It would appear that the purpose of the secretion is to seal the hole caused by the ovipositor. That it does not stimulate the plant to action the following will demonstrate. The imagines from galls of *Trigonaspis crustalis* make a

row of punctures in the veins of young and tender leaves in May or June. The marks are very distinct, and the eggs may be easily detected in the tissue of the leaf, but no change takes place until the larva hatches late in August, or early in September; then the galls of *Biorhiza renum* quickly develop.

Since oak gall formation does not begin until the larva hatches, it is certain that the influence of the larva is necessary, not only for the early stage of development, but also for its completion. Rapid cell-multiplication results from the irritation caused by the larva feeding, and very soon the gall acquires a vascular system of its own, and becomes a more or less independent structure.

The cells nearest the larva are very rich in starch granules, while those of the exterior contain tannin, or colouring pigments, or become transformed into hairlets, papillæ, etc.

In every case, except one, on the death of the larva cell-multiplication ceases. Growth also ceases if the gall be removed from its place of attachment before it has reached a certain stage. It will also die, sooner or later, if the twig or leaf it is upon is severed from the tree. The larva will then either perish, or, if possible, pupate; the resulting imago, however, is almost always poor and undersized.

But many of the autumn galls, especially the *Neuroteri*, fall from the leaf, and also with the leaf while attached, so soon as the frosts commence, and providing the galls lie in moist situations, slow expansion continues, accelerated by the returning warmth of spring, until pupation takes place; then growth finally ends.

The exception to the rule, that gall growth ceases with either the death of the larva or its pupation, is presented in English galls by *Andricus inflator*. This gall develops from a bud. It is largely composed of fibro-vascular tissue, and forms an enormously thickened and shortened shoot, with a central longi-

tudinal cylindrical cavity, at the lower end of which is a little, partly-attached larval cell. This cell is undoubtedly amenable to the laws controlling other oak galls, but not so the outer structure. That continues its growth, throws out buds from which leaves of normal size expand, and not infrequently a shoot will grow from the apex, upon which, in the next summer, a gall of the same species will develop (see Plate XI, div. C.)

The gall of *Andricus curvator*, when upon a twig or leaf petiole, exhibits similar peculiarities, but not to so great an extent; when a leaf is involved in its growth there is no comparison. This gall is also bilocular; the larval cell, however, is loose within the external gall growth, while that of *Inflator* is attached.

In the compound gall of *Aphilothrix fecundatrix* the inverse is exemplified. The inner gall, when pushed out in the late summer by the dying leaf scales, falls to the ground, and continues growth in a manner similar to that of the *Neuroterus* galls. The leaf scales, although dead, persist for many months, and only disappear from the twig when pushed off by new growth in the following spring.

**The component parts** of galls are variable.

The simplest forms are those of *Spathegaster baccarum* and *Trigonaspis crustalis*, in which the tissue is very loose, filled with a copious thin fluid, and the exterior merely a thin epidermis with chlorophyll.

After the emergence of the imago it withers and shrivels to a condition sometimes beyond recognition.

The next form is that of galls such as *Andricus noduli*, *A. nudus*, *Aphilothrix fecundatrix*, *A. quadrilineatus*, *A. solitarius*, in which the inner layer is moderately thick, and is composed of cells containing nutritive materials for the larva, and surrounded by a thin layer of hard woody cells filled with colour pigments. The same is found in *Aph. globuli*, with the addition of an outer sappy green rind. *Aph. Sieboldi* partakes of the same nature, but the rind, instead of

being green, is red or crimson, and from it exudes a sweet sticky substance. In *Dryophanta scutellaris* there are three distinct layers. Surrounding the larva are the primitive nourishing tissues; next is a thin layer of bundles of hard cells, these being surrounded with a thick coating of palisade-like cells, with a thin epidermis containing colouring matter.

Three galls, although plurilocular in growth, are widely dissimilar in the covering which surrounds the cells when the galls are in perfection of growth. *Aph. radicis* not only has the appearance of a truffle, but when cut is very much like one; it also resembles a potato, and has the same solid but sappy consistence. Although usually below ground, decay is slow. In *Teras terminalis* the texture is looser, but contains more sap in proportion; it ultimately becomes spongy, and, except the cells, decays during the following winter. *Andricus ramuli* is perhaps unique. The little larval cells, massed together to the number of ten or twelve, are entirely concealed by a dense mass of long white simple hairlets, neither the origin nor the structure of which appears to be known.

A more complex structure is that of *Neuroterus lenticularis*. When examined in September it is found to consist of a central mass of cells, full of primitive nourishment for the larva which occupies the centre; these the larva consumes before the gall falls. Outside these cells are bundles of palisade-like cells, which are surrounded with a thick layer of other cells containing starch granules, and upon these the larva feeds before it pupates. A thick epidermis with chlorophyll granules forms the exterior, from which there grows numerous hairlets arranged in a stellate manner.

*Cynips Kollari* is not only the most complex of British galls, but also the most durable. According to Beyerinck ('Beobachtungen über die ersten Entwicklungsphasen einiger Cynipidengallen,' p. 142 *et seq.*), when the gall approaches maturity the cellular tissues become differentiated into eight layers: (1) The

exterior, consisting of epidermis with unicellular hairs containing red pigment in their cell contents; (2) colourless hypodermal cells, beneath which is (3) a layer of small meristematic cells; then (4) a thick layer of large cells rich in tannin, below which follow, (5) the cambian ring, (6) primary starch cells, (7) cells containing crystals, and (8) a thin layer of primary nutritive tissue composing the walls of the larval cell.

**The colours** in many oak galls are very varied and rich.

They range from white and cream through all tints of yellow, from very pale to deep orange, and from a very pale green to a rich dark hue, and through almost every shade of red, some of the tints of which are very attractive. Only one kind of gall yields a purple, and that colour is in the hairlets with which it is clothed (*Spathegaster Taschenbergi*). The browns vary from very pale, through various shades of reddish-brown, to chocolate.

No English gall student appears to have published results of investigations into the origin of the colours. This is rather remarkable, because the colours are always so prominently before the collector, and in many instances it is the colour which gives the charm to the gall.

Dr. Marion Newbigin's researches ('Colour in Nature,' 1898) have shed much light upon the physiology of pigments and colours in plants and animals. But the colours of vegetable galls do not appear to have received her attention. Since most galls are almost as complex in their structure as the plant on which they grow, and as it has already been shown, are so indissolubly associated with the energising functions of the tree, and also built up of the same materials, may it not be inferred that the coloration of galls is produced in the same manner as in other parts of the plant?

Chlorophyll-green is, of course, the supremely im-

portant pigment, and with it are associated lipochrome pigments, whose nature and amount determine the exact shade of green displayed by the vegetable organs.

"The fixed or lipochrome pigments occur in the form of solid particles in the cell, and the free or anthocyan pigments, in solution in the cell sap" (*loc. cit.*, p. 70).

Galls, which during their median or final stages of growth are yellow or orange, obtain their tints from the lipochromes, which take the place of the chlorophyll-green.

A series of pigments known as anthocyans, in a soluble condition, are blended with the cell-sap; they form the colouring materials and manifest themselves most prominently in the epidermis and underlying tissue.

Anthoxanthin is the yellow pigment; it is common and widely distributed. In the case of galls it appears to manifest itself as soon as the chlorophyll-green diminishes, and becomes intensified until the orange is reached. Red is the most prevalent, and all the tints are due to lipochromes or to anthocyans. Much of it can be dissolved out in water.

It may be remarked that red is more common in galls maturing in late summer and in the autumn than those of spring time—a feature paralleled in the autumnal tints of foliage and fruits.

Dr. Newbigin is of opinion that, in plants, tannin plays the part of a brown pigment. This is more than probable in oak galls since very few of those which develop in the spring and mature in early summer change to brown, whereas almost all the autumn forms assume that colour at a comparatively early age.

The formation of tannin and its oxidation are most active during the time these galls are growing.

## CHAPTER II.

### SOME FEATURES OF OAK GALL GROWTH.

THE COMMON ORIGIN: THE CAMBIUM REGION.

I. DURATION OF GROWTH:
(a) *Rapid;* a few days. (b) *Slow;* several months.

II. POSITIONS OCCUPIED:
(a) *Root.* (b) *Stem.* (c) *Leaf.* (d) *Flower.*

III. SIMILARITY OF GROWTH.

IV. DISSIMILARITY OF SHAPES:
(a) *Globular.* (b) *Ovoid.* (c) *Reniform.* (d) *Lenticular.* (e) *Aberrations.*

V. VARIATIONS IN SIZE, TEXTURE, COLOUR:
(a) *Girth.* (b) *Length.* (c) *Succulent.* (d) *Woody.* (e) *Green.* (f) *Red.*

VI. MODIFICATIONS IN DEVELOPMENT:
(A) *Due to External Influences;*
(*a*) Overcrowding. (*b*) Environment.
(B) *Due to Internal Influences;*
(*a*) Parasites. (*b*) Inquilines.

VII. SMELL.

VIII. TASTE.

The common origin of all vegetable galls is the cambium layer, or region, of the plant. Unless the

egg is laid within or upon its tissues no gall formation takes place. Taking this, therefore, as the main feature upon which gall formation depends, it will not be difficult to trace a few leading characteristics relating to the development, environment, aberrations, etc., in British oak gall growth.

They may be tabulated as shown on page 9.

## Duration of Growth.

(a) *Rapid ;* a few days.

The periods of duration of growth are either very short or protracted. In point of rapidity probably no other oak gall develops and reaches maturity with such speed as does *Spathegaster Aprilinus*. Under ordinary conditions three or four days are sufficient for it to be completely formed and reach its maximun of size. *Spathegaster baccarum*, *S. tricolor* and *Trigonaspis crustalis* are about equal with each other in the same respect, and either may be mature within seven or eight days. This does not imply that the inhabitant, or inhabitants, have passed through the metamorphoses and the imagines ready to emerge, although in the case of *S. Aprilinus* only a few days more are required for its accomplishment.

(b) *Slow ;* several months.

The gall of *Cynips Kollari* doubtless requires a longer time to attain maturity than any other. Beginning growth early in April, it steadily progresses until September before it ceases. But *C. Kollari* is a gall by itself. It has been described as neither catkin, leaf, bud, nor stem gall, belonging, indeed, to another and separate category.

*Aphilothrix radicis* is the next slowest in growth, five months being occupied in its development. Its persistency and protracted decay are about equal to those of *C. Kollari*, extending to two or even three years.

## Positions Occupied.

(*a*) Root. (*b*) Stem. (*c*) Leaf. (*d*) Flower.

This section presents the same features as are found in all vegetable galls. The division of the plant into four primary parts affords the only simple and comprehensive scheme of classification. The student desirous of following this phase of the subject is referred to the author's previous work, 'British Vegetable Galls,' pp. 24-30.

Of those on roots there are two galls of distinctive and definite forms, *Biorhiza aptera* and *Aphilothrix radicis*. While the former has never been found growing above ground, the latter is occasionally met with on small twigs springing from the tree trunk, at a foot or two above the soil (see Plate XXX, div. A).

The most characteristic gall on the main stem, or trunk of the tree, is that of *Trigonaspis crustalis*, which in reality is a transformed bud. *Aphilothrix albopunctata* is typical of an external gall on the twig, and *Andricus noduli* of a gall concealed within the tissues of the twig. Numerous examples could be cited of galls attached to the leaf. The mid-rib, its off-shoots, the under surface (mostly) of the blade, occasionally the upper surface, the margin, and also the petiole all have a gall or galls peculiar to them.

The staminate flowers are attacked, a typical example being *Aphilothrix quadrilineatus*. Seven other galls are also found on the catkins. The acorn, being a subsequent development of a fertilised flower, is included in this sub-section, the only gall found within the cotyledons being that of *Andricus glandium*.

## Similarity of Growth.

There is a remarkable similarity in the appearance of many galls of the same or allied genera, especially in galls occurring on the continent, but not as yet recorded for Britain. The collector of oak galls will find upon looking over a collection of European oak

galls, or a series of illustrations, many forms which resemble well-known British specimens; *e. g. Dryocosmus cerriphilus* on twigs of *Q. cerris*, is very much like *Aphilothrix corticis* and *A. Sieboldi*, which do not appear on *Q. cerris* in Britain; *Cynips cerricola* is like *Biorhiza aptera; Andricus crispator* like *Spathegaster baccarum; Neuroterus saliens* like *N. ostreus; A. cydoniæ* like *A. inflator; N. lanuginosus, Cecidomyia cerris*, and *C. circinnans* all resemble *N. lenticularis* and *N. fumipennis*. Of British forms, *Andricus circulans, Spathegaster albipes*, and *S. verrucosus* are similar in form; so also are *Andricus globuli, A. autumnalis, A. collaris* and *A. clementinæ*. Further illustrations might be given were it necessary. It is also noteworthy that the positions these galls occupy on the tree are very similar.

### Dissimilarity of Shapes.

(a) *Globular* = spherical = globulose.—This is a somewhat prevalent form, but subject to variation in which the opposite poles are depressed, such galls as, *e. g. Dryophanta agama* and *D. divisa* being termed oblate. Examples of *C. Kollari* are not infrequently seen which are as perfectly spherical as though they had been turned on a lathe. *Aphilothrix globuli* is normally true to shape; denuded of its outer green rind, it is an almost perfect sphere.

(b) *Ovoid* = oviform.—This term is applied to those galls whose long axis considerably exceeds that of the short axis.

*Spathegaster albipes* typifies this form, although it has a small style at the distal end.

(c) *Reniform.*—One gall is kidney-like in outline—that is *Biorhiza renum.* Some specimens are very true to form; others, however, approximate an ovoid, and now and again a globular form will be found. *N. ostreus* occasionally approaches the reniform shape, and when mature, and spots and basal scales are absent, it is

difficult to determine. The larval cell of *Andricus curvator* is also occasionally somewhat reniform.

(d) *Lenticular.*—This form of growth is confined to the three leaf spangles, and in *N. lenticularis* and *N. fumipennis* it is very constant, except when the galls are over-crowded. *N. læviusculus*, however, departs from the true lenticular shape to a considerable extent.

(e) *Aberrations.*—Deviations from normal conditions of both shape and situations.

The most remarkable examples of aberrations in oak gall growth are found in specimens of *C. Kollari.* On Plate XXXVI a number of unique specimens are represented. Double, triple, and quadruple galls are due to two, three, or four eggs being deposited in the same leaf-axil, the distance between each being so slight that as soon as the larvæ hatch they are in close contact, and although they may each form a cell they are but slightly separated from one another. Sometimes they interfere with each other's growth, and then only one will survive to pupate. But supposing that all reach the imago stage they may not all succeed in emerging. One or more may commence to gnaw in the direction of the longest axis and not have sufficient endurance to reach the exterior, perishing in the attempt to eat through double the normal amount of gall substance.

Figs. 38 and 39 are scarcely recognisable as double galls, yet each contained two larvæ; so also does Fig. 40; a slight division is, however, noticeable. Figs 23–28 are double, but of very considerable unequal development, showing that one larva lived for a short time only. Figs. 29, 30, 33–47, 41, 42 all have a well-defined constriction. All these specimens were attached to the twigs at a point immediately above the figures. But in Figs. 31, 32, 43, and 44 one sphere only is in connection with the twig; the other sphere is united to the opposite pole in a Siamese-twin union. They are distinct from the common double form. In each

case, except that of Fig. 32, both sections have reached maturity. Each section possesses a larval cell.

Two or three galls of *Andricus curvator* frequently grow together, forming but one cavity, with two or three larval cells. Or the gall may develop near the base of the petiole, and produce a swelling bearing a strong resemblance to *A. inflator*. *Neuroterus lævius-culus* affords some interesting variations, a few of which are represented in Fig. 14, where they are also briefly described.

## Variations in Size, Texture, Colour.

*Size:* (a) *Girth.*—The smallest of all known galls is that of *Neuroterus minutulus*, Gir. It is not yet recorded for Britain. "It is spherical, 1·2 to 1·5 mm. in diameter, thickly covered with short conic-ovate tubercles, and of a rusty brown colour" ('The Entomologist,' vol. x, p. 173).

To return to British galls. The dimensions attained by *Aphilothrix radicis* undoubtedly exceed those of any other gall. The largest the author has found was on a very old stump, on June 18th, 1902. It measured 32 cm. at its greatest girth. Had it not been removed it would have increased considerably by the end of August, at which time it would have attained maturity. *C. Kollari* develops into the largest unilocular gall; specimens measuring 75 mm. in girth are not uncommon (See Plate XXXVI, fig. 1). The cherry-gall occasionally attains 63 mm. in girth.

(b) *Length.*—The genus of Andricus furnishes at least nine examples of galls whose external measurements do not exceed 2 mm. in length. Two of these seldom attain that length. Both *A. nudus* and *A. pilosus* are normally not more than 1·5 mm. long. The latter species appears to be larger, but that is due to the hairlets with which it is covered.

The stalked-spindle gall, caused by *Aphilothrix callidoma*, far surpasses all oak galls in its length. Specimens

attain 30 mm. in length and 12 mm. in girth. *A. seminationis* (thought by some writers to be the same gall), which develops on the catkin instead of on a twig, is the next in length, but it seldom exceeds 8 mm. in length.

*Texture:* (c) *Succulent.*—There is little difference in the soft and juicy nature of *Spathegaster baccarum* and *Trigonaspis crustalis*. A gall of either species measuring 42 mm. in girth contains 12–14 minims of fluid. A specimen of *Dryophanta scutellaris* will yield a large amount of fluid, but not so much in proportion to the gall-substance as the former species. From *Aphilothrix radicis* and *Teras terminalis* a moderate amount of moisture can be expressed. No other gall contains a sufficiency of moisture worthy of remark.

(d) *Woody.*—This term, of course, applies only to galls when mature. All are more or less soft during the early stages of formation. Of simple structures, those of *Andricus curvator* on twigs and petioles, *A. inflator*, and *A. solitarius* are moderately woody. Others of a harder texture are *Aphilothrix corticis*, *A. Sieboldi*, *Biorhiza aptera*, and those of the *Dryophanta* genus. The small hard cells of *Andricus ramuli*, and the conglomerated cells with the surrounding woody growth of *Aphilothrix radicis* are, however, surpassed by *C. Kollari*, which is the hardest and most woody of all.

*Colour:* (e) *Green.*—Green is the prevailing colour. It is due entirely to chlorophyll. From an exceedingly pale shade, as in *Spathegaster tricolor* (denuded of hairlets), or *Aphilothrix corticis*, various gradations of this colour are to be found until as deep a shade as seen in any oak twig or leaf is manifested in many specimens. The most beautiful of all green shades is, perhaps, that of the oak-marble, when in June and July its epidermis is a beautiful golden green. Green is generally succeeded by brown of various shades. The brown pigment is probably due to tannin taking the place of the chlorophyll.

(f) *Red.*—The same chromatic gradations are found in this colour, from the most delicate suffusion of pink, as in *T. crustalis*, until a deep crimson or rose-madder is reached, as shown in *A. Sieboldi*. The most charming example of a median red tint is that of *D. scutellaris* when at the zenith of its glory. *Teras terminalis* also often exhibits a wealth of beautiful tints. The brilliant red spots or stripes on the green ground of *S. baccarum* accentuate its resemblance to a red-currant berry. The red stripes on *Dryophanta longiventris* are worthy of remark. The pretty pink and light red of *D. divisa* deserves notice; it is, however, transitory—the brown soon asserts itself. The crimson margin of many specimens of *Neuroterus læviusculus* provides a charming contrast to the greenish-yellow centre. The red and crimson stellate hairlets of *N. fumipennis* and *N. lenticularis* clothe these galls with rare and most beautiful effect. In addition to these distinctive colours all tints of yellow, also orange, both pale and deep, are to be seen in many galls. White is somewhat unusual, *Andricus noduli* giving the best example. *Aphilothrix Sieboldi* is often cream coloured when shielded from the light by loose earth or dead leaves.

## Modifications in Development.

(a) *Due to external influences.*—This division in the study of oak galls should receive the attention of the collector and the student, because from the examination of affected specimens some very interesting facts can be deduced, and much of the economy of gall-producing agents and their allies understood. It is a section which is very near that of "Dissimilarity of shape due to aberrations," yet sufficiently distinctive to be separated.

Of the modifications in shape and size caused by—

(a) *Overcrowding* not much need be said. The

deformities thus produced are well illustrated in *Andricus æstivalis*, which normally is cup-shaped; *B. aptera* when solitary is globular. Three species of *Neuroterus* are often much out of shape on account of overcrowding, as may be seen on Plate LX, div. A; and *A. Sieboldi*, *B. renum* and *C. Kollari* are at times subject to much distortion from the same cause.

(b) *Environment.*—This also requires little more than a passing notice. Those galls whose normal position is on the under-surface of the leaf do not usually attain their customary dimensions when on the upper surface. A terminal, or nearly terminally situated, specimen of *Aphilothrix callidoma* is rarely as long as when axillary. *C. Kollari* is sometimes badly pinched in a forked twig (Plate XXXVI, figs. 9–14), or when bunched together in clusters (Plate XXXVIII).

(B) *Due to internal influences.*—(a) *Parasites* are the principal agents in causing these modifications. They destroy the rightful owner of the gall, and in all unilocular galls growth is usually arrested; the structure either remains a diminutive form of what it would have been, or some peculiarity is accentuated, such as the style on *A. solitarius* and on *C. Kollari* (see Plate XXXIX, div. C), or increase in the number of ridges on *Aphilothrix callidoma*.

(b) *Inquilines* do not usually destroy the larva, but only live within, and feed upon, the tissues of the gall in company with the owner, but not in the same larval cavity. In the majority of galls tenanted by inquilines no deviation from the normal dimensions are noticeable. This is exceedingly well exemplified in specimens of *C. Kollari* on Plate XXXIX, div. B. It is in every way normal, yet from it there have emerged the rightful owner and thirty-two inquilines, but their combined depredations have been so great as to leave the exterior a mere shell.

Of all galls, whether on the oak or any other British plant, none appears to harbour more parasites and inquilines and visitors than that of *Teras terminalis*,

the oak-apple. It is on record ('Alternating Generations,' pp. 77–79) that Mr. Francis Walker reared from a number of these galls specimens of Insects, Arachnidæ, and Acari, belonging to seventy-five species. The effect upon this gall is to increase its rotundity rather than to produce malformation in its contour. A normal mature specimen measures about 8 cm. in girth, whereas one containing a host of inquilines and parasites measured 18 cm. in girth—an exceedingly fine specimen.

## Smell.

Collectors of galls are aware that many species possess a distinctive odour, which it would appear acts as a means of defence against enemies other than inquilines and parasites.

Cameron has ably summed up the subject in the following manner: "This phenomenon is doubtless accompanied by some noxious principles which make the larvæ unpalatable to birds, etc., and is found chiefly in the larger species which inhabit large galls all the year round. Both the larva and imago may give out an offensive odour. *C. Kollari* and *Dryophanta folii* (= *scutellaris* of this work) are cases in point. The smell given out is usually bug-like, but Paszlavsky ('Wien. Ent. Zeit.,' 1883, 130) mentions that *D. folii* has the smell of ripe apples, *A. radicis* of lemon, *A. Sieboldi* and *C. tinctoria* of caramel or fresh malt, with a trace of bug-smell. According to the same authority the *folii* individuals bred from the Sessile-Oak have the smell much more intense than those from the pedunculated species" ('Brit. Phyto. Hymen.,' vol. iv, p. 15).

## Taste.

The taste of oak galls to the human palate does not appear to have been described in any writings. That,

when disagreeable, the taste is in some instances due to the larva within will readily be understood from the previous quotation.

*Spathegaster baccarum* on catkins has the least taste of any kind. It is soft and very juicy. The larva itself is but slightly acid in taste. *Andricus curvator* is sappy, but somewhat bitter; *A. glandulæ*, *A. solitarius*, *Aphilothrix albopunctata*, and *A. fecundatrix* are not disagreeable, but they are devoid of a distinctive flavour. The rind of *A. Sieboldi* is slightly sweet, but the woody part is unpleasant.

All the species of the *Dryophanta* and *Neuroterus* genera are insipid. That is probably due to the fact that although rich in starch they are poor in tannin. *Trigonaspis crustalis* is the most unpleasant of any kind. It is bitter and very disagreeable, which is probably due to tannin and gallic acid. These flavours may have a deterrent effect upon the appetites of Lepidopterous and Coleopterous larvæ, since rarely are galls seen that have been attacked by them, *Teras terminalis* being an exception. Birds also may be warned off most kinds by the same cause. One kind, however, is greedily devoured by ground-birds in the North. The galls of *Neuroterus lenticularis* are extensively eaten by game-birds, notably Black-game (*Tetrao tetrix*, L.) In the crop of many of these birds large quantities of the galls were found along with other food. The crop of one bird contained a number estimated at "not less than 500" ('Trans. Ento. Soc.,' 1907, pt. iv, p. 84). Doubtless pheasants, partridges, and other ground-birds thoroughout the country feed upon these galls.

## CHAPTER III.

### THE NUMERICAL ASPECT OF OAK GALLS.

The great abundance of many species of oak galls is often commented upon by field naturalists, but the phenomenon is seldom referred to in publications. It is, however, a feature which annually manifests itself in a most pronounced manner.

In districts where hedge-banks are neglected, and woods are not cut down more than once in twelve or fourteen years, the gall-wasps have every facility to multiply and spread unchecked—an advantage of which they fully avail themselves.

The diminutive size of most species doubtless affords them considerable immunity from the voracity of carnivorous insects, nor do they often become the food of spiders. If the snare of almost any sylvan spider be examined, it will be found that captive insects are very few whose wing expanse is less than 1·5 or 2 mm. As the strands of most snares are from 5 mm. to 10 mm. apart, and some much wider, it may be assumed that numbers of the smaller Cynipidæ pass through the meshes without detention, while larger insects are entangled in the sticky threads.

Doubtless they are enabled to escape the notice of many enemies on account of their lethargic habits, and a tendency to simulate death.

The main factor, however, in the abundance of galls, is the prodigious number of ova these tiny insects are capable of producing, and also the leisurely and effective manner in which they oviposit. An instance observed and recorded by Dr. Adler is perhaps the most enlightening concerning this. An imago of *Biorhiza aptera* "was put upon a little oak, and soon began to prick a bud; when it had finished the first

bud, it went on without interruption to another, and was altogether eighty-seven hours busily employed in laying its eggs. In two buds I counted 582 eggs" ('Alternating Generations,' p. 72).

So accurately are the ova placed either within, or upon, the cambium layer, that failure in gall-production is rare.

The operation of egg depositing is a delicate one and it demands much care and time.

When *Neuroterus lenticularis* settles on a bud, the long and slender terebra is inserted near the apex and pushed between the leaf-scales down to the base of the bud; then it curves upwards, penetrating a part of the bud axis, until it comes into contact with that part of the embryo leaf which will be the under-surface when expanded; the gall of *Spathegaster baccarum* then develops. *N. læviusculus*, whose mode of oviposition is similar, requires from fifteen to twenty minutes to perform the same operation. But piercing the vegetable tissues is only one part; the egg with its long stalk has to be pushed along until it reaches the termination of the puncture. For each egg a separate tube has to be made in the bud, because the egg-stalk occupies too large an amount of space in the tube to allow another egg to be pushed by the side of it.

Efficiency is aimed at by the Cynips, and she is rewarded for her labours and care by a high percentage of satisfactory results.

How it is possible for the insect to determine the exact spot for the egg to lie is beyond the scope of the present consideration of the phenomenon, except to mention that certain tactile hairlets, whose bases are connected with nerves, are situated on the ovipositor, which are also employed in the discrimination between leaf-buds and flower-buds.

In comparison with the size of the abdomen the ovaries are very large, and many species of the Cynipidæ contain enormous numbers of ova.

The ovaries of *Cynips Kollari* have been shown by

Beyerinck to contain about 800 ova. It is quite certain, however, that she seldom, if ever, lives to deposit so many. Single galls of *Aphilothrix radicis* commonly contain 60 to 80 larval cells, and not infrequently 120 to 150. The gall, of which half is shown in Plate XXVI, div. A, contained 180 cells. A most careful examination of the gall, and the spot from whence it developed, failed to show that it was due to the energies of more than one insect.

Ova are more abundant in the species which cause autumn galls than in those which cause summer galls. The numerousness of autumn galls on leaves is very remarkable, much more so in some years than in others.

For several autumns the author has given some attention to this phase of the subject. The following are amongst the most noteworthy examples of which a record has been kept :

| Galls of | Length of leaf exclusive of petiole. | Breadth of leaf from tip to tip of widest lobes. | Number of galls on the leaf. |
|---|---|---|---|
| *Dryophanta divisa* | 11 cm. | 6·2 cm. | 32 |
| ,, ,, | 10 ,, | 5·4 ,, | 34 |
| *Neuroterus ostreus* | 12·2 ,, | 8 ,, | 27 |
| ,, ,, | 8·5 ,, | 5·1 ,, | 28 |
| ,, ,, | 9·4 ,, | 6 ,, | 31 |
| ,, ,, | 11·5 ,, | 7·3 ,, | 42 |
| *Biorhiza renum* | 12·3 ,, | 8 ,, | 32 |
| ,, ,, | 7 ,, | 3·5 ,, | 33 |
| ,, ,, | 7·2 ,, | 4·3 ,, | 35 |
| ,, ,, | 11·6 ,, | 6·8 ,, | 48 |
| ,, ,, | 14 ,, | 7 ,, | 48 |
| ,, ,, | 6·8 ,, | 4·2 ,, | 51 |
| *Neuroterus numismatis* | 9 ,, | 7·2 ,, | 358 |
| ,, ,, | 10·3 ,, | 7 ,, | 465 |
| ,, ,, | 10·5 ,, | 7·5 ,, | 518 |
| ,, ,, | 9·4 ,, | 5·3 ,, | 609 |
| ,, ,, | 14 ,, | 9 ,, | 681 |
| ,, ,, | 15·8 ,, | 10·1 ,, | 698 |

(See also description of same species.)

*Neuroterus fumipennis*—

3453 galls on 15 leaves off one bush.

| | |
|---|---|
| Fewest galls on one leaf . . | 115 |
| Most „ „ „ „ . . | 489 |
| Average per leaf . . . | 230 |

Weight of the galls, 2 dr., 1 sc., 6 gr.

*Neuroterus lenticularis*—

1944 galls on 12 leaves off one bush.

| | |
|---|---|
| Fewest galls on one leaf . . | 72 |
| Most „ „ „ „ . . | 288 |
| Average per leaf . . . | 162 |

Weight of the galls, 4 dr., 1 sc., 17 gr.

These leaves were gathered after twenty-two days without rain. The galls were removed from the leaves, counted, and weighed at once, all the figures being verified in several ways.

To ascertain if the galls of *N. fumipennis* would have weighed more had the weather been wet, they were spread in a shallow dish and exposed to rain for three hours. They were then allowed to dry off superfluous moisture. Upon weighing again it was found they were 12 grains heavier than before.

So far as the author's observations have extended, the largest number of galls of a few other species on single leaves are:

| | | |
|---|---|---|
| *Dryophanta scutellaris* . | 9 | on one leaf. |
| *Spathegaster tricolor* . | 12 | „ „ |
| „ *baccarum* . | 8 | „ „ |
| „ „ . | 17 | „ catkin-stalk. |
| *Aphilothrix quadrilineatus* | 35 | „ „ „ |
| *Cynips Kollari* . . . | 38 | „ twig. |
| *Aphilothrix Sieboldi* . . | 138 | „ „ |
| „ *corticis* . . | 32 | within an area 4·5 cm. in diameter. |
| *Trigonaspis crustalis* . | 12 | within an area 15 cm. in diameter. |

On one leaf, 14 × 9 cm., there were growing:

1 *Neuroterus ostreus* . 2 *Dryophanta scutellaris.*

122 *Neuroterus numismatis* 21 *N. fumipennis* = 146 galls.

On another leaf, 14·5 × 7·5 cm.:

5 *Neuroterus ostreus* . 12 *Dryophanta divisa.*

37 „ *numismatis* 123 *N. fumipennis* = 177 galls.

It is very remarkable that the abundance of the spangle galls in particular upon a leaf does not affect its normal size, shape, outline, or thickness. There is therefore no detriment to the foliage on account of the presence of hundreds of thousands of these galls on a bush or tree, nor is the growth and development of either hindered.

The galls on catkins undoubtedly prevent the growth of thousands of acorns, but that is of small consequence since thousands more are available for seedling oaks, or for pig food and small rodents. The value of the tree is in its timber and its bark.

In connection with the numerical abundance of galls, two correspondents have kindly communicated the following: "It may be of interest to you to know that several oaks (*pedunculata*) which I specially noted in May as having an abnormal number of red-currant galls upon the catkins, are at the present time (August) quite free from galls of any kind, but some little 'shrubby' oaks in their immediate vicinity have their leaves covered with *N. lenticularis*. In other places in the same wood the Turkey oak and our common oak are growing side by side, so close that the branches intermingle; the Turkey oak is quite free from galls, the others have *numismatis* and *lenticularis* in large numbers, chiefly on leaves at the apex of the branches" (E. W. Swanton, Haslemere, Surrey, in lit., September 4th, 1904).

This latter peculiarity has been noticed on several occasions by the author. So also has the strange fact that enormous numbers of galls of several species will be found in one part of a wood and nowhere else in the same wood.

The other correspondent writes: "Several workers in the West Riding of Yorkshire have noticed that the oak trees which are much attacked by *Aphilothrix fecundatrix* usually produce acorns having pink cotyledons. So pink are they that the colour shows through the seed covers. Of course this may be only a coincidence, but several of us have observed it for some years" (In lit., W. P. Winter, Moorhead, Shipley, December 29th, 1907).

## CHAPTER IV.

### THE CYNIPIDÆ AFFECTING THE OAK.

Since the Cynipidæ are such interesting and remarkable insects, a few pages will be devoted to a very brief description of the imagines and their early stages. More than a mere outline of these facts is not desirable, since the present volume is designed to treat of the galls they produce; nor, indeed, is it possible to do this much without quoting largely from two works frequently mentioned in previous and subsequent pages, both of which works contain exhaustive and detailed information concerning these gall-wasps. There is practically no feature of great importance that can be added.

But there may be many collectors, students, and also readers who have not access to other works on the subject of oak gall producers, and they would welcome some information concerning the Cynipidæ. For their assistance this chapter is inserted.

The name of Cynipidæ was given to this group of the aculeate Hymenoptera by Linnæus.

They are very interesting insects in several ways. Almost all of them are either gall producers or are parasitic upon other insects. The distinguishing features of the family, according to Cameron ('Brit. Phyto. Hymen.,' vol. iii, p. 142), are shown in eleven particulars, an important one being that the abdomen is petiolated and laterally compressed.

The imago has many points of great interest. So

far as is known the species which produce galls on the oak do not take food, nor frequent flowers for nectar; they, however, occasionally imbibe water. Many kinds when alarmed fold the wings, tuck their legs and antennæ close to the body, and remain motionless for some time.

They seldom fly more than a very short distance, their distribution being accomplished more frequently by the wind than by their own efforts.

Several observers have recorded the fact that *Cynips Kollari* is a most lethargic insect. Hundreds of imagines may be reared, and only very rarely will one be seen on the wing. Nor is this peculiarity confined to that species; it is common to most.

On one occasion the author opened a gall of *Dryophanta disticha* which contained a mature imago. It at once ran about the table, and when a glass was placed over it it ran up the side and expanded its wings completely, but neither then, nor when the glass was reversed, did it attempt to fly.

Almost all the species cling with remarkable tenacity to leaf or twig, or even one's finger, and it requires a sharp and strong puff of wind to dislodge them.

The imagines of most kinds are difficult to rear, because it is not easy to maintain the natural conditions of life. But even when it has been possible to accomplish this, success does not often follow. Some remain in the larval stage for many months (*e. g. Andricus glandium*, *Aphilothrix fecundatrix*), and for many months more in the pupal condition, and then perhaps they will die before the imago stage is reached. Doubtless, in their natural surroundings of hedges, woods, trees, etc., innumerable multitudes never complete their metamorphoses. A few species are able to endure great cold. Cameron states that *Biorhiza aptera* appears during frost and snow in winter time and deposits ova (*loc. cit.*, vol. iv, p. 3).

Immediately after leaving the galls the Cynipidæ begin to lay their eggs, and speedily die. The act of

oviposition—seldom or frequent, as the case may be —is carried out with remarkable certainty in the right part of the plant. As is shown on another page, error of judgment means the loss of progeny.

The study of the imagines will be found very puzzling to the general entomologist, as there is a very general likeness amongst the species. The inquilines, especially, greatly resemble the true gall producers.

The bodies of the Cynipidæ are of very beautiful and bright metallic colours. Red, green, orange and blue predominate. The wings also are exceptionally iridescent. The imago of *C. Kollari* is the prettiest, having a bright metallic yellow, orange and purple body, and highly iridescent wings. All the species are small, varying from 2 mm. to 5 mm. in length. Many are very agile, and all are graceful in their movements.

They have four wings. The two anterior wings are about the same length as the body; the other two are about half the size; the margins are usually fringed with minute hairlets. Some species are wingless.

The antennæ are long in comparison with the size of the insect. In the males there are generally one or two joints more than in the females; they are also thinner.

The abdomen of the male is differently shaped from that of the female, but there is no difference in the coloration of the sexes. The difference in the size and form of the ovipositor depends upon the generation of the insect. In those species which appear in the spring it is much shorter and less curved than that possessed by those which oviposit in the autumn. The process of egg-laying on the part of gall producers is somewhat complicated; it is therefore necessary that the instrument with which it is performed should be elaborate. It is known as the terebra, or ovipositor. It consists of three portions: the seta, and two serrated spiculæ. When at rest the entire instrument

is concealed within the abdomen. The seta is a very stiff bristle united to the interior of the abdomen and controlled by five distinct sets of muscles. If a transverse section of the terebra be examined it will be seen that the seta occupies about half the area, which is circular. The spiculæ are alike in outline and serration, and occupy the remainder of the area.

The action of the ovipositor when making a hole for the insertion of an egg is very similar to the movements of the puncturing or stinging apparatus of other aculeate Hymenoptera; e. g. wasps and bees.

So deeply and firmly do the organs penetrate the plant tissues that the insect is sometimes unable to withdraw them, and they are either broken off or torn away from the abdomen together with the mechanism which controls them.

Some of the oak gall Cynipidæ require from fifteen to twenty minutes to deposit one egg (e. g. *Neuroterus læviusculus*).

The actual process of oviposition can be divided into three stages, which, according to Adler ('Alternating Generations,' p. 119), are these: "(1) The canal is bored, the ovipositor gliding under the imbricated scales to the base of the bud, and then being driven into the centre of the bud-axis. (2) The egg passes out of the ovarium to the base of the ovipositor, where the egg-stalk is pinched between the two spiculæ, and the egg is pushed along the ovipositor. (3) After the point of the ovipositor is withdrawn the egg-body enters the pierced canal and is pushed forward by the ovipositor until it reaches the bottom."

The number of eggs deposited by a single individual varies. Those of the summer generations produce from 200 to 400 eggs, the agamous generations several hundreds more.

The eggs of this family are remarkable in having what is known as an egg-stalk which is attached to the anterior part of the egg. It is a continuation of the yolk sac, and has the function of a respiratory organ

conveying to the embryo a supply of oxygen which otherwise could not reach it.

The larvæ are fat, fleshy, and legless, white or cream colour. When removed from the larval cell and placed on a flat surface they will remain almost inactive. They lie within the larval cavity with head and tail directed slightly towards each other along the ventral surface. The body has thirteen segments. The mandibles are short, broad, and sharply cusped. They pupate in the galls without exception. The length of time required for development is variable. Nothing passes through the body.

The pupa is the same colour as the larva, until shortly before the emergence of the imago, when it changes to a deep pink, the eyes become distinct and the appendages also. The antennæ and legs are enclosed in pellicles, and are placed along the ventral surface of the thorax; the wings are like small bags placed on the sides of the thorax.

The most wonderful features connected with the life-history of this family of gall producers are the alternations of generations, sometimes also called heterogenesis, in which the young do not resemble their parent, but their grand-parent; and parthenogenesis, or virgin production. Thus these insects, although somewhat insignificant in appearance, are of extreme scientific interest on account of the alternations which the various broods present of winged or wingless, and sexual and sexless, individuals at different times of the year.

The phenomenon of alternating generations is not confined to the Cynipidæ. It occurs in the Salpinidæ; among some species (the liver-fluke) in the parasitic Entozoa; it is also one of the means of propagation among the Hydromedusæ and the Polyzoa.

Dalbert de Chamisso was the first to observe this phenomenon, when in 1815 he accompanied, as naturalist, an expedition round the world.

His observations, published in 1819, were not believed,

but as years passed investigations made by other naturalists (Sars, Siebold, and Lovén) proved that he was correct.

In 1842 J. J. S. Steenstrup published ('Über den Generationswechsel') all that was known on the subject. The essay was translated into English by George Rusk, and published by the Ray Society, 1845. Steenstrup quaintly describes this mode of reproduction as "a peculiar form of fostering the young of the lower classes of animals." The preface (*loc. cit*, p. 1) contains the following paragraph: "Alternation of generations is the remarkable, and till now inexplicable, natural phenomenon of an animal producing an offspring, which at no time resembles its parent, but which, on the other hand, itself brings forth a progeny, which returns in its form and nature to the parent animal, so that the maternal animal does not meet with its resemblance in its own brood, but in its descendants of the second, third, or fourth degree or generation."

The bi-sexual, therefore, gives rise to the asexual or agamic, and the agamic in its turn to the bi-sexual. Moreover, the two generations produce galls which differ entirely in shape, size, and situation.

One generation consists of females only, the other includes both males and females. The bi-sexual insect is the result of the union of the male and female, the agamic when that condition is absent.

The theories of non-sexual reproduction are very complex. The facts, however, are simple. From many oak galls which mature in the spring or early summer females only emerge, and without assistance of the male they lay eggs from which larvæ hatch. This is known as parthenogenesis, a word given to the phenomenon by Professor Sir Richard Owen. The galls caused by these larvæ mature in early autumn, and from them there issue both male and female imagines, from the union of which eggs are deposited, and the resultant larvæ produce galls like their agamic grandparent. The ability to reproduce parthenogenetic eggs

often secures the perpetuation of the species more effectually than sexual reproduction. Individuals who lay their eggs in winter are unhindered by the requirements of fertilisation, and the ability to reproduce independently is an advantage to them during the period of frosts and snow. It is not confined to winter species. *Cynips Kollari* and others possess no male; all the imagines are perfect female forms.

## CHAPTER V.

### THE BRITISH OAK.

The British oak, known generally as the common oak, is plentiful in the British Isles, and universally distributed throughout Europe and Asia, except in the extreme northern parts. It is the best known and the most enduring of all forest trees.

Its botanical name is *Quercus robur*, from the Latin and Greek respectively. The ancients were fully acquainted with its durable and useful qualities, and thus it is not surprising that the generic and specific names should convey the meaning of hard or strong wood of oak.

The genus *Quercus* embraces about three hundred species. Whether regarded as a commercial object, or on account of a large number of the species being useful in so many ways, the oak tree is of great importance, and its utility is not surpassed by any other genus of forest tree.

*Q. robur* may be regarded as the type of the oaks which have sinuated leaves. The tree attains dimensions considerably in excess of those of other species of *Quercus*, mainly as regards the size of the trunk and the lower limbs. It is not very lofty, but its lower limbs spread over a considerable area, *Q. cerris* frequently surpassing it in height by forty to fifty feet, but does not spread so far.

In summer and winter alike the British oak commands attention: in early summer because of the delicate emerald green of the unfolding leaves, which soon expand into a wealth of rich green umbrageous verdure.

By the time autumn arrives other developments have taken place, and mingled with the brown and sere leaves there are countless leather-brown acorns. Autumn winds and winter storms shake down the acorns, tear off and scatter the foliage and leave the tree in unclothed grandeur. Its huge trunk and massive limbs, gnarled, scored, and weather-beaten by tempests of hundreds of years, are then revealed to perfection, while the characteristic twisted and elbowed growth of the lesser branches and the twigs are clearly silhouetted against the sky.

There is a considerable tendency to variation in the growth of the tree, and on this account botanists do not appear to be agreed with regard to *Q. robur* and its varieties. Some are of opinion that there is but one definite species, viz. *Q. robur*. Others consider the trees which bear sessile acorns and stalked leaves to be a distinct species, and trees with pedunculated acorns and stalkless leaves another species, and have named them *Q. sessiliflora* and *Q. pedunculata* respectively. Other botanists recognise three forms: the two just mentioned, but described classically as *Q. robur sessiliflora* and *Q. robur pedunculata*, and an intermediate form in which both acorns and leaves are pedunculated, the leaves being somewhat pilose. To this form the name of *Q. robur intermedia* has been given. Many foresters distinguish two sub-species and several varieties. Undoubtedly *Q. robur* exhibits two distinct forms, one being represented by *pedunculata*, the other by *sessiliflora*, with many unimportant intermediate forms. That the extremes are sufficiently definite to merit the terms of species seems to be the opinion of most botanists and writers, therefore throughout this work they are used. Fruit and leaves of both are shown on Plate III.

The growth of seedling oaks is very interesting, much more so if the structure of the acorn be studied before planting any. Acorns gathered in the autumn will yield the greatest amount of instruction. Descrip-

tions in most botanical works will assist a beginner to understand the various parts of the fruit.

Acorns intended for planting should be left out of doors during the winter. If they have been kept indoors they should be soaked for several days in water. A large flower-pot nearly full of earth having been prepared, six or eight acorns may be arranged on the earth and a little loose earth sprinkled over them. If this is done in March or April, healthy little plants will be developed by July. The familiar acorn-glass affords a pleasant way in which the growth of the root and its fibres can be watched.

The two divisions of the inner part of an acorn are the cotyledons, which contain reserve materials for the maintenance of the young plant. When they absorb water the pericarp (or outer skin) bursts at the pointed end, and the radicle pushes its way out, bends downwards, and penetrates vertically into the ground, becomes the root, and sends out on all sides root-fibres which pick up nourishment from the soil. Meanwhile the plumule has appeared from the same opening; rising slowly and pointing upwards, it becomes the stem of the future tree. It grows from the part known as the hypocotyl, and elongates into a slender stem upon which at first scale-leaves appear. When it has attained about three inches delicate-lobed foliage-leaves unfold. For some time the plumule and the radicle draw their nourishment from the cotyledons, which rapidly dissolve in order to supply the demand. When wholly exhausted the cotyledons disintegrate and fall away from the hypocotyl.

At the end of the first year the primary root will have attained a length of about fifteen inches, and the young stem be about six inches high.

If it is desired to keep the little trees, they should be removed from the pot and each replanted in a separate pot or put in open ground. A most interesting study may be enjoyed if one or two acorns each of *Q. pedunculata*, *Q. sessiliflora*, *Q. cerris*, and *Q. Ilex* be

planted in a flower-pot and allowed to remain for several years.

For experimental gall-growing acorn seedlings are best at the third or fourth year.

The following observations made of the growth from an acorn of a small tree may be of interest:

A large acorn of *Q. pedunculata* was planted in open ground of a garden in the autumn of the year 1875, and the spot marked. The following summer the seedling developed in the usual manner. It has now (1908) grown to the following dimensions: Height, 20 ft.; girth of trunk at emergence from the ground, 35 in.; at 3 ft. from the ground, 28 in.; area covered by lower limbs, 15 ft. in diameter.

The oak often throws out new wood during the summer in the form of long, pale-green (red also sometimes) sappy shoots, which frequently bear many fully-developed leaves. These shoots are known as Lammas shoots, from the fact that they are seen early in August. They grow from buds, which instead of remaining dormant until the following spring thrust out their latent growth on account of a wet season following several hot, dry months. Some trees always produce these shoots. A specimen shown to the author several years ago was 7 inches long, with 12 leaves on it. It was growing from a shoot of the year, measuring 5 inches, with 9 leaves, all of which bore a great number of *Neuroterus lenticularis* galls, while the leaves of the Lammas shoot had no galls on them.

The strength and durability of oak timber is such as is found in no other European tree, and when grown in perfection it is the most valuable wood produced in temperate climates. It is hard, little liable to crack or split, and being close-grained is easy to work. The heart-wood varies somewhat in colour; its normal colour is a pale brown.

The technical properties of oak wood are very varied. The chief feature is the annular rings, which

are well marked. In a transverse section (across-grain or horizontally as the tree stands), they can be easily counted and the age of the tree ascertained—one ring for each year. In the centre is the pith, 1 to 4 mm. in diameter, formed of small, thick-walled cells. The annular rings are slightly undulating, bending outwards between the medullary rays, which are of two kinds; one large, broad, and glossy, the other very numerous and small (see Plate II). It is impossible to distinguish between the wood of the two species.

"Oak wood makes excellent charcoal, especially for metallurgic purposes; the Sussex iron, formerly regarded as the best produced in Britain, was smelted with oak charcoal from the great woods of the adjacent weald" ('Encyclopædia Britannica,' art. "Oak.")

The bark is the most valuable part of the tree, and its value depends upon the amount of tannin it contains. The trunk and large limbs yield an abundant supply. In young trees the yield is about 8 per cent. of tannic acid; in old trees it is much less. Trees of thirty to forty years' growth yield the largest percentage. *Q. sessiliflora* yields a larger amount of tannic acid than does *Q. pedunculata*.

The flowers are monœcious (*i. e.* both sexes on the same tree). The staminate or male flowers of each species are arranged in clusters on long slender filaments, and are known as catkins. The female or pistilate flowers are sessile in one species (from which it takes its specific name), and pedunculated in the other, and either single or in groups of two, three, or more.

The leaves of each species are broad and deeply sinuated, the lobes being bluntly rounded. They are arranged on the twig in an alternate manner. Normally they attain a length of 12 to 14 cm. and 7 to 9 cm. at greatest breadth of blades. There is, however, considerable variation. A perfectly-formed mature leaf off a large tree may not exceed 3 cm. in length,

while from a sapling of about two years' growth the author obtained in 1898 several leaves 36 cm. long and 19 cm. wide.

Many leaves also are long and very narrow, with entire margins and a blunt extremity.

Although the general hue of the upper-surface of the leaves towards the close of summer is dull brown, this colour often changes either wholly or in patches to a warm russet-brown, with blotches of yellow, light orange, and red. Specimens that have had large numbers of galls of the genus *Neuroterus* upon them show these colours to perfection, especially noticeable in the case of galls caused by *N. numismatis*.

Leaves from which there is a total absence of chlorophyll do not bear galls.

On young trees and brushwood the withered leaves often remain until the following spring, when the growth of new wood and expanding buds causes them to fall off.

Two other species of *Quercus* may also be briefly described, since they are referred to in subsequent pages:

(1) The Turkey oak, *Q. cerris* (Plate IV, div. A). It is a tall, graceful tree with long, narrow, deeply-notched, dark green leaves, which have a petiole of medium length. The acorns are large, ovoid in shape, about half of which is enclosed in the cupule. The interior of the cupule is silvery-white; the exterior is covered with scales which are very long (12 to 15 mm.), and very numerous (as many as 400), and yellowish-green in colour.

This oak was introduced into England by Miller about the year 1735. It is now somewhat commonly distributed over Britain, and as it flourishes in nearly all soils, and grows twice as fast as *Q. robur* it is a good and useful species in parks, plantations, etc. The wood is good, but it is not so heavy as that of *Q. robur*.

In some seasons enormous numbers of acorns are

produced. They are exceedingly acrid; this may be much reduced by baking.

The trees are raised best from acorns.

(2) The evergreen oak, *Q. Ilex*. (Plate IV, div. B).

The natural habitat of this tree is in the southern parts of Europe.

It bears an abundance of leaves which are dark bluish-green on the upper-surface and covered with greyish pubescence on the under-surface.

The tree is an evergreen. The shape of the leaf is mostly ovate, terminating with a sharp point. The margins may be entire, or serrated, and sometimes prickly, when it has much the appearance of the holly, a resemblance which has caused it to be named *Quercus Ilex*, or the "holm oak."

The young shoots are as remarkable for their light hue as the full-grown tree is for the characteristic sombreness of its foliage.

The acorns are on short peduncles, and oblong in shape; sometimes sweet and bitter acorns are produced on the same tree, but it is usual for a tree to bear either all sweet or all bitter.

In early life the tree grows very rapidly, but after a few years much more slowly. In warmer climates than England it attains a height of 80 or 90 feet, and lives to a great age. It has a great partiality for sea-air, and it thrives well along the sea coasts of England, especially in the south. It can bear the rough south-west gales without injury.

The colour of the wood is dark brown, very hard, close grained, durable and flexible.

# CHAPTER VI.

## HINTS ON COLLECTING AND MOUNTING OAK GALLS.

Collecting oak galls is not at all difficult. Searching for them is a delightful occupation. Good eyesight is essential, because there are many kinds small in size and obscure in growth.

The equipment for collecting is simple. **A vasculum** fitted with a broad shoulder-strap is no trouble to carry; but if the collector's object be to make an extensive collection, or to photograph the various forms and aberrations of galls, it is necessary to carry a spacious receptacle for the specimens. **Several small tin boxes** are likewise necessary. In them rare or special specimens can be put without fear of damage they might sustain amongst the other twigs.

One essential implement of the collector is **a pair of nippers** with sharp edges (Fig. 1). They far surpass a knife in efficiency for severing twigs. To cut twigs with some kinds of galls on them (e. g. *Aphilothrix albopunctata*, *A. Malpighii*) with a knife is in most instances to lose the gall, because the movement of the twig will jar off the gall, and when it has fallen amongst grass, leaves, etc., it is exceedingly difficult to recover.

When using nippers to a twig which has upon it a scarce gall, or a very fine example, a sheet of paper spread beneath the twig will enable the gall to be recovered if it should fall off.

**A pruner** or **averancator,** with cord attached, is another requisite (Fig. 2). When on the end of a stick, specimens can be secured which otherwise would

be out of reach. It is especially useful for cutting off galled catkins, and *Teras terminalis*.

A walking stick is a useful, although not necessary, part of the collector's equipment; because with knife or saw a sapling can be obtained which when ten or fifteen feet high is of greater value than the ordinary companion.

**A small tenon saw** will facilitate the acquisition of specimens of *Dichæna quercina* when on large oak stems. **A little tallow** in a tin box will be wanted, to smear on the saw and prevent binding when cutting thick green wood.

**Field glasses** are useful in detecting small galls high up in large trees. Galls of *Andricus cirratus*, *A. nudus*, and *A. pilosus* are not easy to see at a distance of eight or ten feet above one's head. An alternative is to prune catkin-bearing twigs until galls are obtained; but that method is destructive and not recommended.

The collector should always have a **strong knife**. There are many ways in which it is useful.

**A small fern-trowel** (Fig. 3) with narrow blade is wanted when the root galls are sought; it is also helpful when stripping off a piece of bark with *Spathegaster Taschenbergi* or *Trigonaspis crustalis* upon it.

**A large sheet of newspaper** or brown paper is of great value. Without it galls are often lost. A few 30 cm. lengths of brown string should not be forgotten.

**A note-book and pencil** are absolutely necessary. Particular spots where galls have been, or are to be found, should be entered, with dates when found, or when the places should be re-visited to observe developments in growth, or to remove the specimens under observation. Rough outlines of the places, such as will refresh the memory and act as guides without loss of time, are also desirable.

The collector will frequently find galls that are not

sufficiently grown to be of advantage and therefore it is well to allow them to remain *in situ*. In order to find them again on the next visit to the spot the twig should have a piece of string tied on it leaving the long ends loose. Make a note of any feature that will facilitate identification of tree or bush. Brown coloured string will not be readily noticed by anyone passing the spot, but the collector will soon find it again. The author has watched the growth and afterwards obtained many fine specimens in that way.

Great care has been taken in the selection and arrangement of the specimens illustrated in the following plates, and also in the descriptions of the species, to assist the collector in discovering them. It is not, therefore, here necessary to describe the usual part of tree or bush most likely to yield specimens.

Leisure and patience are needful and a thorough examination of twigs, leaf-axils, and leaves should be made.

When searching for oak galls the peculiarities of the alternation of the generations should not be forgotten, and therefore districts should be sought, and frequently visited, where the woods contain plenty of oak saplings of from three to eight years' growth, with a number of large trees there as well, or near by. Very damp woods do not usually yield many kinds. The reason why is as yet unknown.

Diligent and careful search amongst oak scrub is generally rewarded with many specimens. Not only should the outer twigs and leaves of a bush be thoroughly scrutinised, but examination made of the interior and the small shoots at the base.

The stunted growth on road-side banks, especially the banks of old or little-used lanes, should always receive attention, and hedges around fields amply repay careful search.

A windy day is not recommended as a suitable occasion on which to search. The continual movement of the foliage makes detection very difficult and wearies the eyes.

**Mounting** galls and the imagines which emerge from them may be accomplished in various ways. The particular method of arrangement in the cabinet or wall-case may be left to the collector to adopt which ever is most suitable to the conveniences at command. One thing is most essential: the galls must be allowed to dry thoroughly before placing them in their final positions.

The following suggestions may prove useful to the collector who has not decided upon any plan of arrangement:

A small label should be affixed to each specimen, or cluster of specimens, bearing (*a*) the species of oak, (*b*) the cause of gall, (*c*) locality where found, (*d*) date of find, (*e*) a number corresponding with the same in note-book or catalogue.

Imagines of average size may be fixed on a small piece of white card, or put in a small glass phial, which has upon it a number corresponding with that on the gall-label, and date of emergence. Parasites and inquilines should be put in a separate phial, labelled accordingly, and placed by the side of that containing the Cynips.

Very small imagines which require a lens or microscope for their examination may be mounted in the following manner. Cut a piece of card of about double the thickness of a post-card, the same size as a microscope slip, viz. 75 mm. by 25 mm. and with a steel punch of 12 mm. diameter make a hole in the card. Remove the slight blur caused by the punch with a sharp knife, or rub it down with the thumb-nail. This part of the card is then seccotined, and a microscope cover-slip placed on and allowed to dry. When dry, affix a name label on the card, fill in particulars such as have already been suggested, and then place the creatures in the cavity of the card. Seccotine the margin of the cavity and close it in with another glass slip. Put it aside to dry with a small weight on it to keep it flat and firm.

Microscope slides may be obtained with cavities in them of various depths. In such the insects can be placed, and kept secure by a cover-slip affixed and ringed in the usual manner.

If the collector wishes to secure the numerous insects that emerge from most galls, they should be put in glass jam-jars and fine muslin tied over the opening. A little experience will dictate the most suitable places in which the jars should be kept. Some require a good amount of warmth, some may be placed in sunshine, others require shade. All should be attentively watched and mould removed when it appears.

From some galls insects will emerge during the second, and occasionally the third year, after the galls matured; therefore it is not advisable to remove them too soon from the jars. But there are also others which will not yield any insects unless natural surroundings are very closely imitated, and for this purpose ordinary flower-pots with earth, sand, dead leaves, and such like in them are as satisfactory as can be obtained.

To have a number of seedling oaks of two or three years' growth, and carry on experimental breeding of the makers, and observe the growth of the galls they produce, is a most fascinating study.

Collections of oak galls in museums are rare; very few private collections exist; the collector and student has, therefore, an opportunity of acquiring an interesting and unusual amount of material in a little-known subject, and of adding to scientific knowledge.

**Preserving** galls in their natural beauty is a very difficult matter. There does not appear to be any known or recognised method by which they can be prevented from shrivelling and loss of colour. If gathered when mature the hard and woody kinds do not alter very greatly. The succulent kinds, however, shrivel quickly and lose their colour. It does not seem to be possible to preserve their colours or shape in any way comparable with their pristine condition.

A few experiments with fluids as preservatives show that methylated spirit or even pure alcohol is of no value as they extract all colours. Pure glycerine, or a mixture of equal parts of glycerine and water, is of little value. Solutions of corrosive sublimate, and also of formalin, are not successful mediums, for in many cases the leaf, the stem, or the gall itself loses more or less of the natural colours, and then the true value of the gall is deficient.

There is, perhaps, no better record of the natural appearance of the galls than an accurately coloured drawing, or a photograph as near to, or the actual size of the specimens it represents.

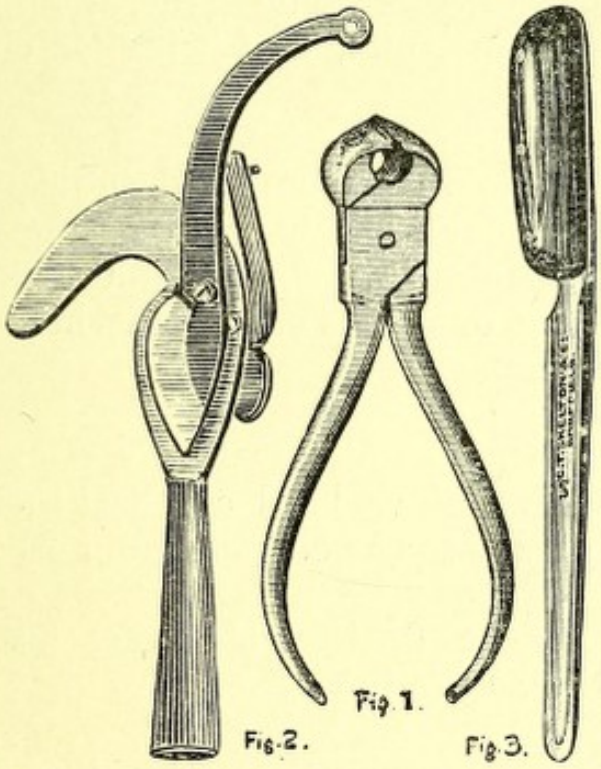


Fig. 1.—A pair of nippers. Fig. 2.—A pruner. Fig. 3.—A fern-trowel.

## TERMS EMPLOYED IN THE SYNOPTICAL TABLES.

*The following terms* employed in the synoptical tables of each gall are intended to convey these meanings :

"**English name of gall**": The majority of the English names occur in 'Alternating Generations,' and are very appropriate.

"**Position of gall**": This indicates where the gall is normally situated. Deviations are referred to elsewhere.

"**Manner of growth**": The general appearance of the gall; its shape, etc., and whether concealed or obvious.

"**Colours**": The first mentioned indicates that the gall is of that colour when in earliest stages of growth, and that it assumes the shades and tints following until it arrives at or passes maturity, when it is usually of that colour named last.

"**Average dimensions of a mature specimen**": These must not be regarded as hard and fast measurements, but more as guides to the collector and student.

"**May be sought** during the months of": The months mentioned are inclusive.

"**Growth is complete** by the end of": With reference to galls, such as the *Neuroterus*, *Biorhiza*, and other genera of similar growth, the month stated indicates that the galls complete the stage of growth in the situations in which they began growth, and not that they have arrived at a condition in which the imagines always emerge. It must be borne in mind that many galls expand considerably with the return of spring.

Observations were made in the south of England; an allowance of a week or two should therefore be made by the collector in northern localities.

"**The typical condition of the gall is**":

"**Unilocular and unilarval**": The actual gall structure consists of one larval cell only, and contains one larva only.

"**Pleurilocular but unilarval**": The gall structure is made up of more than one larval cell (sometimes as many as, or more than, fifty cells), but that each cell contains one larva only. The expression does not include galls usurped by parasites or tenanted by inquilines. Parasites usually live in cells (*e. g.* in gall of *C. Kollari*), but inquilines merely cause cavities in the tissues of the gall.

"**Bilocular but unilarval**": That within the gall structure are two cavities, one of which is occupied by the larva; or that a single larval cell is surrounded by an envelope of gall-substance which may be thin and non-adherent to the larval cell as in *Andricus curvator*, or thick and adherent, as in *A. inflator*.

"**Parasites**, Nos.," "**Inquilines**, Nos.": To minimise space, and obviate the frequent repetition of names, a complete alphabetically arranged list of the parasites and inquilines having numbers corresponding with those in the synoptical tables, will be found at the end of the volume.

As regards the synonyms of the insects, it should be noted that the lists are neither strictly comprehensive, nor do the names profess to be placed in chronological order, nor is reference made to the literature in which they are to be found.

Except when otherwise specified, the galls may be found on either *Quercus pedunculata* and *Q. sessiliflora*.

The word "gall" is held to mean the actual growth surrounding the cavity containing the larva, whether it be thin, as that of *Spathegaster albipes*; or thick as that of *Dryophanta scutellaris*; or the tissues which surround two or more larval cells, such as *Teras terminalis* or *Aphilothrix radicis*. In three species, *Andricus curvator*, *A. inflator*, and *Aphilothrix fecundatrix*, it is necessary to remember that the actual larval chamber is concealed within a non-adherent case, or by leaf scales, which may be quite correctly also termed the gall.

All the specimens illustrated by photographs (except Plates II, XXXII, LX, div. B, and LXI), were gathered by the author within a radius of ten miles of Hastings.

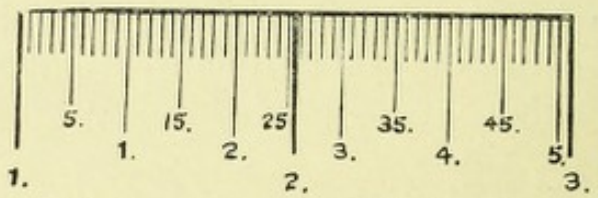


Fig. 4.—mm., cm., and inch scale.

## A TABLE OF BRITISH CYNIPIDÆUS GALL-PRODUCERS WITH THEIR ALTERNATE GENERATIONS (WHERE KNOWN).

| Sexual Generation. | Agamous Generation. |
|---|---|
| Andricus æstivalis. | |
| ,, amenti. | |
| ,, circulans. | ? Cynips Kollari. |
| ,, cirratus. | Aphilothrix callidoma. |
| ,, clementinæ. | |
| ,, curvator. | ,, collaris. |
| ,, gemmatus. | ,, corticis. |
| ,, glandium. | |
| ,, glandulæ. | |
| ,, inflator. | ,, globuli. |
| ,, lucidus. | |
| ,, noduli. | ,, radicis. |
| ,, nudus. | ,, Malpighii. |
| ,, pilosus. | ,, fecundatrix. |
| ,, ramuli. | ,, autumnalis. |
| ,, solitarius. | |
| ,, testaceipes. | ,, Sieboldi. |
| | ,, albopunctata. |
| | ,, marginalis. |
| | ,, quadrilineatus. |
| | ,, seminationis. |
| Teras terminalis. | Biorhiza aptera. |
| Trigonaspis crustalis. | ,, renum. |
| | Dryophanta agama. |
| | ,, disticha. |
| Spathegaster verrucosus. | ,, divisa. |
| ,, similis. | ,, longiventris. |
| ,, Taschenbergi. | ,, scutellaris. |
| ,, tricolor | Neuroterus fumipennis. |
| ,, albipes. | ,, læviusculus. |
| ,, baccarum. | ,, lenticularis. |
| ,, vesicatrix. | ,, numismatis. |
| ,, Aprilinus. ? | ,, ostreus. |
| | ,, punctatus. |

## **Andricus æstivalis,** Giraud.

(Plate V, div. A.)

*Andricus æstivalis*, Mayr, Cameron, Mosley.
**English name of gall.**—"The Cup Gall."
**Position of gall.**—On staminate catkins of *Q. cerris*.
**Manner of growth.**—Sessile, glabrous, gregarious, conglomerate.
**Colours.**—Pale green, greenish-yellow, brown.
**Average dimensions of a mature specimen.**—Height, 10 mm.; breadth, 8 mm.
**May be sought** during the months of May to July.
**Growth is complete** by the end of June.
**The typical condition of the gall** is bilocular, but unilarval.
**The larva** pupates in the gall. **The imago** emerges during June and July.
**Parasites,** Nos. 14, 24, 180. **Inquilines,** Nos. 3, 4. (These figures correspond with those in the list at end of volume, where the names of the insects and their authors' names are given in full.)

This gall appears to have escaped the notice of British collectors. I am not aware of any record of it being found in Britain. It is so distinctive that no collector could fail to identify it. Probably it may be discovered, especially as *A. glandium* has been found in acorns of the same oak (see p. 59).

Cameron captured a female insect at Loch Lomond, which agreed with a type sent him by Professor Mayr ('Brit. Phyto. Hymen.,' vol. iv, p. 107). He does not state, however, if he found any of the galls.

The galls occur in numbers of 20–40, conglomerated on the catkin stalk, and while growing somewhat resemble a mulberry. The size of the clusters varies considerably. Some measure 35 mm. in length and 75 mm. in girth. They are more or less pressed into one another at the point of attachment to the catkin stalk by reason of their number, but they are quite free from each other at their distal extremity. The stalk becomes twisted and thickened.

A single gall is about 10 mm. high, 8 mm. in breadth, pointed at the base, and opening out at the top into a cup shape. It consists of two parts, an outer case and

the larval cell within it. The lower half contains one or more cells; there may be as many as five.

The outer wall rises above this portion and forms an empty cup-shaped space. The rim of this outer growth, when mature, often becomes ragged, shrunk, and twisted, it also curls inwardly, meeting at or near the centre.

The colour of the gall is a very pale green, or a greenish-yellow, and during the period of formation it is soft and succulent, ultimately it hardens considerably. The investing tissue is at first greenish-yellow, often suffused with red, which, as growth proceeds, turns reddish-brown, and when mature is hard and woody.

## **Andricus amenti,** Giraud.

(Plate V, div. B.)

*Andricus amenti*, Mayr, Fitch, Cameron, Mosley.
**English name of gall.**—"The Hairy Catkin Gall."
**Position of gall.**—On staminate catkins of *Q. sessiliflora*.
**Manner of growth.**—Pilose, single, and in clusters.
**Colours.**—Pale green, greenish-yellow, brown.
**Average dimensions of a mature specimen.**—Length, 2 mm.; breadth, 1 mm.; girth, 3 mm.
**May be sought** during the months of May and June.
**Growth is complete** by the end of June.
**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during June and July.
**Parasites,** Nos. 62, 83, 104.

This gall was first recorded for Britain by Professor Trail, who found it at Braemar. It is also recorded from Kew.

The galls are small and inconspicuous. They are found attached to the staminate catkins of *Quercus sessiliflora*, in groups of twos and threes, but sometimes as many as eight in one cluster.

The shape of the gall is oviform, somewhat elongate, rounded and narrow at the base, tapering towards the

apex, which is bluntly pointed or sometimes mammilated. It is hard and woody, with very thin walls which form a large larval cavity without an inner gall. The exterior is covered with short, simple, yellowish hairs, most of which fall away when the gall is past maturity and the surface becomes rough.

"The gall is very similar to that of *pilosus*, but generally the latter may be known by being somewhat larger, not so globular, stouter, and not tapering so much at the apex, as a rule, nearly as broad as at the base; the hair is longer" ('Brit. Phyto. Hymen.,' vol. iv, p. 94).

On account of their very small size these galls easily escape observation, but their presence may often be detected if catkins with bent and thickened stalks are carefully examined with the aid of a pocket lens.

The imago is very small, about 1·7 mm. long; yellow, and orange in colour; wings hyaline. It eats its way out of the gall during the latter part of June or quite early in July.

The galls do not fall, and often remain, together with the stalk, on the tree throughout the summer.

## **Andricus circulans,** Mayr.

(Plate V, div. C.)

*Andricus circulans*, Cameron, Fitch, Mosley.

**English name of gall.**—"The Turkey Oak Bud Gall."

**Position of gall.**—In axillary buds of *Q. cerris*.

**Manner of growth.**—Glabrous, glossy, gregarious, conglomerated.

**Colours.**—Yellowish-brown, red, reddish-brown.

**Average dimensions of a mature specimen.**—Height, 4 mm.; breadth, 1·5 mm.; girth, 4·5 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during May.

**Parasite,** No. 18.

**Alternate agamous generation** (according to Beyerinck), *Cynips Kollari*, Hartig.

The late Miss E. A. Ormerod, LL.D., found some of these galls on a tree of *Quercus cerris* in Kew gardens in the year 1878, which, although not exactly corresponding with the continental form of this species, were, however, considered by Cameron to be sufficiently like those of *A. circulans* to warrant the inclusion of this gall in the list as British.

For many years I have most carefully examined stubs and trees of *Q. cerris* but have failed to find the galls.

During dry and hot weather the long linear scales, which are a noticeable feature of *Q. cerris*, close towards one another over the galls and hide them from view to so great an extent that detection is difficult, but when the atmosphere is damp the scales relax and stand out in such a manner as to allow the galls to be seen.

These galls are gregarious in their manner of growth, occurring in clusters of three, four, or even eight, and they are sometimes so closely packed together as to be considerably flattened; at times there may be one gall in the centre with others arranged round it in a circle. The normal shape is an elongate ovoid and very similar to small ant pupæ. The walls of the gall are very thin.

The resemblance of these galls to those of the closely-allied species, *A. burgundus*, Gir., is very great. The imagines, however, are quite different, and in addition to this, the galls may be distinguished from each other by the fact that those of *A. burgundus* do not appear until about five weeks later than those of *A. circulans*.

### **Andricus cirratus,** Adler.

(Plate XIV, inset.)

*Andricus cirratus*, Mayr, Cameron.
**English name of gall.**—"The Tufted Gall."
**Position of gall.**—On staminate catkins of *Q. sessiliflora*.
**Manner of growth.**—Gregarious, pilose, concealed.

**Colours.**—Pale green, dark green, brown.

**Average dimensions of a mature specimen.**—Height, 2 mm.; length, 1 mm.; girth, 3 mm.

**May be sought** during the months of April (late), May, and June.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during June.

**Alternate agamous generation:** *Aphilothrix callidoma*, Hartig.

This gall does not appear to be very widely distributed throughout Britain, or it may be, that by reason of the inconspicuous habitat, as well as its small size, it has been overlooked, or confused with that of *A. ramuli*.

The imagines of *callidoma* apparently prefer to oviposit in catkin buds situated high up in the tree, where, without the aid of a pruner, they are unattainable. I have only once found them within ten feet of the ground. Upon the same tree, with field-glasses, numerous others could be seen twenty and thirty feet higher up.

"The gall is placed on the stalk of the male catkin; at its base two shallow impressions may be recognised which are derived from the sutures of the anthers from which the gall sprang. The galls are often placed so closely together that they appear to form one woolly mass" ('Alternating Generations,' p. 54).

The affected catkins are considerably shortened and seldom project beyond the bud, while others growing from the same stem attain normal dimensions.

The shape of the larval chamber is oval; the diameter of its long axis is about 2 mm. It is rounded at the base and apex; from the former spring a few long white hairs which are three or four times longer than the gall. The gall grows quickly, reaches maturity in about twenty days, and then falls to the ground.

It may be distinguished from *A. ramuli* because it

develops about a month earlier, and the imagines also appear earlier.

### **Andricus clementinæ,** Mayr.

(Plate V, div. D.)

*Cynips clementinæ*, Giraud; *Andricus clementinæ*, Cameron; Mosley; *Aphilothrix clementinæ*, Giraud.

**English name of gall.**—"The Pointed Pea Bud Gall."

**Position of gall.**—In axillary beds of *Q. sessiliflora*.

**Manner of growth.**—Pilose, solitary, rugose, ovoid, spheroidal.

**Colours.**—Pale yellow, dark yellow, brown.

**Average dimensions of a mature specimen.**—Height, 5 mm.; breadth, 3 mm.; girth, 9 mm.

**May be sought** during the months of October and November.

**Growth is complete** by the end of October.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the following autumn.

**Parasite,** No. 66. **Inquilines,** Nos. 132, 145.

This pretty little gall has been recorded as British by Cameron, who found it "in Cadder Wilderness near Glasgow" ('Brit. Phyto. Hymen.,' vol. iv, p. 105). There does not appear to be any other record of its occurrence in Britain.

Owing to its small size and rather close resemblance to other axillary bud-galls it may have escaped detection by other gall collectors.

The normal shape of the gall is spheroidal, and it would bear a close resemblance to *Aphilothrix globuli* but for a small conical projection on its summit due to an elongation of the outer surface. The base also is elongated to a point, but that is not noticeable while the gall is *in situ*. When both these features are pronounced the shape is somewhat ovoid.

The surface has scattered over it a number of small flattened conical projections, which are concealed beneath a quantity of vitreous whitish hairs, some being recurved in the direction of the point of attachment, while others near the summit are straight and very numerous.

The gall consists of two thin layers, and an inner loose larval chamber.

The colour of the external layer is dark-yellow; that of the internal layer reddish-brown, the larval chamber more or less yellowish.

The imago which causes the gall appears to prefer to oviposit among the highest branches of the tree.

A peculiarity about this gall has been observed, viz. that they fall to the ground after the first frost, retaining the bud-like scales attached to their base. When *A. globuli* falls to the ground the scales have either previously dropped off or they are left on the twig.

*A. globuli* has never been observed so high up on the tree as *Andricus clementinæ* grows.

## **Andricus curvator,** Hartig.

(Plates VI, VII.)

*Andricus curvator*, Mayr, Müller, Fitch, Adler; *A. perfoliatus*, Schenck; *A. dimidiatus*, Schlechtdl.; *Cynips curvator*, Thomson; *C. axillaris*, Hartig.

**English name of gall.**—"The Curved Leaf Gall."

**Position of gall.**—On blade, mid-rib, or petiole of leaf.

**Manner of growth.**—Glabrous, glossy, single, conglomerated, anastomosing.

**Colours.**—Pale green, light brown.

**Average dimensions of a mature specimen.**—Length, 8 mm.; breadth, 8 mm.; girth, 24 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of July.

**The typical condition of the gall** is bilocular, but unilarval.

**The larva** pupates in the gall. **The imago** emerges during August.

**Parasites** and **inquilines** are given on p. 58.

**Alternate agamous generation:** *Aphilothrix collaris*, Hartig.

This gall is widely distributed throughout Britain. It appears in the form of a swelling of the young leaves of both species of oak, as plentifully on young

stubs as on young and old trees. The leaf is considerably distorted by the growth of the gall, and frequently the material which would have formed a leaf is almost absorbed in the formation of the gall, a small portion only developing to form a ridge or frill upon the surface. Under such conditions of growth the gall-mass is usually more or less globular, but when situated upon the blade of the leaf the shape is very irregular, although the bulk may not be more than normal.

A solitary mature globular specimen on the end of a twig, having little or no leaf membrane attached, has the appearance of a small gall of *Cynips Kollari*.

Growth is rapid, and during the early part of the time the gall is solid and firm, although somewhat succulent, and it extends in equal, or nearly equal, proportions on both surfaces of the leaf. As maturity approaches a large cavity is formed, within which is the inner gall; a small, reddish-brown larval cell, ovoid in shape, loosely adherent, with very thin walls, and about 2 mm. in its long axis, occasionally with a minute papilla at one end.

Two, three, and sometimes four galls will anastomose, and upon cutting the mass open it will be seen that the inner galls are in some cases separated by very thin septa, or the cavity remains undivided.

When gall growth takes place at the base of a petiole the whole of the petiole is involved and a considerable swelling results. When situated at the extremity of a twig, and small portions of leaves develop upon the gall structure, there is a close resemblance to a gall of *A. inflator*.

It is extremely abundant on some trees, affecting mostly the small twigs springing from the trunk, where not infrequently almost every leaf is galled. It may also be found in great plenty on bushes and very young trees. Apparently it occurs but rarely on the higher boughs of old trees.

Some of the imagines of *Aphilothrix collaris* emerge

from their galls so late in the spring that finding the leaves too much developed they oviposit in the buds of Lammas shoots, and in due course galls may be seen upon the leaves of these shoots as well as on leaves of the twigs from which the Lammas shoots spring.

A few representative examples of galls on twigs and leaf-petioles in autumn–winter condition will be found on Plate VII, div. A, and a fine specimen of a recurved twig, in growing condition, is illustrated on the same Plate, div. B.

Parasites and inquilines on this species are very numerous.

Parasites, Nos. 19, 21, 26, 31, 34, 35, 37, 42, 44, 56, 59, 71, 75, 78, 80, 83, 87, 96, 98, 105, 108, 115, 116, 121, 146, 151, 154.

Inquilines, Nos. 69, 109, 127, 128, 130, 136, 139.

### **Andricus gemmatus,** Adler.

(Plate V, div. E.)

*Andricus gemmatus*, Cameron, Mosley.
**English name of gall.**—"The Bud Gall."
**Position of gall.**—In the leaf axils.
**Manner of growth.**—Glabrous, sessile, gregarious.
**Colours.**—Pale green, green, reddish-brown, brown.
**Average dimensions of a mature specimen.**—Height, 2 mm.; breadth, 1 mm.; girth, 3 mm.
**May be sought** during the months of May and June.
**Growth is complete** by the end of June.
**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during July and August.

**Alternate agamic generation:** *Aphilothrix corticis*, Linn.

This is a very small and obscure gall, and although widely distributed it is not often observed. It is more or less oval in shape, sometimes narrower at the apex than at the base. The apex is frequently the only portion visible, and very careful searching is necessary

to find the gall. The easiest way is by looking for a minute hole in an axillary bud. Adler, who was the first to discover this gall, says they are sometimes found free on the shoots ('Alternating Generations,' p. 39); and Cameron says they may be found on the apex of young leaves ('Brit. Phyto. Hymen.,' vol. iv, p. 89).

## **Andricus glandium,** Giraud.

(Plates VIII, IX, div. A.)

*Andricus glandium*, Mayr, Cameron, Fitch, Mosley; *A. rufescens*, Mayr.

**English names of gall.**—"The Acorn Gall," "The Cotyledon Gall."

**Position of gall.**—In the cotyledons (concealed by the pericarp).

**Manner of growth.**—Glabrous, glossy, gregarious, conglomerated.

**Colours.**—White, cream, pink, brown.

**Average dimensions of a mature specimen.**—Length, 4 mm.; breadth, 3 mm.; girth, 9 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of September.

**The typical condition of the gall** is plurilocular, but unilarval. Usual number of cells about eight.

**The larva** pupates in the gall. **The imago** emerges during the spring. Cameron says, "they take from three to four years to arrive at maturity."

**Inquiline,** No. 145.

This gall is remarkable for the fact that although there may be many larval cells in an acorn, there is seldom any appreciable difference in the size of the acorn as compared with others not containing galls; consequently it is not until the pericarp is removed that the collector can be certain of having obtained them. The larval cells displace the same bulk of the cotyledons as they occupy; they are not embedded in them, and readily separate when the pericarp is removed.

The shape of a mass of larval cells is sometimes

ellipsoidal, but mostly the outline is irregular. A solitary larval cell, however, is ovoid in shape. It measures 3 mm. long and 2 mm. broad. The walls are thin. The interior is white or very pale-green or yellow, and slightly glossy. The exterior is brown, or reddish-brown.

This gall was discovered on *Q. cerris* in Kew gardens, in the year 1877, by Miss E. A. Ormerod, LL.D. I believe I was the first in Britain to find the galls on *trees growing wild:* In the first instance in acorns that had fallen from a tree of *Q. cerris*, in Sir A. Lamb's park, at Beauport, near St. Leonards, in the spring of 1902, in considerable numbers; and then in a growing condition on the same tree in the autumn. From that tree, and others of the same species, in the same park, I have obtained galls each year since. In the same spring I also found the same galls in acorns on the ground, and in other acorns still attached to the twigs of a tree of *Q. pedunculata* in a wood at Hollington, also at St. Leonards, but not in such numbers. The two trees are, in a direct line, about three miles apart.

When acorns are kept under artificial conditions the larvæ delay their pupation for several years. I now (May, 1908) have some that have been in the larval state for six years. Parasites (species undetermined), however, have appeared the summer following from galls gathered from a tree in the previous autumn.

## **Andricus glandulæ**, Mayr.

(Plate X.)

*Cynips glandulæ*, Schenck; *Aphilothrix glandulæ*, Mayr, Hartig, Fitch; *Andricus glandulæ*, Cameron.

**English names of gall.**—"The Thatched Gall," "The Little Acorn Gall."

**Position of gall.**—In the axillary leaf bud.

**Manner of growth.**—Solitary, pedunculated, pubescent, glossy, longitudinally grooved.

**Colours.**—Pale green, green, pale brown.
**Average dimensions of a mature specimen.**—Height, 6 mm.; girth (at base), 12 mm.
**May be sought** during the months of July to September.
**Growth is complete** by the end of September.
**The typical condition of the gall** is bilocular, but unilarval.
**The larva** pupates in the gall. **The imago** emerges during the following spring.
**Inquiline,** No. 136.

This dainty little gall may be easily distinguished from all other British oak galls by the profusion of long white, silky, and glossy recurved hairs with which it is almost covered, the exposed portion being the papilla.

It develops from an axillary bud on young twigs; very rarely on wood of more than two years' growth.

As soon as it bursts from the bud it is distinctly noticeable owing to the silky-whiteness of the long hairs which are arranged like thatching (without the rods and spars), on a circular hay-stack or wheat-stack, the little papilla standing erect in the centre, hence the English name of "thatched gall" which I propose for it.

As growth proceeds the hairs remain adpressed to the gall, the texture of which becomes woody.

The lower portion of the gall is expanded into a turban-like base having occasionally a number of leaf-scales adherent beneath it; these ultimately fall off and expose a somewhat stout process or peduncle by which the gall is held to the twig. In some examples this basal portion is much more fully developed than in others.

The shape of the gall when mature is that of a truncated cone, bearing upon its summit a very small mastoid growth, known as the papilla, which is subject to much variation in size. It is a pale greenish-yellow colour and is destitute of hairs in all stages of its development.

During the winter the gall falls to the ground, or it

is pushed off by the growth of new wood in the following spring.

When denuded of hairs the gall is seen to be longitudinally furrowed, but this may sometimes be distinguished without the removal of the hairs, as in inset specimen. (Plate X.)

When the gall is inhabited by an inquiline it does not attain its usual proportions.

Internally the gall is divided into nearly equal parts by a septum, the lower portion being hollow, or filled with fibrous reticulations, the upper portion contains the true gall, which is adherent to the inner walls.

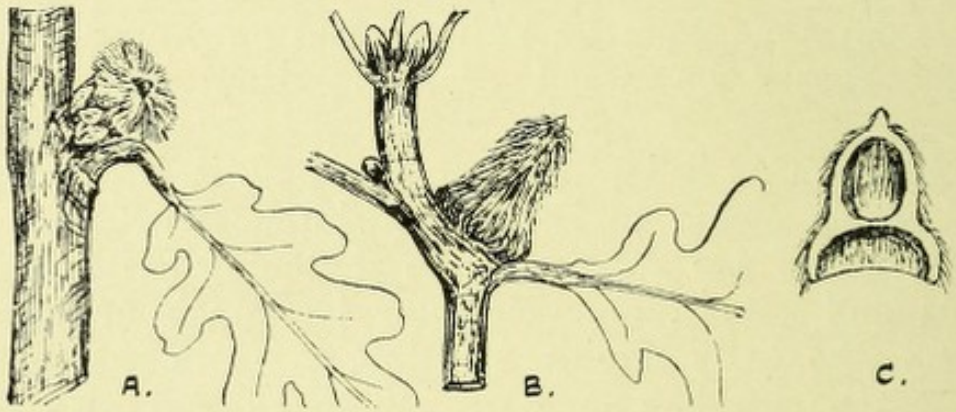


FIG. 5.—Galls caused by *Andricus glandulæ*. A. Young, showing leaf-scales, and "thatched" appearance. B. Mature. C. Longitudinal section. All × 2½, dele. ad nat. E.C.

The larval chamber has a whitish interior and is ovoid in shape.

I am not aware as to the distribution of this gall in Britain, whether it is plentiful or scarce; possibly it extends over wide areas and would be more frequently observed but for its brief period of growth, rapidity in reaching maturity, and then falling to the ground.

It has occurred in all the districts in which I have searched, but it appears to be extremely local, and sometimes it will not be found on more than two or three trees in the same wood, and those widely separated from each other.

According to my own observations it occurs mostly on oak bushes of eight to ten years' growth, also on

small trees, but more generally on the lower than the upper branches; very rarely on scrub-oaks of less than three years' growth.

## **Andricus inflator,** Hartig.

(Plate XI.)

*Andricus inflator*, Adler, Müller, Mayr, Mosley, Fitch, Cameron; *Cynips inflator*, Thoms.

**English name of gall.**—"The Twig Gall."

**Position of gall.**—At the extremity of twig or shoot.

**Manner of growth.**—Single, glabrous, sessile, glossy.

**Colours.**—Green, dark green, brown, dark brown.

**Average dimensions of a mature specimen.**—Height, 15 mm.: breadth, 10 mm.; girth, 30 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of September.

**The typical condition of the gall** is bilocular, but unilarval.

**The larva** pupates in the gall. **The imago** emerges during June to August.

**Parasites,** Nos. 21, 56, 83, 87, 154. **Inquiline,** No. 110.

**Alternate agamic generation:** *Aphilothrix globuli*, Hartig.

The gall results from the gall-wasp laying its egg in the axis of the terminal bud. When the bud develops in the spring the apical portion remains whitish for a long while.

In all stages of development the gall is easily recognisable.

In some districts this gall is exceedingly abundant, and many oak bushes have a very great number of the galls on the twigs; but there is not always a proportionate abundance of the alternate generation in the succeeding autumn.

The egg is laid in the axis of a bud during September or October by *Aphilothrix globuli*. No gall-growth takes place until the following spring, when the larva hatches. Rapid swelling of the tissues then begins, resulting in an enormously thickened and stunted shoot. During the summer leaves and occasionally short twigs grow from the exterior of the gall. In

the mature state it is an attractive and interesting object.

The exterior of the gall bears several ridges of irregular outline which may, or may not, encircle the growth. From these ridges, at different points, buds develop in the autumn and remain until the following spring, when most, if not all, become abortive and fall off; if one remains a long slender twig may sprout from it. I have seen several specimens in which the termination of the twig bore a gall of the same species.

After the imago has emerged the outer gall continues growing until the autumn—an unusual feature in spring galls.

In the centre of the structure is a deep cylindrical hole. It is about 3 mm. in diameter and 10–12 mm. deep. At the bottom is the elongate-oval larval and pupating chamber. An exceedingly thin septum, slightly pilose on the interior, closes the mouth of the hole.

"*Curvator*, it may be noted, forms terminal swellings like those of *inflator*; but these are seldom so elongated, and the internal cavity is larger and more particularly wider" ('Brit. Phyto. Hymen.,' vol. iv, p. 82).

## **Andricus lucidus,** Mayr.

(Plate V, div. F.)

*Cynips lucida*, Hartig; *Aphilothrix lucida*, Mayr, Hartig; *Andricus lucidus*, Cameron; *A. lucida*, Mosley.

**English name of gall.**—"The Bristly Gall."

**Position of gall.**—In the axils of the leaves.

**Manner of growth.**—Sessile, hirsute, single, clustered, deciduous.

**Colours.**—Pale brown, ultimately brown.

**Average dimensions of a mature specimen.**—Globular form; girth, 30 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of September.

**The typical condition of the gall** is plurilocular, but unilarval. Usual number of cells, about fifteen.

**The larvæ** pupate in the gall. **The imagines** emerge during April and May.
**Inquilines,** Nos. 17, 132.

This gall is mostly globular in form, but it varies in size, and also in shape from that of a cherry to that of a walnut. It is found generally on bush and scrub oaks.

"Its whole surface is covered with stiff, stalky, or fibrous projections, which stand out radiately, and terminate in a rusty-red papilla. In section it exhibits a hard texture with numerous egg-shaped cavities; in these live the larvæ, without being separately enclosed in an inner gall" (Mayr).

Mosley recorded it in 1892 occurring in Whitley Woods, Yorkshire.

## **Andricus noduli,** Hartig.

(Plates XII, IX, div. B.)

*Andricus noduli*, Mayr, Marshall, Adler, Müller, Walker, Mosley; *A. trilineatus*, Hartig, Cameron.
**English name of gall.**—"The Knot Gall."
**Position of gall.**—Beneath the bark of twig and in leaf petiole.
**Manner of growth.**—Separate, gregarious, glabrous, concealed.
**Colours.**—White, very pale green, pale brown.
**Average dimensions of a mature specimen.**—Length, 2 mm.; breadth, 1 mm.
**May be sought** during the months of June to August.
**Growth is complete** by the end of July.
**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during August and September.
**Parasites,** Nos. 56, 103. **Inquilines,** Nos. 17, 110, 128, 145.

**Alternate agamic generation:** *Aphilothrix radicis*, Fabr.

Upon reference to Plate IX, div. B., it will be seen that the autumn–winter condition of twigs and leaf petioles containing many of these galls is very conspicuous on account of the swollen and nodulose appearance. It is only when many galls close to each

other are developing, or have arrived at maturity, that the twigs give evidence of their presence.

Solitary galls, or several scattered along an ordinary slender twig, are difficult to locate. This may be understood by referring to A, Plate XII.

The galls are much more abundant in twigs than in leaf petioles.

This is a most obscure gall, and difficult for the uninitiated gall collector to find. It may usually be found by peeling off the bark of shoots near where galls of *Aphilothrix radicis* have grown. It occurs only in shoots of the year, or in a leaf petiole.

Its situation is beneath the bark, more or less embedded in the xylem, and is therefore completely hidden from view. Its presence in a shoot can only be conjectured by a very slight swelling of the bark immediately above where the gall is situated.

The gregarious habit does not furnish any additional indication. In a leaf petiole, however, considerable thickening is produced, and the galls are usually more numerous there than in a shoot.

Mayr says: "On *Quercus pubescens* the swelling occasioned by this gall is still less perceptible on account of the tomentum on the surface, and sometimes it (the swelling) is entirely absent."

After the imago has emerged the swollen part of the bark subsides, but the minute circular exit-hole betrays the position of the empty gall.

I have found that this gall occurs more frequently on stub-oaks, young trees, and bushes in hedges than on large trees.

The gall is widely distributed throughout Britain, and in places very plentiful, a fact accounted for by the vast number of imagines from an average-sized gall of *A. radicis*.

## **Andricus nudus,** Adler.

(Plate XIII, div. A.)

*Andricus Malpighii*, Cameron; *A. nudus*, Mosley.
**English name of gall.**—"The Bald Seed Gall."
**Position of gall.**—On the flower-stalk of staminate catkin.
**Manner of growth.**—Sessile, glabrous, glossy, gregarious, pointed.
**Colours.**—Pale green, yellowish-green, yellow, brown.
**Average dimensions of a mature specimen.**—Length, 1·5 mm.; breadth, 1 mm.; girth, 3 mm.
**May be sought** during the months of May and June.
**Growth is complete** by the end of May.
**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during June.

**Alternate agamic generation:** *Aphilothrix Malpighii*, Adler.

This gall is found usually on the high branches of large trees. It is very small and inconspicuous, and but for its gregarious manner of growth would rarely be noticed. It is ovoid in shape, with a minute nipple-like process on the apex, upon which there may be a very few small hairs; otherwise it is perfectly glabrous. Seven appears to be the usual number of galls in a cluster, and seldom more than two clusters on the same catkin stalk.

It was first discovered and described by Dr. Hermann Adler during his investigations in 1876–8. I have found it plentiful on *Quercus sessiliflora* at Hastings.

## **Andricus pilosus,** Adler.

(Plate XIII, div. B.)

*Andricus pilosus*, Licht., Mayr, Cameron, Mosley.
**English name of gall.**—"The Hairy Catkin Gall."
**Position of gall.**—On the flower-stalk of staminate catkin.
**Manner of growth.**—Sessile, pilose, solitary (usually), ovoid, pointed.
**Colours.**—Pale green, green, pale brown, dark brown.

**Average dimensions of a mature specimen.**—Length, 2 mm.; breadth, 1·5 mm.; girth, 4·5 mm.

**May be sought** during the months of May and June.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during June.

**Alternate agamic generation:** *Aphilothrix fecundatrix*, Adler.

This pretty little gall, although very similar in size and shape to *Andricus nudus*, differs from it in being thickly covered with whitish hairlets; it is also more or less solitary in its manner of growth.

It is found mostly on *Q. pedunculata*; "the reason for *A. fecundatrix* preferring" (to oviposit in the catkins of) "this species of oak is probably because it flowers about fourteen days earlier than *Q. sessiliflora*" (Adler, 'Alternating Generations,' p. 50).

## **Andricus ramuli,** Linn.

(Plate XIV.)

*Cynips quercus-ramuli*, Linn; *Teras amentorum*, Hartig; *Andricus ramuli*, Schenck, Adler, Licht., Mayr, Müller, Fitch; *Cynips ramuli*, Cameron, Marshall, Mosley.

**English names of gall.**—"The Woolly Gall," "The Cotton Gall."

**Position of gall.**—On the staminate catkin.

**Manner of growth.**—Hirsute, gregarious, conglomerated, oval.

**Colours.**—Green, dark green, yellowish-brown.

**Average dimensions of a mature specimen.**—Length, 2 mm.; breadth, 1 mm.; girth, 3 mm.

**May be sought** during the months of May and June.

**Growth is complete** by the end of June.

**The typical condition of the gall** is plurilocular, but unilarval. Usual number of cells, about twelve.

**The larva** pupates in the gall. **The imago** emerges during July and August.

**Parasites,** Nos. 21, 23, 45, 62, 64, 104, 154. **Inquilines,** Nos. 17, 130, 136.

**Alternate agamic generation:** *Aphilothrix autumnalis*, Hartig.

This gall was observed in England by Dr. Sir Thomas Browne, and mentioned by him in correspondence with Dr. Merrett in 1668 (see Introduction).

It is undoubtedly one of the most distinctive and delicate galls of the oak.

So far as my observations of this species have extended, it appears that it may be found more frequently on *Q. sessiliflora* than on *Q. pedunculata*. On the continent, however, *Q. pubescens* seems to be the favourite tree.

This interesting and most attractive growth is one which commands more than a passing notice from all persons who see it for the first time. It has the appearance of a tuft of white cotton-wool, and among the green leaves and yellowish catkins it looks exceedingly pretty and dainty.

These galls attain maturity of form very rapidly, and the period during which they retain their pristine beauty is also very brief; in sheltered positions it is from five to seven days. Considerable care must be exercised while gathering them. They are very delicate, and any undue pressure will compress the hairs and render it impossible to restore them to their original form. Heavy rain will also disfigure them. The hairs at first are more or less separate from each other; about 15–20 mm. long, somewhat glutinous and wool-like, and when in a mass are not resilient.

The entire structure, or compound gall, consists of clusters of conglomerated larval chambers each of which constitutes a true gall. The clusters vary in number from two to ten, and contain about fifteen larval chambers in each. It is from these clusters the hairs grow, and being in close proximity to each other unite to form an oval or globular-shaped mass of white hairs, about the size of a walnut or a cherry respectively.

In drying the mass diminishes to about half its original size. This is due to the contraction of the hairs, which become convoluted and interwoven. The colour changes to a yellowish-brown soon after maturity, and the imagines then make their exit. The galls occasionally develop from a leaf-bud.

## **Andricus solitarius,** Mayr.

(Plate XV.)

*Diplolepis solitarius*, Fonsc.; *Cynips ferruginea*, Hartig, Schenck; *Aphilothrix solitaria*, Fonsc., Mayr, Fitch; *Andricus solitarius*, Cameron, Mosley.

**English names of gall.**—"The Hairy Spindle Gall," "The Red-haired Bud-gall."

**Position of gall.**—Develops from a terminal or axillary bud.

**Manner of growth.**—Solitary, pubescent, spindle shape.

**Colours.**—Green, yellowish-brown, brown, reddish-brown.

**Average dimensions of a mature specimen.**—Height, 10 mm.; breadth, 4 mm.; girth, 12 mm.

**May be sought** during the months of June to September.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during September.

**Parasites,** Nos. 38, 46, 66. **Inquilines,** Nos. 130, 136, 145.

Cameron appears to have been the first to describe this gall for Britain. He found specimens in Cadder Wood, near Glasgow. In the years 1873–5 it was also found in Nottinghamshire by Mr. G. B. Rothera and Dr. Ransom.

It is now distributed with moderate frequency all over the country, growing more generally on bushes in woods than on branches and twigs of trees. In some localities it is abundant, in others seldom or never seen.

The specimen in the inset of Plate XV is unusual in having a small mamelon on its surface. The persistent leaf-scales, characteristic of this species, at the base of the gall are also easily noticeable.

This species is of remarkable appearance and variable in form, situated indiscriminately in terminal and axillary positions. Easily recognised by being profusely covered with glossy and soft hairs of a ferruginous colour, which are longer and denser at the apex of the gall than elsewhere. When maturity is

past most of the hairs fall off; they may also be easily removed by leaves or twigs rubbing against them.

The gall is usually surrounded at its base by small leaf-scales; sometimes attached by a rather long and stout peduncle; almost always surmounted by a styliform prolongation, which may be two thirds the length of the larval chamber, or even as long.

The style varies much in shape, sometimes quite straight, sometimes considerably curved, ending bluntly or bearing a small papilla; growing from the centre of the apex of the larval chamber, or somewhat on one side.

The larval chamber is large, the walls very thin. Occasionally the exterior will be slightly constricted near the base; sometimes longitudinally striated; almost always glossy when the hairs are removed, and woody and hard in texture.

Seldom two galls on the same twig, very rarely more than two. Some remain attached all through a mild winter, others fall at the slightest touch.

## **Andricus testaceipes,** Hartig.

(Plate XVI.)

*Andricus Sieboldii*, Mayr; *A. testaceipes*, Mayr, Adler, Licht., Kalt., Cameron, Mosley.

**English name of gall.**—"The Leaf-vein Gall."

**Position of gall.**—On the petiole, under surface of mid-rib, and its offshoots.

**Manner of growth.**—Glabrous, single, glossy, imbedded.

**Colour.**—Green.

**Average dimensions of a mature specimen.**—Length, 2 mm.; breadth, 1 mm.

**May be sought** during the months of July to September.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during August and September.

**Parasite,** No. 56.

**Alternate agamic generation:** *Aphilothrix Sieboldi*, Hartig.

Concerning Inquilines from this gall, Cameron says: "*Synergus apicalis* and *Ceroptres arator* are supposed to be reared from the galls of *testaceipes*, but they really may have been from those of *noduli*, the petiole galls of which may have been mistaken for those of *testaceipes*' ('Brit. Phyto. Hymen.,' vol. iv, p. 87).

Considerable doubt seems to exist in the minds of some authors as to whether this species is, or is not, the same as *Andricus noduli*. The habits of both species are much alike; the galls of each are the same in size and shape and develop in stem and petiole alike, *Andricus testaceipes* alone, apparently, on the veins of the leaf.

According to Adler the imagines cannot be distin-

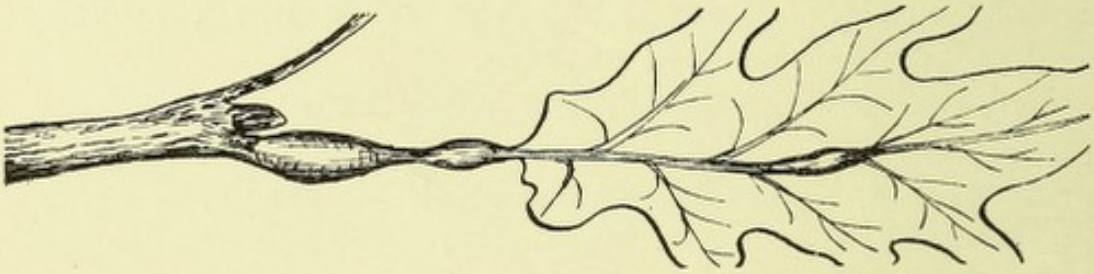

Fig. 6.—Galls caused by *Andricus testaceipes*, on petiole and mid-rib of leaf of *Q. sessiliflora*. dele. ad nat. E.C.

guished with certainty from each other, their time of emergence is identical, and they oviposit in the same manner. Mayr conjectured as to whether petiolar galls containing a larva of *Andricus noduli* were originally produced by *A. testaceipes*, and *A. noduli* has only introduced its eggs, or whether the galls are primarily produced by *A. noduli* alone. Although he gathered hundreds of these galls in the months of August and September he could not solve the problem.

Adler's experiments show that the imagines from the galls in leaf-veins and petioles, known as those of *Andricus testaceipes*, lay their eggs in shoots above ground and produce *Aphilothrix Sieboldi* galls, which, although gregarious, are unilocular; and the imagines

known as those of *Andricus noduli*, from galls under the bark of twigs, and petioles also, oviposit below ground on roots and root-fibres and produce compound plurilocular galls which are not only totally different in shape, texture and colour, but are not gregarious, viz. *Aphilothrix radicis*.

## **Aphilothrix albopunctata,** Schlechtendal.

(Plate XVII.)

*Cynips majalis*, Giraud; *C. albopunctata*, Schlch.; *Andricus albopunctata*, Mayr; *Aphilothrix albopunctata*, Adler, Licht., Mayr, Fitch, Cameron, Mosley.

**English name of gall.**—"The Spotted Bud Gall."

**Position of gall.**—In lateral and (occasionally) terminal buds.

**Manner of growth.**—Solitary, sessile, glabrous, glossy, longitudinally grooved.

**Colours.**—Green, greenish-yellow, pale brown.

**Average dimensions of a mature specimen.**—Height, 8 mm.; breadth, 4 mm.; girth, 12 mm.

**May be sought** during the months of May and June.

**Growth is complete** by the end of June.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the following spring.

**Parasites,** Nos. 39, 49, 56, 66, 181. **Inquilines,** Nos. 130, 136.

I have found this gall, empty, but firmly attached to a twig as late as September 10th (1907).

At C in Plate XVII is shown a young gall emerging from among the leaf scales. It is rather difficult to obtain a specimen in that condition. It will be seen that the apex is depressed, the smooth-pointed projection rising from the base of the concavity. The depression quickly fills up and elevates the projection.

The sides of the young gall are longitudinally furrowed; these also disappear as the gall grows, but reappear when it has attained maturity.

This gall is subject to considerable variation in size, shape, and manner of growth. Some illustrations are

here given. Care must be exercised when severing the twig on which they are growing. They are easily dislodged, and having fallen to the ground are seldom recoverable. In the cabinet also care must be taken in handling them. They are usually quite solitary, *i. e.* not more than one on a twig. Occasionally two may be found near each other, and one twig I found had three within a distance of 33 mm., each growing from lateral buds.

A large proportion of these galls will be found to be quite empty. They are usually situated on the

FIG. 7.—Galls caused by *Aphilothrix albopunctata*, illustrating variability in situation, form, and marking. dele. ad nat. E.C.

smallest twigs, sometimes in company with *Andricus solitarius*.

Its growth is rapid. When the gall bursts through the bud scales it is usually green in colour, with very few or no spots upon it. The exterior consists of a somewhat thick soft rind which shrinks in thickness a great deal as the gall nears maturity; beneath this are the cell walls, which are thin. The larval chamber is large and occupies the entire cavity. As growth proceeds cream-coloured or pale-yellow spots appear in the rind, elliptical in shape, and extending in a longitudinal direction.

Numerous (15–20) furrows traversing the length of

the gall also appear. These are deeper, and also broader in some specimens than in others.

The base is almost always surrounded by bud scales. In some examples these are absent or indistinct. An occasional example will be attached to the twig by a stout peduncle. Under a pocket lens a number of very small purple, glossy papillæ are seen in a few specimens. The apex is generally surmounted with a distinct projection, mostly simple, sometimes recurved.

The gall develops as early as April, but normally in May, from the buds of the previous year's twigs. As soon as maturity is past the gall falls off.

Of the many hundreds I have found of these galls the largest measures 12 mm. high and 18 mm. at greatest girth.

Cameron apparently considers this the same as *Aphilothrix quadrilineata*, and all its characteristics certainly favour the idea.

It appears to have been first recorded as British by E. A. Fitch, from Essex in 1874.

It is common and widely distributed; more easily obtainable on stub-oaks and small bushes than on large trees.

Adler says: "*Aphilothrix albopunctata* produces the same gall as that from which it emerges."

## **Aphilothrix autumnalis,** Hartig.

(Plate XXIII, div. B.)

*Cynips autumnalis*, Hartig; *Andricus autumnalis*, Mayr; *Aphilothrix autumnalis*, Licht., Mayr, Fitch, Cameron, Adler.

**English name of gall.**—"The Autumn Gall."

**Position of gall.**—In lateral, axillary, and terminal buds.

**Manner of growth.**—Sessile, glabrous, solitary, prolate.

**Colours.**—Green, brown.

**Average dimensions of a mature specimen.**—Height, 5 mm.; breadth, 4 mm.; girth, 12 mm.

**May be sought** during the months of September and October.

**Growth is complete** by the middle of October.

**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** seldom emerges until the spring of the second year.
**Parasite,** No. 56. **Inquilines,** Nos. 128, 133, 138, 144.

**Alternate sexual generation:** *Andricus ramuli,* Linn.

This is an obscure gall and not easy to find; more than half of it, even when full grown, is covered with bud-scales. The gall collector needs to be very persevering when searching for it.

It is generally found in terminal leaf-buds, and covered with a greenish succulent rind which ultimately changes to a brownish colour and dries to a thin layer, which remains on some specimens, but falls off others and leaves indistinct longitudinal furrows on the surface of the gall. The shape is that of a prolate spheroid, the lower pole of which is unattached, although imbedded in the xylem of the twig, the upper pole produced into a mastoid form. It matures rapidly and very soon afterwards usually falls to the ground.

This gall bears a close resemblance to those of *Andricus collaris* and *A. globuli.* There are, however, a few distinguishing features. In comparing it with the former species Cameron says "it is shorter and more spherical than the gall of *collaris* . . . the conical point is more distinct, and there is no coloured band." Mayr, referring to the same subject, adds that there is much similarity between the galls of *Aphilothrix autumnalis* and *Andricus globuli*; both are more than half covered with bud-scales, when fresh of a green colour, thin fleshy reticulation beneath the scarf-skin, and a small round wart at the summit; but "it differs from the gall of *A. globuli* in its more oval form, in the surface of the inner gall having no reticular rings, but blunt longitudinal striations, which also show on the surface of the brown gall."

## **Aphilothrix callidoma,** Hartig.

(Plate XVIII.)

*Cynips callidoma*, Thomson; *Andricus callidoma*, Mayr, Cameron; *Aphilothrix callidoma*, Licht., Mayr, Fitch, Adler, Mosley.

**English name of gall.**—"The Stalked Spindle Gall."

**Position of gall.**—Axillary buds.

**Manner of growth.**—Solitary, glabrous, glossy, spindle shape.

**Colours.**—Pale green, green, yellowish-green, brown.

**Average dimensions of a mature specimen.**—Length, 18 mm.; girth, in centre, 9 mm.

**May be sought** during the months of May to October.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the following spring.

**Parasite,** No. 111. **Inquilines,** Nos. 133, 145.

**Alternate sexual generation:** *Andricus cirratus*, Adler.

The elegant shape and marked originality in the form of this gall distinguishes it above all other British oak galls.

It grows from an axillary bud, but more frequently on the slenderest twigs of stub-oaks, and near the ground, than in any other situation. Once only have I found a specimen on a branch as high up as ten feet from the ground. It is shown as an inset in Plate XVIII.

The gall is cylindrical in outline, with each end attenuated, producing a fusiform or spindle-shaped growth. Each attenuation is solid, usually of great length, the basal one generally the longest, sometimes twice or three times longer than the central portion; the distal end may be short and recurved.

The larval chamber is situated in the centre. During growth it is difficult to decide without dissection where the gall is solid—the enlargement is so gradual. When dry the attenuations shrink (in thickness only) almost to a thread. As the larval chamber does not shrink it can then be easily located. Its cell walls are very

thin, the interior is large, ellipsoidal in shape, about 5 mm. in its vertical axis, and 2 mm. in the horizontal.

The exterior has upon it longitudinal ridges, much more distinct and sharp-edged in some specimens than others, and entirely absent from some. Their colour is frequently pink and purple, but it fades when the gall is dry. They usually number from four to eight. I have found a specimen with ten. Their symmetrical arrangement can be seen best in a transverse section of a gall.

Although the galls appear during several months they grow quickly and mature rapidly, and fall to the ground unless inhabited by inquilines. Those which vary from the normal shape in having short peduncles and are more obese, will remain attached to the twig for a long while. The length they attain is remarkable. I have found dozens of varying sizes up to 22 mm., many 25 mm., and one 29 mm. long. They usually project obliquely from the twig, and are slightly curved, sometimes standing erect on a horizontal branch and perfectly straight, sometimes at right angles on an upright twig, very rarely pointing downwards, and apparently never adpressed.

Mayr describes this gall, from specimens found on *Quercus pubescens*, as "Scantily covered with moderately short, white, deflected hairs." Pubescence does not appear when the galls are on other species of *Quercus*.

These galls were first described by Malpighi in 1682; and Giraud was the first to breed and describe the imago in 1859. E. A. Fitch appears to have been the first to discover it in England, at Rayleigh in Essex, in 1874. I have found it local but plentiful in woods and coppices in various parts of the Hastings zoological district each season since 1899.

The majority of the galls are occupied by the parasite or the inquilines.

The imago does not emerge from some galls until the second spring after pupation.

## **Aphilothrix collaris,** Hartig.

*Cynips collaris*, Hartig, Schenck.; *C. tegmentorum*, Schtdl.; *C. fasciata*, Schtdl.; *Aphilothrix collaris*, Mayr, Adler, Licht., Fitch; *Andricus collaris*, Mayr, Cameron, Mosley.

**English name of gall.**—"The Collared Bud Gall."

**Position of gall.**—In lateral and terminal leaf buds.

**Manner of growth.**—Solitary, glabrous, glossy, concealed.

**Colours.**—Green, greenish-yellow, brown.

**Average dimensions of a mature specimen.**—Height, 3 mm.; breadth, 2 mm.; girth, 6 mm.

**May be sought** during the months of August and September.

**Growth is complete** by the end of September.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the spring of the second year.

**Parasites,** Nos. 117, 50. **Inquilines,** Nos. 133, 135.

**Alternate sexual generation:** *Andricus curvator*, Hartig.

The quickest way to discover this deeply-hidden gall is to longitudinally slice, with a sharp knife, every bud on twigs of a likely bush until the typical appearance of a galled bud is remembered; then by removing a few leaf scales only of other buds undamaged specimens can be secured.

A most obscure gall by reason of its diminutive size and in being almost entirely concealed by the leaf scales until quite mature; then only a small portion of the apex is visible, which usually being brownish in colour harmonises with the leaf scales and renders detection very difficult.

"It is hard, woody, conical or oval, sometimes almost round and smooth, the apex narrowed to a point, forming a blunt cone surrounded by a zone differently coloured from the rest of the gall" ('Brit. Phyto. Hymen.,' vol. iv, p. 90).

From the case of each gall is formed a slender appendage which penetrates deeply into the axis of the bud. When the gall is mature this appendage contracts and the gall falls to the ground, but other specimens which contain parasites or inquilines remain

*in situ* for some months firmly rooted in the twig, affording "an instance in this of what is frequently found to be the case, that when an inquiline lays its egg in an immature gall the growth of the gall is altered with the death of the original larva, and becomes pathological" ('Alternating Generations,' p. 44).

Although the sexual generation is so plentiful, *collaris* is somewhat uncommon and does not appear to have been often found by the collector.

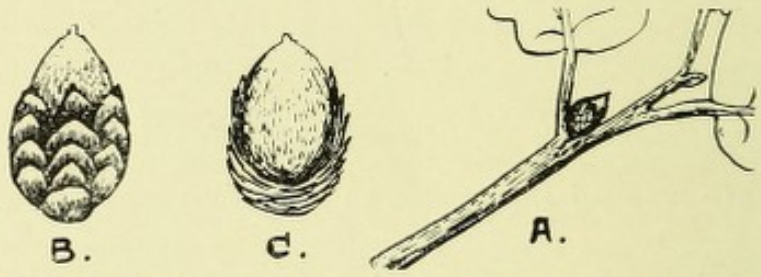


Fig. 8.—Galls caused by *Aphilothrix collaris*. A. *In situ*, nat. size. B. Enlarged × 4. C. Some leaf scales removed × 4. In part after Mayr.

It is sometimes embedded in the leaf scales of *A. fecundatrix*.

## **Aphilothrix corticis,** Linn.

(Plates XIX, XXII, div. A.)

*Cynips corticis*, Hartig, Schenck., Kalt., Kirch., Thoms.; *Andricus corticis*, Mayr, Cameron, Mosley; *Aphilothrix corticis*, Adler, Mayr, Licht., Fitch, Ormerod.

**English name of gall.**—"The Bark Gall."

**Position of gall.**—In the bark, in the rim of a callus, in axil of a branch.

**Manner of growth.**—Glabrous, glossy, gregarious, conglomerated, embedded.

**Colours.**—Greenish-yellow, yellow suffused with pink, purple, brown.

**Average dimensions of a mature specimen.**—Depth, 10 mm.; breadth, 4 mm.; girth, 12 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during June.

**Parasite,** No. 158. **Inquiline,** No. 131.

**Alternate sexual generation:** *Andricus gemmatus*, Adler.

This species of gall is often more or less concealed by dead leaves, moss, or loose earth, but sometimes situated prominently in a callus or other incrassation of a stub.

The autumn–winter condition of these galls is shown in Plate XXII, div. A.

Embedded deeply in the bark, and not easy to see, because of their brownish colour, these galls are constantly overlooked. It is only during the very earliest period of exposure, and later on after the imagines have eaten their way out, that the galls attract attention—in the former condition by reason of their pale colour, in the latter, because of the clusters of little holes.

They occur in aggregations, and vary in numbers from three or four to forty or more, very rarely less than three; mostly in a deep split in the bark; frequently in a callus resulting from injury, or in the new growth where a limb has been removed; sometimes in semi-exposed roots; and occasionally in the axis of a bough growing out from the bole of the tree.

The shape of this gall is fairly constant, obconical being the type. It varies, however, especially during the period before maturity, when it may be oval with the lower apex somewhat pointed; this ultimately penetrates deeply into the tissue around it. When conglomerated they are often greatly distorted, flattened longitudinally, and irregular in size and form.

The appearance of the gall when pushing through the bark is glossy, succulent, and fleshy, very pale yellow, or greenish. The visible portion known as the cap is more or less globose, and about 3 mm. in diameter. The structure continues to rise until it is

about 3 mm. above its surroundings, by which time it will have altered to a brownish colour, and the texture hard and woody.

The cap is concave within, and soon after the gall reaches maturity it falls off, leaving the larval chamber with a very thin but hard convex septum upon it, and the upper margin of the thick cell walls exposed. The imago ultimately eats its way through the septum.

The exposed margin is bordered by a thin rugged rim, within which is enclosed a circle of about twenty small punctures, with the hole of emergence in the centre. These little punctures "belong to an earlier period of growth; and through them passed the vascular bundles that nourished the upper sappy half of the gall" ('Alternating Generations,' p. 38).

Miss E. A. Ormerod appears to have been the first to discover and record this gall in Britain, and also to figure a type specimen in two conditions of growth from a cluster found in 1877, in the neighbourhood of Isleworth.

An oak stump in a coppice or a wood is one of the surest situations in which to find these galls, more especially if there be a number of small boughs growing from the stump. A careful scrutiny should also be made of trunks of old trees. When in clusters and exposed, as shown in the centre of Plate XIX, they are not difficult to find, but if a gall is solitary, and in the folds of a callus, as seen near the top of the same illustration, detection is less easy. After they have turned brown, or if surrounded by moss, they may very easily be overlooked, and on that account their distribution may be much wider than is generally known.

### **Aphilothrix fecundatrix,** Hartig.

(Plates XX, XXI, XXII, div. B.)

*Cynips gemmæ*, Linn., Schnck.; *C. fecundatrix*, Hartig, Marshall, Müller; *Aphilothrix gemmæ*, Mayr, Fitch; *Aph. fecundatrix*, Adler, Licht.; *Andricus fecundatrix*, Mayr, Cameron; *A. gemmæ*, Mosley.

**English names of gall.**—"The Artichoke Gall," "The Hop-strobile Gall," "The Hop Gall," "The Larch-cone Gall."

**Position of gall.**—In axillary and terminal buds.

**Manner of growth.**—Single, sessile, aciniform, concealed.

**Colours.**—Green, dark green, reddish-brown.

**Average dimensions of a mature specimen.**—Height, 8 mm.; breadth, 4 mm.; girth, 12 mm.

**May be sought** during the months of June to September.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the following spring. Sometimes not until two or three years afterwards.

**Parasites,** Nos. 11, 30, 47, 56, 59, 66, 116, 118. **Inquilines,** Nos. 128, 132, 145.

**Alternate sexual generation:** *Andricus pilosus*, Adler.

This gall was observed in England by Dr. Sir Thomas Browne, and mentioned by him in correspondence with Dr. Merrett in 1668 (see Introduction).

The branch shown on Plate XX has thirteen strobiles growing on it, and it may be considered a very fine and unusual example of so numerous an aggregation.

This growth consists of two parts totally distinct from each other in appearance, shape, size, structure, manner of growth, and colour; the outer and easily recognisable portion, composed of a large number of imbricated leaf-scales; the inner and invisible part, a small pip-like, glossy, more or less hard, substance.

The leaf-scales are of two shapes. Those occupying a central position are long, narrow, and thread-like, usually about ninety in number, and thickly covered with long silky hairs. The external or enveloping leaf-scales are not so numerous, oval or somewhat triangular in outline, of varying shades of green, mostly margined with a deeper shade of the same colour, or with pink or purple, and these scales also are thickly covered, but on the external surface only, with long silky adpressed hairs, many more of which spring from the margins and produce a delicate fringe.

The scales completely conceal, and effectually shelter, the inner pip during its formation.

This pip, which is the true gall, constitutes the nourishment for the larva, and within the tissues it eats a cavity, forming the larval chamber. In shape it may be pyriform, an elongated oval, or like a grape-pip. The smaller or lower end is truncated or flattened, and placed in direct contact with, and affixed to, the axis of the bud. The distal end is deeply depressed, within which is situated a very small yellowish cone having a glossy vertex. At first the colour is pale green or greenish-yellow, which, however, soon becomes dark green, and later reddish-brown. Early in its formation it is soft and sappy, the cell walls thick, and easily opened with a finger-nail, later it hardens greatly. When nearing maturity numerous (40–50) longitudinal striations, which extend from base to summit, may be seen on its surface. The average dimensions are 8 mm. high and 12 mm. at greatest girth. The interior is oval, whitish in colour, the larva occupying the entire space.

Until it attains its full growth the gall remains firmly fixed, but about the second week in August the axis of the bud contracts; the base of the scales thus being brought close together press against the lower part of the pip, causing it to separate from the axis and finally to be pushed upwards until it falls out. In Plate XX two strobiles can be seen where the galls have reached a position in which a movement of the branch will cause them to fall. They were in this condition when found by the author.

During the early formation of the leaf-scales the shape of the mass is more or less globular. Three types of this form can be seen at *d*, *e* in Plate XXI. It then emerges into the form of an ellipse or an oval, *c*, *a*, the central scales soon afterwards pushing their way through the distal apex and forming a cone or strobile, when the appearance (*b*) is like that of a miniature artichoke, hence one of its popular names.

When it reaches this condition it is an indication that the gall is about to be pushed out, and this soon takes place, *g*. The central scales continue to lengthen for some time after the gall has gone (*f*), but their growth is dependent upon the condition of the season, whether it be early or late when the gall falls; if the latter, no change takes place in the length of the scales. These scales separate somewhat from one another, but the whole cluster remains on the twig or branch throughout the winter; the coldest and roughest weather seemingly has no power to dislodge them. The new growth in the spring usually pushes them off (see Plate XXII, div. B).

They are mostly sessile and axillary in their situation; many, however, are elevated on a peduncle 20 mm. or more long, and many others are in a terminal position.

Soon after the gall has fallen to the ground it attains maturity. The exterior becomes hard and firm, the colour deepens to a reddish-brown, and it is difficult to find amongst dead leaves, grass, loose earth, etc.

It remains in that condition for a period which may extend to two and a half years, before the imago issues from it. Some galls, however, do not leave the scales from various causes, the principal being the presence of parasites or inquilines instead of the rightful owner. Such examples are occasionally found in the winter and spring.

These strobiliform growths are exceedingly common all over England, and are found more plentifully on bushes and young trees than on large trees during the months of June and October, both inclusive, in a fresh state, varying according to the locality, and in the old condition for many months more.

Cameron and Fitch both state that the larvæ and pupæ of a Tortrix, *Carpocapsa juliana*, may be commonly found among the leaf-scales and the imago easily reared.

## **Aphilothrix globuli,** Hartig.

(Plate XXIII, div. C.)

*Cynips globuli*, Hartig, Schenck., Kirch.; *Aphilothrix globuli*, Mayr, Licht., Adler, Fitch; *Andricus globuli*, Mayr, Cameron, Mosley.

**English name of gall.**—"The Globular Gall."

**Position of gall.**—In lateral and terminal buds.

**Manner of growth.**—Sessile, solitary, glabrous, globular, oblate.

**Colours.**—Pale green, green, greenish-brown, bluish.

**Average dimensions of a mature specimen.**—Globular; girth, 12 mm.

**May be sought** during the months of September to November, and occasionally in December.

**Growth is complete** by the end of October.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during April of the second year.

**Parasites,** Nos. 14, 38, 44, 56, 113, 118. **Inquilines,** Nos. 1, 133, 138, 145.

**Alternate sexual generation :** *Andricus inflator*, Hartig.

A favourite situation for these galls is on the long and slender twigs which so often grow from the bole of an old oak situated in a more or less open wood. I have seen scores of such twigs with from one to eight galls in terminal and axillary positions.

Small bushes near the bole of the tree, or more generally those just beyond the limits of the lower branches, will also frequently yield numerous specimens, while the small twigs of the branches themselves will often have galls.

This is one of the late autumn galls, specimens frequently being seen *in situ* during November and occasionally in December. It is a pretty little gall, mostly oblate in shape; this, however, is not apparent until it is mature and divested of the outer rind. Many specimens are quite spherical. It is formed in a bud and bursts through the leaf-scales during October. For a short time only a small portion of the growing gall can be seen, but ultimately about two thirds of

its bulk is visible, the lower third being concealed by the leaf-scales. These do not fall off.

The gall is composed of two layers, the outer forming a soft, thick, sappy, green rind, which envelops the larval chamber all the while it is on the twig, but "when the gall falls out of the bud the sappy rind is loosened, and the woody inner gall left bare" (Adler, 'Alternating Generations,' p. 40). If, however, the gall is gathered before maturity, this exterior dries and shrinks, producing irregular reticulations which unite at the apex in a point, caused by a small cone beneath. The inner layer, which forms the larval chamber, has thin walls enclosing a large cavity, whitish inside. The outer surface of these walls is marked with a network of very fine irregular lines, only to be seen with the aid of a pocket lens. This portion becomes hard and woody when the gall is fully developed. At the point opposite the base grows the small cone previously mentioned, reddish or yellowish in colour. It is not visible while the rind is soft and thick.

## **Aphilothrix Malpighii,** Adler.

(Plate XXIII, div. A.)

*Andricus Malpighii*, Mayr, Cameron, Mosley.

**English name of gall.**—"Malpighi's Gall."

**Position of gall.**—In axillary buds.

**Manner of growth.**—Solitary, sessile, slightly pilose, spindle shape.

**Colours.**—"Green, often with reddish stripes" (Cameron).

**Average dimensions of a mature specimen.**—Height, 4 mm.; breadth, 1·5 mm.; girth, 4·5 mm.

**May be sought** during the months of September and October.

**Growth is complete** by the end of September.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the spring of the second year.

**Alternate sexual generation:** *Andricus nudus*, Adler.

This gall stands more or less obliquely from the twig, upon a hemispherical base formed of the aborted bud out of which it has grown. It may be sessile, or attached by a short peduncle. It is in the form of a narrow cylinder, the distal end of which bears a small, glabrous, glossy, mastoid process.

Its growth occupies about three weeks, by which time it reaches maturity and then falls to the ground.

A special feature characterising the growth of this gall is the hemispherical reddish-brown base which is firmly adherent to the twig in a leaf axil.

The gall appears to be rare. I have never found more than the one specimen illustrated, although

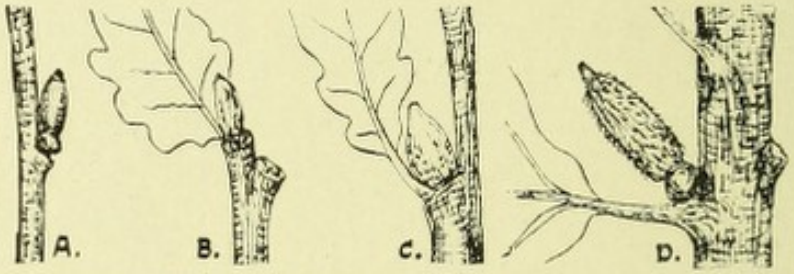


Fig. 9.—Galls caused by *Aphilothrix Malpighii*. A. After Cameron. B, C. After Adler, each × 2. D. The same specimen as in Plate XXIII, div. A. × 4. dele. ad nat. E.C.

quantities of galls of *Andricus nudus* are found year after year in the same wood. I found it in a wood at Hastings during September 1901, and knowing for certain that I should not be able to visit the spot again for several weeks, gathered it, but unfortunately failed to rear the inhabitant.

Cameron describes the gall as smooth. My specimen is clothed with numerous short, recurved, adpressed hairlets, of a somewhat golden colour, except at the apex, and devoid of ridges. Adler does not refer to the presence or absence of hairlets. Cameron's illustration ('Brit. Phyto. Hymen.,' vol. iv, Plate VII, fig. 2) corresponds as regards position, base, size, and partly in outline, with my specimen.

Adler, in 'Alternating Generations,' Fig. 12, illustrates two galls on a twig. They are sessile, and

much more spindle-shaped than the previous specimens, and also distinctly ridged—a feature neither mentioned by him in his description of the gall, referred to by Cameron, nor found in my specimen.

There may be, however, variations in mode of growth such as would allow each of the above to be representative.

They are illustrated in Fig. 9 for comparison, and to assist the collector to identify any he may find.

## **Aphilothrix marginalis,** Schlechtendal.

(Plate XXIV, div. A.)

*Cynips marginalis*, Mayr, Schltdl.; *Andricus marginalis*, Mayr, Cameron; *Aphilothrix marginalis*, Mayr, Licht., Adler, Fitch, Mosley.

**English name of gall.**—"The Marginal Gall."

**Position of gall.**—On margin of leaf; sometimes on mid-rib.

**Manner of growth.**—Sessile, solitary, glabrous, glossy.

**Colours.**—Green, striped with pink or red, yellowish, brown.

**Average dimensions of a mature specimen.**—Height, 4 mm.; breadth, 3 mm.; girth, 9 mm.

**May be sought** during the months of May and June.

**Growth is complete** by the end of June.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the same or the following month.

**Parasite,** No. 66.

Cameron says: "Neither as regards the gall, or insect, is this to be known from *A. 4-lineatus*. I have no doubt that it is only *A. quadrilineatus*, the galls of which occur on the leaves" ('Brit. Phyto. Hymen.,' vol. iv, p. 96). Mayr remarks that they so greatly resemble each other as to be indistinguishable.

In form this gall is irregular; it may be conical, oval, or roundish, more or less deeply ribbed longitudinally, and when on leaves larger than when on catkins.

The larval chamber is large with thin walls.

## **Aphilothrix quadrilineatus,** Hartig.

(Plates XXV, XIII, div. C.)

*Andricus quadrilineatus*, Hartig, Schenck, Mayr, Fitch, Cameron, Mosley; *Aphilothrix quadrilineatus*, Adler, Licht.; *Cynips 4-lineatus*, Thoms; *Andricus flavicornis*; *A. ambiguus*; *A. verrucosus*; *A. pedunculi*; *A. glabrusculus*, Schenck.

**English name of gall.**—"The Furrowed Catkin Gall."

**Position of gall.**—On the flower-stalk of staminate catkin.

**Manner of growth.**—Sessile, glabrous, glossy; gregarious, longitudinally grooved.

**Colours.**—Pale green, greenish-yellow, reddish-brown.

**Average dimensions of a mature specimen.**—Length, 4 mm.; breadth, 3 mm.; girth, 9 mm.

**May be sought** during the months of May and June.

**Growth is complete** by the end of June.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the following spring.

**Parasites,** Nos. 8, 66, 154. **Inquiline,** No. 130.

I have found as many as thirty-five of these galls on a catkin stalk measuring 70 mm. in length.

The regularity with which the galls of this species appear on the same tree is remarkable. I have observed several trees, 80 to 150 years old, for the past fifteen years on which they have occurred each summer without intermission. Probably they were there many years before my observations began, and they will annually reappear until the trees are thrown, or they decay.

This gall was first found in Britain by Professor Trail, in the year 1873, at Aberdeen. In the following summer E. A. Fitch discovered it at Raleigh in Essex. It is now well known, and widely distributed all over the country.

It appear to be more frequently found on *Quercus pedunculata* than on *Q. sessiliflora*, and often it is on the same catkin as *Spathegaster baccarum* and *Aphilothrix seminationis*.

It is subject to great variations in size, shape, and

also in the number, length, and depth of the furrows. Some examples are quite smooth, and but for the absence of the sharp pointed apex peculiar to the galls of *Andricus nudus*, many small specimens might pass as that species. Yet mature galls of *A. quadrilineatus* often show a papilla when dry; *A. nudus*, however, never attains the same dimensions.

Considerable indecision appears to have existed amongst writers as to the identity of this gall when it was first noticed on the continent. Its great variability doubtless accounts for this, and it also affords an explanation of its many synonyms, to which Schenck unnecessarily contributed five.

Some years it appears in great profusion, clusters of eight and ten galls being frequently found on a catkin stalk. A very fine example I found in 1907 consisted of fifteen galls upon one stalk within a length of 23 mm.

"Notwithstanding that this gall is very abundant it is by no means easy to rear the fly. From the majority of the galls parasites are usually obtained; then the larva in a large number of instances does not develop into the imago for two years" ('Alternating Generations,' p. 91).

### **Aphilothrix radicis,** Fabricius.

(Plates XXVI, XXX, div. A.)

*Cynips radicis*, Fabr., Hartig, Schenck, Kalt., Marshall; *Aphilothrix radicis*, Mayr, Adler, Licht., Fitch, Walker, Müller; *Andricus radicis*, Mayr, Cameron, Mosley.

**English name of gall.**—"The Truffle Gall."

**Position of gall.**—On exposed roots, base of trunk and branches growing therefrom.

**Manner of growth.**—Glabrous, sessile, solitary, conglomerated.

**Colours.**—Cream, pink, orange, red, reddish-brown.

**Average dimensions of a mature specimen.**—Height, 45 mm.; length, 60 mm.; breadth, 40 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of the second autumn.

**The typical condition of the gall** is plurilocular, but unilarval. Usual number of cells, about sixty.

**The larva** pupates in the gall **The imago** emerges during the second spring.

**Parasites,** Nos. 44, 103, 149, 152, 161, 175, 178. **Inquiline,** No. 131.

**Alternate sexual generation:** *Andricus noduli,* Hartig.

This gall was observed in Britain by Sir T. Browne, M.D., in 1668 (see Introduction).

In the year 1870 it was brought before the notice of entomologists by A. Müller, who reared some imagines.

It is so distinctive in situation, texture and coloration that once having been seen there is no difficulty in recognising it in any of its various forms, and of distinguishing it from the other root gall, *Biorhiza aptera*.

The typical situation for this gall is on the largest roots of old oak trees where they branch off from the base of the trunk, and partly, or entirely, concealed by loose earth, leaves or moss. It is found also at a depth of about six inches below the ground, and it occurs on the trunk of the tree, rarely, however, at a greater height than two feet from the ground level, and still more rarely on a small branch springing from the base of the trunk, as shown in Plate XXX, div. A. Of many dozens of specimens I have seen two only have occurred in such an uncommon situation. The most certain place, perhaps, to find this gall, is a hedge bank where a stub-oak forms part of the hedge, and its roots (here and there exposed) are old and extensive. The alternate generation is sure to be near by.

The form of the gall is exceedingly variable. It is difficult to define a typical figure.

When formed below ground the shape depends upon the density of the surrounding earth, and it may be flat, ovoid, pyriform, globular, or as indicated above; and sessile or attached by a stout peduncle. Moreover it does not appear to attain so great proportions as

when above ground. I have observed that when situated on the trunk, or a branch, the majority of single growths (*i. e.* like that in Plate XXX, div. A), approach a reniform or an oval shape, and are sessile. Such a specimen may be regarded as the result of the oviposition of but one imago, whereas that in the lower half of Plate XXVI, being due to several, perhaps four, imagines.

The size, likewise, differs considerably, varying from that of a marble to upwards of 30 cm. at greatest girth.

The gall appears in September and continues growing for some weeks. About November it ceases to grow until the spring, when formation is resumed, and by the end of the summer it is mature ; the larvæ then pupate and remain in that condition through the winter, the imagines coming out about April. During formation the gall is succulent, of the consistence of a potato, more or less smooth externally and slightly glossy ; when nearing maturity it becomes firmer, and finally hard and woody. Small and medium size aërial specimens usually have about half their surface deeply furrowed, producing elevations of irregular shape, size, and height, and mostly pointed.

The larval chambers are exceedingly numerous. They are normally globular in shape, about 3 mm. in diameter, with thin, hard, and woody walls, firmly affixed to each other in a somewhat concentric pattern, and occupying the centre of the surrounding tissue. After the gall has arrived at maturity this tissue undergoes various changes. It loses much of its solid nature, becomes soft and open in texture, thus offering little resistance to the imagines in eating their way to the exterior. Finally it decays away, leaving the tenantless larval chambers in a conglomerated condition, whitish in colour, and adherent for some time.

The colour is regulated according to situation. Below ground it is white, or dirty white, sometimes with a rose tinge ; beneath leaves or moss it is suffused

with pink or red, lasting for some time, then deepening to brown; upon the trunk it is mostly reddish-brown throughout the whole of its growth, changing at last to chocolate brown.

The largest specimen of this gall of which I have any record was composed of five sections, forming an oblong-obvate outline and ob-compressed, and attained a girth of 32 cm. It grew on the short stump of a very old oak tree in a wood near Hastings. I visited the spot intermittingly during a period of twenty-five months to note its growth, and then, as hundreds of imagines had left it and there were signs of approaching decay, I removed it for further examination. Another interesting specimen I discovered at Hastings was growing out of an ivy stem encircling a large oak tree. The gall was in its first year of growth and consequently immature. For several reasons I was obliged then and there to remove it, and did so by sawing away a length of the ivy stem, with the gall remaining upon it. It was globulose in form, brownish in colour, with a rough surface, and 25 mm. in diameter. It is now in my collection of oak galls.

The popular designation of "truffle gall" is singularly appropriate, both its appearance and manner of growth when beneath the ground coinciding with that of the fungus. The black truffle (*Tuber melanospermum*) exists a few inches under ground, and although partial to beech woods is found amongst oaks also. Its external appearance is very much like that of a *radicis* gall.

### **Aphilothrix seminationis,** Giraud.

(Plate XXIV, div. B.)

*Cynips seminationis*, Giraud, Mayr; *C. inflorescentiæ*, Schltd.; *Aphilothrix seminationis*, Adler, Licht., Fitch, Mosley; *Andricus seminationis*, Mayr, Cameron.

**English name of gall.**—"The Barley-corn Gall."

**Position of gall.**—On the stems of staminate catkins and on leaf margin.

**Manner of growth.**—Solitary, glabrous, glossy, spindle shape.
**Colours.**—Cream, green, greenish-yellow, suffused with pink or red, brown.
**Average dimensions of a mature specimen.**—Length, 6 mm.; breadth, 2·5 mm.; girth, 7·5 mm.
**May be sought** during the months of May and June.
**Growth is complete** by the end of June.
**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during the following spring.
**Parasite,** No. 44. **Inquilines,** Nos. 127, 130.

This gall is slightly pubescent when young. Some specimens are slightly pedunculated, and also marked with longitudinal ribs more or less sharply defined.

Catkin stems bearing these gall are often abnormally thickened, and remain on the twigs all the summer. Leaves are peculiarly indented or deformed in shape.

The gall closely resembles that of *A. callidoma*, but may be distinguished from that species by its point of origin—it never grows from a bud.

## **Aphilothrix Sieboldi,** Hartig.

(Plates XXVII, XXVIII, XXIX, XXX, div. B.)

*Cynips Sieboldi*, Hartig; *C. corticalis*, Schenck; *Aphilothrix Sieboldi*, Mayr, Adler, Licht., Müller, Walker, Fitch; *Andricus Sieboldi*, Mayr, Cameron, Mosley.
**English name of gall.**—"The Red-barnacle Gall."
**Position of gall.**—On small branches and twigs near the ground.
**Manner of growth.**—Sessile, glabrous, glossy, gregarious.
**Colours.**—Cream, yellowish, pink, crimson, reddish-brown.
**Average dimensions of a mature specimen.**—Height, 6 mm.; breadth, 6 mm.; girth, 15 mm.
**May be sought** during any month of the year.
**Growth is complete** by the end of September.
**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during the following spring.
**Parasites,** Nos. 44, 66, 175. **Inquiline,** No. 131.

**Alternate sexual generation:** *Andricus testaceipes*, Hartig.

This gall was first recorded as British by A. Müller in 'The Gardener's Chronicle,' No. 40, p. 1312; fig.

239 illustrating a specimen (1870). It was also independently found by H. Moncrieff at Portsmouth in January, 1873, the specimen being a good sized twig with a large aggregation of galls around it.

The galls may now be found in almost any hedgerow containing oak bushes.

When the habitat of this gall is understood there is little difficulty in finding numerous specimens in localities where they occur. It is almost certain to be found quite low down near the roots in thick parts of a hedge, sometimes hidden by dead leaves, moss, or loose earth. Very seldom at a greater height than three feet above the ground, and never on the higher boughs, nor in a situation exposed to direct sunlight. A favourite place is on a road-side bank which is well covered with herbage, including small oak bushes whose shoots are occasionally cut off by the hedge trimmer. In such spots I have found some of the best, and most remarkable specimens in my collection. Diligent and careful search is however often necessary. It appears to be restricted to certain areas, and not found at all in some localities. It is one of the most distinctive of the oak galls, and unlike any other British species.

An egg is laid by *Andricus testaceipes* beneath the bark of a shoot in late summer. The gall begins to grow during September, and the bark soon rises in consequence. At the close of the autumn, growth ceases, but with the return of spring it is resumed. About May the bark bursts, and the gall increases rapidly. Before the end of July it has reached maturity, and the larva pupated. During August and September the imago develops within the puparium, but it does not emerge from the gall until the following spring.

The red colour of the gall varies in intensity. I have found them where concealed from all light, of a very pale yellow or cream colour, the apex only slightly touched with pink. A cluster of this kind is depicted

in the lower right hand corner of Plate XXVII. And from that condition they advance through all shades of pink and red to a deep purple. It is rarely, if ever, green.

The shape is generally conical; some specimens are oblate with the apex produced into a small papilla. The lower portion is also conical descending deeply into the zylem, and remaining there after the decay of the superstructure. During growth many specimens have the upper surface rounded, and when crowded together they are considerably compressed, and there does not appear to be any apex or papilla, but both of these ultimately develop and can be seen.

The substance of the gall is composed of two layers. The inner, yellowish in colour, thin, and woody, and striated from the apex to the periphery. It encloses a rather large larval chamber. The outer layer is much thicker. It is composed of a soft and sappy rind containing the red colouring matter, and from it a slightly sweet mucilaginous substance exudes. It may frequently be covered with a bloom. Ants are very fond of the sweet substance, and build a dome of earth over clusters of the galls. I have found several very fine examples of this. Whilst recognising the fact that the protection thus afforded prevents parasites and inquilines from attacking the galls, I do not agree with those who consider the sweet substance as a means devised by the gall to entice ants to it and induce them to protect it; nor that the exudation is for the purpose of ensnaring unfriendly insects and other small creatures. Repeated observations lead me to the conclusion that ants are aware that by building a dome, the galls are protected from premature evaporation and drying, thereby securing a more copious and lasting exudation for their exclusive enjoyment. Galls not protected from the drying action of midsummer heat in this way, or by dead leaves, moss, or earth have less moisture in the rind than those which are protected.

When the gall is mature the rind dries, cracks, and falls away, leaving the yellowish-brown inner layer. If the gall is gathered before maturity, the rind will dry and adhere as a thin skin, so closely as to show the striæ beneath it.

Small birds, principally tits, break open the galls in winter time, and devour the inhabitants.

This gall seldom occurs singly, *i. e.* only one on a shoot or twig; it is characterised by the large numbers clustered together—seventy or more within a linear distance of 7 cm.

When a great many are crowded on a shoot, they penetrate the zylem so deeply that further growth of

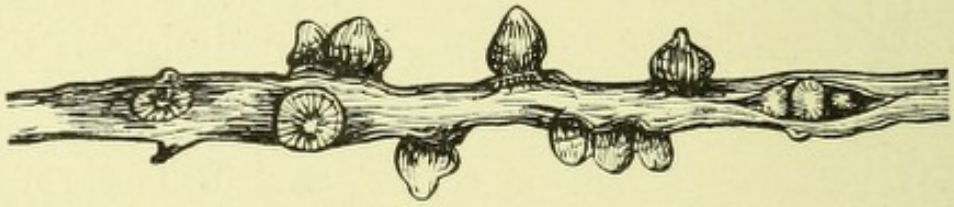

Fig. 10.—Galls caused by *Aphilothrix Sieboldi* illustrating typical shapes and situations. Nat. size, dele. ad nat. E.C.

the shoot is prevented. It does not, however, decay, but will remain attached for some time, and, frequently shoots may be found bearing new galls near to those of one and two previous years.

This gall received its specific name after M. von Siebold, who was one of the earliest to find the galls at Dantzig and Frieburg.

## **Biorhiza aptera,** Fabricius.

(Plates XXXI to XXXIII.)

*Cynips quercus terminalis*, Fabr.; *Teras terminalis*, Marshall; *Biorhiza terminalis*, Mayr; Cameron. *Biorhiza aptera*, Adler; Mayr; Müller; Marshall. *Cynips aptera*, Fabr.

**English name of gall.**—"The Root Gall."

**Position of gall.**—On roots and rootlets.

**Manner of growth.**—Glabrous, sessile, gregarious, coalescent.

**Colours.**—Pink, yellowish-brown, red, reddish-brown, chocolate brown.

**Average dimensions of a mature specimen.**—One larval cell: Height, 8 mm.; girth, 30 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of October.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the winter and the spring.

**Parasites,** Nos. 15, 175.

**Alternate sexual generation:** *Teras terminalis*, Fabr.

"The time given by different authorities for the appearance of the flies varies, some having found them in November and some in March; according to my own observations the latter date must be considered exceptional, at least in this place (Schleswig). I have for many years found the flies regularly in the end of December and beginning of January" (Adler, 'Alternating Generations,' p. 71).

This gall appears to have been well known in the south of England prior to the year 1874. But it had only been observed on the roots of oak trees that had been blown down by gales, and not as the result of entomological research. It occurs on the subterranean roots only; on the largest and thickest, as well as on the most slender, but with greatest frequency on those varying in dimensions from that of a quill to that of a lead pencil.

It is seldom solitary, but when so the size ranges from 5 mm. to about 15 mm. in diameter, and the shape is more or less globular.

The general condition of growth is gregarious, and in conglomerated clusters of considerable numbers; the overcrowding in some masses being so great that distortion and fantastic shapes are the result. Some clusters resemble the gall of *Aphilothrix radicis*, but may be easily distinguished from that species by (*a*) the outline of the cluster showing each separate larval chamber; (*b*) each larval chamber, although attached to those next it, may be separated without injury; or (*c*) by making a transverse section, when it will be

seen that the larval chamber of this species is very much larger than that of *A. radicis*.

The galls of *B. aptera* may readily be obtained by removing earth with a small trowel, or a piece of stick, from the side of a bank on which an oak tree is growing. A position similar to that depicted on Plate XXXIII, will yield an abundance of specimens. They are always covered with earth—sometimes sparingly—and usually at a depth of about three inches.

In the year 1873 some of these galls were found on the roots of Deodars at Wimbledon, and were exhibited at a meeting of the Royal Horticultural Society by Dr. Masters. It was considered to be the first instance in which a Cynips had been known to attack any species of *Conifer*. They have since been found on the roots of *Prunus*, *Fagus sylvatica*, and *Vitis vinifera*.

The male imagines are always alate, the females are mostly apterous; occasionally there are rudimentary wings. Upon leaving the gall the female creeps up the bole of the tree, along a limb, and after choosing a terminal bud, bores a large number of holes with her ovipositor; the ova being afterwards pushed down the holes until they form a mass at the base of the bud. The operation of oviposition is sometimes very protracted. Dr Adler observed that one female occupied eighty-seven hours in depositing 582 ova in two buds ('Alternating Generations,' p. 72).

The presence of so large a number of ova (about 290), and a corresponding number of holes, in so small a bud as that of the oak, must inevitably injure the interior, and extensive destruction of the tissues of the plant does actually take place; so much so that occasionally the whole bud axis is cut through, and no gall formation takes place. When, however, gall formation begins the apex of the real bud is severed from its twig, and, remaining loosely attached to the swelling, is lifted up and retained for some time. See Plate LVII, div. A.

The beautiful photo-micrographs on Plate XXXII,

by W. H. Hammond, of a transverse section through a bud with ova *in situ*, and of three ova alone, deserve careful examination.

## **Biorhiza renum,** Hartig.

(Plate XXXIV.)

*Trigonaspis renum*, Mayr; *Trigonaspis megaptera*, Cameron; *Biorhiza renum*, Giraud, Adler, Müller, Mayr, Fitch.

**English name of gall.**—"The Kidney Gall."

**Position of gall.**—On the under-surface of leaf.

**Manner of growth.** — Glabrous, glossy, gregarious, conglomerated.

**Colours.**—Yellowish-green, green, red, purple, dark brown.

**Average dimensions of a mature specimen.**—Reniform type: Height, 1 mm.; length, 2 mm.; breadth, 1 mm.

**May be sought** during the months of September and October; occasionally November.

**Growth is complete** by the end of October.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during May and June.

**Parasites**, Nos. 2, 10, 59, 74, 105. **Inquilines**, Nos. 134, 138, 139, 140, 143, 145.

**Alternate sexual generation:** *Trigonaspis crustalis*, Hartig.

The ovoid and spherical forms, and solitary specimens of this gall are apt to be confused with those of *Neuroterus ostreus* by anybody beginning to collect oak galls. Many examples are very much alike. Several features, however, serve to distinguish the species. *B. renum* is rarely spotted, and then not to the same extent as *N. ostreus*, the latter though is sometimes without spots. *B. renum* never has the little valve-like membraneous pieces of leaf tissue at its base, nor the minute papillæ on its surface as does *N. ostreus*, while the latter never occurs in parallel rows.

The shape and mode of growth of this gall are both distinctive and attractive. The shape is that indicated by its specific appellation, viz. like a kidney. Occasionally specimens develop into an ovoid and a spherical

form. The galls occur in groups and in large numbers on the under-surface of the leaf attached to the mid-rib and the lateral offshoots, in parallel rows, and numbering as many as sixty on a leaf. Each gall is complete and distinct from those near it, and is held in its position by an extremely short and delicate peduncle, so slender that the gall is easily detached. During the month of September they appear as if by magic. The growth is rapid and the first stage is completed very speedily. During October the peduncle shrivels, and the galls fall to the ground. A few will persist until early in November if climatic conditions are favourable. I have found specimens as late as the 12th of the month.

Rearing the imagines is a difficult matter. The larvæ are but partly grown when the galls fall, and they do not pupate until the early autumn of the following year. Some emerge during the months of December and January, most of the remainder not until May and June following; while a few delay their appearance for six or even twelve months longer.

The best place to search for these galls is amongst the leaves of stunted oak-bushes on hedge banks that have a northern aspect; and in well wooded districts they may be found in great profusion.

## **Cynips Kollari,** Hartig.

(Plates XXXV to XXXIX.)

*Cynips Kollari*, Mayr, Schenck., Newman, Fitch, Straton, Walker; *C. lignicola*, Marshall, Stainton, Parfitt; *C. quercus petioli*, *Quercus terminalis*, Westwood; *C. tinctoria*, Vollenhoven.

**English names of gall.**—"The Devonshire Gall," "The Oak Marble," "The Oak Nut," "The Marble Gall."

**Position of gall.**—On twigs and on branches.

**Manner of growth.**—Single, solitary, gregarious, coalescent, glabrous, spherical.

**Colours.**—Pale green, golden yellow, emerald green, dark green, brownish-yellow, reddish-brown.

**Average dimensions of a mature specimen.**—65 mm.

**May be sought** during any month of the year.
**Growth is complete** by the end of August.
**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during September and October.
**Parasites,** Nos. 44, 51, 52, 54, 57, 61, 68, 108, 116, 179.
**Inquilines,** Nos. 17, 130, 132, 134, 137.

**Alternate sexual generation:** (According to Beyerinck), *Andricus circulans*, Mayr.

"These galls are not acorns, as the oak would have willed that they should be, but are the nearest approach to acorns that the oak can produce under its affliction. . . . The gall consists of two parts,—the larger is spherical . . . and represents the carpel of the acorn, or the acorn proper, and the saucer-shaped cushion, on which it rests, represents the cupule or cup, or calyx; the small pointed process exactly opposite the point of attachment being the persistent stigma of the acorn." E. NEWMAN, 'The Entomologist,' No. 135, p. 284.

A very great amount of interest surrounds this gall.

The casual observer is attracted by its globular form; warm brown colour; solid and hard texture. Noticed by such, usually when hedgerows are leafless, or perhaps in a collection of galls, or in a museum case, little thought is given to its rightful place in gall nomenclature; consequently it is more frequently spoken of as the oak-apple, than by its correct name of oak-marble.

The gallist, however, regards the brownish sphere as replete with most interesting features.

At one time it was the subject of a great amount of entomological literature, and correspondence; and probably its remarkable qualities will continue to furnish themes for many writers.

*Cynips Kollari* made its appearance in England about seventy-four years ago. In the year 1834 it was observed in Devonshire by Mr. Jordan, but he did not make the discovery known to entomologists, until

about twenty years later. In 1848 Mr. Parfitt noticed many of the galls in the same county, as also did Mr. Stainton a few years later. Its authentic history, however, as British, commenced on November 6th, 1854, when Mr. Rich was present as a visitor at the meeting of the Entomological Society of London, and exhibited some sprays of oak thickly covered with large galls. Mr. Rich reported at the meeting, that the gall was very abundant in Somersetshire, and Gloucestershire. ('Proc. Ento. Soc.,' 2nd series, vol. iii, p. 38.)

At first the gall was observed only in the vicinity of Exeter, where, in two large nursery gardens, young oak trees were greatly distorted. For many years it was known as the Devonshire gall. From those south-western counties it gradually spread along the north-western part of England and over Wales. In the year 1858 Mr. F. Smith, of the British Museum, obtained from Devonshire a very large number of the galls, and distributed them in different localities around London, for the purpose of observations. By so doing the spreading of the species throughout the remainder of England was accelerated. Now the gall may be found in almost every hedgerow, where there is oak, throughout the whole of Britain, in some districts in great abundance.

Soon after the galls had become ubiquitous in the three counties previously mentioned, many persons were apprehensive that the growth of oak trees, and the timber, would be imperilled by the destruction of the acorns, and the distortion of the twigs, if the spreading of the gall remained unchecked. Several writers advocated that the galls should be utilised in the manufacture of ink, and, since they seldom formed on any part of the tree at a greater height than a few feet, children should be employed to gather them, and by that means extermination would be soon accomplished. Analysis, however, showed that not more than 17 per cent. of tannin could be obtained from the

gall, whereas the true ink-gall yielded 40 per cent. more.

At the time of its appearance in this country the manufacture of cloth was a prominent industry in Exeter, Tiverton, and several neighbouring towns; and large quantities of *Cynips tinctoria* were imported for dyeing purposes. Whether *C. Kollari* was introduced for experimental purposes with the hope of superseding the Aleppo species, there is no confirmatory evidence. It will perhaps never be ascertained how this species of *Cynips* originated in this country. *C. Kollari* was known prior to that period for very many years throughout the whole of middle European countries.

As the gall spread over the country, and became known among entomologists, it was occasionally mistaken for three Continental forms of similar appearance and habit. One is *C. lignicola*, which is rather larger than a pea, occurs singly, also in twos and threes; it has a large oval. larval cell, and is generally of a spherical form, but it is distinguished by having an outer covering similar in appearance to leaf scales. Another form is *C. conglomerata*, which sometimes occurs singly but mostly in dense semi-racemous clusters of fifteen to twenty-five individuals, also rather larger than a pea. Externally it resembles a normal gall of *C. Kollari* in having a small style, and in being hard and brown when mature; also internally, in being composed of a spongy parenchyma. *C. Kollari* has also been confused with *C. tinctoria*, the ink-gall from the Levant, on account of its external features. Although the normal form of *C. Kollari* is smooth and spherical, an examination of Plate XXXV will reveal a remarkable similarity as regards size, shape, papillæ, and ridges. The larval cell in both is central and ellipsoidal in form. The imagines also, of each species, are much alike.

The oak-marble is found in great profusion in hedges, along lanes, and scrub oaks in coppices. Low

bushes and young trees in woods are sometimes badly attacked. Fully developed trees do not often bear galls.

Towards the end of September, or early in October, the parent Cynips emerges from a gall of the year, and at once seeks leaf buds in which to oviposit. She appears to prefer buds on slender and delicate twigs, but occasionally pierces those on the sides of larger branches. As soon as the egg is deposited, growth and development begin. A blastem forms around the egg and the larva hatches. A small and inconspicuous swelling is then formed on the twig. Very slight increase takes place until the following April or May. The embryo gall then becomes more readily noticeable, and by the end of June it will have attained the size of an ordinary pea, bright green in colour if exposed to the light, but golden yellow if in deep shade. Many specimens are also spotted, or streaked with crimson. Until the gall attains several millimetres in diameter, the tissues are enclosed within an epidermis which contains a reddish sap. Few or many one-cell hairs are scattered over its surface.

During July larva and gall rapidly enlarge; the epidermis, not keeping pace with the increase, splits into numerous small scales which quickly fall off leaving the surface a beautiful apple-green colour. Early in August considerable internal changes take place, the principal being that the primary nutritive tissue disappears, and oil globules and several proteids form the food of the occupant of the cell, the walls of which harden considerably. Little change is then noticeable except in coloration, until the latter part of September. The structure has then become firm and hard. It has attained maturity, and assumed a brownish-yellow or reddish-brown hue. It is firmly attached to the seat of growth, and will maintain its position for two, three, or more, years, neither wind, rain, hail, nor frost, dislodging it.

The gall may be sessile and axillary upon the side of a stout branch or shoot, or it may be terminal upon a thin stem a few millimetres only in length, or securely affixed to a long slender twig. An example of the latter character, found by the author at Hastings in 1895, is of a globular specimen, 66 mm. in girth, situated terminally on a twig 38 cm. long, and not more than 3 mm. in diameter throughout its entire length.

Normally the gall is globular. It is smooth all over, except at the pole opposite to that of attachment to the twig where it bears a small, sharp-pointed style (which is occasionally bifid), chocolate brown in colour. It consists of dead tissue, and is sometimes described as the pseudo-stigma, and the pseudo-carpel. It can be recognised during early development. When normal development of the gall is arrested early by parasites, or inquilines, the style is accentuated (Plate XXXVI, figs. 7, 8).

Many oak-marbles gathered in winter and spring, have numerous small dark brown excrescences upon them which have pushed their way through the exterior of the gall. Hitherto these appear to have been known as brown bodies. In January, 1908, the author, believing them to be due to fungoid agency, sent specimens to the Royal Herbarium at Kew. They were there identified as being attacked by the fungus *Phoma gallorum*, Briard, a species for the first time recorded as occurring in Britain. See Plate XXXIX, div. A.

The surface of the gall frequently has one or many small conical protuberances upon it (Plate XXXV), which vary much in size and height. There may be only one (figs. 17, 18), or as many as twelve or fifteen (fig. 7), all separate (figs. 10, 11), or coalescent in the form of a ridge (fig. 8), or ridges (fig. 5). For these conical elevations I propose the name of papillæ. They are quite distinct in shape from the style. They arise gradually from

their surroundings and are of the same texture and colour.

In the year 1897 M. W. Beyerinck ("Ueber di Sexuelle Generation von *Cynips Kollari*," 'Marcellia,' vol. i, p. 13) imprisoned a few imagines of *C. Kollari* on a young tree of *Q. cerris*, and observed that they pierced the buds. Upon opening the buds, he found that a number of ova had been deposited. In October, 1901, the experiment was repeated, and in the following February there were signs of gall growth. By April galls of *Andricus circulans* had fully matured, and early in the following month imagines came out, which proved to be those of *A. circulans*. Further experiments were made with a like result—an enormous number of *circulans* galls on every twig of the experimental tree.

He also found that out in the open, the galls of *C. Kollari* showed first indications of growth at the beginning of June, or about fourteen days later than the emergence of *A. circulans*. This he regarded as a further confirmation of the alliance, and alternating, of the two species. He was not able to get *A. circulans* to oviposit in *Q. pedunculata*. He also believes that *A. burgundus* is the sexual form of *C. tinctoria*.

## **Dryophanta agama,** Mayr.

(Plate XL.)

*Cynips agama*, Hartig; *Dryophanta agama*, Hartig, Müller, Cameron, Fitch.

**English name of gall.**—"The Yellow Pea Gall."

**Position of gall.**—On the under-surface of the mid-rib and its offshoots.

**Manner of growth.**—Single, glabrous, glossy, nodulose (inconspicuous), oblate.

**Colours.**—Pale yellow, orange yellow, yellowish-brown.

**Average dimensions of a mature specimen.**—Height, 4 mm.; length, 5 mm.; breadth, 4 mm.

**May be sought** during the months of June to August.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during the autumn.
**Parasites,** Nos. 39, 47, 88, 89, 119, 122, 159, 177, 180.
**Inquilines,** Nos. 127, 128, 134.

The specimens shown in the plate can hardly be considered as typical of this species. They were not found until past maturity, and the leaves were beginning to wither; consequently the galls are slightly above the average normal size, and fewer in number than is usual.

In the Hastings district they are rare, and no other specimens have been found that would serve the purpose of an illustration.

This species is not mentioned in 'Alternating

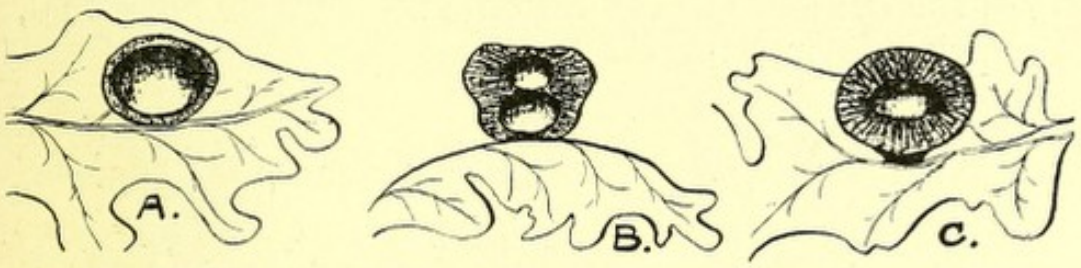


FIG. 11.—Sections of galls caused by (A) *Dryophanta agama*, (B) *D. disticha*, (C) *D. divisa*. All × 2. Dele. ad nat. E.C.

Generations,' and very little is recorded about it in any treatise on galls.

The galls are found mostly on oak bushes in woods, and stunted growths along hedge banks. One year they may be numerous, the next, scarce, and no reason can be assigned.

Their normal position is on the offshoots of the midrib; they are, however, occasionally attached to that also. They vary in number on a leaf to as many as ten, seldom more than twelve.

In shape they are oval, or ovoid, occasionally globular, much flattened next the leaf. They are attached by a very short, but stout, peduncle. The position of attachment does not show on the upper surface of the leaf.

The texture of the gall is hard, but the walls are thin ; and the larval chamber very large. The exterior is rarely suffused with pink or red. This forms one external distinguishing feature from *D. divisa*, which is pink during the greater part of its growth. Both species are about the same size, but *divisa* is generally slightly larger. Both, also, frequently have flat, reddish-brown, very small nodules scattered over the exterior.

This gall was first observed in England about forty years ago, the imagines having been reared by Albert Müller and recorded in ' Proc. Ento. Soc. Lond.,' 1870, xxxiv.

Although an alternate generation does not appear to be known, the fact that the imago does not normally pass the winter in the gall, would indicate that a sexual, or spring form, may exist.

### **Dryophanta disticha,** Hartig.

(Plate XLI.)

*Cynips disticha*, Hartig, Schnk.: *Aphilothrix disticha*, Mayr; *Andricus disticha*, Mayr; *Dryophanta disticha*, Mayr, Cameron.

**English name of gall.**—"The Two-Cell Gall."

**Position of gall.**—On the under-surface of the mid-rib and its offshoots.

**Manner of growth.**—Single, glabrous, slightly glossy, unique in form.

**Colours.**—Yellowish-white, pale yellow, light brown, reddish-brown.

**Average dimensions of a mature specimen.** — Height, 4 mm.; length, 6 mm.; breadth, 4 mm.

**May be sought** during the months of July to September.

**Growth is complete** by the end of August.

**The typical condition of the gall** is bilocular but unilarval.

**The larva** pupates in the gall. **The imago** emerges during the autumn.

**Parasites,** Nos. 19, 44, 46, 47, 59, 64, 105, 112, 114, 117, 120, 150, 151, 154, 180, 183. **Inquilines,** Nos. 127, 134.

In some districts this gall is exceedingly rare. Nowhere does it appear to be plentiful. Only very

seldom will as many as fifteen or twenty galls be found on one bush; but when this does occur the contiguous bushes may be searched in vain for more specimens.

This gall is very distinctive in appearance and construction. It is firmly attached by a very small pointed portion of its base. The point of attachment does not show on the upper surface of the leaf. It may be found more frequently on oak trees and bushes in woods than on those along hedgerows; occurring rather sparingly, not many leaves on the same branch being galled, and, seldom more than six or eight specimens on one leaf.

The interior is bilocular; a condition caused by the convergence of the inner walls to form a thin hori-

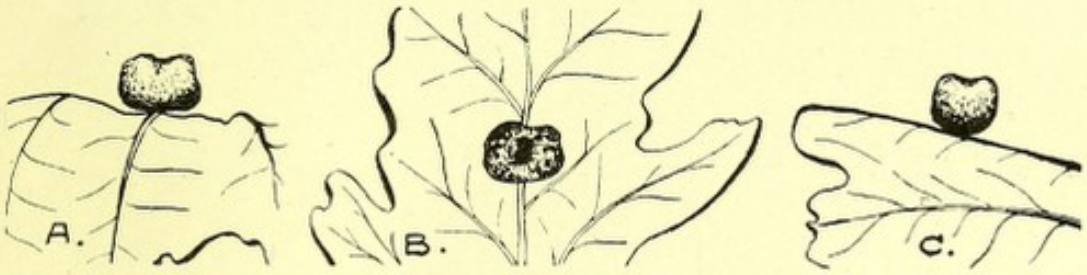


FIG. 12.—Three aspects of the same gall caused by *Dryophanta disticha*. A. Side. B. Top. C. End. All nat. size. Dele. ad nat. E.C.

zontal division devoid of any opening. The upper cavity is tenantless. The lower cavity is the larval chamber. The imago eats its way out through the base of the structure.

Exteriorly the gall is glabrous, slightly glossy, and unique in outline. The upper portion is distinctly umbilicated, from the centre of which there arises, in some specimens, a minute papilla. When viewed under a lens, most of the galls are seen to be studded with few, or many, raised brown spots. The shape of the gall is sometimes circular, but normally it is longer than broad, the height being about the same as the breadth.

This species is not mentioned in 'Alternating Generations'; and it appears to have escaped the notice of most British gall collectors.

The remark anent a sexual form of *D. agama* (p. 110), applies to this species also.

Occasionally examples will be found developing on the upper surface of a leaf.

## **Dryophanta divisa,** Adler.

(Plate XLII.)

*Dryophanta divisa*, Mayr, Fitch, Müller; *Cynips divisa*, Hartig; *Spathegaster verrucosus*, Schltdl., Adler, Licht., Mayr.

**English name of gall.**—"The Red Pea Gall."

**Position of gall.**—On the under-surface of the mid-rib and its offshoots.

**Manner of growth.**—Single, glabrous, glossy, globulose, oblate.

**Colours.**—Pale yellow, orange yellow, pink, red, light brown.

**Average dimensions of a mature specimen.** — Height, 5 mm.; length, 6 mm.; breadth, 5 mm.

**May be sought** during the months of June to October.

**Growth is complete** by the end of September.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during October and November.

**Parasites**, Nos. 19, 39, 44, 47, 49, 88, 95, 105, 119, 125, 151, 177, 180. **Inquilines**, Nos. 127, 134, 142.

**Alternate sexual generation :** *Spathegaster verrucosus*, Schltdl.

With the aid of a lens it can be seen that the surface of these galls is frequently dotted with minute papillæ, and occasionally there will be a well-defined flat papilla a little darker than the surrounding colour, opposite the basal attachment.

The pink or red colour may be entirely absent, but even when present its vividness fades with age, and it is sometimes completely changed to a pale brown.

This gall is similar in appearance to that of *D. agama*, but several features distinguish it from that species; *e. g.* (*a*) very glossy surface, (*b*) pink colour, (*c*) normally more numerous upon a leaf, and (*d*) more widely distributed; but the infallible characters are (1) the thick walls, (2) small larval chamber, and (3)

inability to flatten the gall with pressure between the thumb and finger.

Many specimens are spherical. The normal condition is slightly longer than broad, and distinctly flattened at the top and bottom. It is attached by a short, but stout, peduncle.

The usual number on a leaf is about 10 to 15, but 25 to 35 is not unusual. On one occasion I found three leaves, all on one stem, bearing 32, 32, and 35 galls. In some seasons they are in such profusion that their weight causes the leaves to hang down considerably. They are often found in company with either, or all, of the *Neuroterus* species on the same leaf.

The name "red pea gall" is indicative of the beautiful colour with which nearly all specimens are suffused during development; when mature the red fades, leaving a pale, but pleasing shade of brown. In common with all the globular oak-leaf galls, they normally remain attached to the leaf all through the winter, although that may have fallen after several frosts.

## **Dryophanta longiventris,** Hartig.

(Plate XLIII.)

*Cynips longiventris*, Hartig; *Dryophanta longiventris*, Adler, Cameron, Mayr, Fitch, Müller.

**English name of gall.**—"The Striped Gall."

**Position of gall.**—On the under-surface of the mid-rib and its offshoots.

**Manner of growth.** — Single, glabrous, glossy, globulose, papillated.

**Colours.**—Pale yellow, with pink or red bands, stripes, or spots.

**Average dimensions of a mature specimen.** — Height, 7 mm.; length, 9 mm.; breadth, 8 mm.

**May be sought** during the months of July to October.

**Growth is complete** by the end of September.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during October.

**Parasites,** Nos. 12, 25, 28, 44, 119, 125, 151, 180. **Inquilines,** Nos. 128, 134.

**Alternate sexual generation :** *Spathegaster similis*, Adler.

A very attractive and pretty gall, retaining its singular outline and much of its delicate coloration, as a dry specimen in the cabinet.

When inhabited by inquilines the structure seldom attains the normal dimensions. If gathered before maturity it shrivels, and the papillæ, whether solitary or in ridges, stand out prominently.

No doubt need be entertained as to the identity of this gall. It is unlike any other form, from its earliest growth, to maturity. The most noticeable feature


Fig. 13.—Sectional aspects of gall caused by *Dryophanta longiventris*. A. Cross section. B. Longitudinal section. C. Transverse section. All × 2. Dele. ad nat. E.C.

is the number of pale-coloured papillæ scattered all over its surface, which frequently coalesce and form ridges extending from side to side, and also in concentric and circular outlines. The depressed portions of the gall are pink and red; colours which are accentuated by the pale yellow of the papillæ, and which do not entirely disappear even when the gall is past maturity.

The shape is globulose, but flattened at the base; the basal portion being transversely indented by the rib of the leaf. It is firmly attached to the rib by a small projection of its own growth. Development is arrested when tenanted by parasites or inquilines and the size remains small, but under normal conditions it may be 8 mm. high, and 10 mm. in diameter.

If a number of the galls be gathered late in Sep-

tember, the imagines will continue to emerge during the following month, and until the middle of December.

Albert Müller appears to have been the first to record this species occurring in Britain, having found it about forty years ago in the neighbourhood of Norwood.

It is moderately abundant in the Hastings district. I have found it almost exclusively on oak bushes of *Q. pedunculata* in woods where there are also large oak trees; the earliest date being June 30th.

Very rarely more than eight galls develop on one leaf.

## **Dryophanta scutellaris,** Hartig.

(Plates I, XLIV, XLV.)

*Cynips quercus folii*, Linn.; *C. folii*, Hartig, Schenck, Schltdl.; *C. scutellaris*, Schenck; *Dryophanta folii*, Mayr, Müller, Marshall, Cameron; *D. scutellaris*, Mayr, Oliver, Fitch, Adler.

**English name of gall.**—"The Cherry Gall."

**Position of gall.**—On the under-surface of the mid-rib and its offshoots.

**Manner of growth.**—Single, glabrous, glossy, globulose, succulent.

**Colours.**—Pale yellow, yellowish-green, pale green, pink, rose-madder.

**Average dimensions of a mature specimen.**—Globulose form—diameter, 17 mm.

**May be sought** during the months of July to October, and on fallen leaves until April or May of the following year.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the autumn and winter. "According to some observers the flies appear in October, and according to others not until March . . . if kept in a room they appear in November, but not . . . if in the open air. The fly begins in October to gnaw a passage from the central chamber . . . towards the periphery, but does not quit the gall . . . this depends entirely upon the weather. . . . I have repeatedly noticed that the warm days of January and February entice the flies out . . . but should frost continue many flies do not appear until March" (Adler, 'Alternating Generations,' p. 61).

**Parasites,** Nos. 6, 7, 9, 19, 43, 44, 46, 56, 67, 77, 88, 96, 125, 151, 166, 180. **Inquilines,** Nos. 60, 110, 134, 142, 145.

**Alternate sexual generation:** *Spathegaster Taschenbergi.*

This is the largest, most conspicuous, and brightest coloured, of the leaf galls. Very few galls can vie with it for beauty.

It grows on the under-surface of the leaf, firmly attached to the rib by an exceedingly small projection of its own growth. The basal portion is not flattened as is the case with most of the leaf galls, but there is often a long narrow indentation caused by the rib of the leaf. Specimens are occasionally to be seen on the upper surface of the leaf; they are usually rather smaller than the normal size. Some turn dark red and reddish-brown when only half developed, and are more succulent than others not so coloured.

The composition of the gall, is a tough outer rind enclosing a soft, loose, and spongy parenchyma, in the centre of which is the larval cavity without any inner gall. When old, and the moisture has dried, the surface becomes greatly wrinkled.

It is somewhat variable in size, but not excessively so. The largest I have found measured 23 mm. in diameter. Upon examination it proved to be perfectly free from parasites and inquilines.

The numbers on one leaf also fluctuate somewhat. Three, four, and five are frequently seen; six, seven, and eight occasionally. The largest number I have found on one leaf is twelve. Eighteen on two leaves —although not English specimens—as shown on Plate XLV, are worthy of recording, as also is the Frontispiece.

Some galls fall from the leaves at the approach of autumn, others continue to adhere, although the leaf itself has fallen.

The imagines are easy to rear; some emerging during October and November, others in the following spring.

## **Neuroterus fumipennis,** Hartig.

(Plates XLVI and LX, div. A.)

*Neuroterus fumipennis*, Tasch., Mayr, Thoms., Adler, Licht., Fitch, Müller, Cameron, Marshall; *Spathegaster tricolor*, Schenck, Hartig, Mayr, Adler, Licht.; *S. varius*, Schenck.

**English name of gall.**—"The Cupped Spangle Gall."

**Position of gall.**—On the under-surface of the leaf.

**Manner of growth.**—Gregarious, numerous, cupulate, stellately pilose.

**Colours.**—Green, greenish-yellow, covered by pink, rose-madder, and red hairlets.

**Average dimensions of a mature specimen.**—Height, 1·5 mm.; diameter, 3 mm.

**May be sought** during the months of July to September.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during May.

**Parasite,** No. 182. **Inquiline,** No. 142.

**Alternate sexual generation:** *Spathegaster tricolor*, Hartig.

When this gall occurs in great profusion on a leaf the appearance is very beautiful. The prevailing colour is rose-madder, varying from a pale shade to a very deep tint. It is wholly due to numerous microscopic stellate hairlets, which, under magnification give off an aureate sheen. As the leaf and the galls dry the colour diminishes in brilliancy.

Concerning the profusion of this gall: One leaf measuring (without petiole) 153 mm. long and 68 mm. from tip to tip of widest lobes, supported 489 galls, and so crowded were they that 18 galls were within one square cm. A part of the leaf is shown on Plate LX, div. A.

It is sometimes difficult to distinguish most immature and some mature specimens of this gall from those of *N. lenticularis*. They resemble each other very closely by reason of a profusion of very small reddish glossy hairlets scattered upon the upper and under-surfaces.

In its normal and typical condition there are several distinctive features. (*a*) Its average diameter (3 mm.) is less, (*b*) the upward curve of its rim is more pronounced, (*c*) the central papilla is not so distinct, (*d*) the under-surface is rarely whitish or yellowish, (*e*) nor is it usually so abundant as *N. lenticularis*.

The mode of attachment to the leaf is by means of an extremely short and thin peduncle which retains the gall with considerable tenacity until the autumn, when it decays and the gall falls from the leaf. The moisture of the earth allows development to continue gradually until the gall is about double its former thickness.

Cameron remarks: "The larva does not develop until April, being later in its development than *lenticularis* and *numismatis*, the imago not appearing until May" ('Brit. Phyto. Hymen.,' vol. iv, p. 134). Adler also says: "Although these galls fall to the ground in October it is only during the month of March [of the following year] that larval development begins; towards the end of April it becomes a pupa, and the perfect insect appears in May" ('Alternating Generations,' p. 23).

Some years this gall, in common with the other *Neuroterus* species, occurs in extraordinary abundance, not only as regards the number of oak leaves bearing galls, but the profusion of the galls on the leaves. The autumn of 1907 was such an occasion.

## **Neuroterus læviusculus,** Schenck.

(Plate XLVII.)

*Neuroterus pezizæformis*, Schltdl.; *N. læviusculus*, Mayr, Adler, Fitch, Schenck, Licht., Cameron; *Spathegaster albipes*, Schenck, Licht., Mayr, Adler.

**English name of gall.**—"The Smooth Spangle Gall."

**Position of gall.**—On the under-surface of the leaf.

**Manner of growth.**—Glabrous, glossy, separate, scattered, cupulate.

**Colours.**—Pale yellow, yellowish-green, green, pink, red.

**Average dimensions of a mature specimen.** — Height, 1 mm.; length, 4 mm.; breadth, 3 mm.

**May be sought** during the months of July to September.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during the spring.

**Parasites,** Nos. 165, 182. **Inquiline,** No. 142.

**Alternate sexual generation :** *Spathegaster albipes*, Schenck.

This gall appears to have been first noticed in Britain by Miss E. A. Ormerod, LL.D., who found specimens on oak trees in Kew Gardens in 1870.

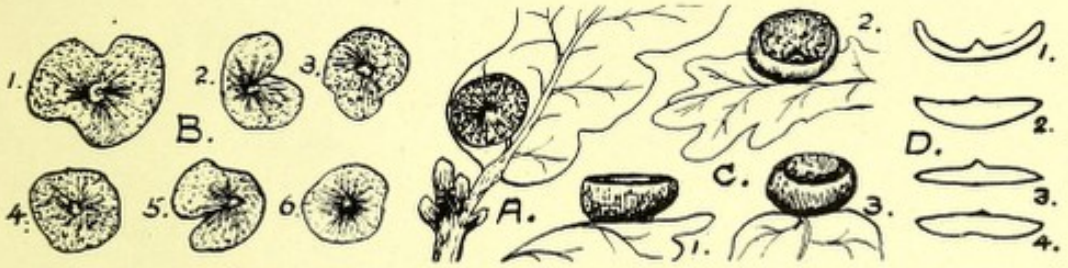


Fig. 14.—Galls caused by *Neuroterus læviusculus*. A. On upper surface of leaf. B. 1-6, variations in outlines. C. 1-3, bowl shape, on under-surface of leaf. D. 1-4, diagrammatic sections. All × 2. dele. ad nat. E.C.

In both shape and colour this gall is subject to greater variations than those of its congeners.

The gall may resemble a beautiful miniature cream-coloured waxen cup, with a tiny cone, standing up like a spike, from the base of the concavity. It may be a delicate shade of yellowish-green, and shaped like an elegantly formed saucer, the centre having a minute papilla. Yet another form, is that of a tiny plate, rose-red or purple in colour, with hardly a trace of a central elevation. Many cupulate examples are pale in colour, except the rim which may show quite a contrast in a bright red, or a reddish-brown.

The outline of the gall is mostly rather longer than broad, or even half as long again as broad. Many specimens are circular.

The margin may be entire, or incised to nearly half

its breadth, and there may be two or three incisions in the same gall.

The centre of the gall is usually occupied by a small sharp-pointed cone, paler in colour than the surrounding tissues with sometimes a few whitish vitreous hairlets at its base.

This gall never occurs in such profusion on a leaf as the other *Neuroterus* species, but it more frequently develops on the upper surface of the leaf. In common with them, however, it is attached by a delicate peduncle, and it is also deciduous. It is always glabrous, and sometimes highly glossy.

## **Neuroterus lenticularis,** Olivier.

(Plate XLVIII.)

*Cynips lenticularis*, Olivier; *C. quercus-baccarum*, Linn.; *Neuroterus Malpighii*, Hartig, Tasch., Thoms., Müller, Marshall; *N. lenticularis*, Adler, Mayr, Schenck, Fitch; *N. lævisculus*, Schenck; *N. pezizæformis*, Schltdl.; *N. fumipennis*, Hartig; *Spathegaster interruptor*, Hartig; *S. varius*, Schenck.

**English name of gall.**—"The Common Spangle Gall."

**Position of gall.**—On the under-surface of the leaf.

**Manner of growth.**—Gregarious, pilose, separate, conglomerate, numerous.

**Colours.**—Green, greenish-yellow, covered by orange-red, rose-red, crimson, and reddish-brown hairlets.

**Average dimensions of a mature specimen.** — Height, 1·5 mm.; diameter, 5 mm.

**May be sought** during the months of July to October.

**Growth is complete** by the end of August.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during March and April.

**Parasites,** Nos. 19, 29, 47, 56, 76, 83, 108, 116, 123, 154, 163, 165, 182. **Inquiline,** No. 142.

**Alternate sexual generation:** *Spathegaster baccarum*, Linn.

This is the largest, and the most abundant of the cupulate, lenticular galls. It occurs throughout Britain.

The first sign of gall growth, on the under-surface

of the young and tender leaf, is a number of minute pimples, which rapidly enlarge to small yellowish-green discs closely adhering to the leaf, but attached only by the delicate and small pedicle peculiar to the lenticular galls. It soon attains its maximum proportions. The gall structure retains its yellowish-green

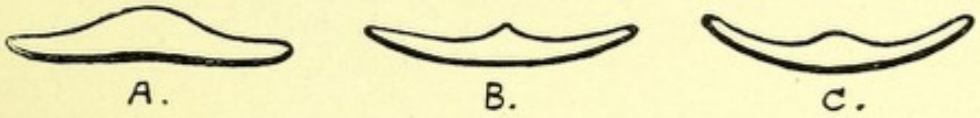


FIG. 15.—Diagrammatic sectional outlines of galls caused by: A. *Neuroterus lenticularis*. B. *N. fumipennis*. C. *N. læviusculus*. All × 4. dele. ad nat. E.C.

colour, but it is concealed by a dense covering of radiating stellate hairlets of an orange-red or reddish-brown colour.

The periphery is circular, the rim slightly curved upwards; in the centre is a small obtusely conical elevation. The under-surface is almost flat, with a

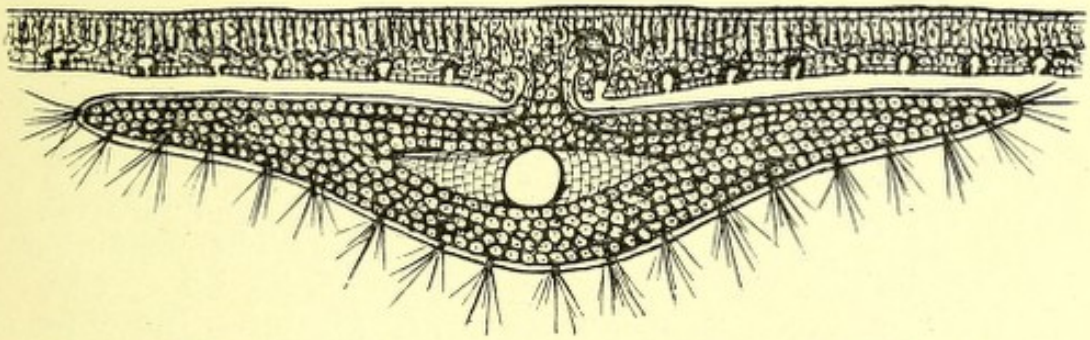

FIG. 16.—Section of leaf, and a mature gall caused by *Neuroterus lenticularis* showing tissues and stomata in leaf; larval chamber (in centre), and stellate hairlets on lower margin of the gall. × 18. In part, after Beyerinck. dele. E.C.

few whitish spots near the margin, and but few hairlets.

These galls are scattered all over the under-surface of the leaf, but very rarely attached to the mid-rib, or its offshoots. The upper surface exhibits minute pale yellowish spots corresponding to the point of attachment.

The usual number of galls on a leaf is 80–100. These figures are, however, greatly exceeded in seasons when such galls are prolific.

They fall to the ground late in September, and during October, development continuing very gradually through the winter, and until the imagines emerge in March and April.

They are extensively eaten by game birds.

## **Neuroterus numismatis,** Olivier.

(Plate XLIX.)

*Cynips numismatis*, Olivier; *C. quercus-tiaræ*, Curtis; *Neuroterus Reaumuri*, Hartig, Schenck, Marshall; *N. numismatis*, Mayr, Adler, Licht., Müller, Cameron; *Spathegaster vesicatrix*, Schltdl., Mayr, Adler, Licht.

**English name of gall.**—"The Silk-Button Spangle Gall."

**Position of gall.**—On the under-surface of the leaf.

**Manner of growth.**—Glossy, smooth, hemispherical, gregarious, umbilicate.

**Colours.**—Golden yellow, bright ochre, golden brown.

**Average dimensions of a mature specimen.**—Height, 1·5 mm.; girth, 9 mm.

**May be sought** during the months of August to October.

**Growth is complete** by the end of September.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during March and April.

**Parasites,** Nos. 13, 39, 40, 41, 72, 76, 163. **Inquiline,** No. 142.

**Alternate sexual generation:** *Spathegaster vesicatrix*, Schltdl.

Mayr considers this to be "the most beautiful of all the lenticular galls."

The entire gall is covered, and also coloured by closely set, smooth, glossy, golden-brown adpressed hairs, and these impart to it a very real appearance of a diminutive silk-covered button.

The galls are deciduous, falling to the ground in October and November, maturing during the next

three months. The imagines appear earlier than those of any leaf gall.

This small, but strikingly beautiful, and unique shaped gall, excites admiration on account of its attractive appearance, and also because of the enormous numbers so frequently to be seen on a leaf. Probably there is no other gall so numerous within any given area as this species.

In the summer and autumn of 1904 oak galls were unusually abundant, and those of *N. numismatis* appeared to exceed all other kinds. Mr. E. W. Swanton, of the Educational Museum at Haslemere, kindly communicated to me that he "picked three leaves (of *Q. pedunculata*), at random from an oak branch, the leaves of which were plentifully sprinkled with the silk-button gall, and carefully counted the galls upon them. On the first were 502, the second 558, the third 681; a total of 1741 galls—an average of 580 for each leaf." I noticed the same phenomenon in several parts of Sussex during the same autumn, and have in my own collection leaves bearing similar numbers.

The gall is small and requires the aid of a lens to discern the peculiarities of its structure. It appears as a small flat disc attached by an extremely short pedicle, grows rapidly, and varies much in size. Ultimately it becomes circular in outline, flat next to the leaf, and hemispherical in shape. A circular depression at the top occupies rather more than one-third of its total diameter.

All the lentiform galls appear to have been observed in England by Dr. Sir Thomas Browne, and mentioned by him in correspondence with Dr. Merrett in 1668.

### **Neuroterus ostreus,** Hartig.

(Plate L.)

*Neuroterus ostreus*, Giraud, Mayr, Müller, Fitch, Adler; *Andricus ostreus*, Mayr, Cameron.

**English name of gall.**—"The Oyster Gall."
**Position of gall.**—On the under-surface of the mid-rib and its offshoots.
**Manner of growth.**—Glabrous, glossy, ovoid, spherical.
**Colours.**—Pale yellow, yellowish-green, pink, pale brown.
**Average dimensions of a mature specimen.** — Ovoid: Height, 2 mm.; length, 3 mm.; breadth, 2 mm.
**May be sought** during the months of August to October.
**Growth is complete** by the end of September.
**The typical condition of the gall** is unilocular and unilarval.
**The larva** pupates in the gall. **The imago** emerges during March. When kept under favourable conditions, imagines will appear from galls, which have matured early, during November; but from others late in maturing the imagines do not emerge until March.
**Parasites,** Nos. 5, 44, 79. **Inquilines,** Nos. 141, 142.

**Alternate sexual generation:** *Spathegaster Aprilinus*, Gir.

Leaves bearing from 12 to 30 galls are frequently seen. I found during September, 1901, near Hastings, a twig of *Q. pedunculata* having eight leaves, all of which were galled, the total number of galls upon them being 207. The largest leaf measured 115 mm. long, and had 42 galls upon it.

The only galls with which this species can be confused are those of *Dryophanta divisa*, and *Biorhiza renum*. It is however more frequently met with than the former, and less frequently than the latter. When mature it is smaller than *D. divisa*, and seldom spherical. Other distinguishing features are given in the description of *B. renum*.

Growth is rapid, and complete in about four weeks.

When the gall emerges from the mid-rib or its offshoots it is enveloped by a thin membrane of leaf-tissue, which splits longitudinally and forms two flaps, or valve-like parts, at the base of the gall; these in time wither and fall away. It is in consequence of these flaps bearing a fanciful resemblance to the valves of an oyster shell, that the gall received its trivial name.

During the earliest stage of development the gall is uniformly coloured, but later, numbers of little spots

appear, at first pink, then red, crimson, and ultimately dark brown. The spots have then become slightly elevated, and soon afterwards the colour fades into harmony with the remainder of the gall as it finally assumes a yellowish-brown hue.

The gall structure is moderately hard, and contains a relatively large larval cavity without an inner gall. It is subject to considerable variation in shape and size; features which are mainly due to the presence of parasites. Depth of colour appears to depend upon exposure to the sun.

A gall occasionally develops on the upper surface of a leaf. See Plate L, B.

### **Neuroterus punctatus,** Cameron.

The gall produced by this species is most obscurely situated. I have no record of its occurrence, and I regret inability to describe or illustrate it.

For the guidance of the gallist who might capture the imago, or wish to search for the gall; and also for the student who does not possess, nor have access to, a copy of the work, the following is given *in extenso* from 'Brit. Phyto. Hymen.,' vol. iv, p. 133:

"*Spathegaster punctatus*, Bignell, E.M.M., iii (2) 176. Black; legs flavous, upperside of hind coxæ, antennæ except the first two or three joints, which are lighter fuscous. Eyes not so large nor so prominent as those of *baccarum*. Thorax: the mesonotum trilobate, with deep furrows continued to the scutellum, where the punctures are very shallow, the sides closely punctured. Wings hyaline.

"Length 2·5 mm.

"At first it has all the appearance of *Spathegaster baccarum*, but when closely examined the sculpture of the thorax separates it from that species, and the wings are free from fuscous clouds.

"In *baccarum* the mesosternum is separated from the mesonotum by a raised rounded ridge, much more

prominent than that of the species now described, and the furrows on the mesonotum are much shallower and shorter (Bignell, l.c.).

"Bred by Mr. Bignell from oakbuds which apparently were not expanded or distorted.

"The inquiline is *Saphylotus connatus*. Plymouth."

## **Spathegaster albipes,** Schenck.

(Plate LI.)

*Spathegaster albipes*, Mayr, Fitch, Licht., Schltdl., Adler; *Neuroterus albipes*, Cameron.

**English name of gall.**—"Schenck's Gall."

**Position of gall.**—On the margin of the leaf and on the mid-rib.

**Manner of growth.**—Single, solitary, sessile, oviform, slightly pilose.

**Colours.**—Yellowish-white, greenish-yellow, pale brown.

**Average dimensions of a mature specimen.**—Length, 2 mm.; breadth, 1 mm.

**May be sought** during the months of April to June.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during June.

**Inquiline,** No. 128.

**Alternate agamic generation :** *Neuroterus læviusculus*, Schenck.

Several writers are of opinion that this gall is indistinguishable from other galls of similar shape and size.

In various features it coincides with those of *Andricus nudus*, *A. gemmatus*, *A. circulans;* and a continental species, *Andricus burgundus*. The imago, also, does not possess any definite characters whereby it can be separated.

Cameron appears to have been the first to record this species as British. He found many specimens in the neighbourhood of Glasgow.

It now appears to be generally distributed throughout Britain.

*S. albipes* is found in the latter part of April only in very mild seasons, and when the foliage is well advanced. The second week in May is the usual time of development. Galls, from which the occupant has emerged, may occasionally be found *in situ* as late as the middle of September (one found September 10th, 1907).

The peculiar contraction, incision, or indentation, in one half of the blade of the leaf, often draws attention to the gall, when, otherwise it would be overlooked. Its pale colour also harmonises with the under-surface of the leaf rendering the gall less conspicuous.

It is moderately common, and widely distributed, but somewhat local. Seldom more than one gall appears on a leaf, and more rarely is it seen growing from the petiole; but instances are known where galls are situated on either side of the mid-rib, and also of two galls side by side on the same margin. The side of the gall opposite that next the leaf is generally raised to form a slight ridge, or there may be a few minute protuberances. During growth the distal end of the gall terminates with a minute dark-coloured style which disappears at maturity, as also does much of the pilosity.

It is somewhat remarkable that so small a gall, and the diminutive area it occupies, should arrest so large an amount of leaf tissue as is often the case, causing in some leaves an indentation more than fifty times the area of the gall. It is due to the fact that gall formation begins "on the rudimentary leaf while yet in the bud" ('Alternating Generations' p. 19), and when the leaf expands it cannot recover itself.

### **Spathegaster Aprilinus,** Giraud.

(Plate LII, div. A.)

*Neuroterus Schlechtendali*, Mayr, Schltdl., F. Löew; *N. Aprilinus*, Cameron; *Spathegaster Aprilinus*, Mayr, Licht., Beyer., Adler, Fitch.

**English name of gall.**—"The April Bud Gall."

**Position of gall.**—Mostly in terminal, but also in axillary buds.

**Manner of growth.**—Single, solitary, glabrous, vesiculate, ovoid.

**Colours.**—Pale green, greenish-yellow, pale pink, light brown.

**Average dimensions of a mature specimen.**—Height, 8 mm.; girth, 15 mm.

**May be sought** during the months of April and May.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during May.

**Inquilines**, Nos. 17, 72.

**Alternate agamic generation:** ? *Neuroterus ostreus*, Hartig.

The dimensions of the largest gall of this species, of which I have a record, is—height 15 mm., girth 21 mm.

The proportion of axillary buds containing galls, as compared with terminal buds, is one in four.

"There seems to be some doubt as to the agamic form of this species." Beyerinck bred *Neuroterus Aprilinus* from galls of *Andricus solitarius*. Von Schlechtendal and F. Löew consider *N. Schlechtendali* the agamic form. Mayr considers, "that *ostreus*, being an *Andricus*, can hardly be the agamic of a *Neuroterus*" ('Brit. Phyto. Hymen.,' vol. iv, p. 140). Adler is strongly of opinion that it is *N. ostreus*, and his experience and experiments entitle him to be regarded as correct.

Probably no other British oak gall equals this species in the rapidity with which it develops, and reaches maturity. It is also one of the most obscure as regards its situation. The enfolding leaf-bud scales, and the very few days required for it to become mature and shrivel, combine to render its discovery a difficult matter, overcome mainly by experience. Four or five days only, are necessary, from the time the gall expands sufficiently to increase the size of the bud, until growth ceases, and the imago escapes.

A few of the large outer leaf scales of the bud surround the base of the gall and assist in retaining it in position. The greater part of the upper portion of the gall is bare except for a few of the small inner leaf scales which adhere to it. The gall does not fall to the ground. The structure is of a vesiculate nature, with thin, soft, and sappy walls. The interior forms a large larval chamber. There may be two or three larvæ, each occupying a separate cell, but a larger number of cells generally denotes the presence of inquilines. The cells are oviform in shape, and arranged perpendicularly on their own longitudinal axis. They are large in comparison with the size of the larva. The arrangement is sometimes indicated on the exterior of the gall.

The gall occupies about two-thirds of the bulk of the bud. In shape it is an elongate ovoid, flattened on the inner side for about four-fifths of its entire length. It is found more plentifully on stub-oaks of about five to seven years' growth, than on full grown trees.

## **Spathegaster baccarum,** Linn.

(Plate LIII.)

*Cynips Quercus baccarum*, Linn.; *Spathegaster interruptor*, Hartig; *S. baccarum*, Mayr, Fitch, Müller, Adler, Marshall; *Neuroterus baccarum*, Mayr; *N. lenticularis*, Cameron.

**English name of gall.**—"The Currant Gall."

**Position of gall.**—On the staminate catkins, and on the leaves.

**Manner of growth.**—Glabrous, glossy, gregarious, succulent, globular.

**Colours.**—Pale green, greenish-yellow, pink, red, purple.

**Average dimensions of a mature specimen.**—On catkin: Girth, 7 mm. On leaf: Girth, 10 mm.

**May be sought** during the months of May and June.

**Growth is complete** by the end of June.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during June.

**Parasites,** Nos. 37, 44, 94, 147, 151, 154, 166, 180. **Inquilines** Nos. 127, 128, 130, 136, 138.

**Alternate agamic generation :** *Neuroterus lenticularis*, Oliver.

The galls which develop on catkins are generally suffused with pink, or spotted or striped with red ; those on leaves are mostly a rich translucent green.

They are very soft and contain an abundance of a whitish, tasteless fluid.

No name more appropriate than that of "currant," could have been bestowed upon this gall when growing on a catkin peduncle. When on the under-surface of a leaf, a portion of the gall becomes contexturate with the leaf tissues, the attached portion being marked by a pronounced convexity on the upper surface of the leaf, where it is mostly of a red colour.

The size of those on leaves, is generally about one-fourth more than that of those on catkins.

Rapid development of the imagines is necessitated by the soft, succulent, and perishable nature of the galls, the entire metamorphosis occupying less than fourteen days.

This gall is extraordinarily abundant in some years on both catkins and leaves; twigs and small boughs are frequently weighed down with them. *Quercus sessiliflora* often yields finer specimens, both as regards size, and numerical abundance, than the other species of oak.

It is the commonest of the globular galls, and, but for the restraining action of numerous parasites, and indirectly of inquilines, many oak trees would have no acorns.

The gall consists of a very sappy and soft cellular tissue. The larva occupies the centre, eating a large spherical cavity.

As soon as the imago has escaped, the structure shrivels and decays ; when, however, parasites or inquilines are in possession it retains the globular form,

turns a brown colour, and may be found in that condition as late as the month of September.

This gall was observed in England by Dr. Sir Thomas Browne, and mentioned by him in correspondence with Dr. Merrett in 1668 (see Introduction).

## **Spathegaster similis,** Adler.

(Plate LII, div. B.)

*Spathegaster similis*, Licht., Mayr, Cameron.

**English name of gall.**—"The Green Velvet-Bud Gall."

**Position of gall.**—In dormant adventitious buds of the bark and small twigs.

**Manner of growth.**—Solitary, sessile, pubescent, ovoid, pointed at apex.

**Colours.**—Pale green, green, pale brown.

**Average dimensions of a mature specimen.**—Height, 2 mm.; girth, 5 mm.

**May be sought** during the months of April and May.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during May.

**Alternate agamic generation:** *Dryophanta longiventris*, Hartig.

This gall was discovered by Dr. Adler in the course of his experimental breeding with *D. longiventris*. His remarks are as follows: "The gall is like *Spathegaster Taschenbergi* but more slender and pointed; of greenish-grey colour and with a velvety rind. The colour is caused by a greenish pigment, but this tint is rendered dull by a covering of long white hairs, imparting to it a grey tone. It is especially the stronger and longer pubescence which is the important distinction between this and the *S. Taschenbergi* gall" ('Alternating Generations,' p. 66).

It is scarce in many localities, rare in others, and not found at all in most districts.

I have found but one specimen, which unfortunately was not in a good condition.

## **Spathegaster Taschenbergi,** Schlechtendal.

(Plate LII, div. C.)

*Dryophanta Taschenbergi*, Mayr; *Spathegaster Taschenbergi*, Mayr, Fitch, Adler; *S. flosculi*, Giraud; *S. Giraudi*, Tschek.

**English name of gall.**—"The Purple Velvet-Bud Gall."

**Position of gall.**—In dormant adventitious buds of the bark and small twigs.

**Manner of growth.**—Solitary, sessile, pubescent, ovoid, rounded at apex.

**Colours.**—Violet, dark violet, purple.

**Average dimensions of a mature specimen.** — Height, 3 mm.; girth, 6 mm.

**May be sought** during the months of April and May.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during May and June.

**Alternate agamic generation:** *Dryophanta scutellaris*, Hartig.

The beautiful colour of this dainty little gall is "caused by a peripheral layer of pigment cells, studded over with short white hairs which give the velvety appearance to the surface. The inner kernel of the gall is soft and consists of cells containing starch granules; these are completely eaten by the larva, so that ultimately nothing is left but a thin rind" ('Alternating Generations,' p. 63).

A most beautiful little gall, and worth any amount of trouble to obtain. It is very distinctive in appearance, but somewhat obscure in its habitat.

The galls should be looked for amongst the clusters of adventitious buds and little twigs on the trunks of old trees in woods. Three is the usual number in a cluster, but solitary specimens are not infrequent.

It is advisable to search for them on sunny days; the intensity of light enables the collector to see them more readily.

Considering the abundance of the agamic form, the comparative scarcity of this gall is remarkable.

## **Spathegaster tricolor,** Hartig.

(Plate LIV.)

*Neuroterus tricolor*, Mayr, Cameron; *Spathegaster tricolor*, Schenck, Mayr, Adler, Licht., Fitch, Marshall, Müller; *S. varius*, Schenck.

**English name of gall.**—"The Hairy Pea Gall."

**Position of gall.**—On the under-surface of the leaf.

**Manner of growth.**—Pilose, sessile, globular, succulent, conglomerated, glistening.

**Colours.**—White, very pale green, pale yellow.

**Average dimensions of a mature specimen.**—Girth, 18 mm.

**May be sought** during the months of May to August.

**Growth is complete** by the end of June.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during July.

**Parasite,** No. 44. **Inquilines,** Nos. 127, 130, 139.

**Alternate agamic generation:** *Neuroterus fumipennis*, Hartig.

This gall is very distinctive and easily recognised. It occurs more frequently on scrub-oak bushes, and stunted, and hedge-trimmed growth along road-side banks, than in any other situation. In some districts it is exceedingly abundant.

It occurs in clusters of as many as 15–20 on one leaf, and many will coalesce.

Aggregations of this species are sometimes so large that a leaf, or several leaves on the same twig, will be entirely transformed into gall masses, as shown in the plate.

When solitary the gall is situated on the mid-rib or its offshoots. When first noticeable it is like a tiny hairy elevation of the leaf; as growth proceeds the hairs separate and elongate, some attaining a length of 5–7 mm. They are slender, vitreous and iridescent; at first pink, then crimson, ultimately turning brown, losing all colour, or falling off.

The gall has an acid flavour.

## **Spathegaster verrucosus,** Schlechtendal.

*Spathegaster verrucosa*, Schltdl., Mayr, Fitch; *Dryophanta verrucosa*, Mayr; *D. divisa*, Cameron; *Spathegaster verrucosus*, Adler.

**English name of gall.**—"The Red Wart Gall."

**Position of gall.**—On the leaf, and in axillary and terminal buds.

**Manner of growth.**—Single, solitary, glabrous, glossy.

**Colours.**—Greenish-yellow, pink, orange, red, reddish-brown.

**Average dimensions of a mature specimen.**—Height, 4 mm.; girth, 6 mm.

**May be sought** during the months of April to June.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during May.

**Alternate agamic generation:** *Dryophanta divisa*, Adler.

On the surface of the gall, and generally near the apex, is a very small raised disc, or mamelon. Some galls have more than one. Under magnification it is seen to be a circular, or oval, elevation about 1 mm. in diameter, with a depressed centre through which the imago eats its way out. This mamelon is somewhat variable in colour, but when the gall is mature it assumes the reddish-brown hue of its surroundings.

This gall develops upon three different situations. On the leaf from the end of the mid-rib, or the margin of the blade; at the termination of a twig, and, the axillary bud. This is explained by Adler as being due to the fact that *D. divisa* usually lays her eggs "in the rudimentary leaves." A slight deviation from the normal situation of the egg "makes all the difference as to the positions of the gall. If the egg lies on the point of a leaf, the gall develops on that spot, and the full grown leaf bears a gall on its point; but if the egg lies deeper in the base of the leaf, the whole leaf surface is absorbed, and the gall rests directly on the shortened petiole. . . . the gall is merely substituted for the leaf. When the egg is sunk still deeper into the axis of the bud the whole bud is absorbed in

the gall formation" ('Alternating Generations,' p. 70). The bud may be axillary on a twig, or of adventitious growth on the bole of a large tree.

The bud galls are inconspicuous, bursting through the large outer leaf scales only when nearly mature; a feature in which they resemble *S. aprilinus* and *Aphilothrix albopunctata*.

Those on the leaf, although small, are not difficult to find. They are sessile.

The shape of the gall varies. Some are fusiform, others oval, but the prevailing form is cylindrical, the distal end terminating in curved blunt conical projection.

The walls of the gall are very thin. The interior

Fig. 17.—Galls caused by *Spathegaster verrucosus*. All nat. size. In part after Cameron and Adler. dele. E.C.

constitutes a large larval cavity, without an inner gall. The exterior consists of a peculiar granular glossy rind, clothed with many minute soft pustules filled with a clear liquid. Adler conjectures this is a means of protection against parasites (*l. c.*, p. 69).

## **Spathegaster vesicatrix,** Schlechtendal.

(Plate LV.)

*Spathegaster vesicatrix*, Mayr, Fitch, Ormerod (Miss); *Neuroterus vesicatrix*, Mayr; *N. numismatis*, Cameron.

**English name of gall.**—"The Blister Gall."

**Position of gall.**—In the blade of the leaf.

**Manner of growth.**—Single, solitary, glabrous, glossy, radiate.

**Colours.**—Pale green, grey, pale brown.

**Average dimensions of a mature specimen.** — Height, ·5 mm. ; diameter, 3 mm.

**May be sought** during the months of May to October.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval. Many galls, although externally in every way normal, and without any trace of opening, are quite empty.

**The larva** pupates in the gall. **The imago** emerges during June.

**Alternate agamic generation :** *Neuroterus numismatis*, Oliver.

Dr. Trail appears to have been the first in Britain to find, and to record the occurrence, of this species. On July 5th, 1873, he "observed specimens on leaves of the common oak at Banchory," where he had " seen a few about a month before in their earlier stages, without recognising them as galls." On the 27th of the same month and year, Miss E. A. Ormerod, LL.D., observed the gall on leaves of *Q. pedunculata*, " and noted it as affecting both sides of the leaf."

During the earlier stages of growth the gall is somewhat difficult to detect, but as development (which is rapid) proceeds, both upper and under-surfaces of the galled portion of the leaf project convexedly, and from green, the colour soon passes to grey or whitish. By then, a small papilla will have manifested itself on the summit of the supra convexity, and from it to the circumference, a number of narrow ridges radiate. The radii are not always continuous from the margin to the centre. Although the opposite surface is typically less distinctly marked, many specimens exhibit both papilla and radii with equal clearness, while others are quite smooth.

The larva occupies the whole of the cavity, there is no inner gall. When mature the imago eats its way out through either surface, and the gall will continue to grow after the tenant has vacated it. An inquiline (a *Synergus*), and a parasitic *Torymus*, are known to inhabit the gall.

The periphery of the gall is circular, or oval, and,

as indicated in its trivial name, it is blister-like in its mode of expansion. Seldom more that two appear on a leaf. They may be on either side of the mid-rib, or coalescent; occasionally absorbing part of a small vein, but rarely, if ever, on the mid-rib. When on a lobe of the leaf distortion is sometimes produced similar to that caused by *S. albipes*.

During many years of research I have on several occasions noticed galls on leaves of stub-oaks, very similar to *S. vesicatrix*. Small blisters, about 3 mm. in diameter; irregular periphery; when in nerve axils, triangular; without radii, grooves, or papillæ. Pale green, and greenish-yellow, broadly margined with red. The interior fully occupied with a pure white apodous larva, cecidomyian in shape, about 2 mm. long and ·5 mm. at widest part. It eats its way out and falls to earth to pupate. Afterwards the supra convexity becomes concave. I have neither been able to have the larva identified, nor rear the imago.

## **Teras terminalis,** Fabricius.

(Plates LVI, LVII.)

*Cynips quercus-terminalis*, Fabri.; *Andricus terminalis*, Fabri., Mayr, Walker, Fitch; *Teras terminalis*, Müller, Marshall, Adler; *Biorhiza terminalis*, Cameron.

**English names of gall.**—"The Oak Apple," "King Charles' Apple," "The Apple Gall."

**Position of gall.**—Axillary and terminal on twigs.

**Manner of growth.**—Single, glabrous, glossy, globular, spongy.

**Colours.**—Yellowish-white, suffused with pink and red, pale brownish yellow.

**Average dimensions of a mature specimen.**—Diameter, 25 mm.

**May be sought** during any month of the year.

**Growth is complete** by the end of June.

**The typical condition of the gall** is plurilocular but unilarval. Usual number of cells about thirty.

**The larvæ** pupate in the gall. **The imagines** emerge during June and July.

**Parasites,** Nos. 19, 20, 22, 32, 33, 36, 39, 44, 55, 56, 58, 63, 65, 80, 81, 82, 84, 85, 86, 90, 91, 92, 93, 97, 98, 99, 100, 101, 102, 106, 107, 116, 118, 148, 151, 153, 154, 155, 156, 157, 160, 164, 167, 168, 169, 170, 171, 172, 173, 174, 176, 180, 184 (see pp. 150–152).
**Inquilines,** Nos. 71, 73.

**Alternate agamic generation :** *Biorhiza aptera,* Fabr.

Hyper-parasites and other insects and creatures that have been found upon, within, and reared from galls of *T. terminalis* are very numerous. The student desirous of following the subject will find them enumerated in 'The Entomologist,' No. 152, February, 1876, pp. 29–42; also in 'Brit. Phyto. Hymen.,' vol. iv, p. 120, and in 'Alternating Generations,' pp. 77–79.

This gall received its specific name because of its propensity in developing, usually, from a terminal bud. It, however, develops from axillary buds with equal frequency and vigour.

It is an exceedingly familiar object to persons living in rural districts, and also to those who notice oak trees while passing along country roads, or through woods during the months of May and June, and also July, if the season is late.

The autumn–winter condition of the gall is not so well known. When partly decayed, and most of the inhabitants have escaped from the tissues, the remnant is so unlike its summer condition that few persons regard it as connected with the soft and delicately tinted oak-apple of May and June.

When *Biorhiza aptera* deposits her numerous ova she almost severs the bud from the twig with the continuous puncturings of her ovipositor. Immediately, therefore, gall growth begins, the few remaining connecting cells are ruptured, and the whole of the bud (with, perhaps, the exception of a few basal outer leaf scales), is lifted from its base, and remains adherent to the surface of the gall. The bud may thus be retained in an upright position, or in a jaunty attitude, and unless removed by wind, or other causes,

it will remain in a lightly attached manner for several days. Expansion of the surface of the gall ultimately causes it to fall.

The growth of the gall is rapid, and does not cease until it has attained, in some specimens, a girth of 134 mm. (= $5\frac{1}{4}$ inches), and even larger. Although generally solitary in mode of growth, as many as five are sometimes crowded together. When mature, suffused with pink or madder, and surrounded by several leaves this gall is among the most charming of those on the British oaks.

This gall was observed in England by Sir Thomas Browne, and mentioned by him in correspondence with Dr. Merrett in 1668 (see Introduction).

## **Trigonaspis crustalis,** Hartig.

(Plates LVIII, LIX.)

*Cynips megaptera*, Panzer; *C. crustalis*, Thoms.; *Trigonaspis crustalis*, Licht., Adler; *T. megaptera*, Mayr, Walker, Marshall, Müller, Cameron; *T. renum*, Mayr.

**English name of gall.**—"The Pink Wax Gall."

**Position of gall.**—Low down on bark of trunk, and small twigs growing therefrom.

**Manner of growth.**—Single, glossy, glabrous, gregarious, globular, succulent.

**Colours.**—White, cream, greenish-yellow, pink, red, reddish-brown.

**Average dimensions of a mature specimen.**—Girth, 30 mm.

**May be sought** during the months of April to June.

**Growth is complete** by the end of May.

**The typical condition of the gall** is unilocular and unilarval.

**The larva** pupates in the gall. **The imago** emerges during May and June.

**Parasites,** Nos. 124, 162, 151, 16, 53. **Inquilines,** Nos. 129, 130, 134, 139.

**Alternate agamic generation:** *Biorhiza renum*, Hartig.

This gall was well known in England many years prior to 1874.

It is unusually succulent. The tissues are very fully charged with an acerb, cloudy fluid of which as

much as 10–12 mins. can be obtained, by pressure, from a large gall. The disagreeable bitterness of the fluid makes the gall exceedingly unpleasant to the human palate.

This gall is exceedingly pretty and attractive. The English name of "pink wax" is eminently suitable. It bears some resemblance to *Spathegaster baccarum*, but while that species is almost tasteless, this species is very astringent.

In size, even although mature, it varies greatly; some species being not more than 12 mm. in girth, others attaining 45–50 mm. in girth.

In shape also there is considerable variation, some being oval, ovoid, and spherical. The prevailing form is globular, slightly depressed where attached, and occasionally at the opposite pole also. The walls are very thick; the larval cavity very small.

The mode of growth is such that the gall appears to be sessile, a deception increased when it is surrounded with moss, lichen, ivy, or very small twigs. Its origin is from a bud, not from the bark. It is always attached by a peduncle, which although small, delicate, and easily severed, retains the gall until mature, or the tenant has emerged, and even when it has shrivelled, and become inconspicuous.

At intervals of several years they are particularly abundant, many hundreds appearing on the trunks of old trees. They are found most frequently low down the bole of the tree; they also affect small twigs in the same lowly position, especially when lightly covered with loose earth and leaves; they may also be sought on twigs along the bottom of a hedge; but, the best place of all is the stump of an old pollard oak in a wood or lane.

## GALLS CAUSED BY

## CYNIPS TINCTORIA

on twigs of *Q. pubescens.*

## CYNIPS CALICIS

on cupules of *Q. pedunculata.*

(?— undetermined)

on cupules of *Q. Ilex.*

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### **Cynips tinctoria,** Mayr.

(Plate LX, div. B.)

**English names of gall.**—"The Aleppo Gall," "The Ink Marble."

**Position of gall.**—On twigs of *Q. pubescens.*

The gall caused by this species is so little known and so seldom seen that a brief notice of it may be useful to the student.

It will be seen upon reference to Plate XXXV, figs. 1, 2, 3,; and Plate LX, div. B, that *C. tinctoria* bears a very close resemblance to *C. Kollari*, and many specimens of the latter might be easily mistaken for the Aleppo gall.

But *tinctoria*, when mature, is very much harder in texture than *Kollari* in the same condition, and the cell-walls are quite stone-like. It is surprising that the imago is able to eat a way out through so hard a texture.

*C. tinctoria* is about the same size as *Kollari* and grows in the same positions.

It is found in various parts of Turkey, principally

along the Mediterranean Sea, in the part known as the Levant, the chief market for it being at Aleppo, a town about twenty-five miles inland, in a district of the same name; and from this circumstance it is called the Aleppo gall. It is the most useful and valuable of all galls. Ink is manufactured from them, the process being as follows: The galls are coarsely powdered and thoroughly mixed with chopped straw to maintain porosity of the mixture, put into a deep narrow oak vat having a perforated false bottom, with a tap. Lukewarm water is then poured in, and this percolating, extracts and carries the tannin of the galls with it; this is drawn off and repeatedly run through. A sufficient quantity of water is used, in proportion to the galls, to produce as nearly as possible about 50 per cent. of tannin. After fermentation has taken place the solution is exposed to the air, the tannin splitting up into gallic acid and sugar. Salt of iron (green vitriol), and gum senegal are added. The tannin of the oak gall is different from the tannin of the oak bark.

Another gall, found in certain parts of China, is also used in the manufacture of writing ink. It is hollow, brittle, irregular in shape, covered externally with a grey pubescence. It is caused by an Aphis, and contains a rather higher percentage of tannin than does the Aleppo gall. Both kinds are of more commercial value if collected before the insect emerges.

A gall found in Japan is used for the same purpose. It is rich in tannin, but does not contain so much as the former kinds.

Almost all plants contain tannin, but very few yield the kind suitable for ink-making; the particular kind contained in galls is known as gallo-tannic acid.

Tannin can be dissolved out of plants with a mixture of spirits of wine and ether. The extract when allowed to stand separates into two layers, the lower being a strong solution of the tannin.

## **Cynips calicis,** Burgsdorff.

(Plate LXI, div. A.)

**English name of gall.**—"The Knopper Gall."
**Position of gall.**—On the cupules of *Q. pedunculata*.
From Jersey, the Channel Isles.

This gall is plentiful on the Continent where it is known as the "Knopper Gall" (the gall-nut).

It occurs principally on *Quercus pedunculata*, but also on *Q. sessiliflora*, and makes its appearance in May and June.

It consists of two parts, a thick outer cone-shaped structure, and a small larva cell. The outer structure develops from between the acorn and the cupule, sometimes interfering with the growth of both those parts to so great an extent that they are abortive. It assumes the shape of a truncated cone strongly ribbed radiately, the edges of the ribs being uneven, indented, or drawn out to a point especially around the base. At the apical part is a small hole. The interior is hollow, approximately the same shape as the exterior, usually about 12 mm. diameter, and 4 mm. at the hole. In some specimens a thin transverse partition divides the interior into two parts. Attached to the base of this hollow is the larva cell, which is ovoid in shape, 5 mm. long and 3 mm. broad.

The imago eats its way out through the base of the radiate structure, or, through the partition and escapes through the hole, during February or March of the following year.

The structure remains attached by the peduncle to the tree throughout the winter.

I am not aware of any record of its occurrence in England. The specimens illustrated were forwarded to me from Jersey in 1902. I think, however, it is not improbable that it may make its appearance in the southern counties, and therefore include it in the present series.

A free or loose inner gall, like that of *C. calicis*, is also found in galls produced by *C. cerricola* on twigs and bark of *Q. cerris*, on the continent.

## Undetermined gall on Q. Ilex.

**Position of gall.**—On the cupules of *Q. Ilex.*
? From the Isle of Wight.

The specimens on Plate LXI, div. B, were among a number of galls sent to me for identification from Chadwick Museum, Bolton, in 1902, and were kindly presented to me by the Curator, W. W. Midgley, Esq.

A label attached to them stated that they were from the Isle of Wight, but the collector's name was not on it, nor the locality in which they were found. There is therefore some doubt whether they are indigenous. If they did grow there, probably more specimens might be found in the island now, and perhaps on the contiguous mainland also.

They appear to have been gathered before they were mature.

The cupule is almost normal in bulk, and it is covered with scales in the usual manner, but it is much plicated. The interior is thickly lined with short whitish glossy hairlets. At the base of this cavity is a diminutive undeveloped acorn, which appears to afford protection and food for the larva, and to constitute the true gall. This acorn is reddish-brown in colour, it is firmly attached to the cupule, clothed with microscopic hairlets, and, it consists of three superimposed parts. The lower third is like a circular cushion, about 4 mm. in diameter and 1·5 mm. high, and this portion appears to be the larval chamber; upon it rests another cushion-like part which is about 2 mm. high and the same in diameter, projecting from the top of which are several tiny black curved stigma-like filaments 1 mm. high.

The acorn bears a very close resemblance to galls produced by *Cynips galeata* (Giraud), on twigs of *Q. pubescens*, on the Continent. That species, however, is about three times as large, and devoid of covering.

*Q. Ilex* on the Continent is also galled by:

(1) *Contarinia Ilicis* (Licht.), causing small conical growths, on under-surface of leaf.

(2) *Dryocosmus Australis* (Mayr), causing unilocular, globular, green swelling of edge of leaf.

(3) *Plagiotrochus Ilicis* (Licht.), causing irregular, sub-globose, multilocular swelling of leaf.

(4) *Cecidomyia Lichtensteinii* (Low), causing ovoid pustules on under-surface of leaf.

(5) *Diplosis* sp., causing nail-like growths on under-surface of leaf.

## OTHER GALLS ON THE BRITISH OAKS NOT PRODUCED BY CYNIPIDÆ.

Gall-pits caused by females of **Asterolecanium variolosum,** Ratzeburg.

(Plate LXII.)

*Asterolecanium quercicola*, Sig.; *Planchonia fimbriata*, Fons.; *Coccus variolosum*, Ratz.; *C. quercicola*, *Planchonia quercicola*, Bouch., Maskell, Froggatt; *Asterodiaspis variolosus*, Boas; *A. quercicola*, Bouch, Newstead.

**English name of gall.**—"The Pit-making Oak Coccid."

**Position of gall.**—On small twigs of *Quercus pedunculata* and *Q. sessiliflora*.

**Manner of growth.**—Single, gregarious, coalescent.

**Colour.**—Slightly paler than the surrounding part of the twig.

**Average external dimensions of a mature gall-pit.**—Height, 1 mm.; length, 3 mm.; breadth, 2 mm.

**May be sought** during the months of May to October.

These peculiar circular, but mostly ovoid, swellings on oak-twigs result from external influence.

They are due to the presence of female Coccidæ. These insects pass their life in a fixed spot on the twig, and as the result of their method of feeding, and other causes, irritation is set up in the plant tissues which produces elevated margins of bark around each insect.

The pits thus formed are relatively very deep, the margins rising sufficiently high to conceal the ventral rim of the insect's test.

These gall-pits may be found in many districts in great numbers. Usually on tender and growing twigs of small scrub-oak bushes among the low and straggling herbage of a roadside bank; but they not infrequently appear also on terminal twigs of young trees in woods.

Tits are extremely fond of the insects, and search most diligently for them. When a twig dies, either naturally, or from being severed, the margins of the gall-pits diminish considerably.

## **Diplosis dryobia,** Löw.

(Plate LXIII.)

*Diplosis Liebeli*, Kieffer.

**Position of gall.**—The margins of the lobes of the leaf.

**Manner of growth.**—Glabrous, glossy, crescent-shape.

**Colours.**—Pale green, green, light brown, dark brown, chocolate.

**Average dimensions of a mature specimen.** — Length, 15 mm. ; breadth, 2 mm.

**May be sought** during the months of June to September.

**Growth is complete** by the end of July.

**The typical condition of the gall** is unilocular but multilarval. Usual number of larvæ, 4.

**The larvæ** pupate in the ground. **The imagines** emerge during the spring.

The margins of the lobes are curved upwards and folded down upon the upper surface of the blade, forming a thickened roll within which the larvæ live. The edge of the recurved portion presses very closely upon the surface of the leaf, preventing the intrusion of other small creatures, such as mites, etc., and retaining the larvæ until fully grown when it either gapes to allow them to fall to the ground, or they push their way out. The affected area is not easily noticeable from the other surface of the leaf.

A species of Eriophyidæ, *Epitrimerus cristatus*, Nalepa, a mite which occurs in Central Europe, causes the leaf-margins of *Q. pubescens* to curl in a similar manner ; the folded portions, however, affect the under-surface of the leaf as well as continuing to the extremity of each indentation of the leaf. There is no change of colour in the rolled portions.

It is probable that this species may be discovered in Britain.

The dimensions of the mites are : male, 0·12 mm. long, 0·046 mm. broad ; the female, 0·17 mm. long, 0·057 mm. broad.

Plate LXIV is introduced from ' Zur Kenntniss der Gattung Trimerus,' by the kind permission of Dr. Nalepa, Vienna.

## Galls caused by the Fungus **Dichæna quercina,** Fries.

(Plates LXV, LXVI.)

**Position of gall.**—On twigs, branches and stems of *Quercus pedunculata*, and *Q. sessiliflora*.

**Synonym of fungus.**—*Opegraph quercina*, Pers.

This remarkable fungus gall-formation is frequently seen on stub-oaks by the road-side. Hedges, that are periodically trimmed, are the best to search for specimens. The fungus also affects young trees in woods, where it forms masses of considerable size; but trees of more than about fifty years old appear to be less frequently attacked. In some districts it is very abundant.

Not much is known about the habits of the fungus. Spores settle in a crack or wound in the bark, and when germination takes place the mycelium works its way into the cambium layer and the pith, sets up irritation, and consequent multiplication of cell tissue.

The earliest indication of attack is seen in a slight rounded swelling of the bark, smooth and glossy. This continues for a long time. It affects the smallest twigs, also thick branches, and the stems.

The swelling of the affected part is very slow, and it is some years before the epidermis yields to the pressure of abnormal growth beneath it and splits, mostly in a transverse direction to that of the twig. The coraceous appearance of the excrescences is peculiar to this fungus; they are solid and hard.

The parallel and concentric ridges of projection, correspond with the number of annular rings in the branch.

The fungus probably lives for a great number of years. Except when very abundant on a bush or tree it does no serious injury.

## Gall caused by ? **Dichæna quercina,** Fries.

(Plates LXVII, LXVIII.)

**Position of gall.**—On the trunk of *Quercus pedunculata*, in Broomham Park, Guestling, Hastings.

This enormous swelling affords an excellent illustration of many such growths on oak, elm and other trees, in parks, groves, gardens, and woods in many localities.

It is remarkable that these growths do not cause any noticeable diminution in the height, vigour in expansion, or scarcity of foliage of trees thus affected. Apparently the galls are not detrimental to the well-being of the trees. This, of course, is not unusual, because very few oak galls (excepting such as monopolise buds and catkins) interfere with the development of the surrounding tissues; a character more noticeable in the galls on, and in, leaves, than in any others.

As far as can be ascertained, without cutting into this gall, it is composed of the same materials as the other portion of the trunk. It is without holes of any considerable depth, and appears to be perfectly solid.

The bark, or cortex, is scabrous. Although very similar in appearance to the bark of the trunk, it will not peel off in the same manner.

The scale shown in each plate is 30 cm. (= almost 12 in.) The dimensions are :

| | |
|---|---|
| Girth of trunk immediately beneath swelling | 7 ft. 10 in. |
| Distance from ground to top of swelling | 6 ft. 3 in. |
| Peripheral circumference of swelling | 10 ft. 3 in. |
| Girth of trunk and swelling at equatorial line | 11 ft. 10 in. |

The fruiting stage of all the species of the genus *Dichæna* is rarely seen. Of some species it is not known. Some species are common. All are true parasites.

## A LIST (ALPHABETICALLY ARRANGED), OF PARASITES AND INQUILINES MENTIONED IN THIS VOLUME, WITH NUMBERS CORRESPONDING WITH THOSE ON PREVIOUS PAGES.

Abbreviations of authors' names:—Bou. Bouché. Bri. Brischke. Bur. Burmeister. Cam. Cameron. Dal. Dalman. Fab. Fabricius. Fit. Fitch. För. Förster. Fon. Fonscolombe. Gir. Giraud. Har. Hartig. Kal. Kaltenbach. Lat. Latreille. Lin. Linnæus. May. Mayr. Nee. Nees. Oli. Olivier. Par. Parfitt. Rtz. Ratzeburg. Wal. Walker. Wes. Westwood.

AMERISTUS,
1. parasiticus,

ANTHOMYIA,
2. gallarum, Htg.

AULAX,
3. pinnatus, Gir.
4. pumilus,
5. syncrepidus, Htg.

BRACON,
6. aterrimus, Rtz.

CALLIMONE,
7. antennatus, Wal.
8. auratus,
9. elegans, Wal.
10. fuscicrus, Gir.
11. inconstans,
12. longiventris, Bri.
13. mutabilis, Wal.
14. regius, May.
15. Roboris, Wal.
16. rubriceps, Lat.

CEROPTRES,
17. arator, May.
18. Cerri, May.

DECATOMA,
19. biguttata, Bou.
20. immaculata, Wal.
21. Neesi, För.
22. signata, Rtz.

DICTYOPTERYX,
23. Lœflingiana, Lin.

ELACHESTUS,
24. gallicolus, Gir.
25. cyniphidium, Rtz.
26. petrolatus, Nee.

ENTEDON,
27. cecidomycarnus, Bri.
28. cyniphidium, Bri.
29. flavomaculata, Rtz.
30. leptoneurus,
31. scianeurus, Rtz.

EULOPHUS,
32. agathyllus, Wal.
33. gallarum, Lin.
34. lævissimus, Rtz.
35. metallicus, Nee.
36. ramicornis, Bri.

EUPELMUS,
37. annulatus, Gir.
38. azureus,
39. urozonus, För.

EURYTOMA,
40. æthiops, Wal.
41. curta, Wal.
42. gracillis,
43. nodularis, Wal.
44. rosæ, Nee.
45. semirufa, Gir.
46. setigera, May.
47. signata, Kal.
48. sqamea,
49. squamea, Wal.
50. verticillata, Nee.

HOMALUS,
51. auratus, Lin.
52. cœruleus, Fab.

LIMNERA,
53. exareolata, Bri.

MACROCENTRUS,
54. marginator, Nee.

MEGASTIGMUS,
55. Bohemanni, Rtz.
56. dorsalis, Fab.
57. stigmaticans, Wal.
58. xanthopygus, Föe.
MESOPOLOBUS,
59. fasciiventris, Wes.
NEUROTERUS,
60. parasiticus. Har.
ODYNERUS,
61. trifascatus, Oli.
OLINX,
62. debilis, Gir.
63. Euedoreschus, Wal.
64. gallarum, Bou.
65. scianeurus, Rtz.
66. trilineata, May.
ORTHOSTIGMA,
67. gallarum, Rtz.
ORYMRUS,
68. punctiger,
PERICLISTUS,
69. Brandti, Cam.
PEZOMACHUS,
70. gallarum, Gir.
PLATYMESOPUS,
71. Erichsoni, Rtz.
72. tibialis, Bou.
73. Westwoodi, Rtz.
PLEUROTROPIS,
74. cyniphidium, Bri.
75. metallicus,
76. sosarmus, Fit.
PORIZON,
77. claviventris, Gir.
POSCUS,
78. bipunctatus,
PTEROMALUS,
79. bisignatus, Gir.
80. cordairii, Rtz.
81. decidens, Wal.
82. delectus, Wal.
83. dissectus, Wal.
84. domesticus, Wal.
85. dubius, Wal.
86. Dufourii, Rtz.
87. Erichsoni, Rtz.
88. fasciculatus, Föe.
89. fuscipalpis, Föe.
PTEROMALUS (*contd.*),
90. fuscipennis, Wal.
91. fusciventris, Wal.
92. gallicus, Rtz.
93. hilaris, Wal.
94. immaculatus, Gir.
95. incrassatus, Bur.
96. jucundus, Wal.
97. lecopezus, Rtz.
98. meconotus, Bri.
99. naubolus, Wal.
100. ovatus, Wal.
101. planus, Wal.
102. platynotus, Wal.
103. quercinus, Gir.
104. Ratzenburgi, Gir.
105. Saxesenii, Bur.
106. semifasciatus, Wal.
107. stenonotus, Rtz.
108. tibialis, Wal.
SAPHOLYTUS,
109. commatus, Htg.
110. connatus, May.
SIPHONURA,
111. brevicauda, Nee.
112. brevicaudis, Rtz.
113. chalybea, Rtz.
114. Schmidti, Rtz.
115. viridiænea, Rtz.
SYNTOMASPIS,
116. caudata, Wal.
117. caudatus, Bri.
118. crinicaudis, Rtz.
119. cyanea, Föe.
120. cyaneus, May.
121. dubius, Nee.
122. eurynotus, Föe.
123. fastuosus, Bou.
124. fastuosa, Wal.
125. lazulina, May.
126. regius, May.
SYNERGUS,
127. albipes, Bri.
128. apicalis, Bri.
129. erythrocerus, Htg.
130. facialis, Rtz.
131. incrassatus, Htg.
132. melanopus, May.
133. nervosus, Htg.

Synergus (*contd.*),
134. pallicornis, Bri.
135. palliceps,
136. radiatus, May.
137. Reinhardi, May.
138. ruficornis, Bri.
139. Thaumacera, Dal.
140. tibialis, Htg.
141. tristis, May.
142. Tscheki, May.
143. varius, Htg.
144. variolosus, Htg.
145. vulgaris, May.

Telenomus,
146. phalænarum, Bri.

Tetrastichus,
147. atrocæruleus, Gir.
148. Diaphantes, Wal.
149. quercus, Wal.

Torymus,
150. abbreviatus, Boh.
151. abdominalis, May.
152. amœnus, Lat.
153. appropinquans, Rtz.
154. auratus, Fon.
155. autumnalis, Wal.
156. cingulatus, Nee.
157. confinis, Wal.

Torymus (*contd.*),
158. corticis, Gir.
159. cultriventus, Rtz.
160. cyniphidum, Rtz.
161. erucarum, Gir.
162. flavipes, Wal.
163. fuscicrux, Gir.
164. gallarum, Rtz.
165. hibernans, May,
166. incertus, Föe.
167. inconstans, Wal.
168. leptocerus, Wal.
169. leucopterus, Wal.
170. longicaudis, Rtz.
171. minutus, Wal.
172. muscarum, Nee.
173. mutabilis, Wal.
174. nanus, Föe.
175. nobilis, Gir.
176. propinquus, Föe.
177. pubescens, Föe.
178. radicis, Gir.
179. regius (Devoniensis), Par.
180. regius, May.
181. rubricipes,
182. sodalis, Cam.
183. variolosus, Bou.
184. viridissimus, Bou.

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The twenty-six continental forms of Oak galls of which, according to Beyerinck, the sexual generations are unknown, are: "*ambigua*, *amblycera*, *argentea*, *aries*, *caliciformis*, *caput-medusæ*, *conglomerata*, *conifica*, *coriaria*, *coronaria*, *corruptrix*, *galeata*, *glutinosa*, *Hartigi*, *hungarica*, *Kiefferi*, *lignicola*, *Mayri*, *mediterranea*, *mitrata*, *Pantelli*, *polycera*, *Stefanii*, *tinctoria*, *tormentosa*, *truncicola*" ('Marcellia,' vol. i, p. 19).

# A TABLE OF MONTHS IN WHICH THE BRITISH GALLS ILLUSTRATED IN THIS VOLUME MAY BE FOUND.

It indicates the months in which the gall-structures themselves may be found, but does not necessarily imply that they will be in a living condition, nor that the larvæ or pupæ will always be within them.

| Name of maker of gall. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CYNIPIDÆ: | | | | | | | | | | | | |
| ANDRICUS— | | | | | | | | | | | | |
| æstivalis | — | — | — | — | * | * | * | — | — | — | — | — |
| amenti | — | — | — | — | * | * | — | — | — | — | — | — |
| circulans | * | * | * | * | * | * | * | * | * | * | * | * |
| cirratus | — | — | — | * | * | * | — | — | — | — | — | — |
| clementinæ | — | — | — | — | — | — | — | — | — | * | * | — |
| curvator | * | * | * | * | * | * | * | * | * | * | * | * |
| gemmatus | — | — | — | — | * | * | — | — | — | — | — | — |
| glandium | * | * | * | * | * | * | * | * | * | * | * | * |
| glandulæ | — | — | — | — | — | — | * | * | * | — | — | — |
| inflator | * | * | * | * | * | * | * | * | * | * | * | * |
| lucidus | * | * | * | * | * | * | * | * | * | * | * | * |
| noduli | — | — | — | — | — | * | * | * | — | — | — | — |
| nudus | — | — | — | — | * | * | — | — | — | — | — | — |
| pilosus | — | — | — | — | * | * | — | — | — | — | — | — |
| ramuli | — | — | — | — | * | * | — | — | — | — | — | — |
| solitarius | — | — | — | — | — | — | * | * | * | — | — | — |
| testaceipes | — | — | — | — | — | — | * | * | * | — | — | — |
| APHILOTHRIX— | | | | | | | | | | | | |
| albopunctata | — | — | — | — | * | * | — | — | — | — | — | — |
| autumnalis | — | — | — | — | — | — | — | — | * | * | — | — |
| callidoma | — | — | — | — | * | * | * | * | * | * | — | — |
| collaris | — | — | — | — | — | — | — | * | * | — | — | — |
| corticis | * | * | * | * | * | * | * | * | * | * | * | * |
| fecundatrix | * | * | * | * | * | * | * | * | * | * | * | * |
| globuli | — | — | — | — | — | — | — | — | * | * | * | * |
| Malpighii | — | — | — | — | — | — | — | — | * | * | — | — |
| marginalis | — | — | — | — | * | * | — | — | — | — | — | — |
| quadrilineatus | — | — | — | — | * | * | — | — | — | — | — | — |
| radicis | * | * | * | * | * | * | * | * | * | * | * | * |
| seminationis | — | — | — | — | * | * | — | — | — | — | — | — |
| Sieboldi | * | * | * | * | * | * | * | * | * | * | * | * |
| BIORHIZA— | | | | | | | | | | | | |
| aptera | * | * | * | * | * | * | * | * | * | * | * | * |
| renum | — | — | — | — | — | — | — | — | * | * | * | — |
| CYNIPS— | | | | | | | | | | | | |
| Kollari | * | * | * | * | * | * | * | * | * | * | * | * |

| Name of maker of gall. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CYNIPIDÆ (*contd.*): | | | | | | | | | | | | |
| DRYOPHANTA— | | | | | | | | | | | | |
| agama | — | — | — | — | — | * | * | * | — | — | — | — |
| disticha | — | — | — | — | — | — | * | * | * | — | — | — |
| divisa | — | — | — | — | — | * | * | * | * | * | — | — |
| longiventris | — | — | — | — | — | — | * | * | * | * | — | — |
| scutellaris | — | — | — | — | — | — | * | * | * | * | — | — |
| NEUROTERUS— | | | | | | | | | | | | |
| fumipennis | — | — | — | — | — | — | * | * | * | — | — | — |
| læviusculus | — | — | — | — | — | — | * | * | * | — | — | — |
| lenticularis | — | — | — | — | — | — | * | * | * | * | — | — |
| numismatis | — | — | — | — | — | — | — | * | * | * | — | — |
| ostreus | — | — | — | — | — | — | — | * | * | * | — | — |
| punctatus | — | — | — | — | — | — | — | — | — | — | — | — |
| SPATHEGASTER— | | | | | | | | | | | | |
| albipes | — | — | — | * | * | * | — | — | — | — | — | — |
| Aprilinus | — | — | — | * | * | — | — | — | — | — | — | — |
| baccarum | — | — | — | — | * | * | — | — | — | — | — | — |
| similis | — | — | — | * | * | — | — | — | — | — | — | — |
| Taschenbergi | — | — | — | * | * | — | — | — | — | — | — | — |
| tricolor | — | — | — | — | * | * | * | * | — | — | — | — |
| verrucosus | — | — | — | * | * | * | — | — | — | — | — | — |
| vesicatrix | — | — | — | — | * | * | * | * | * | * | — | — |
| TERAS— | | | | | | | | | | | | |
| terminalis | * | * | * | * | * | * | * | * | * | * | * | * |
| TRIGONASPIS— | | | | | | | | | | | | |
| crustalis | — | — | — | * | * | * | — | — | — | — | — | — |
| OTHER ORDERS: | | | | | | | | | | | | |
| ASTEROLECANIUM— | | | | | | | | | | | | |
| variolosum | — | — | — | — | * | * | * | * | * | * | — | — |
| CECIDOMYIA— | | | | | | | | | | | | |
| pustularis | — | — | — | — | — | — | — | — | — | — | — | — |
| DIPLOSIS— | | | | | | | | | | | | |
| dryobia | — | — | — | — | — | * | * | * | * | — | — | — |
| DICHÆNA— | | | | | | | | | | | | |
| quercina | * | * | * | * | * | * | * | * | * | * | * | * |

# A LIST OF MID-EUROPEAN OAK GALLS, WITH BRIEF CHARACTERISTICS, AND POSITION THE GALL OCCUPIES ON THE TREE.

It is not improbable that some of these species may occur in Britain.

ABBREVIATIONS—

Of Authors' Names: Bur. Burmeister. Can. Canestrini. Foc. Fockeu. Fon. Fonscolombe. Fre. Freymouth. Gir. Giraud. Hey. Heyden. Htg. Hartig. Kie. Kieffer. Kol. Kollari. Lic. Lichtenstein. Lin. Linnæus. Löw. F. Löw. May. Mayr. Nal. Nalepa. Rtz. Ratzeburg. Sch. Schlechtendal. Tro. Trotter. Tsc. Tschek. Wac. Watchl.

Of Characteristics: Glab. glabrous. Greg. gregarious. Pedun. pedunculated. Pub. pubescent. Pluri. plurilocular. Uni. unilocular.

Of Position of Gall: up. s. upper-surface. un. s. under-surface. l. leaf. ax. axillary. t. terminal. un. g. underground.

The different species of *Quercus* are indicated by these figures:

1. *pedunculata*. 2. *sessiliflora*. 3. *pubescens*. 4. *cerris*. 5. *Ilex*. 6. *coccifera*. 7. *pseudo-suber*.

| Name of maker of gall. | Author's name. | Characteristics of gall. | Position on plant. | Species of oak. |
|---|---|---|---|---|
| CYNIPIDÆ: | | | | |
| Andricus— | | | | |
| Adleri . . | May. | Ovoid; 2 mm. long; greg.; pub.; uni.; red | Leaf | 4 |
| ambiguus . . | Sch. | See *flavicornis* | Catkin | 1 |
| Beyerincki . | Tro. | Conical; 2 mm. high; pub.; uni.; orange | „ | 4 |
| burgundus . | Gir. | Elongate-oviform; 5 mm. long; greg.; reddish-brown | Ax. buds | 4 |
| crispator . . | Tsc. | Globular; about 3 mm. diam.; glab.; greg.; yellow | Leaf | 4 |
| Cydoniæ . . | Gir. | Lemon-shape; 12 mm. long; solitary; sessile; pluri. | Ax. and t. buds | 4 |
| fecundator . | — | ? synonym of *Aphilothrix fecundatrix* | — | 1 |
| flavicornis . | Sch. | These species, and also *A. ambiguus* and *A. pedunculi*, possess all the features of *Aph. quadrilineatus* | Catkin | 1 |
| glabriusculus . | „ | | „ | 1 |
| grossulariæ . | Gir. | Pyriform; 6–8 mm. long; greg.; glab.; green | „ | 4 |
| hystrix . . | Tro. | Globular; 2 mm. diam.; solitary; uni. | Twig | 1, 4 |
| Kirchsbergi . | Wat. | Globular; 3–5 mm. diam.; papillated; reddish-brown | Bud | 1, 2 |
| lucidus var. erinaceus | Tro. | Globular; 10–15 mm. diam.; solitary; fibrous projections; pluri. | L. axil. | 1, 2 |
| multiplicatus . | Gir. | Ovoid; covered with distorted leaflets; yellowish-brown | Twigs | 4 |

| Name of maker of gall. | Author's name. | Characteristics of gall. | Position on plant. | Species of oak. |
|---|---|---|---|---|
| CYNIPIDÆ (*cont*). | | | | |
| ANDRICUS (*cont.*)— | | | | |
| nitidus . . | Gir. | Ovoid; 3 mm. diam.; solitary; pilose; uni. | Un. s. l. | 4 |
| occultus . . | Tsc. | Globular; 3 mm. diam.; greg.; uni.; brown | Catkin | 3 |
| Pantelli . . var. fructuum | Tro. | Somewhat like *Cynips coriaria*; pluri. | „ | 1 |
| pedunculi . . | Sch. | See *flavicornis* | „ | 1, 2 |
| petioli . . | Htg. | Cylindrical; glab.; uni.; green | Petiole | 1, 2 |
| Trotteri . . | Kie. | Globular; 2 mm. diam.; greg.; glab.; pedun.; uni. | Twig | 3 |
| urnæformis . | Fon. | Ovoid; striated; greg.; pedun.; reddish-brown | Up. s. l. | 3 |
| superfetationis | Gir. | Ovoid; 5 mm. long; greg.; pub.; uni. | Cupule | 1, 2, 3 |
| APHILOTHRIX— | | | | |
| lucida . . | Htg. | Spherical; 12 mm. diam.; greg.; pub.; pluri.; yellow | Twig | 1, 2, 3 |
| serotina . . | May. | Ovoid; solitary; long hairlets; yellowish-brown | Trunk, nr. ground | 1, 2 |
| singularis . . | „ | Ovoid; 5 mm. long; pub.; uni.; green | Ax. buds | 4 |
| rhizomatis . | „ | Conical; greg.; uni.; like *A. Sieboldi* | Near or un. ground | 1, 2 |
| BIORHIZA— | | | | |
| sinaspis . . | Htg. | Globular; 5 mm. diam.; solitary; pedun.; uni. | Un. s. l. | 1, 2 |
| CYNIPS— | | | | |
| ambigua . . | Tro. | A var. of *C. conifica* | Branch | 1 |
| amblycera. . | Gir. | Very small; short conical projections; pub.; uni. | L. axil | 1, 2 |
| argentea . . | May. | Spherical; 17–30 mm. diam.; coronated; solitary; uni. | „ | 3 |
| aries . . . | Gir. | Elongated; 5 mm. at base; sessile; glab.; uni. | L. bud | 1, 2 |
| caliciformis . | „ | Globular; 5 mm. diam.; pub.; uni.; brown | L. axil | 2, 3 |
| calicis . . | Bur. | *See* Plate LXI and p. 142 | Cupule | 1, 2 |
| caput-medusæ . | Htg. | Covered with numerous red, thread-like projections; uni. | Fl. bud | 2, 3 |
| cerricola . . | May. | Spherical; 25 mm. diam.; solitary and greg.; uni. | Twig | 4 |
| conglomerata . | „ | Spherical; 7 mm. diam.; greg.; uni. | „ | 1, 2, 3 |
| conifica . . | „ | Irregular; furrowed; solitary; pub.; uni. | Branch | 1, 3 |
| conifica var. longispina | Tro. | Conical; 8–12 mm. high; sessile; furrowed; solitary; uni. | „ | 3 |
| coriaria . . | Htg. | Irregular; covered with horn-like projections; solitary; pluri. | Twig | 1, 2 |
| corruptrix var. ambigua | Tro. | Globular; 6 mm. diam.; sessile; solitary; uni. | „ | 1 |

| Name of maker of gall. | Author's name. | Characteristics of gall. | Position on plant. | Species of oak. |
|---|---|---|---|---|
| CYNIPIDÆ (*cont.*) | | | | |
| CYNIPS (*cont.*)— | | | | |
| exclusa | Rtz. | Ovoid; 6 mm. long.; glossy; glab.; uni. | Bud | 1 |
| galeata | Gir. | Bud-like; consists of two globular portions, one containing larva | Twig | 1, 3 |
| gemmea | „ | Globular; 4 mm. diam.; covered with papillæ; uni. | „ | 1 |
| glutinosa | „ | Irregular; size variable; glutinous; greg.; reddish-yellow | „ | 1, 2, 3 |
| glutinosa var. mitrata | „ | Like the type; larger; glossy | „ | 1 |
| Hartigi | May. | Spherical; 5 mm. diam.; covered with conical projections | Bud | 2 |
| hungarica | „ | Spherical; 20–35 mm. diam.; solitary; uni. | Ax. bud | 1 |
| lignicola | „ | Globular; 7 mm. diam.; solitary; glab.; uni. | Twig | 1, 2 |
| polycera | Gir. | Campanulate; uni.; green | L. axil | 2, 3 |
| polycera var. subterranea | „ | Conical; 5–10 mm. high; sessile; greg.; pluri. | Small roots | 3 |
| ramicola | Sch. | Like *A. Sieboldi* | Twig | 3 |
| tinctoria | May. | *See* Plate LX and p. 141 | L. axil | 2, 3 |
| truncicola | „ | Spherical; 5 mm. diam.; furrowed; uni.; brown | Bud | 3 |
| DRYOCOSMUS— | | | | |
| australis | May. | Globular; 5–10 mm. diam.; glab.; uni.; green | Edge of leaf | 5 |
| cerriphilus | „ | Pyriform; 3 mm. long; greg.; pedun. | Twig | 4 |
| DRYOPHANTA— | | | | |
| cornifex | Htg. | Horn-shape; 4–6 mm. long; greg.; uni.; green | Un. s. l. | 3 |
| folii | Lin. | Globular; 7 mm. diam.; solitary; glab.; uni. | „ | 3 |
| macroptera | May. | Elongate-oval; variable size and form; solitary; pluri. | Twig | 4 |
| NEUROTERUS— | | | | |
| lanuginosus | Gir. | Spherical; 5 mm. diam.; pub.; greg.; uni. | Un. s. l. | 4 |
| minutulus | „ | Spherical; 2 mm. diam.; greg.; glab.; uni.; reddish-brown | „ | 4, 7 |
| saliens | Kol. | Ovoid; 3 mm. long; greg.; glab.; green | „ | 4, 7 |
| saltans | Gir. | "The jumping gall" | — | 1, 2, 3 |
| Schlechtendali | May. | Very small; pedun.; glab.; uni.; green | Catkin | 1, 2, 3 |
| PLAGIOTROCHUS— | | | | |
| cocciferea | Lic. | Sub-globose; 4–8 mm. diam.; woody; pluri.; brown | Un. s. l. | 6 |
| ilicis | „ | Sub-globose; irregular size; pluri. | Leaf | 5 |

| Name of maker of gall. | Author's name. | Characteristics of gall. | Position on plant. | Species of oak. |
|---|---|---|---|---|
| CYNIPIDÆ (*cont.*) | | | | |
| SPATHEGASTER— | | | | |
| Giraudi . . | Tsc. | Ovoid; 3 mm. long; solitary; pub.; uni. | Ax. bud | 3 |
| glandiformis . | Gir. | Globular; 7 mm. diam.; pub.; pluri.; red | Catkin | 4 |
| nervosa . . | „ | Globular; 7 mm. diam.; solitary; pub.; uni.; green | Leaf | 4 |
| SYNOPHRUS— | | | | |
| politus . . | Htg. | Globular; 15 mm. diam.; uni.; yellow, with white spots | Ax. and t. buds | 4 |
| DIPTERA: | | | | |
| ARNOLDIA— | | | | |
| Szepligetti . | Kie. | Small lenticular pustules | Leaf | 7 |
| CECIDOMYIA— | | | | |
| cerris . . | Kol. | Conical; 2 mm. high; greg.; pub.; uni. | Un. s. l. | 4 |
| circinnans . | Gir. | Like *Cec. cerris*; about three times larger | „ | 4 |
| Lichtensteini . | Löw. | Ovoid pustules; greg. | „ | 5 |
| CONTARINIA— | | | | |
| ilicis . . . | Lic. | Conical; 5 mm. high; sessile; glab.; uni. | Un. s. l. | 5 |
| DIPLOSIS— | | | | |
| sp. ? . . . | — | Conical; 3–5 mm. high; "nail-like"; glab.; uni. | „ | 1 |
| DRYOMYIA— | | | | |
| circinnans . | Gir. | ? Synonyms of CECIDOMYIA | — | 4 |
| Lichtensteini . | Löw. | | | 5 |
| HEMIPTERA: | | | | |
| PHYLLOXERA— | | | | |
| coccinea . . | Hey. | Rolled lobes of leaf, and swelling of mid-rib and nerves | Leaf | 1 |
| LEPIDOPTERA: | | | | |
| HELIOZELA— | | | | |
| stanneella . . | Fre. | Small; half only of twig affected; reddish-brown | Twig | 3 |
| ERIOPHYIDÆ: | | | | |
| EPITRIMERUS— | | | | |
| cristratus . . | Nal. | Lobe-margins turned under, rolled and thickened | Leaf | 3 |
| massalongoianus | Nal. | Small pale-coloured scabrous spots on leaf | „ | 3 |

The following galls are also mentioned by various Continental authors, but without descriptions:

ANDRICUS—
*Cecconii.*
*pseudo-inflator.*
*rufescens.*
*sufflator.*

CYNIPS—
*coronaria.*
*Kiefferi.*
*Mayri.*
*mediterranea.*

CYNIPS (*cont.*)—
*mitrata.*
*Stefanii.*
*tinctoria-nostras.*
*tormentosa.*
*Tozæ.*

NEUROTERUS—
*glandiformis.*

TRIGONASPIS—
*synaspis.*

ARNOLDIA—
*cerris.*
*homocera.*

CECIDOMYIA—
*subulifex.*
*galeata.*
*quercus.*
*pustularius.*

etc., etc.

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Galls caused by CYNIPS KOLLARI, Hartig.
Exhibiting ridges, papillæ, and styles.

## PLATE XXXV.

1, 2, 3. Galls caused by CYNIPS TINCTORIA with ridges and papillæ, introduced to show how closely they resemble those of *C. Kollari* (*cf.* Plate LX, div. B).

The remainder are English specimens.

4, 5, 8, 16. With well-defined ridges and papillæ like those on 1, 2, 3.

6 to 15. Well-defined papillæ only.

17, 18. A single style only on each.

19, 20, 21. A style and papillæ on each.

22. Large papillæ and ridge.

23 to 27. Very large single papillæ.

28. A specimen similar to 27, with papilla pointing towards observer.

29 to 33. Coalescent papillæ.

The point of attachment of each gall to the twig on which it grew, is immediately above the figures, except in 29 to 33, where it is on the right-hand side.

The specimens have been selected from amongst several thousands. Unfortunately they do not look so remarkable as they really are, partly because they are only two-thirds natural size, and much detail is lost in the photograph.

Aberrant examples of galls of CYNIPS KOLLARI, Hartig.

## PLATE XXXVI.

SINGLE GALLS:

1. A very large globular specimen, 27 mm. in diameter.
2. A typical normal globular specimen, 21 mm. in diameter, with three beneath it dwarfed by parasites.
3. A cluster of five in various stages of development.
4, 5, 6. Pyriform in shape.
7, 8. Fully-grown but tenanted by parasites. Note distinct sharp style on each gall.
9. Developing in a forked twig. 10. Developing in a recurved twig.
11. A similar specimen. The twig continues as in No. 10.
12, 13, 14. Distorted by same cause. Appearance as though pinched between finger and thumb.
15. A normal specimen with rough brownish exterior.
16. A normal specimen with smooth buff exterior.
17. Completion of development entirely prevented by fungus.
18, 19, 20. Completion of development partly prevented by fungus.
21. Three galls on one twig greatly deformed.
22. One gall splitting into three parts.

COALESCENT FORMS:

23 to 37. Twin growths, unequal in size.

38, 39, 40. Each of these contain two larval cells.

41, 42. Co-equal in size, attached to twig where joined to each other (42 is a very fine example).

43, 44. Co-equal in size, one only attached to twig; 31, 32, the same also.

45, 46, 47. Each contain three larval cells.

48, 49. Each contain four larval cells.

31, 32, 43, 44, are interesting from the fact that only one gall is attached to the twig; such forms are not common.

In the case of specimens without twigs, the point of attachment of the gall is immediately above the figures, except 45, 46, 47, where it is on the right-hand side, and 49 on the left-hand.

The extraordinary manner in which some galls of *Cynips Kollari* grow in geometrical, and in peculiarly-arranged groups, is exemplified in

## PLATE XXXVII.

GROUP:

1, 2. Three's. 3 to 8. Four's. 9, 10, 11. Five's.
12. Two two's coalescent, one single.
13. Two coalescent, three single.
14. Two coalescent, four single.

Fourteen groups comprising sixty-one galls.

The conglomerate clusters they form are also remarkable; a few are shown on

## PLATE XXXVIII.

CLUSTER:

1. Two galls coalescent and seventeen single.
2. Two two's coalescent, three coalescent, and seven single.
3. Three two's coalescent and four single.
4. Three two's coalescent and eleven single.
5. Twelve single.
6. Nine single.
7. Three coalescent and eleven single.
8. Eleven single.

Eight clusters comprising one hundred and six galls.

A few galls are obscured by those nearest to the observer.

# INDEX

Words in italics are names of genera or species; figures in italics refer to synonyms; figures in thick type indicate that the reference relates to systematic position.


Acorns, planting of, 35
Activity of cambium layer, 2
Adler, Dr. Hermann, on: gall-formation, 3; Cynipidæ ovipositing, 29; inquiline laying egg in immature gall, 80; rearing imago of *Aphi. quadri.*, 91. Appearance of imagines: of *Bior. aptera*, 99; of *Dryo. scutellaris*, 115; ovipositing of *Bio. aptera*, 20, 100. Colour of *Spathe. similis*, 131; of *S. Taschenbergi*, 132
Agamous generations, 49
Aleppo gall, The, 141
Alternating generations, xviii
*Andricus æstivalis*, **50**
„ *albopunctata*, *73*
„ *ambiguus*, *90*
„ *amenti*, **51**
„ *autumnalis*, *75*
„ *burgundus*, 108
„ *callidoma*, *77*
„ *circulans*, **52**, 103, 108; galls of, resembling those of *burgundus*, 53
„ *cirratus*, **53**, 77; distinguished from *A. ramuli*, 54
„ *clementinæ*, **55**; compared with *Aphi. globuli*, 56
„ *collaris*, *79*
*Andricus corticis*, *80*
„ *curvator*, **56**, 79; extremely abundant, 57; ovipositing in Lammas shoots, 58; peculiarities of, 5; rapid growth of, 57
„ *dimidiatus*, *56*
„ *disticha*, *110*
„ *fecundatrix*, *82*
„ *flavicornis*, *90*
„ *gemmæ*, *82*
„ *gemmatus*, **58**, 81
„ *glabrusculus*, *90*
„ *glandulæ*, **60**; distinctive appearance of, 61; galls of, 62
„ *glandium*, **59**; remarkable feature in, 59
„ *globuli*, **86**
„ *inflator*, **63**; exceptions to rule in, 4
„ *lucidus*, **64**
„ *lucida*, *64*
„ *marginalis*, *89*
„ *Malpighii*, *87*, 67
„ *noduli*, *65*, 92; on *Q. pubescens*, 66
„ *nudus*, **67**, 87
„ *ostreus*, *123*
„ *pedunculi*, *90*
„ *perfoliatus*, *55*

*Andricus pilosus*, **67**, 83
„ *quadrilineatus*, 90
„ *radicis*, 91
„ *ramuli*, **68**, 76; hairs of, 69; rapid maturity of, 69
„ *rufescens*, *59*
„ *Sieboldii*, *71*, *94*, *95*
„ *solitarius*, **70**
„ *terminalis*, *137*
„ *testaceipes*, **71**, 95; galls of, 72; doubtful identity of, 72; Adler's experiments with, 72
„ *trilineatus*, *65*
„ *verrucosus*, *90*
Anthoxanthin, 8
*Aphilothrix albopunctata*, **73**, 73; galls of, 74; rapid growth of, 74
„ *autumnalis*, **75**, 68
„ *callidoma*, 54, **77**; elegant shape of, 77; length of, 78; ridges upon, 78
„ *clementinæ*, *55*
„ *collaris*, **79**; quickest way to discover, 79; galls of, 80
„ *corticis*, 58, **80**; aggregations of, 81; situations of, 82
„ *disticha*, *110*
„ *fecundatrix*, **82**, 68; peculiarities of, 5; persisting of, 85; shape of leaf-scales, 83; the pip, 84; variations in form, 84
„ *gemmæ*, *82*
„ *glandulæ*, *60*
„ *globuli*, 63, **86**; favourite situations of, 86; composition of, 87
„ *lucida*, *64*
„ *Malpighii*, 67, **87**; galls of, 88; apparently rare, 88
*Aphilothrix marginalis*, **89**
Cameron on, 89
„ *quadrilineatus*, **90**; great variation in, 90; regularity of appearance of, 90
„ *radicis*, 65, **91**; numerous larval chambers, 93; typical situation of, 92; variable size of, 93
„ *seminationis*, **94**
„ *Sieboldi*, 71, **95**; attacked by tits, 98; first British record of, 95; fondness of ants for, 97; galls of, 98; habitat of, 96; red colour of, 96; shape of, 97; substance of, 97
„ *solitaria*, *70*
*Asterodiaspis quercicola*, *146*
„ *variolosus*, *146*
*Asterolecanium variolosum*, **146**
*Aulax hypochæridis*, gall of, 2
Autumn galls, weight of, 23

Beyerinck, W. W., on *Cynips Kollari*, 108
*Biorhiza aptera*, **98**, 138; condition of growth of, 99; distinguished from *A. radicis*, 99; number of ova of, 21, 100; on roots; of Deodars, 100; of *Fagus*, 100; of *Prunus*, 100; of *Vitis vinifera*, 100
„ *renum*, **101**, 139; distinguishing features of, 101; imagines difficult to rear, 102; number on leaf, 22
„ *terminalis*, *98*, *137*
Black truffle, The, 94
Bloomfield, The Rev. E. N., M.A., explanatory notes of, xvi
Browne, Sir Thomas, M.D., quotation from letters of, xv, xvii

British Oak, The, 33; growth of seedlings of, 34; variation of growth, 34
British Oak Galls, History of, xv
British Phytophagous Hymenoptera, Monograph of, xviii; quotation from vol. iv, 125

Cambium layer, The, nature of, 1; activity of, 2
Cameron, Peter, on: *Biorhiza aptera* ovipositing, 27; gall formation, 3; gall of *Andricus amenti*, 52; *Aphilothrix collaris*, 79; *A. marginalis*, 89; *Neuroterus punctatus*, 125; inquilines in gall of *Andricus testaceipes*, 72
*Carpocapsa juliana*, 85
*Cecidomyia Lichtenstinii*, 145
Charcoal from oak wood, 37
*Coccus quercicola*, *146*
„ *variolosum*, *146*
Collecting oak galls, 42
Colours of galls, 7
Complex structure of galls, 6
Component parts of galls, 5
*Contarinia Ilicis*, 145
Cotyledons absorbing water, 35
Cynipidæ, The, as gall producers, 26; as gall-wasps, xiv; as parasites, 26; accurate deposition of ova, 28; affecting the oak, 26; alternate generations of, 49; a. g. not confined to, 30; cling with tenacity, 27; beautiful metallic colours of, 28; bi-sexual reproduction of, 31; difficult to rear, 27; larvæ of, 30; lethargic habits of, 27; method of oviposition, 29; non-sexual reproduction of, 31; number of ova of, 29; ovum of, 29; pupa of, 30; terebra of, 28
*Cynips agama*, *108*
„ *albopunctata*, *73*
„ *aptera*, *98*
„ *autumnalis*, *75*
„ *axillaris*, *56*
*Cynips calicis*, **143**
„ *callidoma*, *77*
„ *cerricola*, 143
„ *clementinæ*, *55*
„ *collaris*, *79*
„ *conglomerata*, 105
„ *corticalis*, *95*
„ *corticis*, *80*
„ *crustalis*, *139*
„ *curvator*, *56*
„ *disticha*, *110*
„ *divisa*, *112*
„ *fasciata*, *79*
„ *fecundatrix*, *82*
„ *ferruginea*, *70*
„ *folii*, *115*
„ *4-lineatus*, *90*
„ *galeata*, 144
„ *gemmæ*, *82*
„ *glandulæ*, *60*
„ *globuli*, *86*
„ *inflator*, *63*
„ *inflorescentiæ*, *94*
*Kollari*, 52, **102**; Beyerinck on alternate generation of, 108; first appearance in England of, 103; fungus on, 107; growth of, 106; most durable British gall, 6; ovaries of, 21; possesses no male, 32; protuberances on, 107; sessile and axillary, 107; similarity to three continental forms, 105; structure of, 6; tannin in, 104.
„ *lenticularis*, *120*
„ *lignicola*, *102*, 105
„ *longiventris*, *113*
„ *lucida*, *64*
„ *majalis*, *73*
„ *marginalis*, *89*
„ *megaptera* *139*
„ *numismatis*, 122
„ *quercus baccarum*, *120*, *129*
„ „ *folii*, *115*
„ „ *petioli*, *102*

*Cynips quercus-ramuli, 68*
„ „ *-terminalis, 98, 137*
„ „ *-tiaræ, 122*
„ *radicis, 91*
„ *ramuli, 68*
„ *scutellaris, 115*
„ *seminationis, 94*
„ *Sieboldi, 95*
„ *tegmentorum, 79*
„ *tinctoria, 102*, 105, 108, **141**

*Dichæna quercina*, **148**
*Diplolepsis solitarius, 70*
*Diplosis dryobia*, **147**
„ *Liebeli, 147*
„ sp.? 145
*Dryocosmus Australis*, 145
*Dryophanta agama*, **108**; gall of, 109; shape of, 109; texture of, 110
„ *disticha*, **110**; gall of, 109; apparently rare, 110; not mentioned by Adler, 111; three aspects of gall of, 111
„ *divisa*, **112**, 134, *134*; gall of, 109; distinguished from *agama*, 112; number on leaf, 22; profusion of, 113
„ *folii, 115*
„ *longiventris*, **113**, 131; delicate coloration of, 114; peculiar shape of, 114; three aspects of gall of, 114.
„ *scutellaris*, **115**, 132; Adler on flies of, 115; beauty of, 116; composition of, 116
„ *Taschenbergi*, 132
„ *verrucosa*, 134

English name of gall, The—
Acorn, 59
Apple, 137
April bud, 127
English name of gall (*contd.*), The—
Artichoke, 83
Autumn, 75
Bark, 80
Bald seed, 67
Barley-corn, 94
Blister, 135
Bristley, 64
Bud, 58
Cherry, 115
Collared bud, 79
Common spangle, 120
Cotton, 68
Cotyledon, 59
Cup, 50
Cupped spangle, 117
Current, 129
Curved leaf, 56
Devonshire, 102
Furrowed catkin, 90
Globular, 86
Green velvet-bud, 131
Hairy catkin, 51, 67
Hairy pea, 133
„ spindle, 70
Hop, 83
„ strobile, 83
Kidney, 101
King Charles' apple, 137
Knot, 65
Larch cone, 83
Leaf-vein, 71
Little acorn, 60
Malpighi's, 87
Marble, 102
Marginal, 89
Oak apple, xvi, 137
„ marble, 102
„ nut, 102
Oyster, 124
Pink wax, 139
Pointed pea-bud, 55
Purple velvet-bud, 132
Red barnacle, 95
„ pea, 112
„ wart, 134
Root, xvi, 98

English name of gall (*contd.*), The—
Schenck's, 126
Silk button spangle, xvi, 122
Smooth spangle, 118
Spotted bud, 73
Stalked spindle, 77
Striped, 113
Thatched, 60
Truffle, 91
Tufted, 53
Turkey-oak bud, 52
Twig, 63
Two-cell, 110
Woolly, xvi, 68
Yellow pea, 108
'Entomologist,' The, for 1874 to 1878, xvii
*Epitrimerus cristratus*, **147**; dimensions of, 147
Equipment for gall collecting, 40
*Eurytoma rosæ* in fourteen galls, xiv
Evergreen oak, The, 39

Fitch, E. A., Notes by, in 'The Entomologist,' xvii

Gall, definition of word, 48
Gall-flies, xiii
„ -gnats, xiii
„ -midges, xiii
„ -wasps, xiv; diminutive size of, 20
Ground birds feeding on spangle galls, 19

Hints on collecting and mounting oak galls, 40

Ink, from a Chinese gall, 142
„ from a Japanese gall, 142
„ how manufactured, 142
„ marble, 141
Inquilines in oak galls, 150–152

Knopper gall, 143

Lammas shoots, 36

Mayr, Dr. G. L., translation from, xvii; opinion on *Neuroterus numismatis*, 122
*Megastigmus dorsalis* in eleven galls, xiv
Modifications in development due to environment, 17; external influences, 16; inquilines, 17; internal influences, 17; overcrowding, 16
Mounting oak galls, suggestions for, 43

*Neuroterus albipes*, *126*
„ *Aprilinus*, *127*
„ *baccarum*, *129*
„ *fumipennis*, **117**, *120*, 133; gall of, 121; profusion of, 117; typical condition of, 118; weight of, 23
„ *læviusculus*, **118**, *120*, 126; gall of, 119, 121; outline of gall of, 119
„ *lenticularis*, **120**, *129*, 130; gall of, 121; ovipositing of, 21; weight of, 23
„ *Malpighii*, *120*
„ *numismatis*, **122**, *135*, 136; Mayr's opinion of, 122; number on leaf, 22; Swanton's observations on, 123
„ *ostreus*, **123**, 128; rapid growth of, 124; number on leaf, 22
„ *pezizæformis*, *118*, *120*
„ *punctatus*, **125**
„ *Reaumuri*, *122*
„ *Schlechtendali*, *127*
„ *tricolor*, *133*
„ *vesicatrix*, *135*
Numerousness of Autumn galls, 22
Newbigin, Dr. Marion, on colours, 7
Newman, E., on *Cynips Kollari*, 103

Oak bark, 37
„ galls, aberrations of, 13; beginning of growth, 4; conditions

of growth, 2; colours of, xiii; dissimilarity of shapes of, 12; duration of growth, 10; early development, 3; modifications in, 16; numerical aspect of, 20; positions occupied by, 11; preservation of, 44; rapid growth of, 10; resemblance to Continental forms, 12; similarity of growth of, 11; slow growth of, 10; smell of, 18; taste of, 18; variations—in colour, 15; in shape, xiii; in size, 14; in texture, 15
Oak leaves, colours of, 38
„ tree, flowers of, 37; leaves of, 37; primary root of, 35
„ wood, annular rings of, 37; properties of, 36
*Opegraph quercina*, *148*

Parasites, 150–152
Phloëm, The, 1
*Phoma gallorum*, 107
Pit-making oak coccid, 146
*Plagiotrochus Ilicis*, 145
*Planchonia fimbriata*, *146*
„ *quercicola*, *146*
Principles of oak gall formation, The, 1

*Quercus cerris*, 38; bitterness of acorns of, 39; scales on cupule of, 38
„ *Ilex*, 39, 144; colour of wood of, 39; rapid growth of, 39
„ *pedunculata*, 34; observations on growth of, 36
„ *pubescens*, 144
„ *robur*, 33; the type of oaks, 33
„ „ *intermedia*, 34
„ „ *pedunculata*, 34
„ „ *sessiliflora*, 34
„ *sessiliflora*, 34
„ *terminalis*, *102*

*Saphylotus connatus*, 126
Sexual generations, 49
Simplest forms of galls, 5
Some features of oak gall growth, 9
*Spathegaster albipes*, *118*, 119, **126**; coinciding with some *Andricus* species, 126
„ *Aprilinus*, 124, **127**; unequal rapidity of growth of, 128
„ *baccarum*, 120, **129**; appropriateness of name of, 130; extraordinary abundance of, 130
„ *flosculi*, *132*
„ *Giraudi*, *132*
„ *interruptor*, *120*, *129*
„ *punctatus*, *125*
„ *similis*, 114, **131**; Adler on, 131; rarity of, 131
„ *Taschenbergi*, 116, **132**; beauty of, 132
„ *tricolor*, 117, **133**; acid flavour of, 133
„ *various*, *117*, *120*, *133*
„ *verrucosa*, *134*
„ *verrucosus*, *112*, **134**; Adler on, 134; galls of, 135
„ *vesicatrix*, *122*, 122, **135**; gall similar to, 137; radii on surface of, 136
Southwell, Thomas, F.Z.S., xv
Steenstrup, J. J. S., on alternate generations, 31
Straton, C. R., M.D., translation by, xviii
Swanton, E. W., observations on red-currant gall, 24; of *Neuroterus numismatis*, 123; on abundance of galls, 24
*Synergus facialis* in ten galls, xiv
„ *vulgaris* in nine galls, xiv

Tannin in plants, 142
*Tephritis bardanæ*, xiii
*Teras amentorum*, *68*
„ *terminalis*, *98*, 99, **137**; autumn-winter condition of, 138; numerous creatures in gall of, 18; first reference to, xv
Terms employed in the synoptical tables, 46
Thistle stems, xiii
Trail, Dr., first to discover *Spathegaster vesicatrix*, 136
*Trigonaspis crustalis*, 101, **139**; bitterness of, 140; mode of growth of, 140; unusually succulent, 139
*Trigonaspis megaptera*, *101*, *139*
„ *renum*, 101, *139*
*Tuber melanospermum*, 94
Turkey oak, The, 38
Twenty-six Continental oak galls, 152

*Urophora solstitialis*, xiii

Walker, Francis, notes in 'The Entomologist,' xvii
Weight of autumn galls, 23
Winter, W. P., on pink cotyledons, 25

Xylem, The, 1

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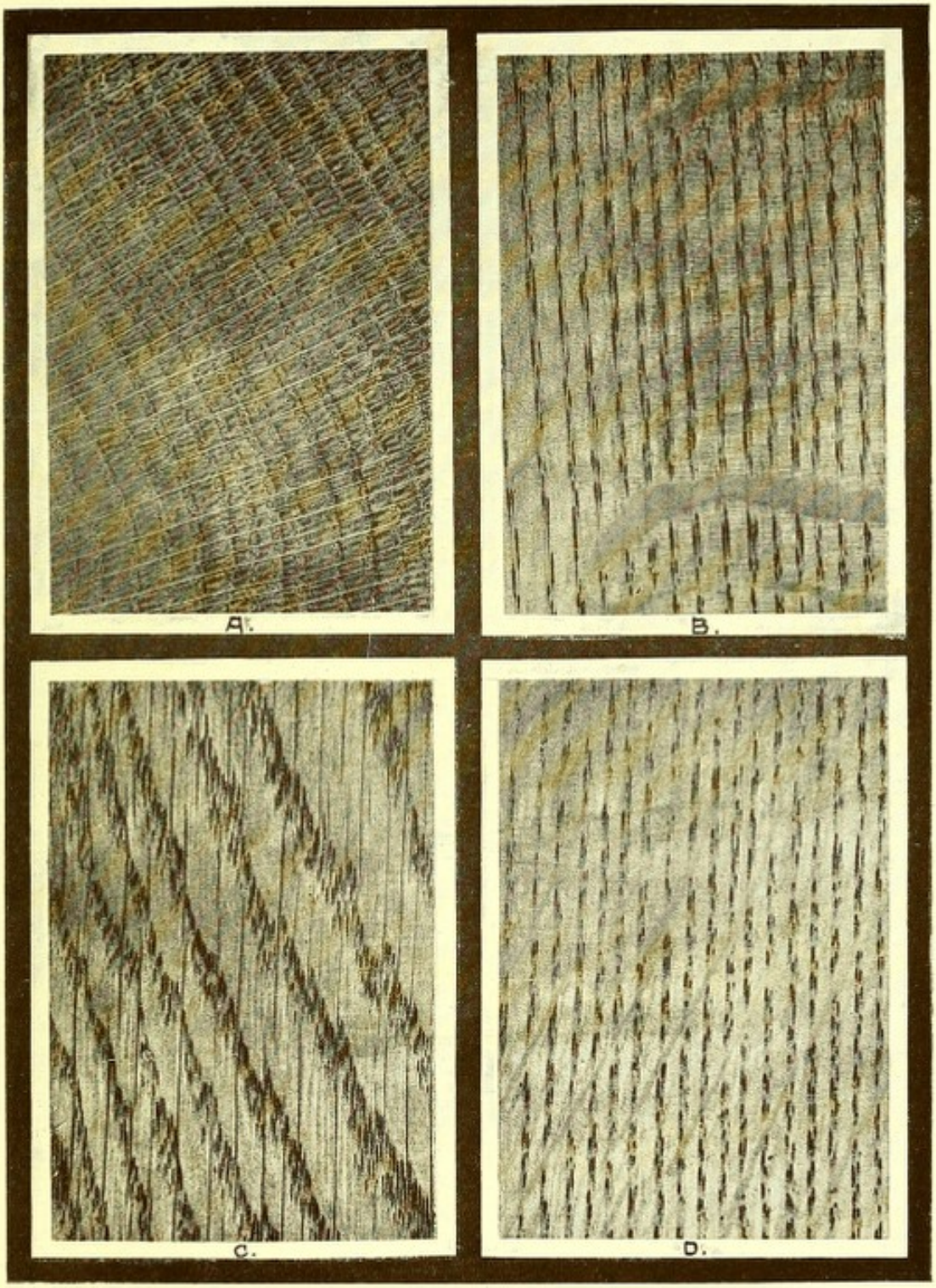
# PLATE II.




Oak wood, showing the difference in appearance of the various sections. Nat. size.

A. Transverse section (a cross grain, horizontally as the tree stands).

B. Vertical radial section (quartered, showing silver grain).

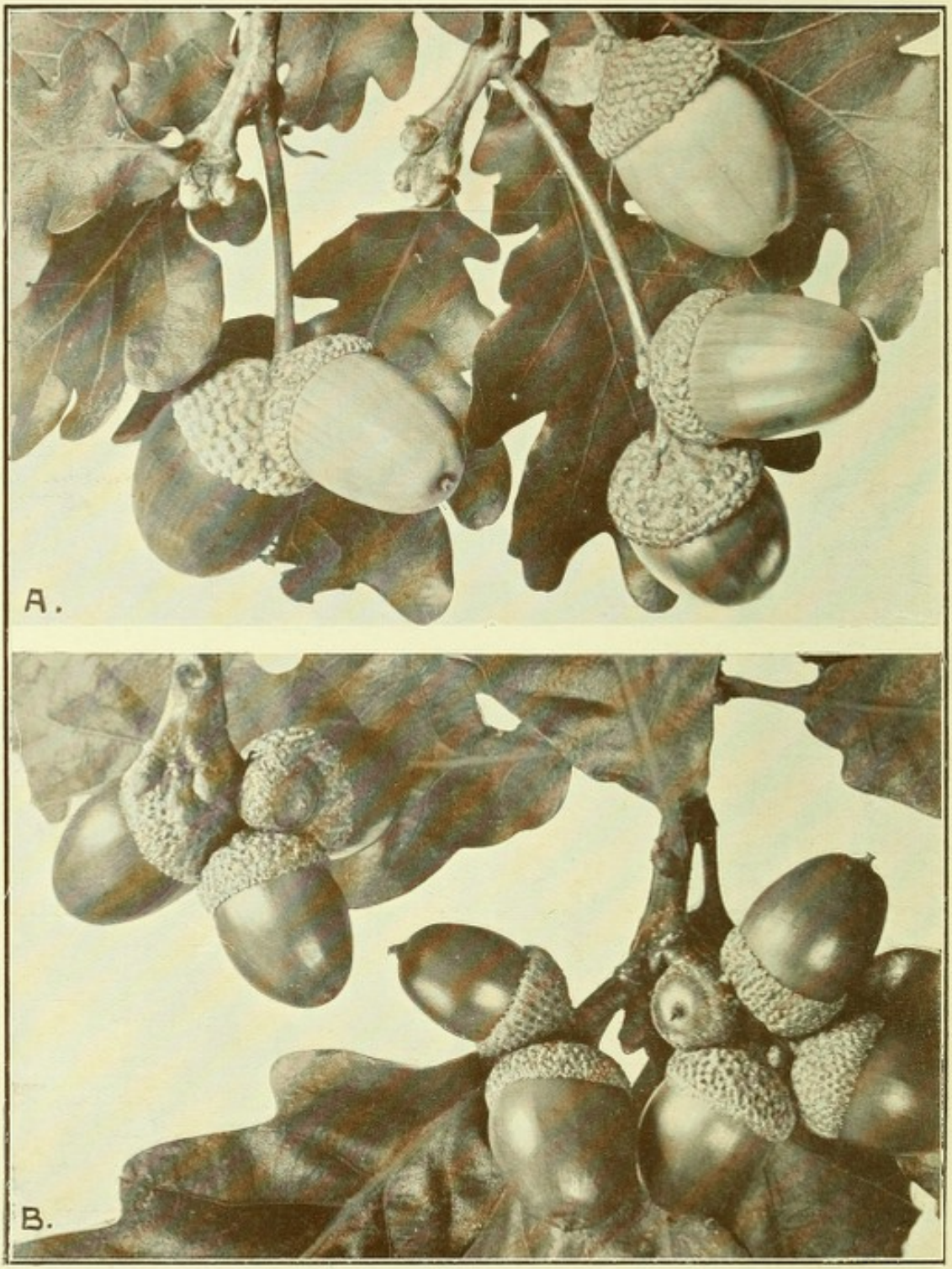
C. Vertical tangential section (plankwise).

D. Vertical section in a direction between B and C.

Photo-micrographs by A. DEANE.

*Adlard & Son, Impr.*

# PLATE III.




The fruit and leaves of
A. *Quercus pedunculata.* B. *Q. sessiliflora*

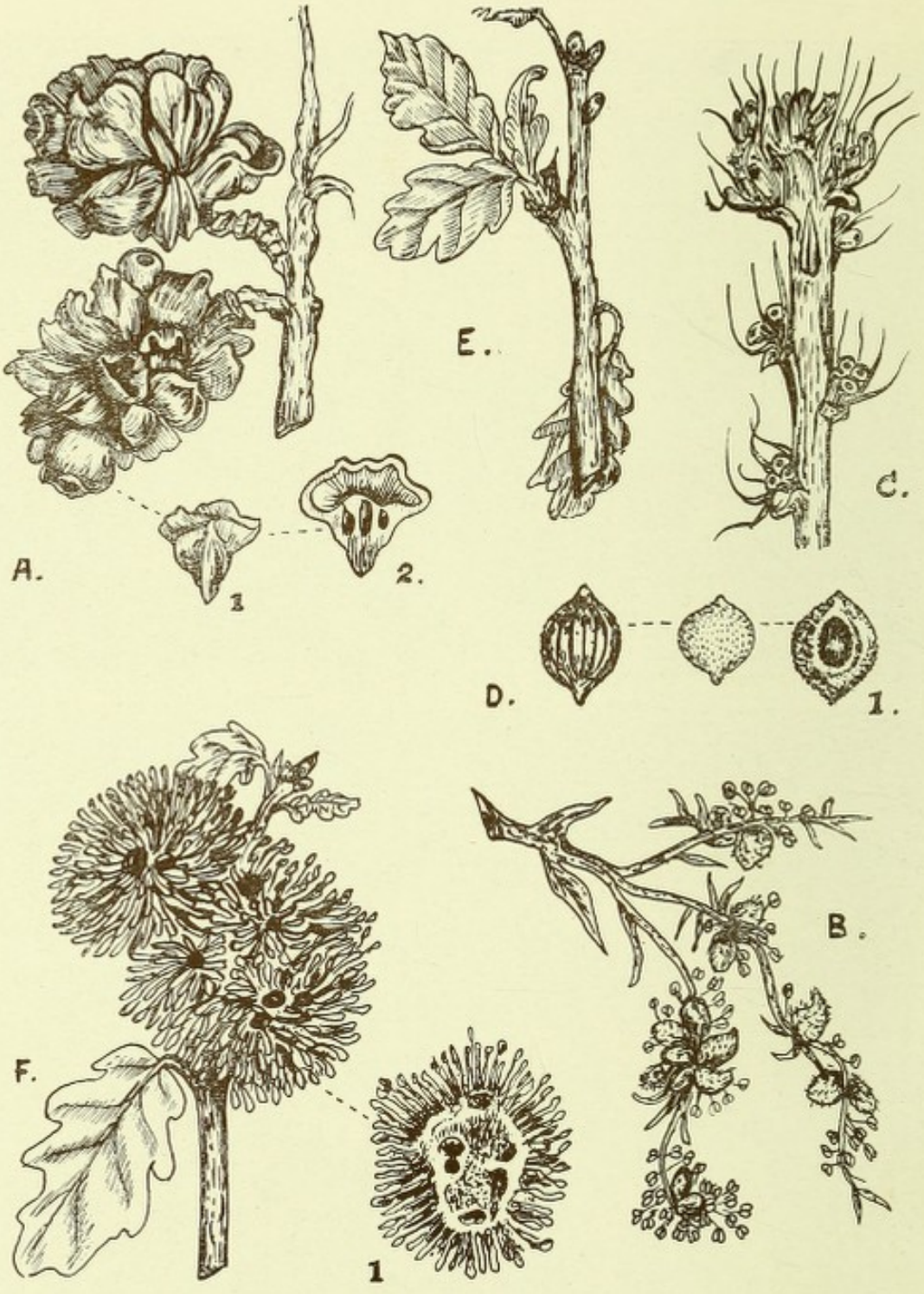
*Adlard & Son, Impr.*

# PLATE IV.


The fruit and leaves of
A. *Quercus cerris.* B. *Q. Ilex* (fruit immature).

*Adlard & Son Impr.*

# PLATE V.




Galls caused by

A. ANDRICUS ÆSTIVALIS. After Mayr. 1. Immature. 2. Vertical section. Nat. size.

B. „ AMENTI. After Cameron. Twice nat. size.

C. „ CIRCULANS. After Mayr. Nat. size.

D. „ CLEMENTINÆ. After Mayr. Nat. size. 1. Vertical section.

E. „ GEMMATUS. After Mosley. Nat. size.

F. „ LUCIDUS. After Mayr. 1. Transverse section.

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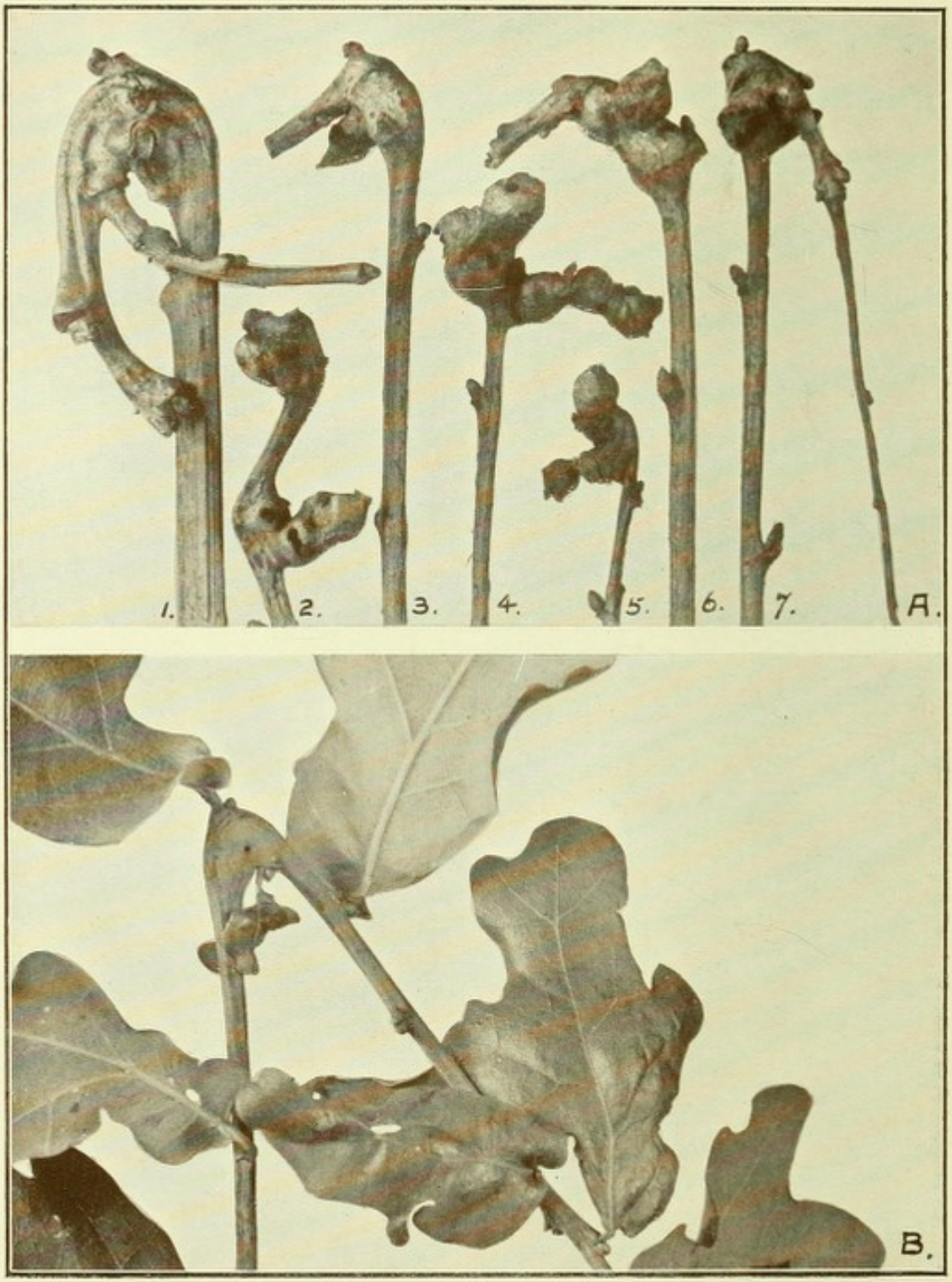
# PLATE VI.

Galls caused by ANDRICUS CURVATOR on leaves of *Q. pedunculata*.
Four-fifths nat. size.

*Adlard & Son, Impr.*

# PLATE VII.




A. Autumn–winter condition of galls caused by ANDRICUS CURVATOR. 1, 2, 3, 6, 7, on twigs; 2, 4, 5, on leaf petioles.

B. A fine specimen of the same species.

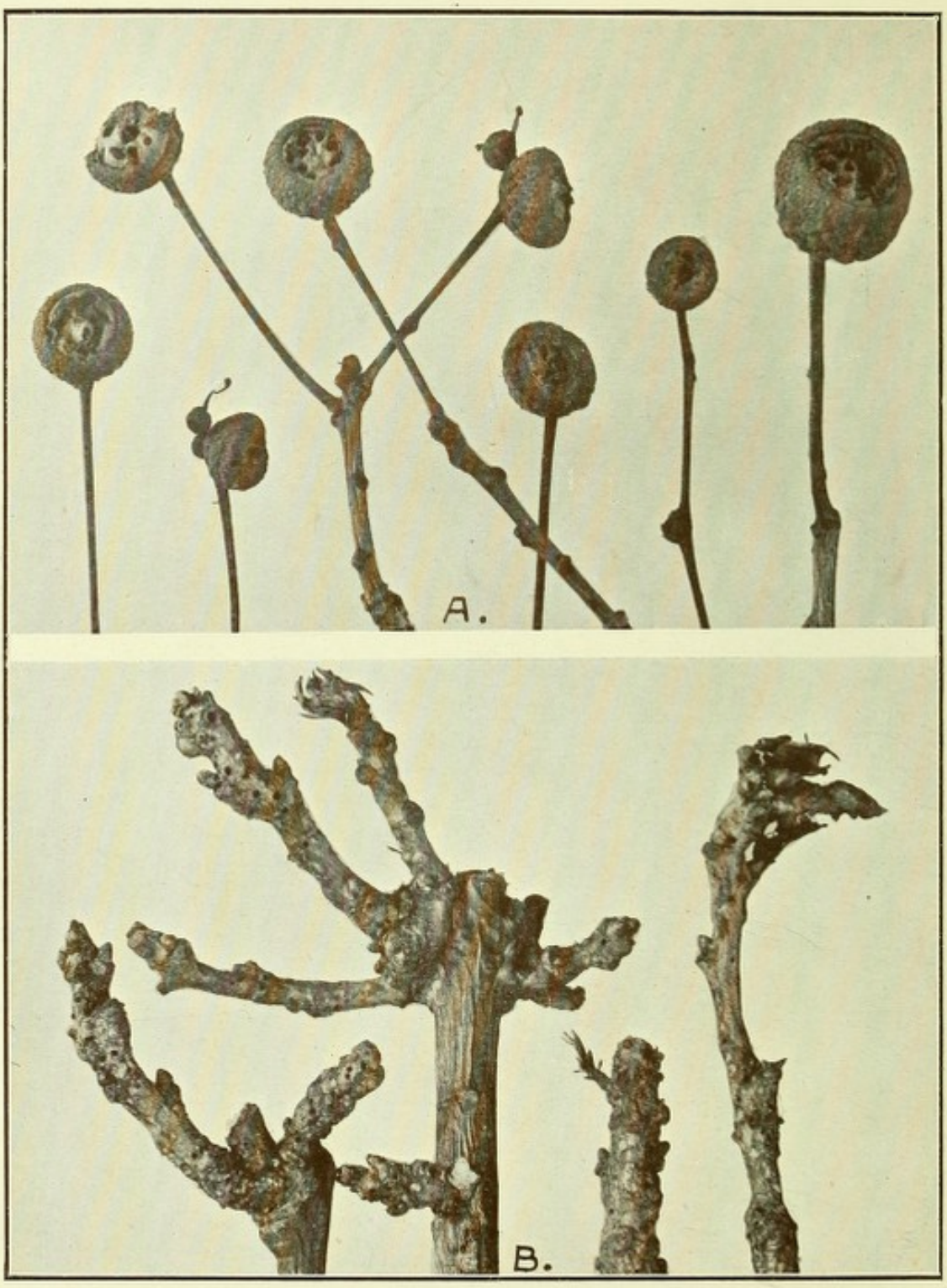
*Adlard & Son, Impr.*

# PLATE VIII.

Galls caused by ANDRICUS GLANDIUM in acorns of *Q. cerris*.
Four-fifths nat. size.

*Adlard & Son, Impr.*

# PLATE IX.




A. Galls caused by ANDRICUS GLANDIUM in acorns of *Q. pedunculata*.
B. Autumn–winter condition of twigs containing galls (old) caused by ANDRICUS NODULI.

Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE X.

Galls caused by ANDRICUS GLANDULÆ in leaf-buds of *Q. pedunculata*.
The specimen in inset is × 2½.
Nearly nat. size.

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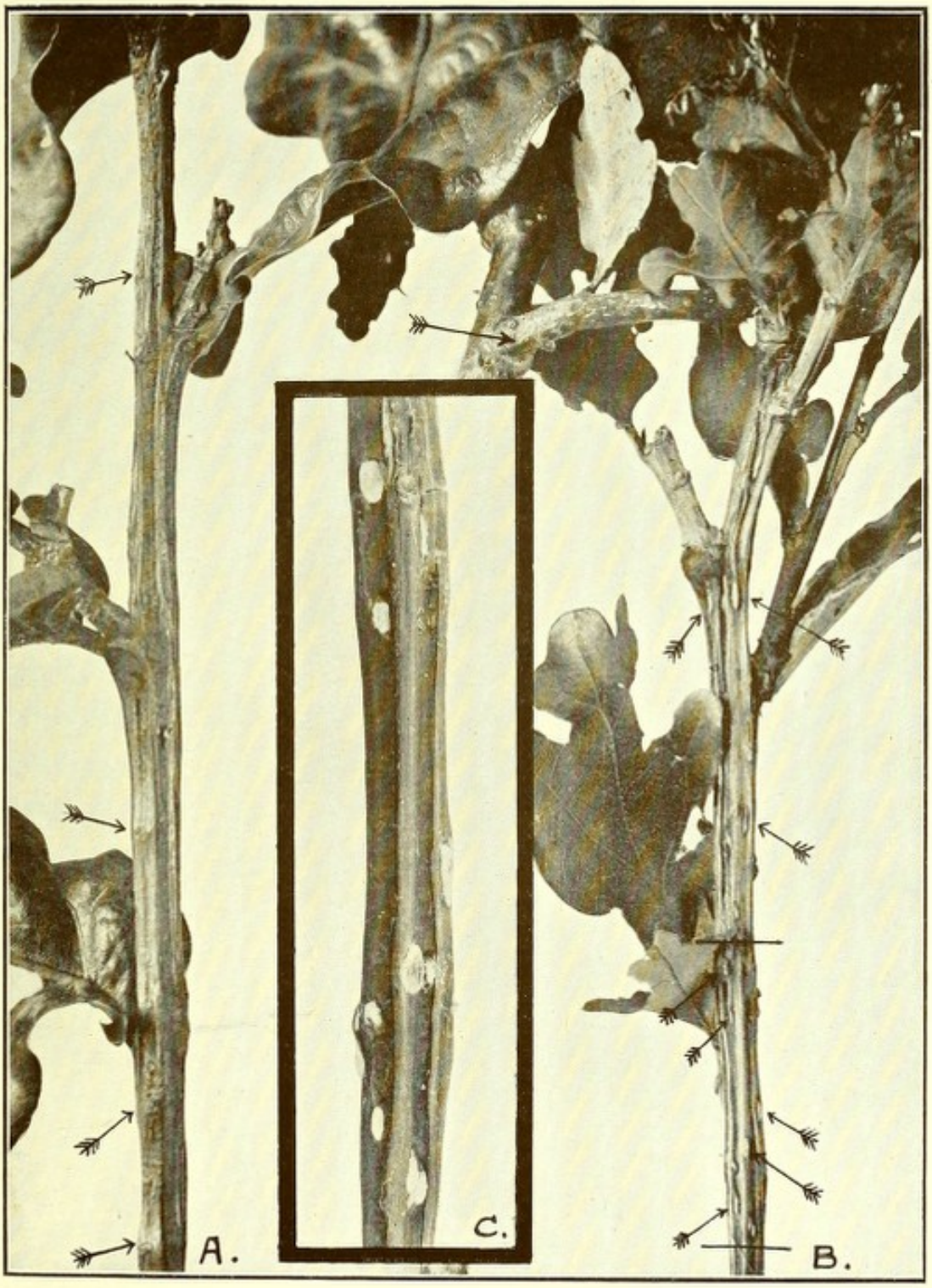
# PLATE XI.


Galls caused by ANDRICUS INFLATOR : A. Early spring condition. B. Late spring condition. C. Summer condition. 1 and 2. Longitudinal sections showing cylindrical cavity, arrow indicating the larval cell.

A and B nearly nat. size. C half nat. size.

*Adlard & Son, Impr.*

# PLATE XII.




Galls caused by ANDRICUS NODULI in twigs of *Q. pedunculata*.

A. Normal condition of twig. B. Bark peeled off to expose galls. C. Portion of twig B between transverse lines × 2½.

A and B nearly nat. size.

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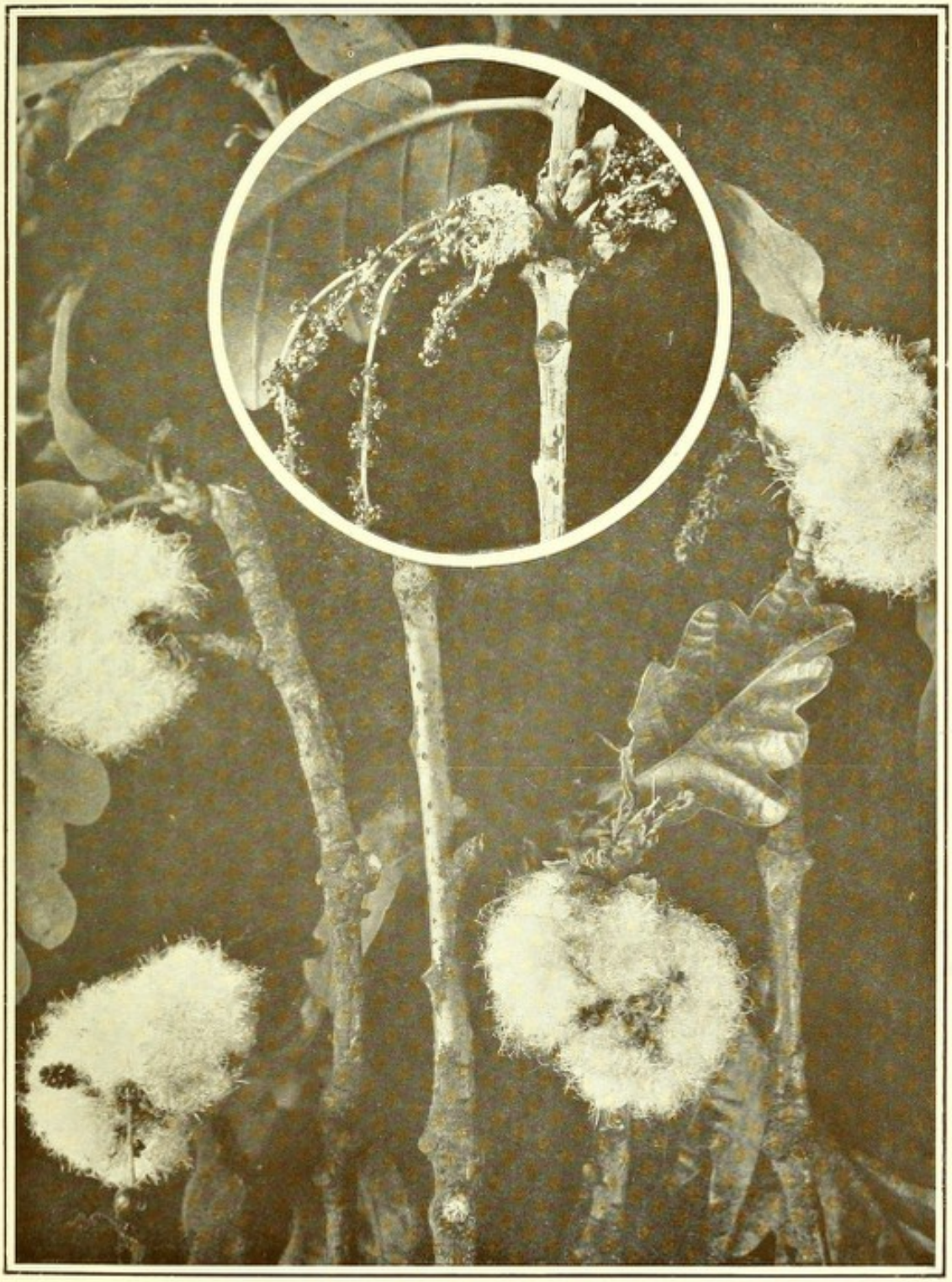
# PLATE XIII.


Galls caused by: A. ANDRICUS NUDUS; B. A. PILOSUS; C. APHILOTHRIX QUADRILINEATUS; on staminate catkins of *Q. sessiliflora*.
A, nearly nat. size. B, C, × 2½.

*Adlard & Son, Impr.*

# PLATE XIV.



Galls caused by ANDRICUS RAMULI on staminate catkins of *Q. sessiliflora*.
The inset is a gall caused by ANDRICUS CIRRATUS on staminate catkins of *Q. sessiliflora*.

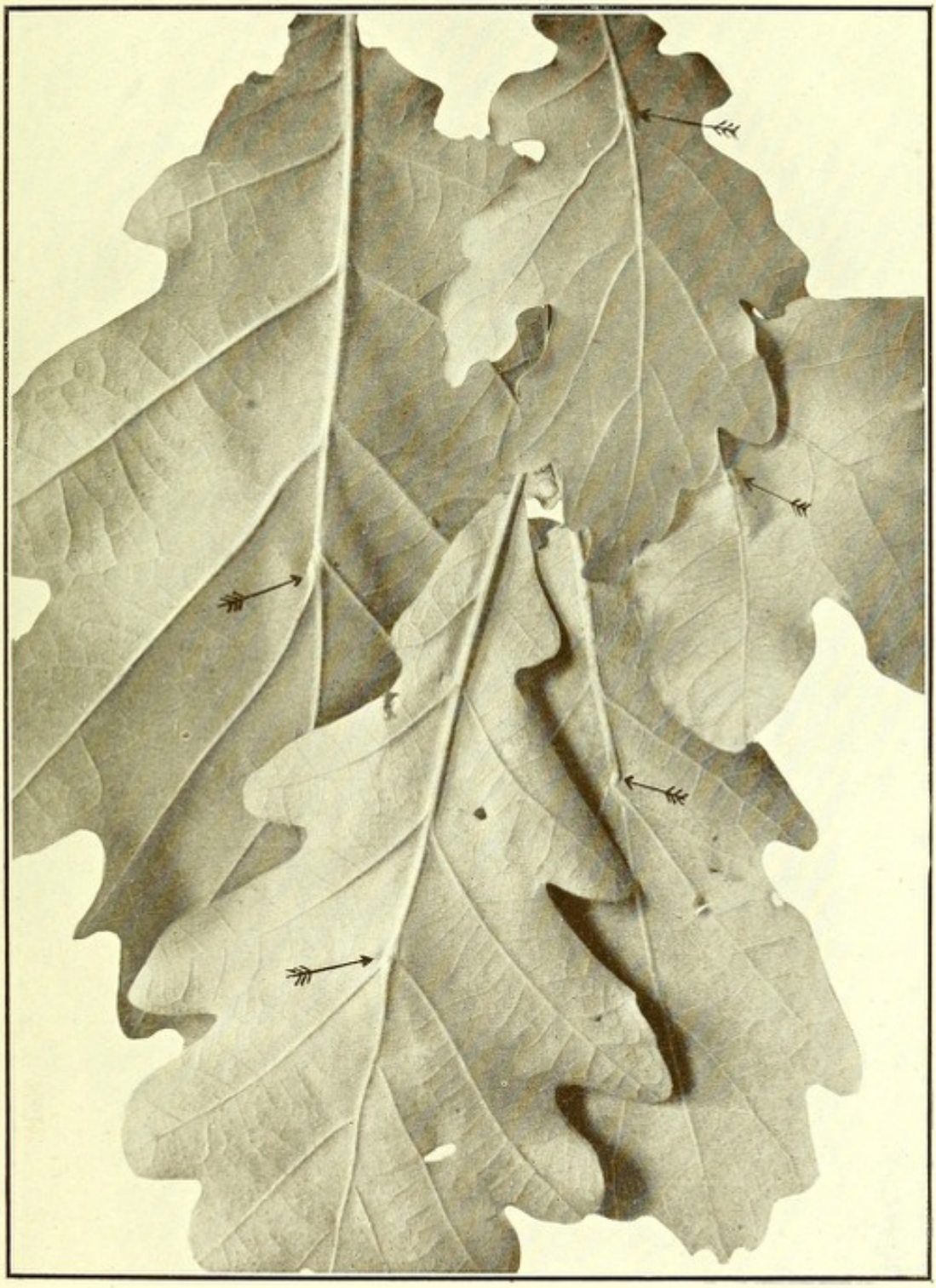
Both nearly nat. size.

*Adlard & Son, Impr.*

Galls caused by ANDRICUS SOLITARIUS in leaf-buds of *Q. pedunculata*.
The inset is a typical specimen × 2½.
Three-fourths nat. size.

*Adlard & Son, Impr.*

# PLATE XVI.



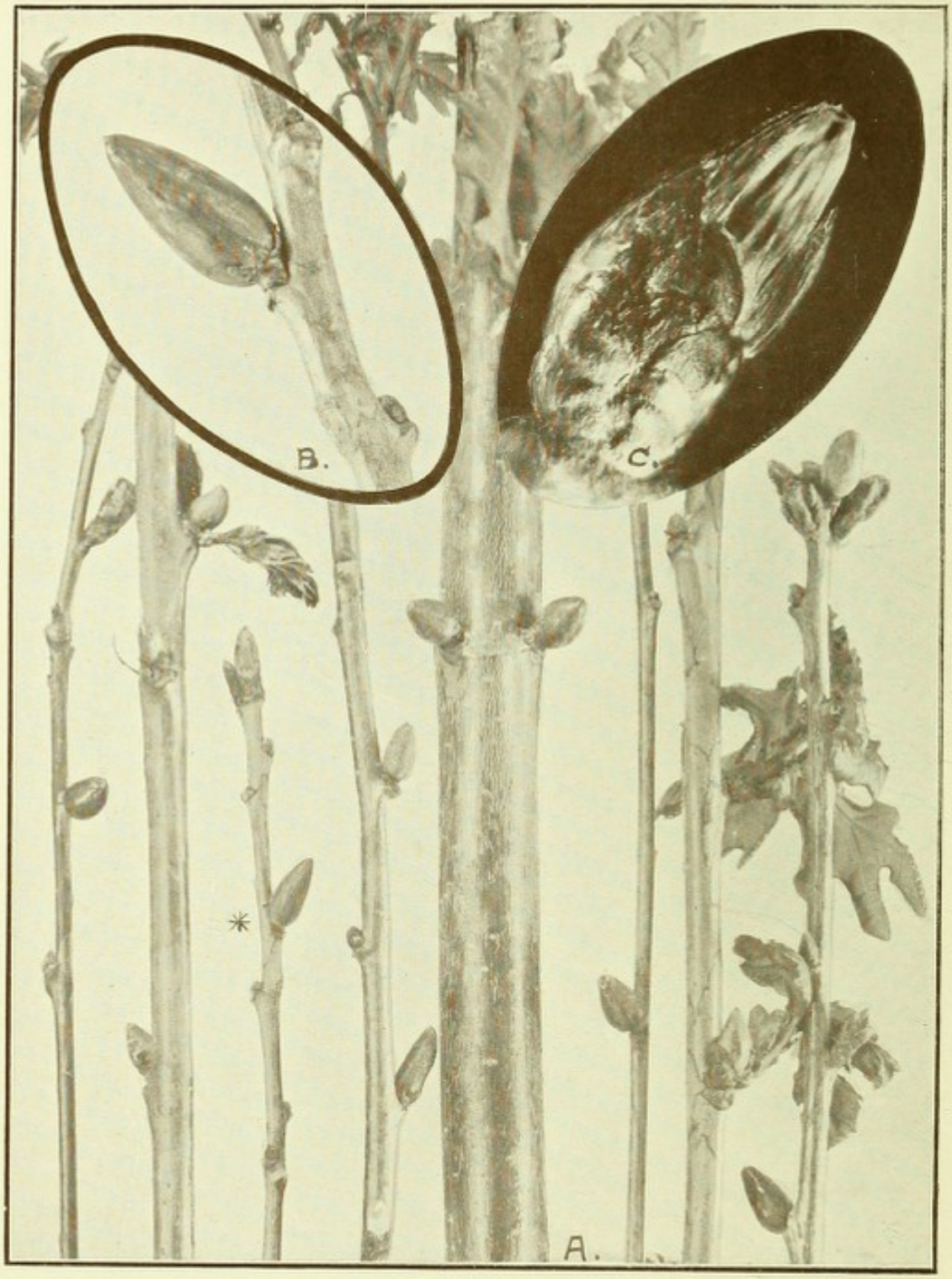
Galls caused by ANDRICUS TESTACEIPES in mid-rib on under surface of leaves of *Q. pedunculata*.

Arrows indicate positions of galls.

Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE XVII.

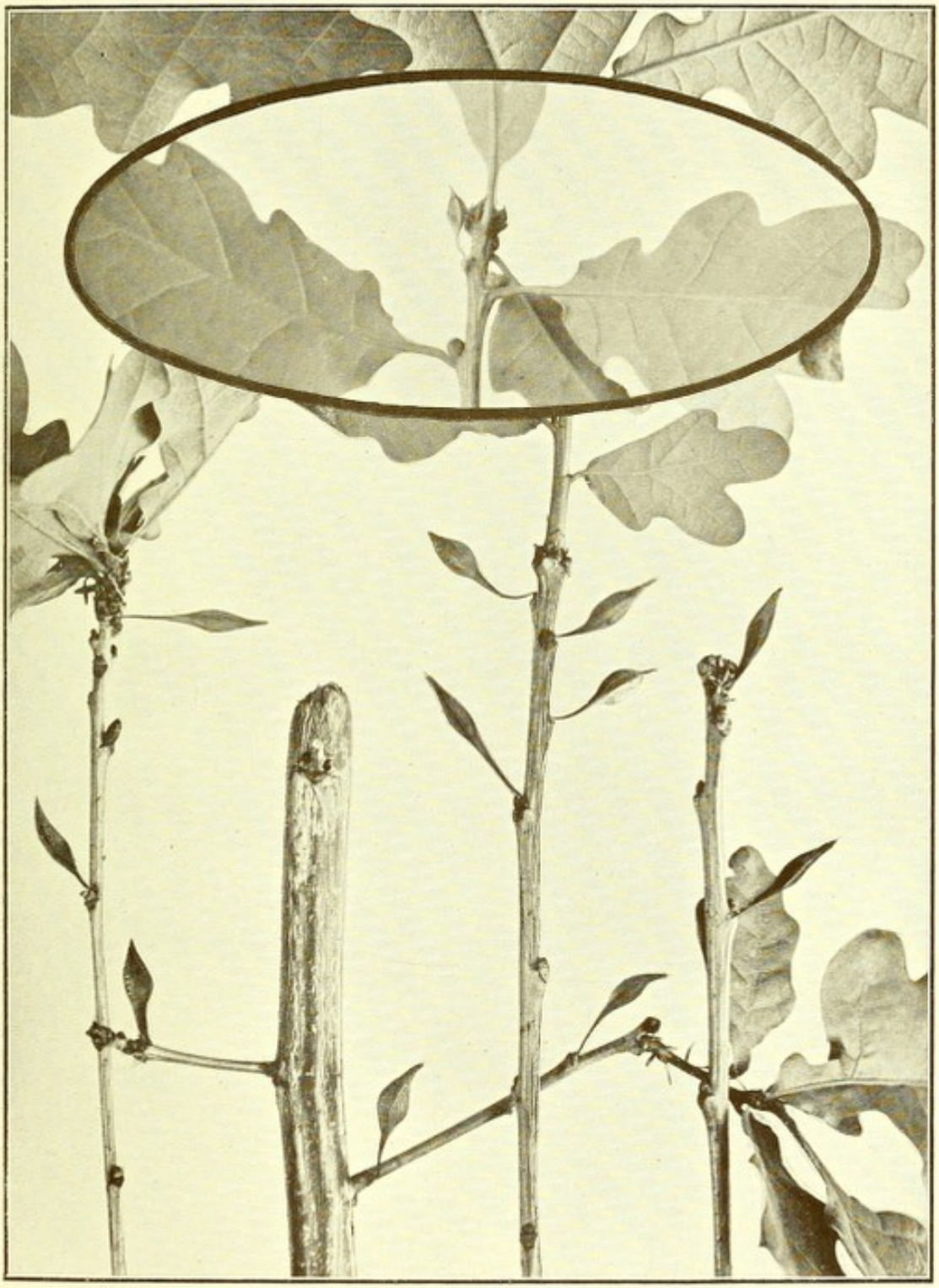



Galls caused by APHILOTHRIX ALBOPUNCTATA in leaf-buds of *Q. pedunculata*.

A. All nearly nat. size. B. The specimen marked * × 2½. C. A young gall pushing through leaf-scales, × 5.

*Adlard & Son, Impr.*

# PLATE XVIII.



Galls caused by APHILOTHRIX CALLIDOMA on twigs of *Q. pedunculata*.
The inset is of a specimen which grew ten feet above ground level.
Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE XIX.


Gall caused by APHILOTHRIX CORTICIS on moss-covered bole of *Q. pedunculata*.

A. One young gall. B. Eight mature galls. C. After the imagines have left the galls.

Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE XX.

Galls caused by APHILOTHRIX FECUNDATRIX in leaf-buds of *Q. pedunculata*.
Arrows indicate two galls emerging from among the leaf-scales.
Three-fourths nat. size.

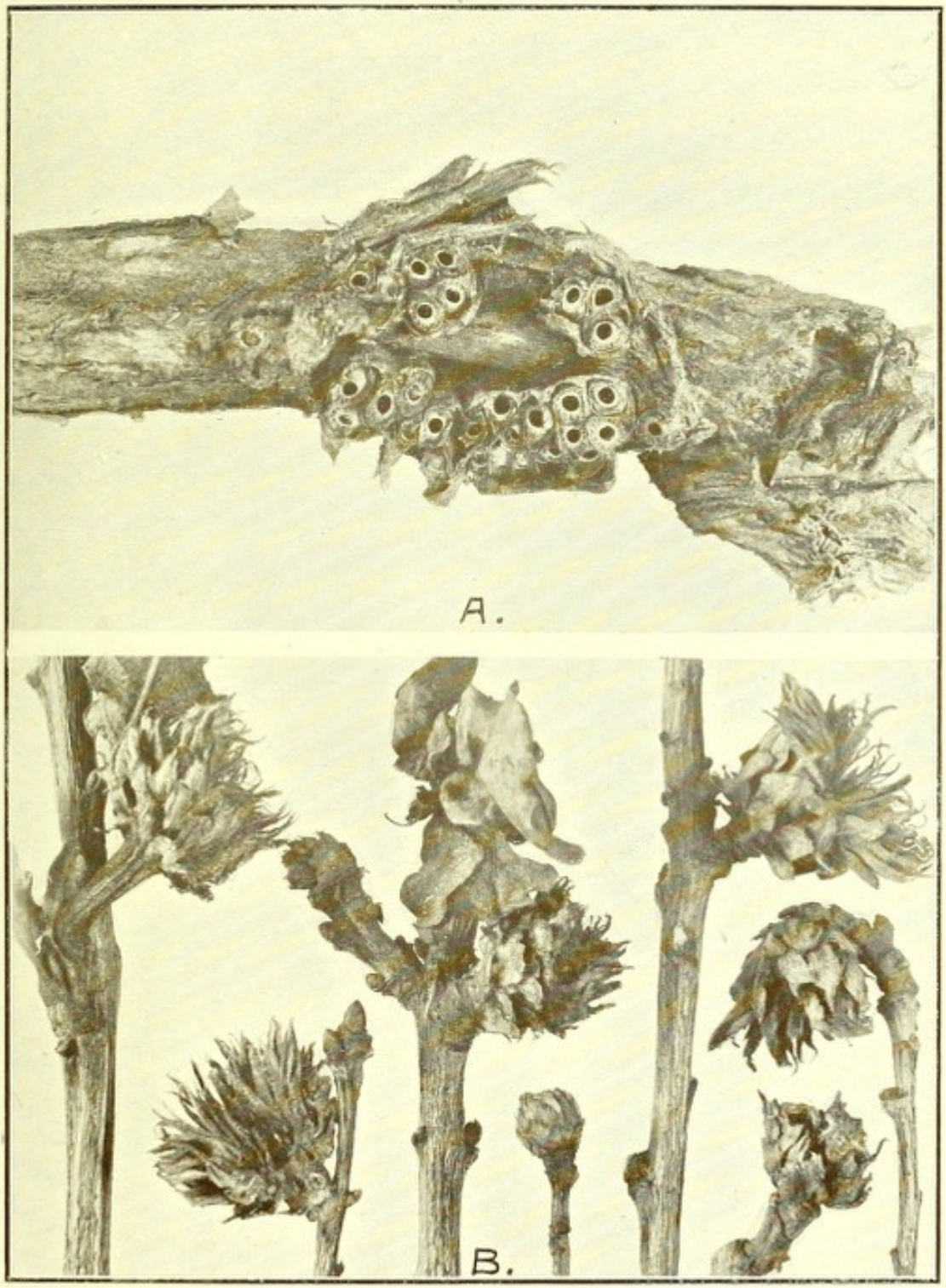
*Adlard & Son, Impr.*

# PLATE XXI.


Galls caused by APHILOTHRIX FECUNDATRIX in leaf-buds of *Q. pedunculata*.
The arrow indicates a gall emerging from among the leaf-scales.
The letters are referred to on pp. 84 and 85.
Four-fifths nat. size.

*Aâlard & Son, Impr.*

# PLATE XXII.




A. Autumn–winter condition of galls caused by APHILOTHRIX CORTICIS.
B. Winter–spring condition of galls caused by APHILOTHRIX FECUNDATRIX.

Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE XXIII.


Galls caused by: A. APHILOTHRIX MALPHIGII; B. A. AUTUMNALIS; C. A. GLOBULI; in leaf-buds of *Q. pedunculata*.
c. Spring-summer condition.
Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE XXIV.


Galls caused by :

A. APHILOTHRIX MARGINALIS on leaves. (Past maturity.)

B. APHILOTHRIX SEMINATIONIS on staminate catkins of *Q. pedunculata*.

Both nearly nat. size.

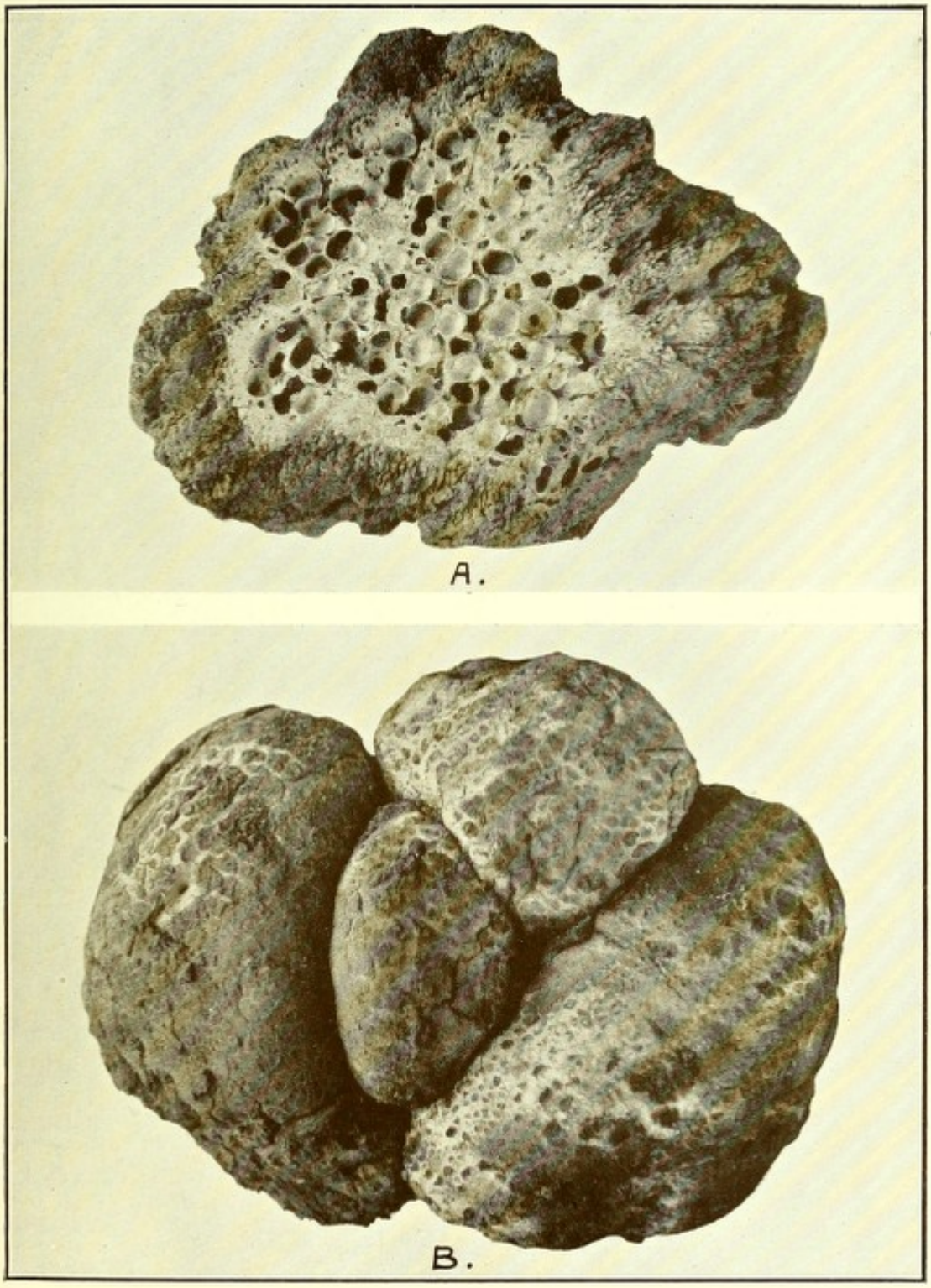
*Adlard & Son, Impr.*

# PLATE XXV.

Galls caused by APHILOTHRIX QUADRILINEATUS on staminate catkins of *Q. pedunculata*. Nearly nat. size.
The inset is of two galls × 4.

*Adlard & Son, Impr.*

# PLATE XXVI.




Galls caused by APHILOTHRIX RADICIS.

A. Section of mature gall, showing larva cells. B. Quadripartite specimen in growing condition.

Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE XXVII.

Galls caused by APHILOTHRIX SIEBOLDI on twigs of *Q. pedunculata*.
Summer–autumn condition.

Nearly nat. size.

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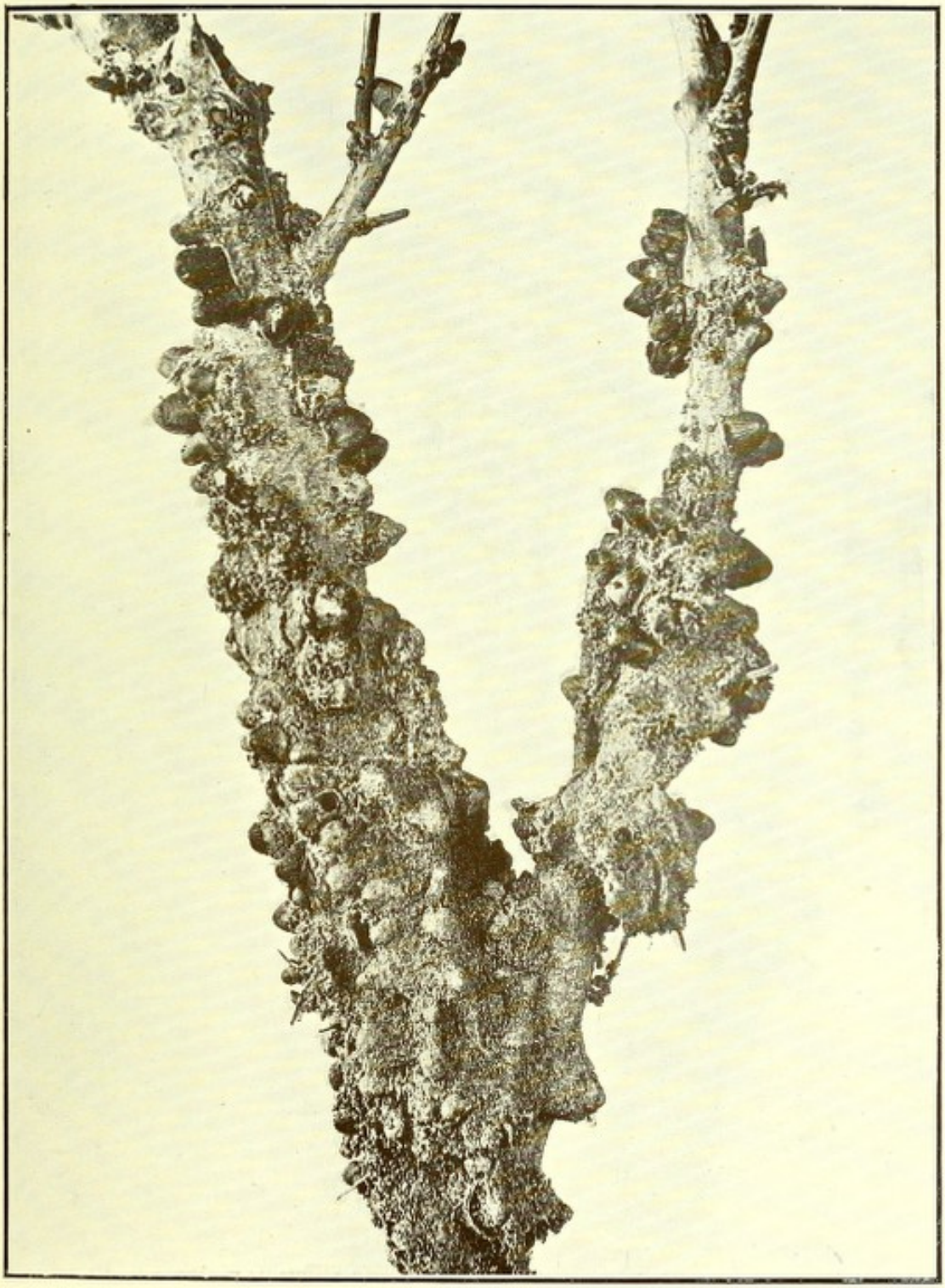
# PLATE XXVIII.

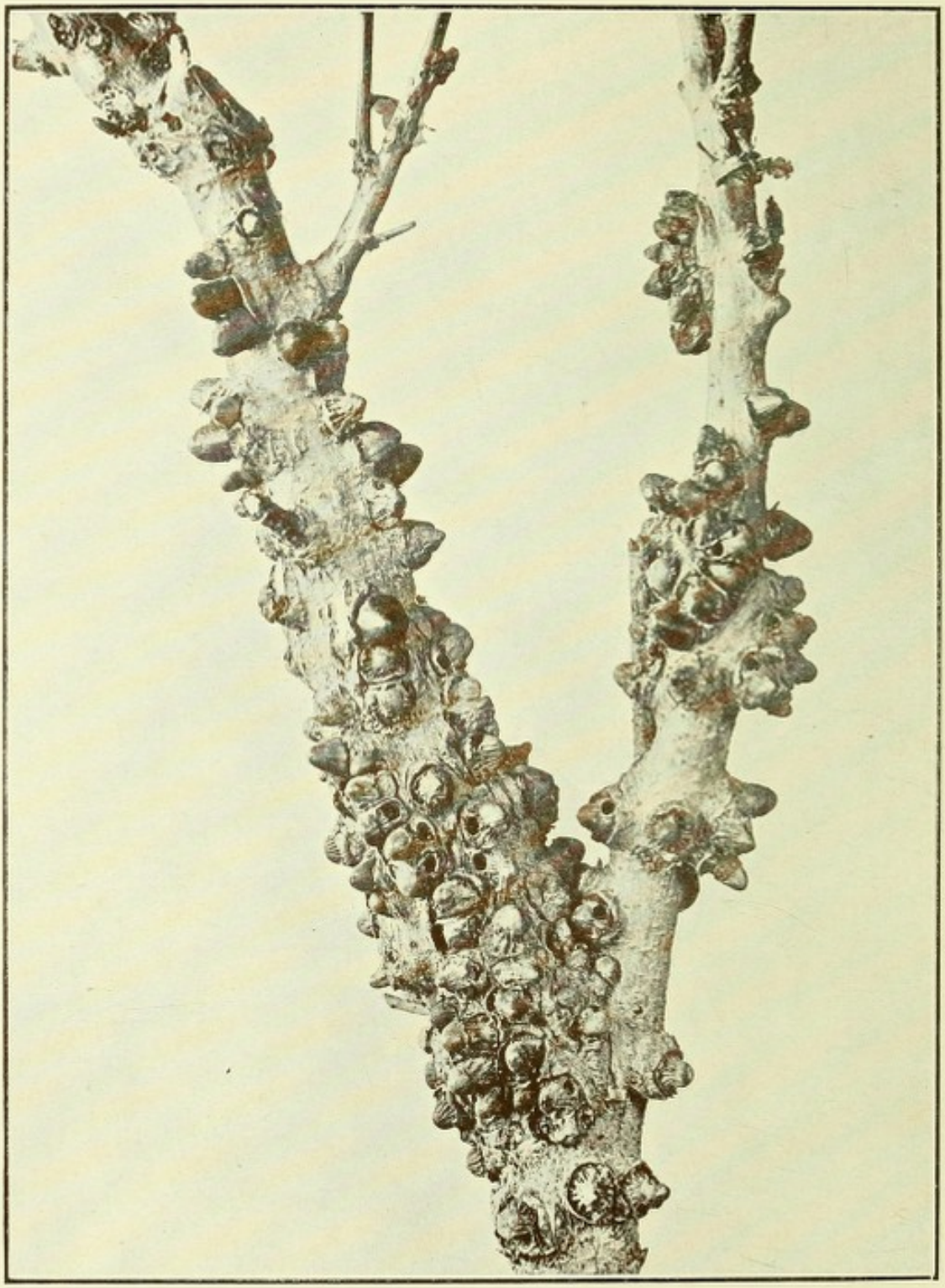


A bifurcated shoot of *Q. pedunculata*, bearing numerous galls caused by APHILOTHRIX SIEBOLDI, most of which are partly or wholly concealed beneath a thin layer of earth formed by ants. A quantity of earth also fell away when the shoot was cut.

Nearly nat. size.

*Adlard & Son, Impr.*

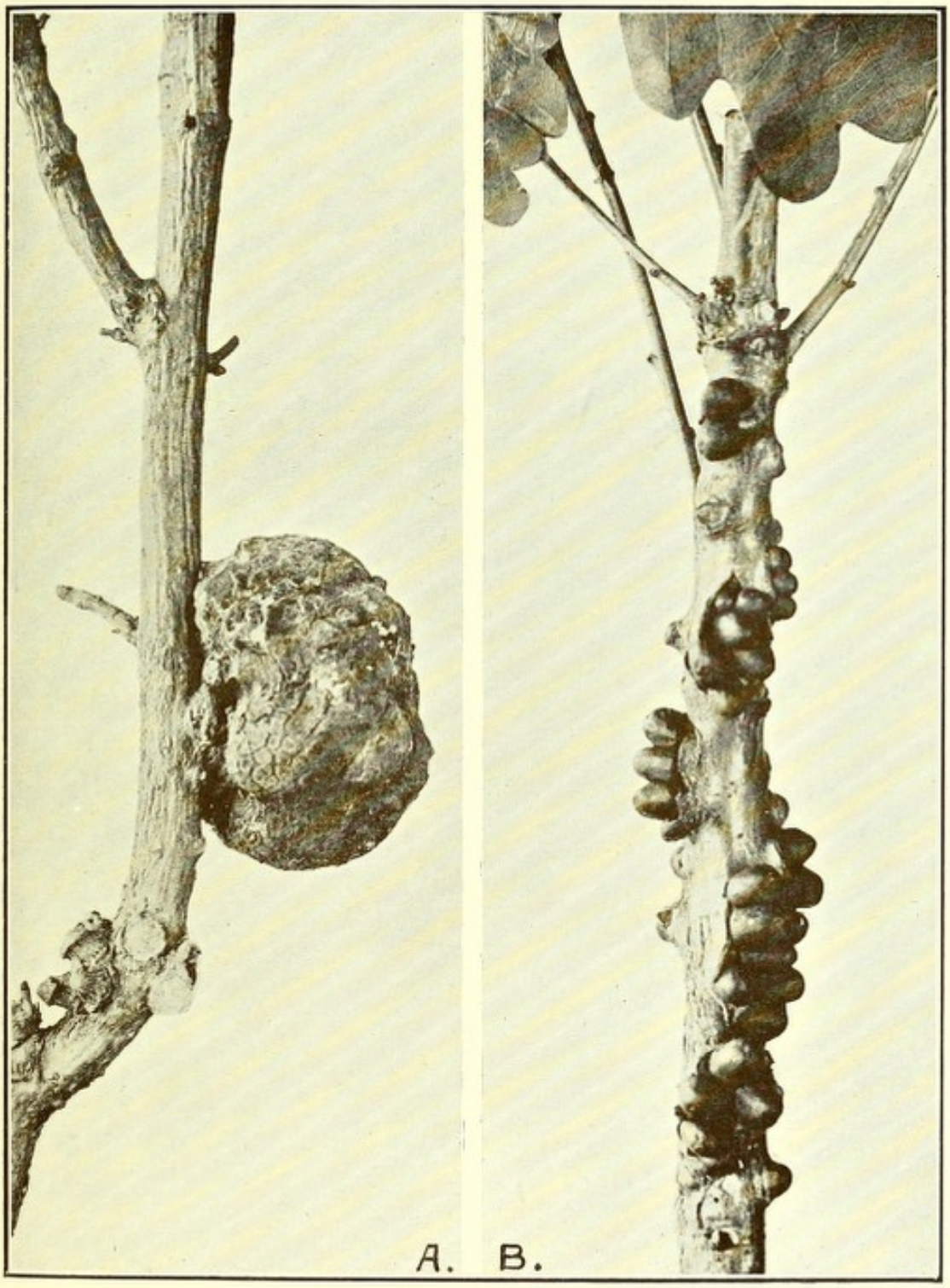
# PLATE XXIX.



The same specimen as shown on Plate XXVIII, with the earth removed.

*Adlard & Son, Impr.*

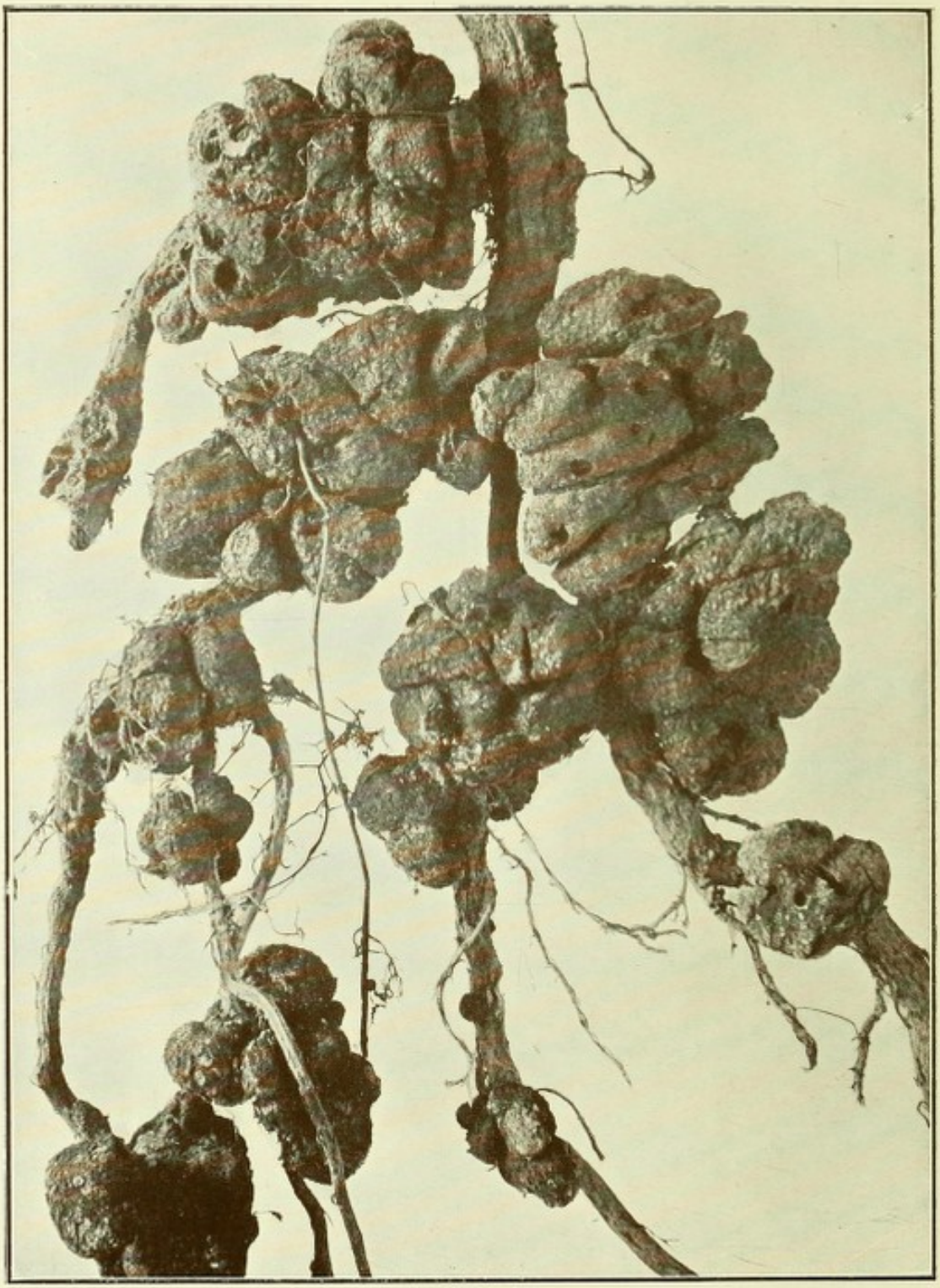
# PLATE XXX.




A. Gall caused by APHILOTHRIX RADICIS in an uncommon situation.
B. Galls caused by APHILOTHRIX SIEBOLDII in growing condition.
Nearly nat. size.

*Adlard & Son, Impr.*

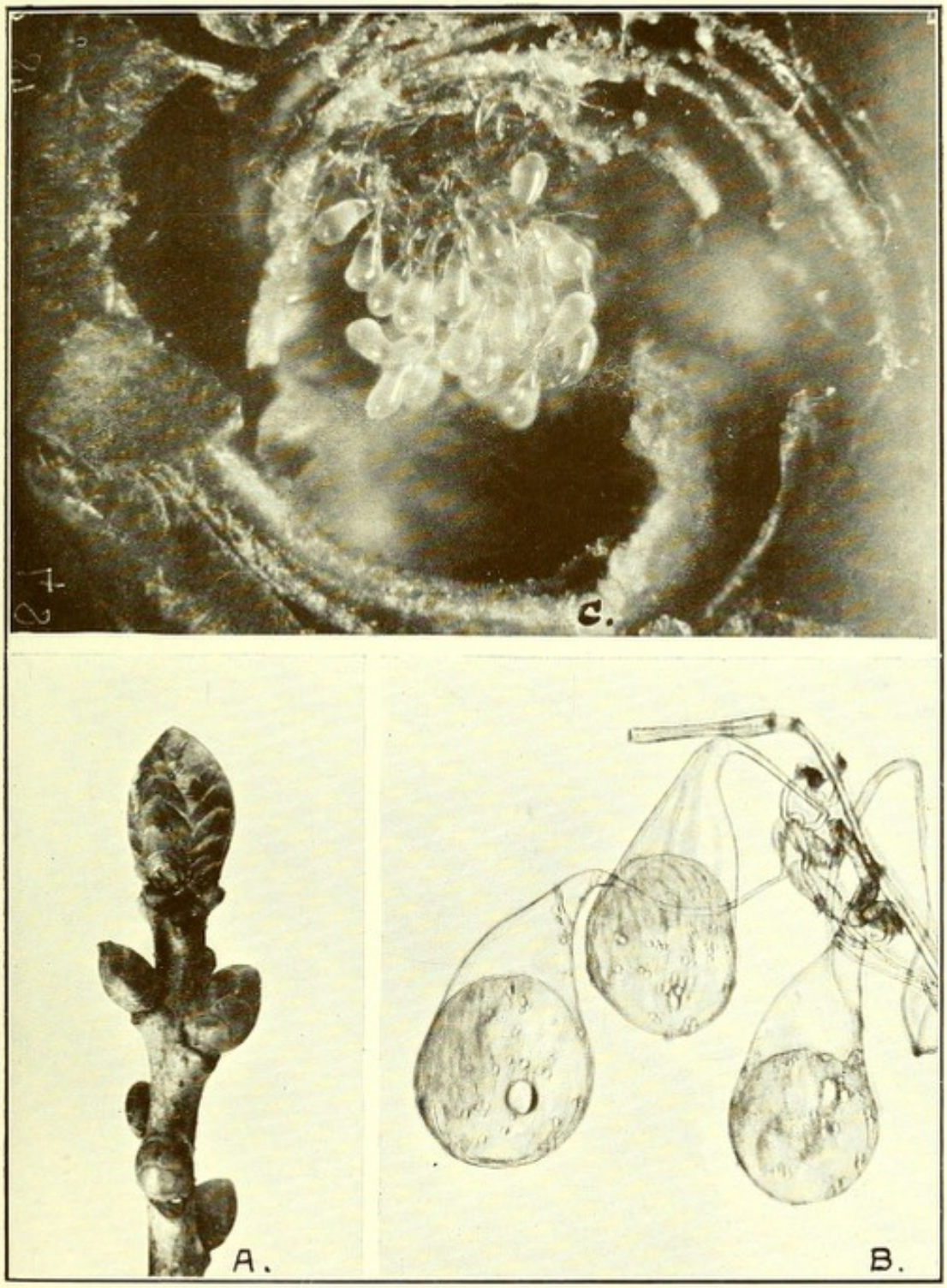
# PLATE XXXI.



Gall caused by BIORHIZA APTERA on roots of *Q. pedunculata*.
Nearly nat. size.

*Adlard & Son, Impr.*

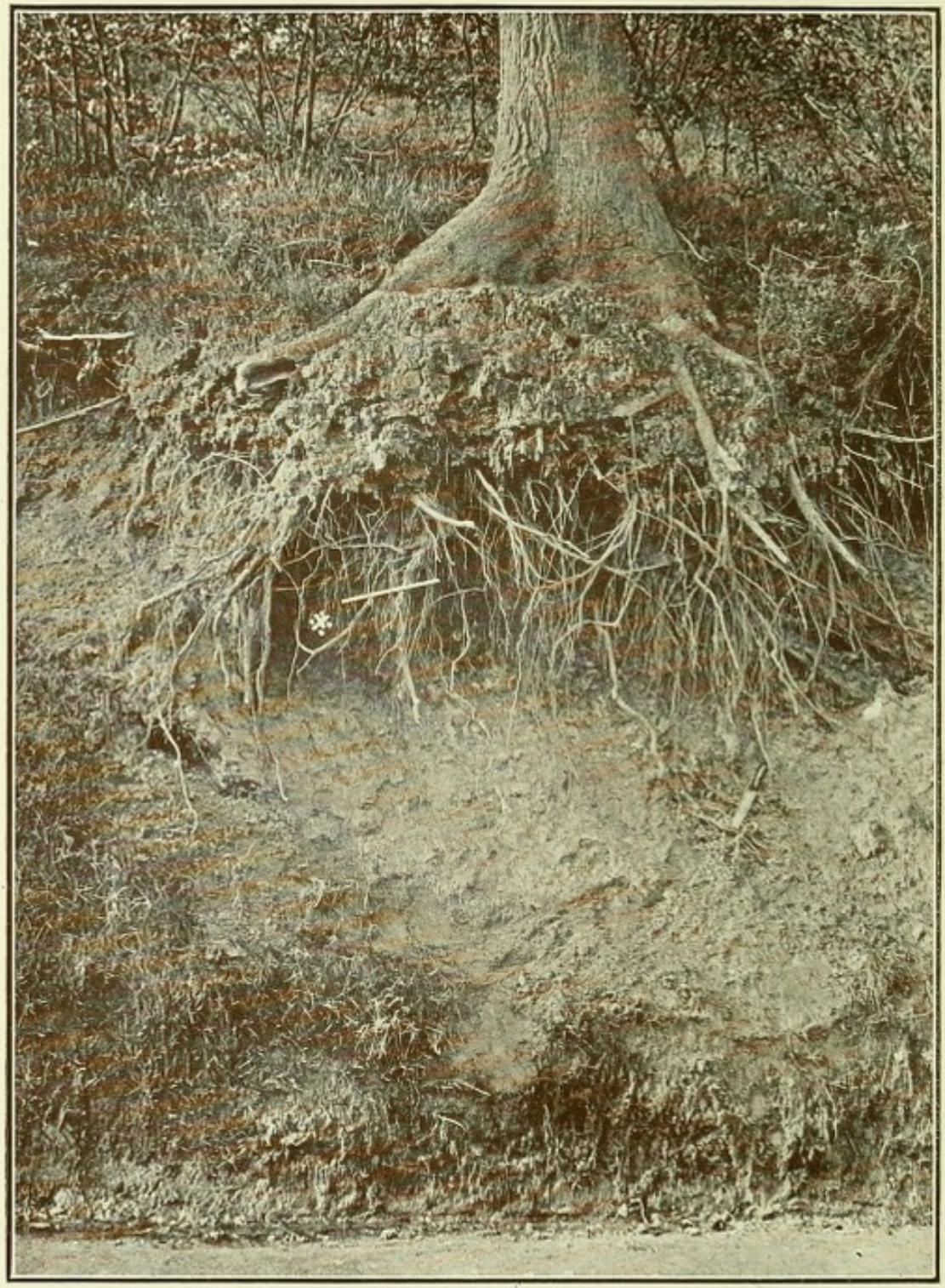
# PLATE XXXII.




A. Apical bud of *Q. pedunculata* containing ova of BIORHIZA APTERA, × 2½.
B. Three ova removed from the bud, × 280.
C. Transverse section through the bud to show ova *in situ*, × 60.
B and C. Photo-micrographs by W. H. Hammond.

*Adlard & Son, Impr.*

# PLATE XXXIII.



Exposed roots of *Q. pedunculata* in Park Road, St. Leonards-on-Sea, upon which were found enormous numbers of galls caused by BIORHIZA APTERA. The scale (marked *) is 30 cm.; the fern trowel indicates where specimens in Plate XXXI were growing.

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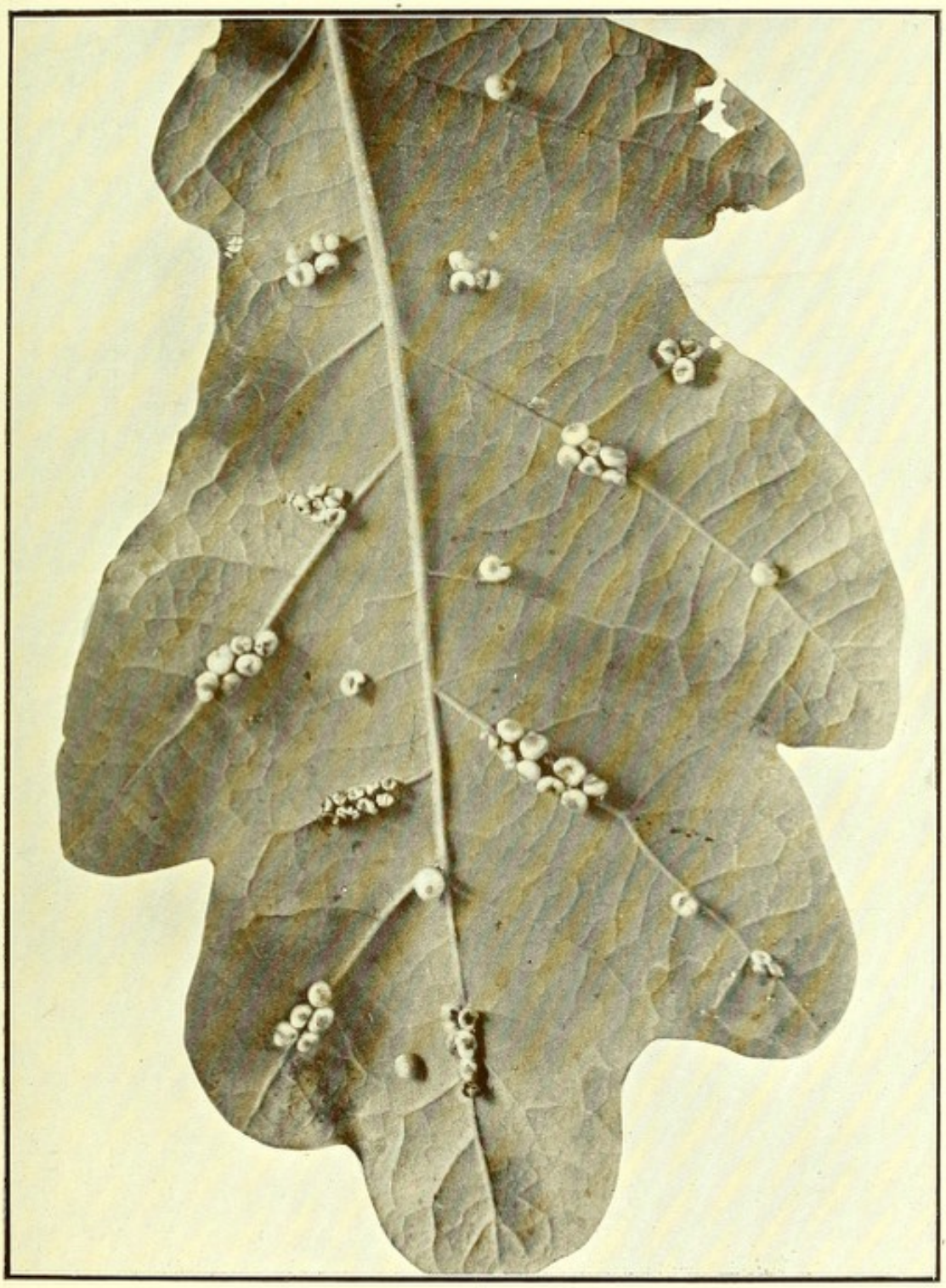
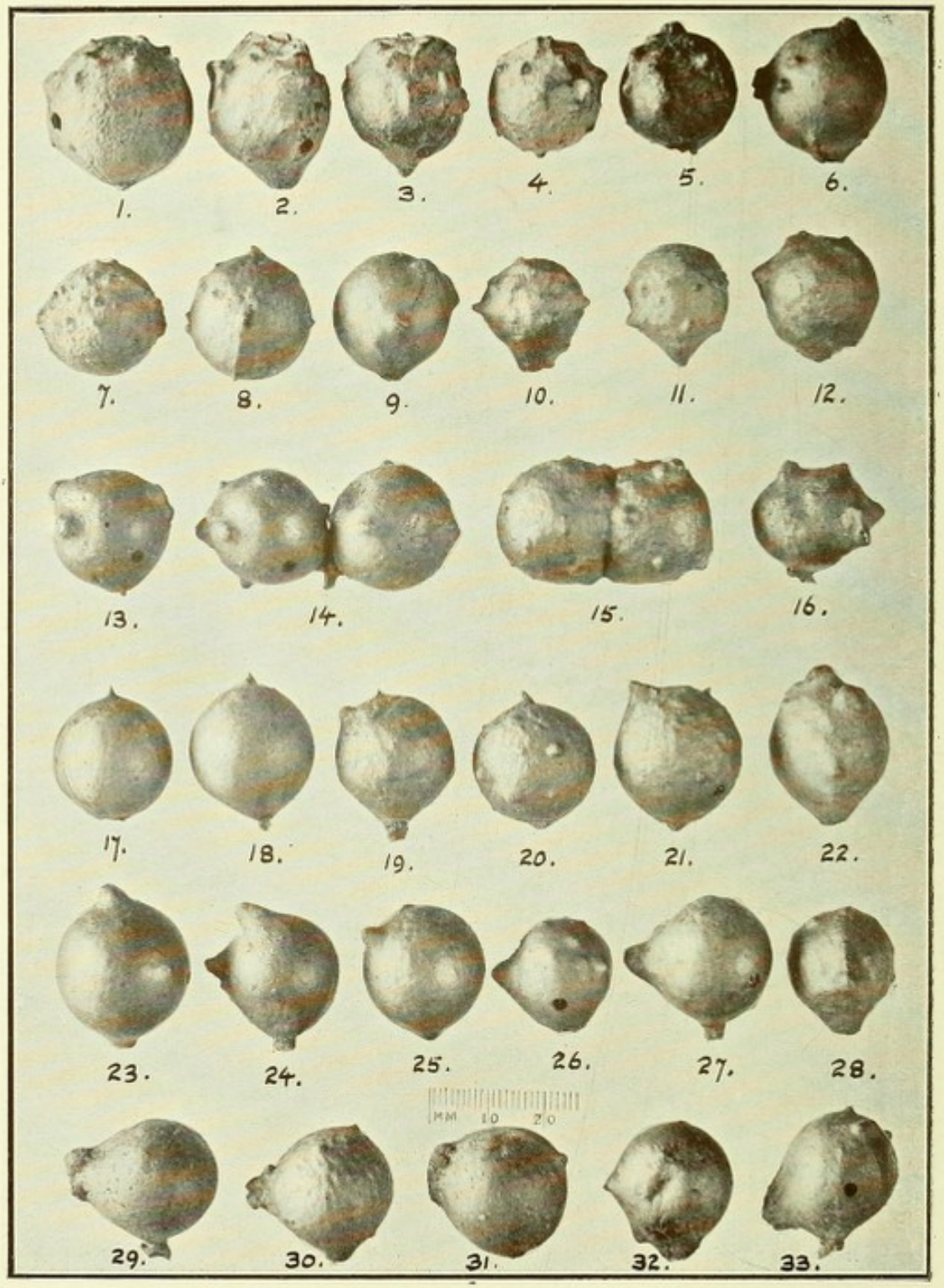
# PLATE XXXIV.



Galls caused by Biorhiza renum on under-surface of leaf of *Q. pedunculata*.
Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE XXXV.

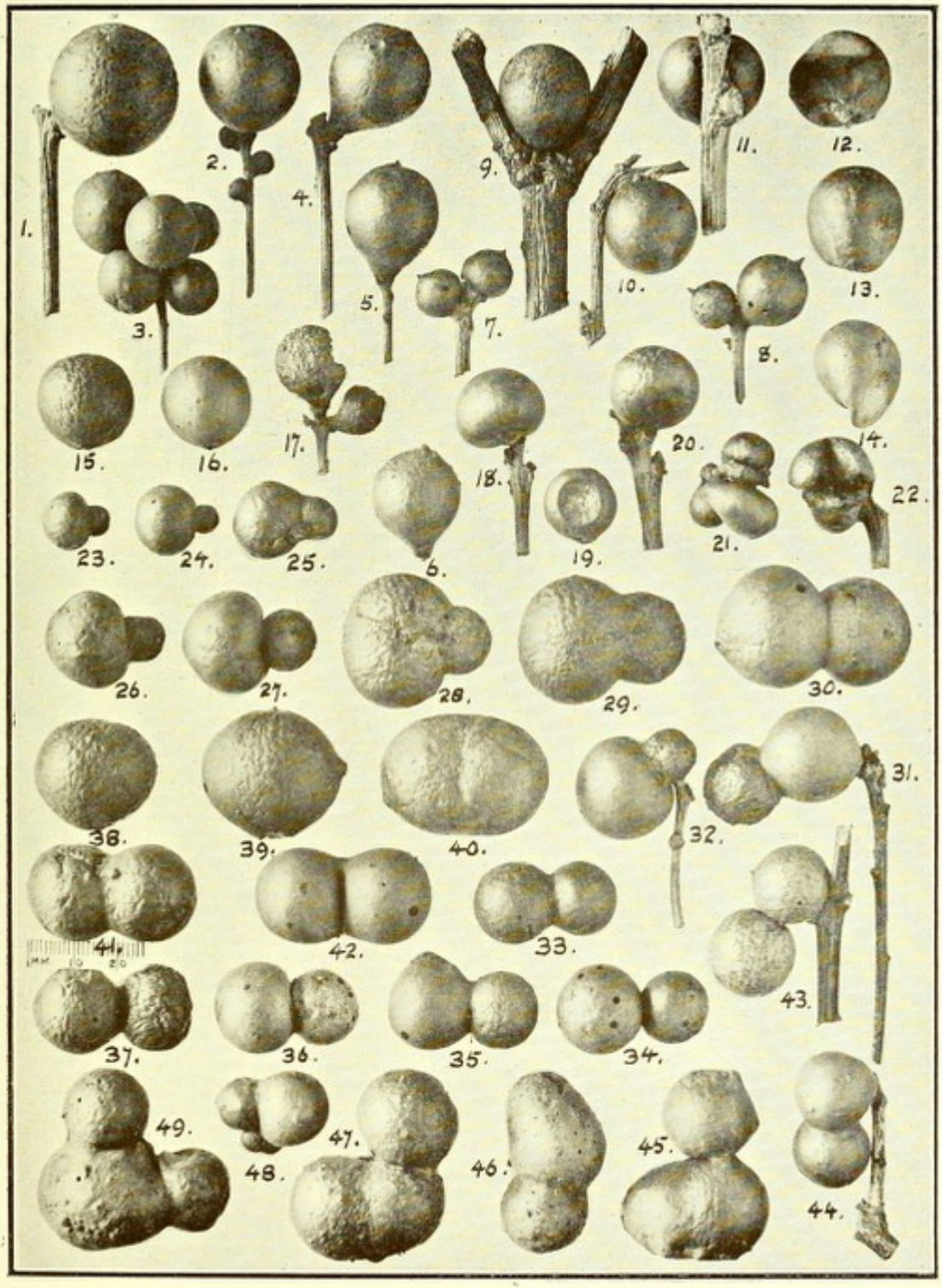



Galls caused by CYNIPS KOLLARI, exhibiting ridges, papillæ, and styles. Two-thirds nat. size.

*For explanations see p.* 159.

*Adlard & Son, Impr.*

# PLATE XXXVI.

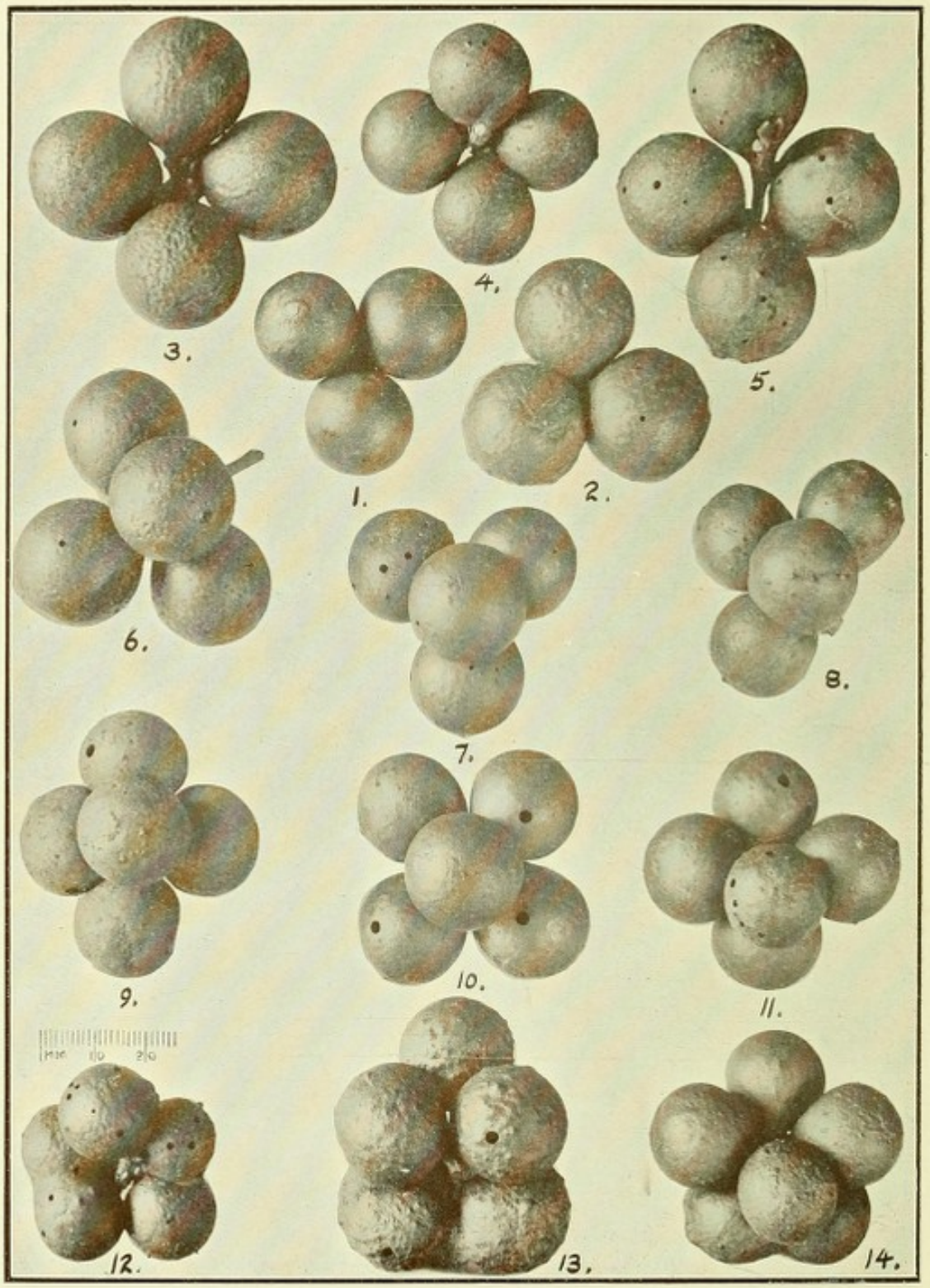



Galls caused by CYNIPS KOLLARI (aberrant examples).
Half nat. size.

*For explanations see p.* 163.

*Adlard & Son, Impr.*

# PLATE XXXVII.

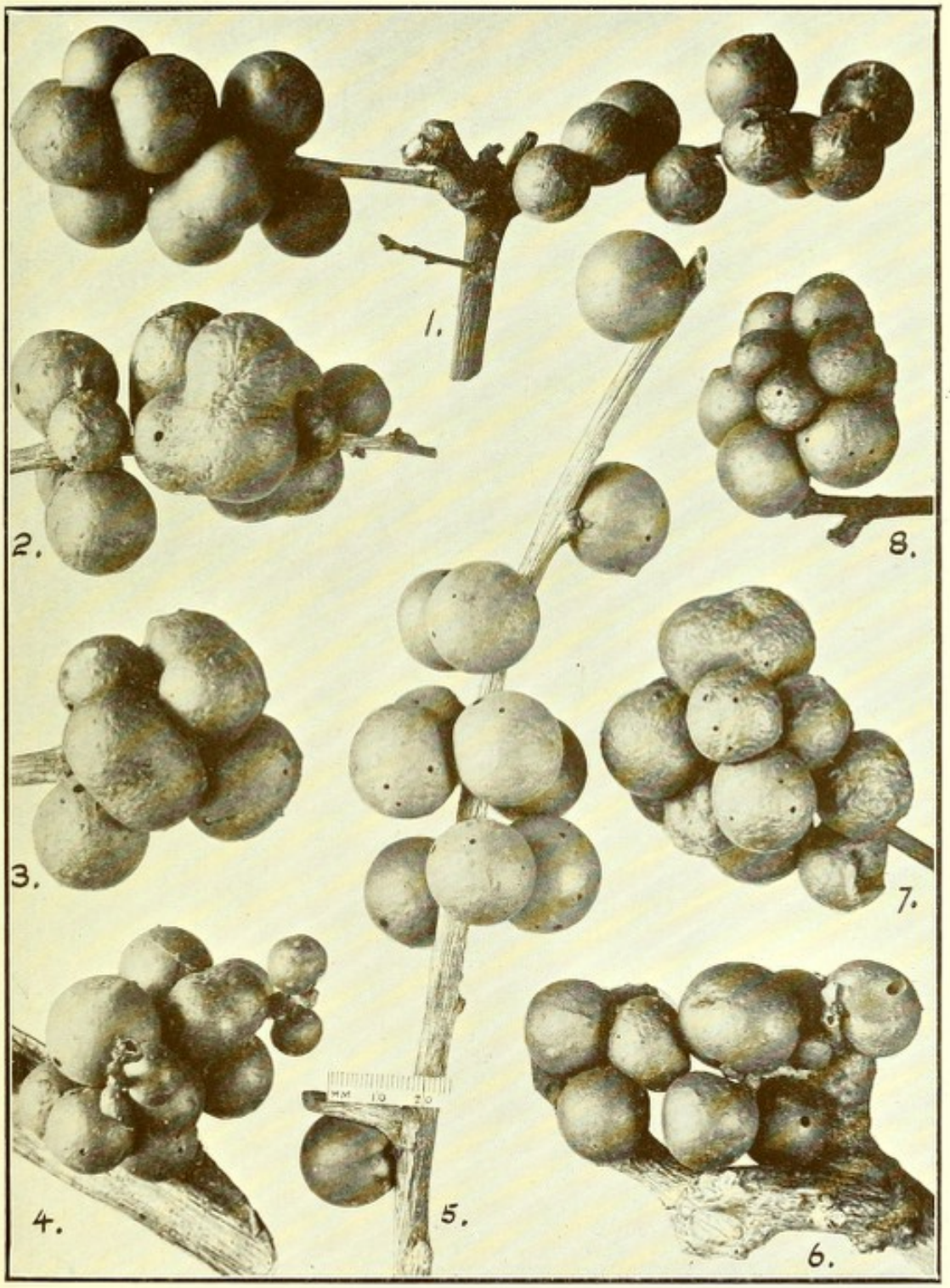



Galls caused by CYNIPS KOLLARI (geometrically-grown groups). Two-thirds nat. size.

*For explanations see p.* 161.

*Adlard & Son, Impr.*

# PLATE XXXVIII.

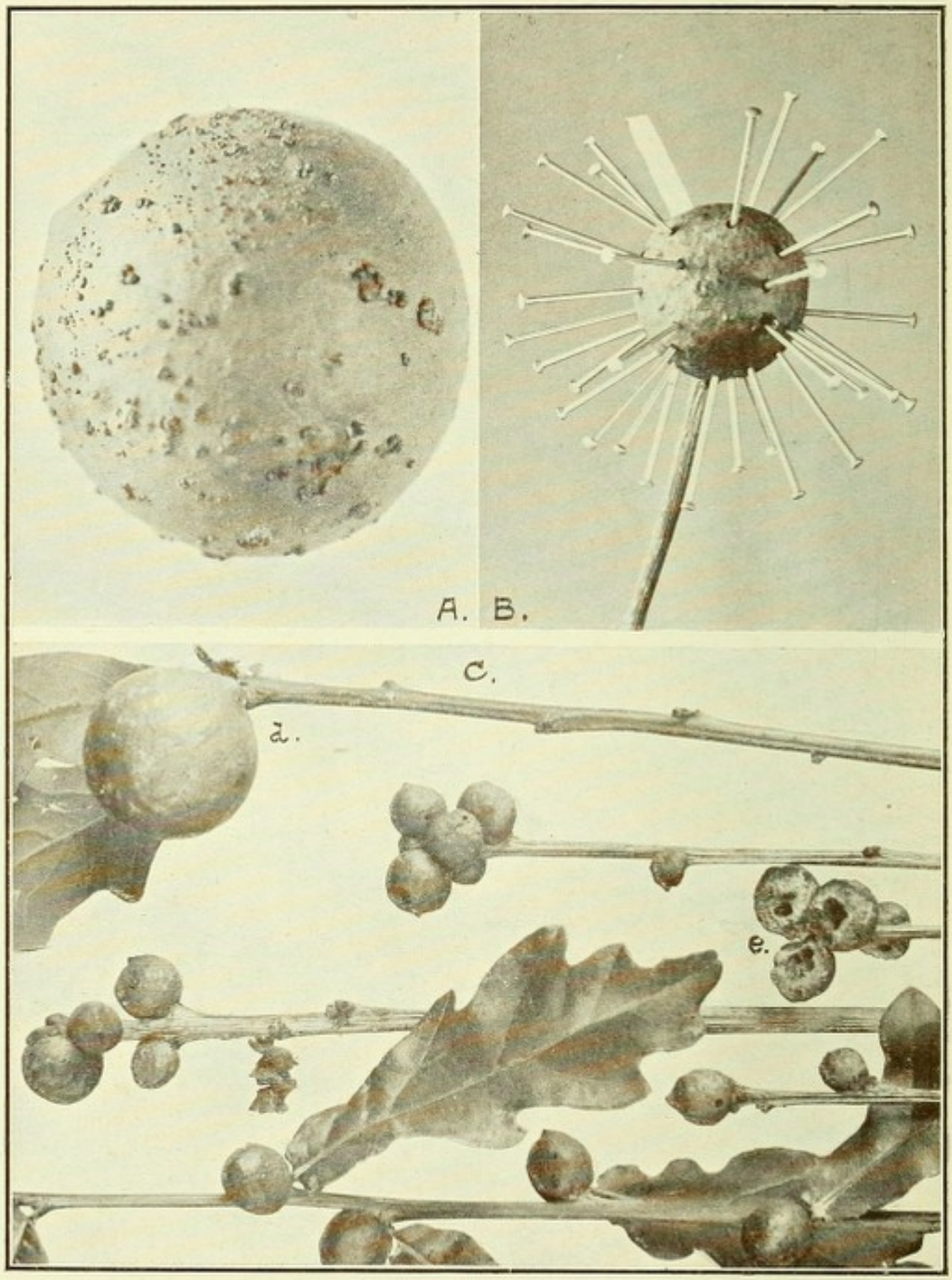



Galls caused by CYNIPS KOLLARI (conglomerate clusters).
Half nat. size.

*For explanations see p.* 161.

*Adlard & Son, Impr.*

# PLATE XXXIX.

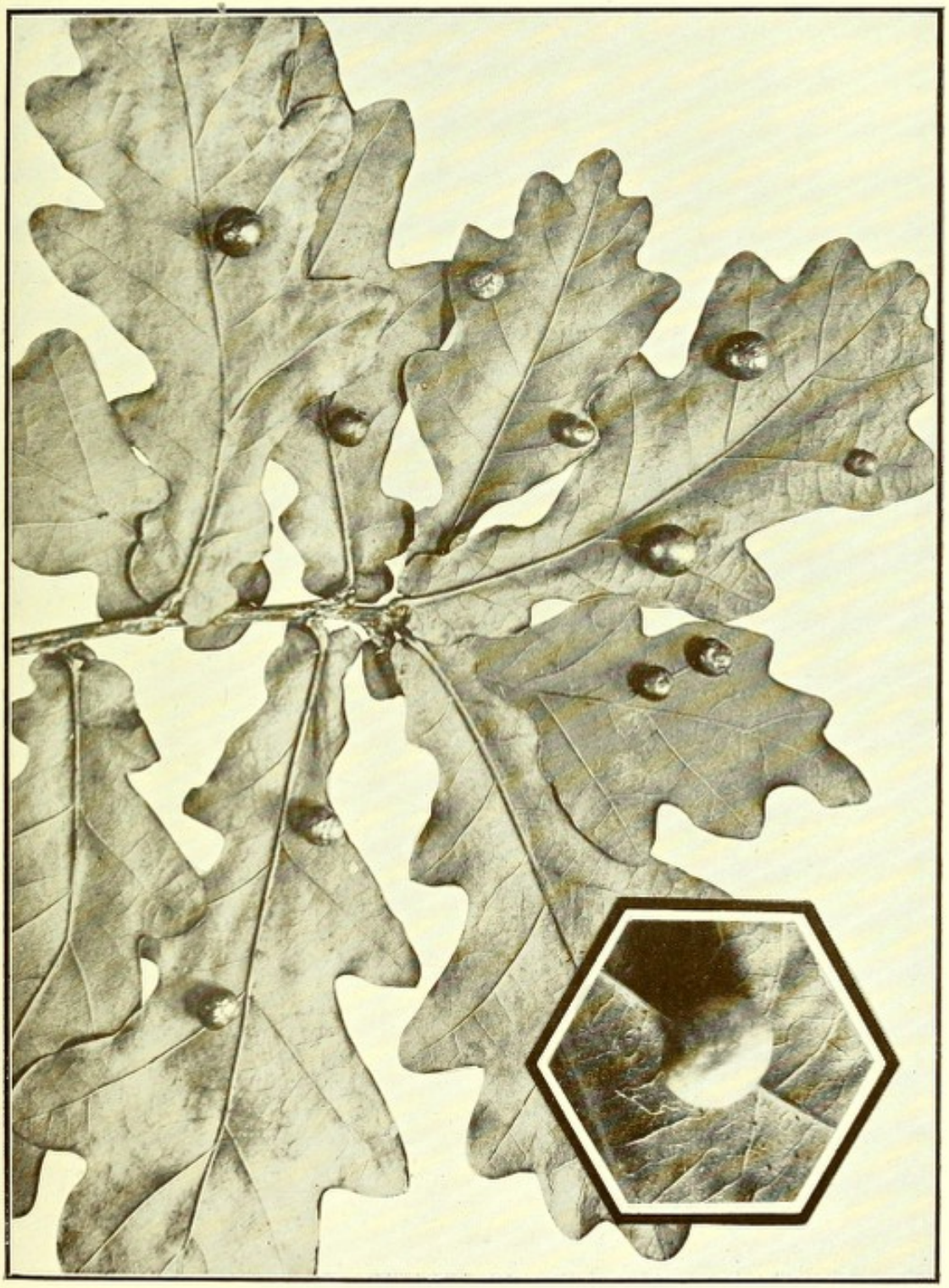



Galls caused by CYNIPS KOLLARI. A. Attacked by the fungus PHOMA GALLORUM. B. A specimen from which thirty-two inquilines have emerged and one CYNIPS KOLLARI; their holes are indicated by pins and a match stick respectively. C. Specimens tenanted by parasites and growth arrested thereby. *d*. A normal specimen for comparison. *e*. Sections showing larva cells.

Specimen A × 2½. B and C nearly nat. size.

*Adlard & Son, Impr.*

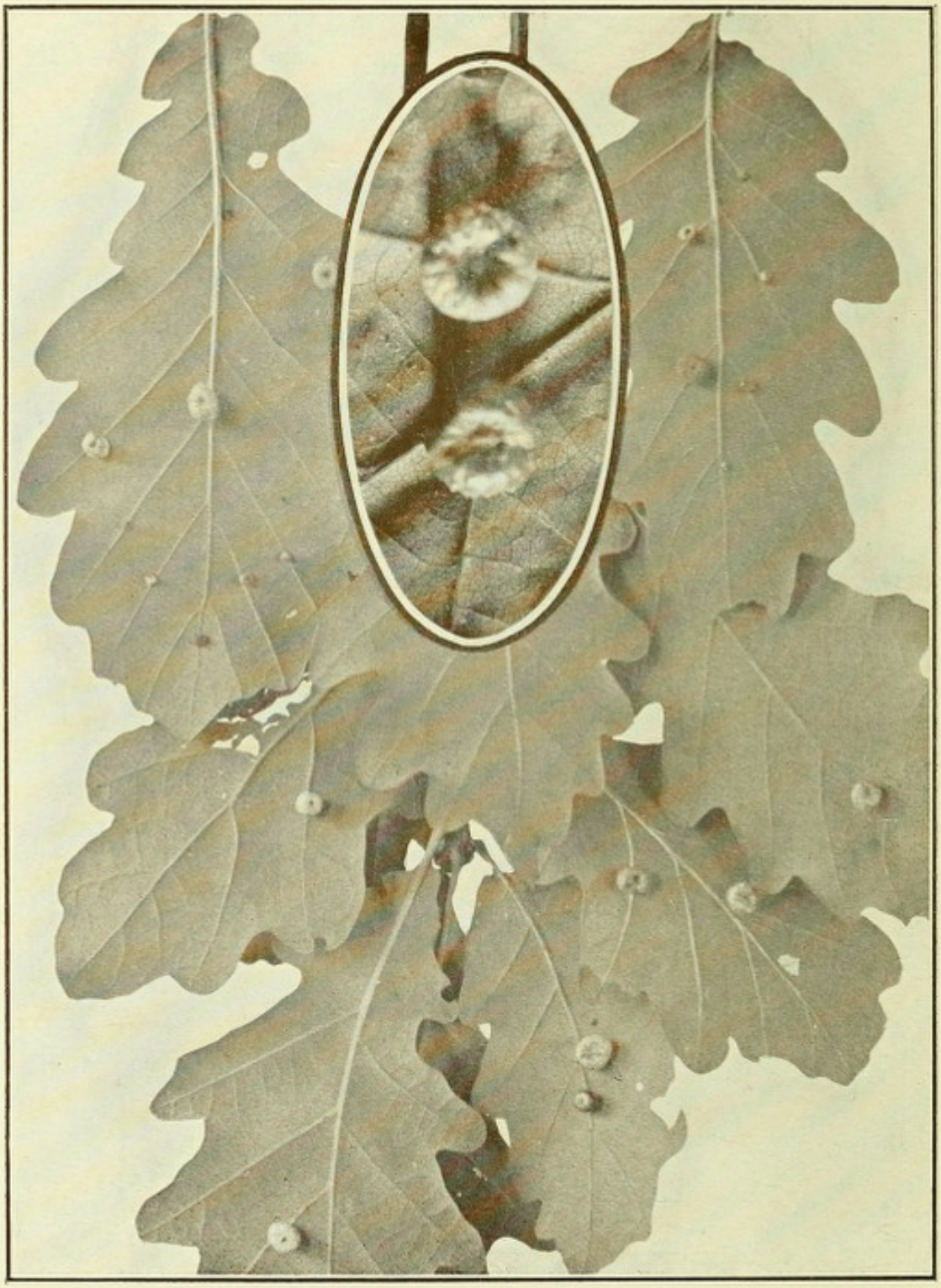
# PLATE XL.



Galls caused by DRYOPHANTA AGAMA on under-surface of leaves of *Q. pedunculata*.
The inset is of specimen × 2½.

Nearly nat. size.

*Adlard & Son, Impr.*

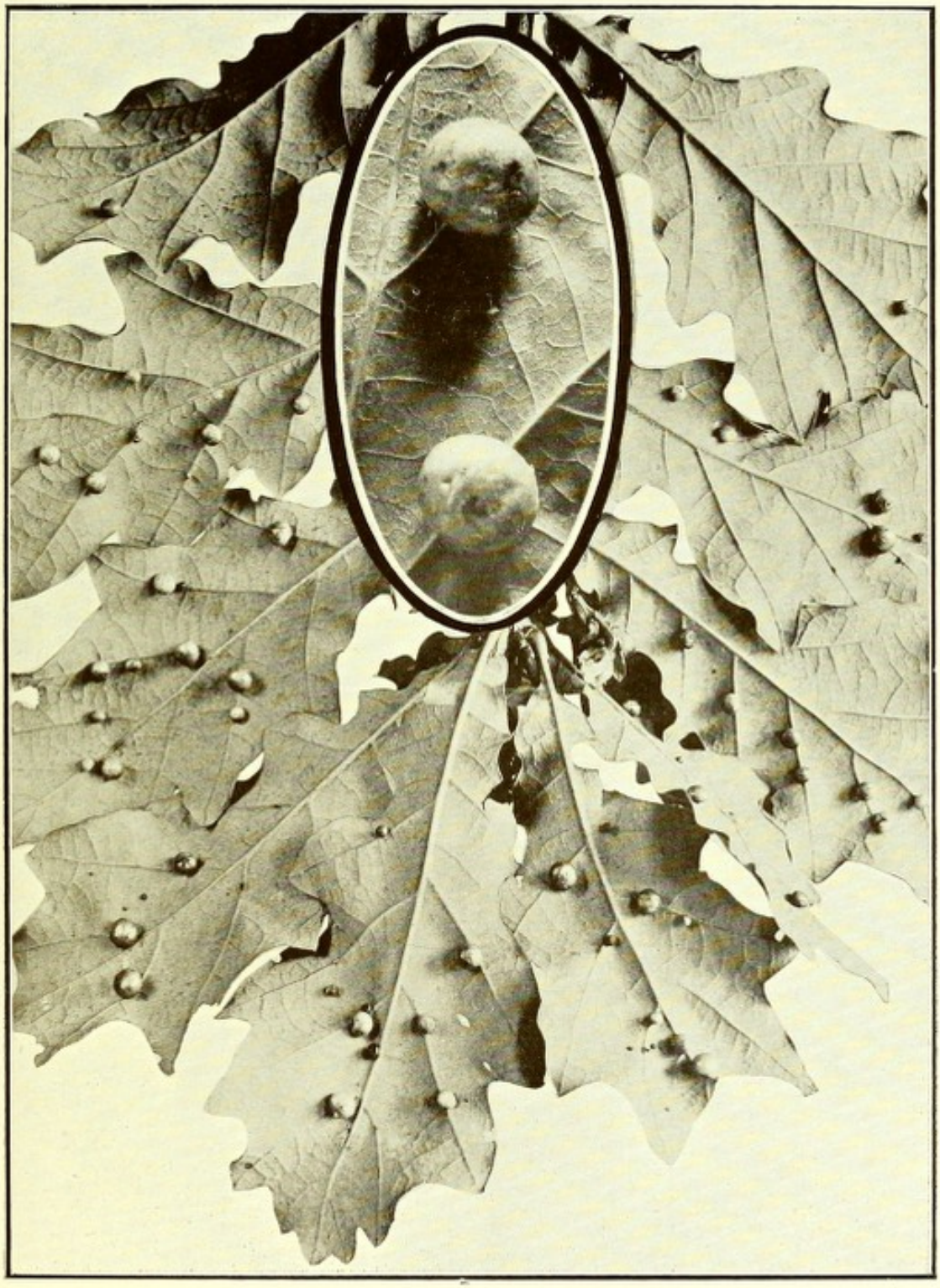


Galls caused by DRYOPHANTA DISTICHA on under-surface of leaves of *Q. pedunculata*. The inset is of specimens × 2½.

Two-thirds nat. size.

*Adlard & Son, Impr.*

# PLATE XLII.



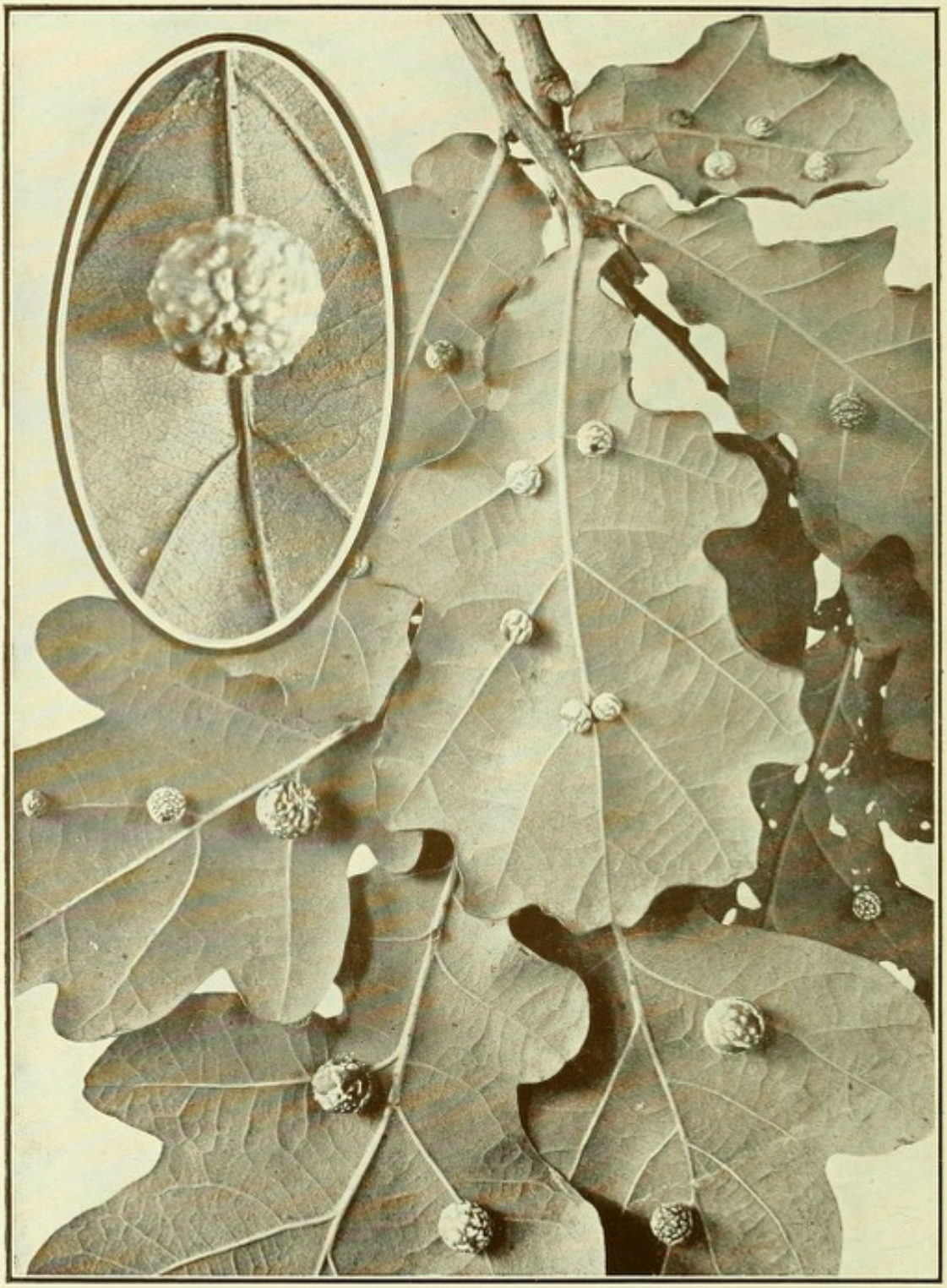
Galls caused by DRYOPHANTA DIVISA on under-surface of leaves of *Q. pedunculata*.

The inset is of specimens × $2\frac{1}{2}$.

Two-thirds nat. size.

*Adlard & Son, Impr.*

# PLATE XLIII.



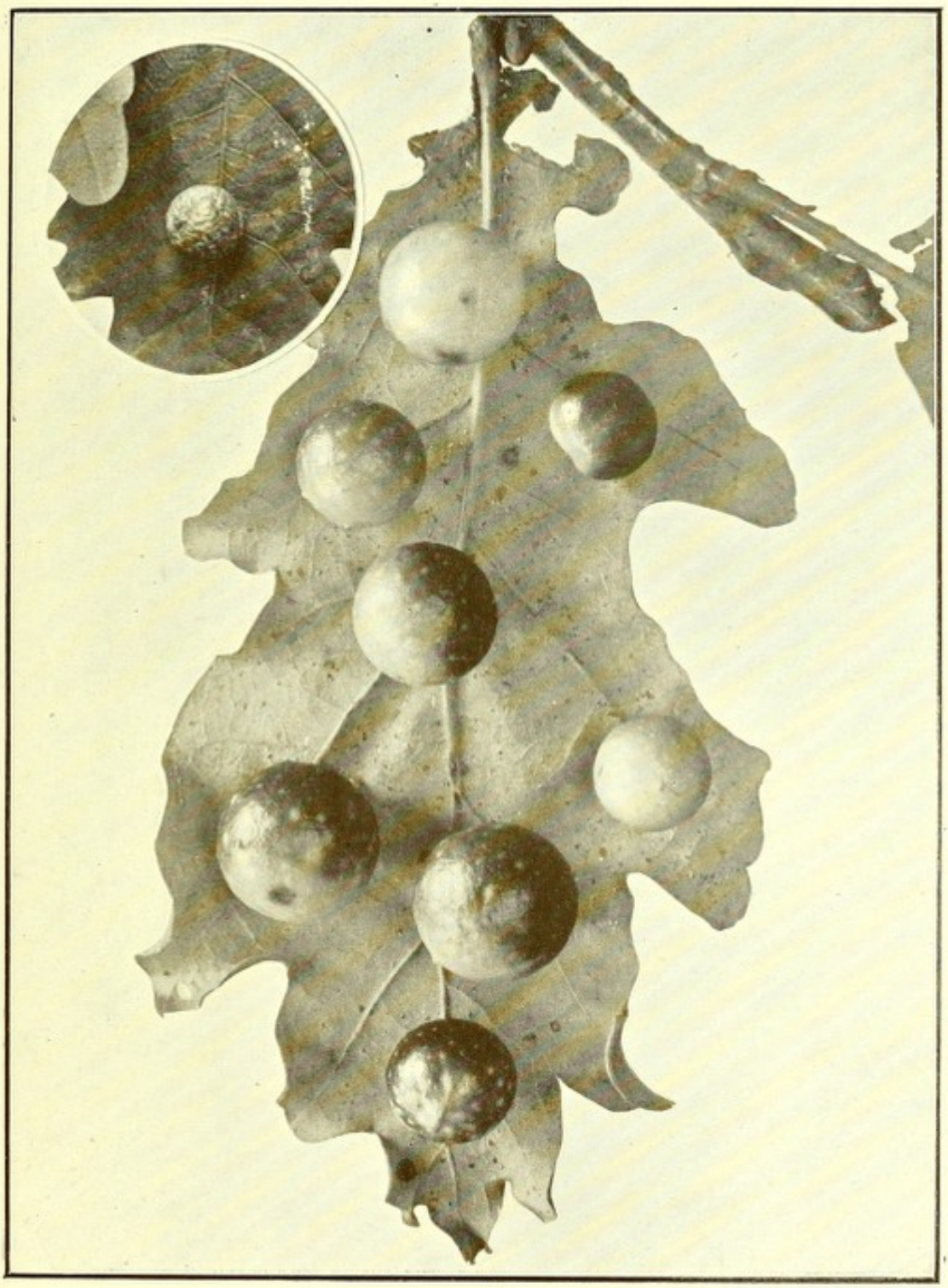
Galls caused by DRYOPHANTA LONGIVENTRIS on under-surface of leaves of *Q. pedunculata*.

The inset is of a specimen × 2½.

Four-fifths nat. size.

*Adlard & Son, Impr.*

# PLATE XLIV.

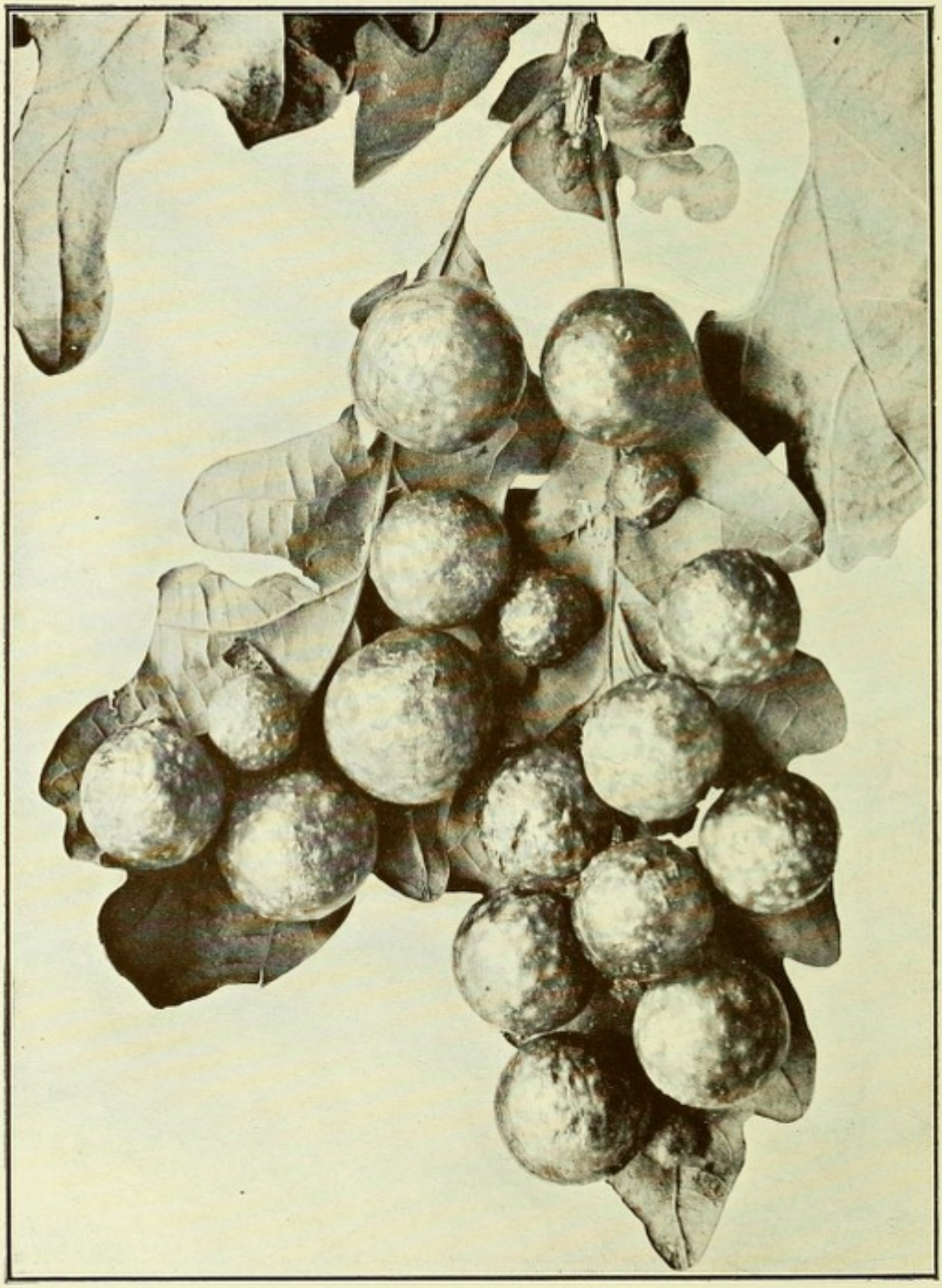


Galls caused by DRYOPHANTA SCUTELLARIS on under-surface of leaves of *Q. pedunculata*.

The inset is of a specimen on upper-surface of leaf.

Nearly nat. size.

*Adlard & Son, Impr.*



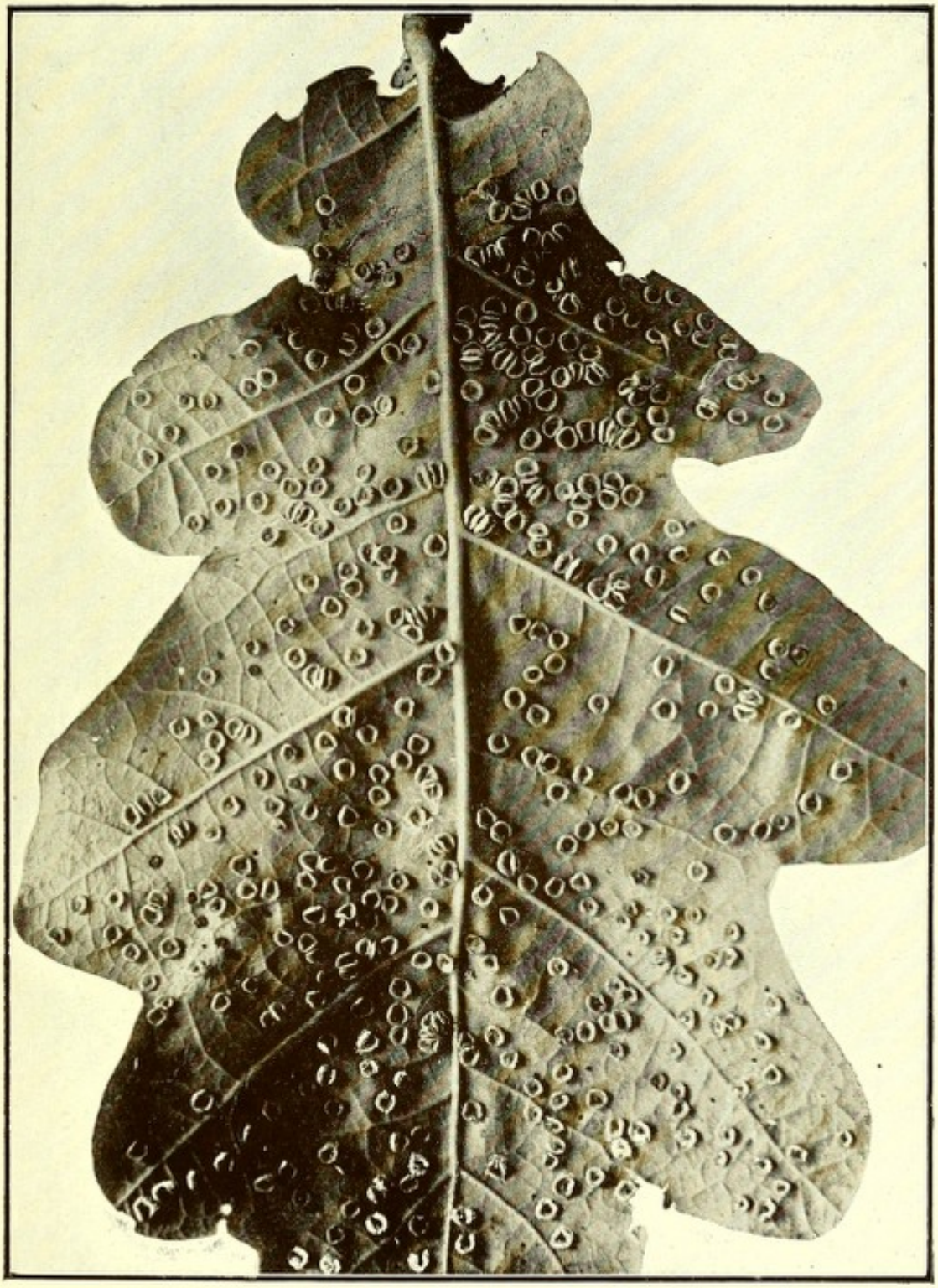
Galls caused by DRYOPHANTA SCUTELLARIS on under-surface of leaves of *Q. pedunculata.*

Nearly nat. size.

From. St. Goar's, Haussen, o/n Germany.

*Adlard & Son, Imvr.*

# PLATE XLVI.

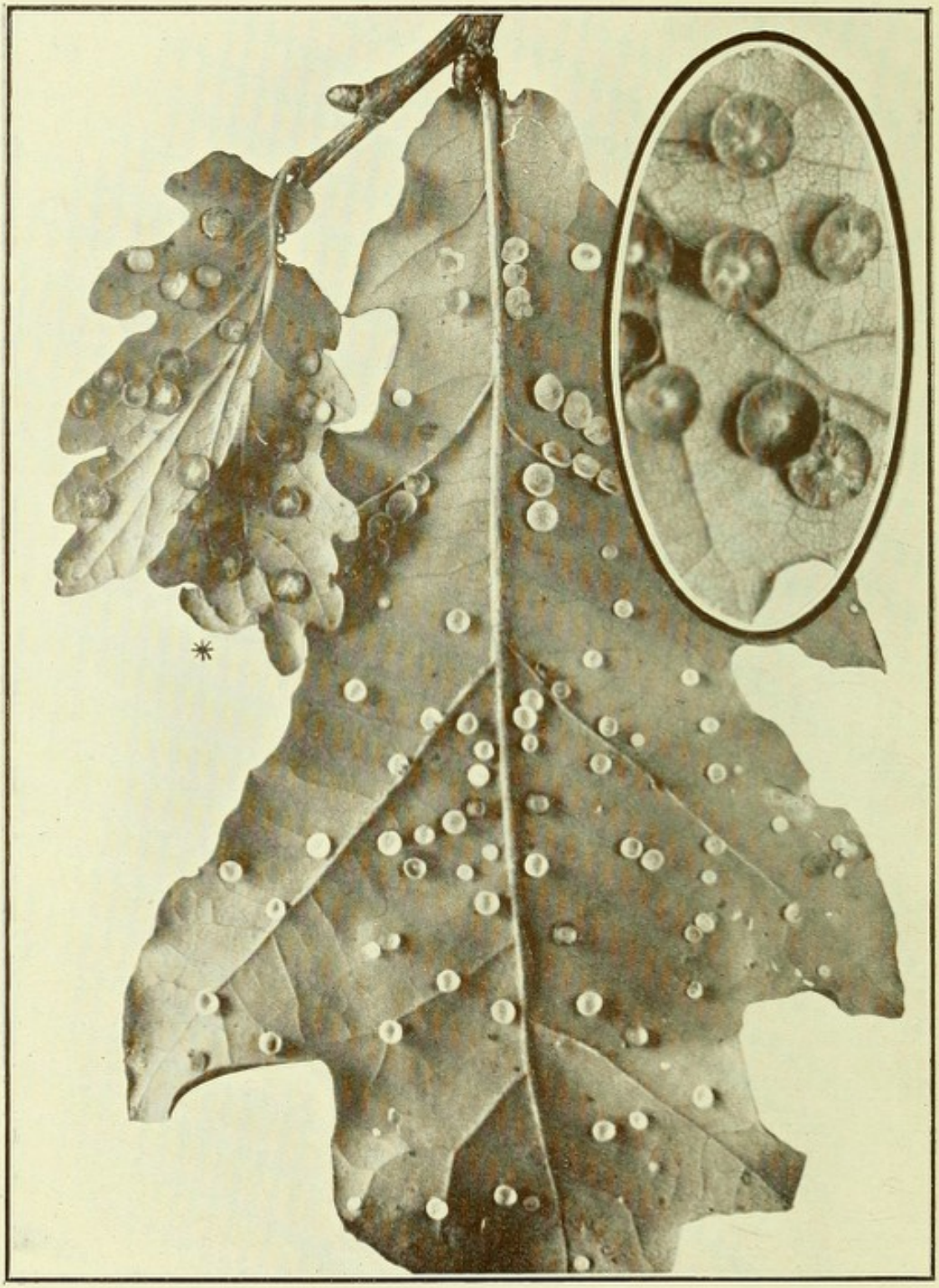


Galls caused by NEUROTERUS FUMIPENNIS on under-surface of leaf of *Q. pedunculata*.

Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE XLVII.



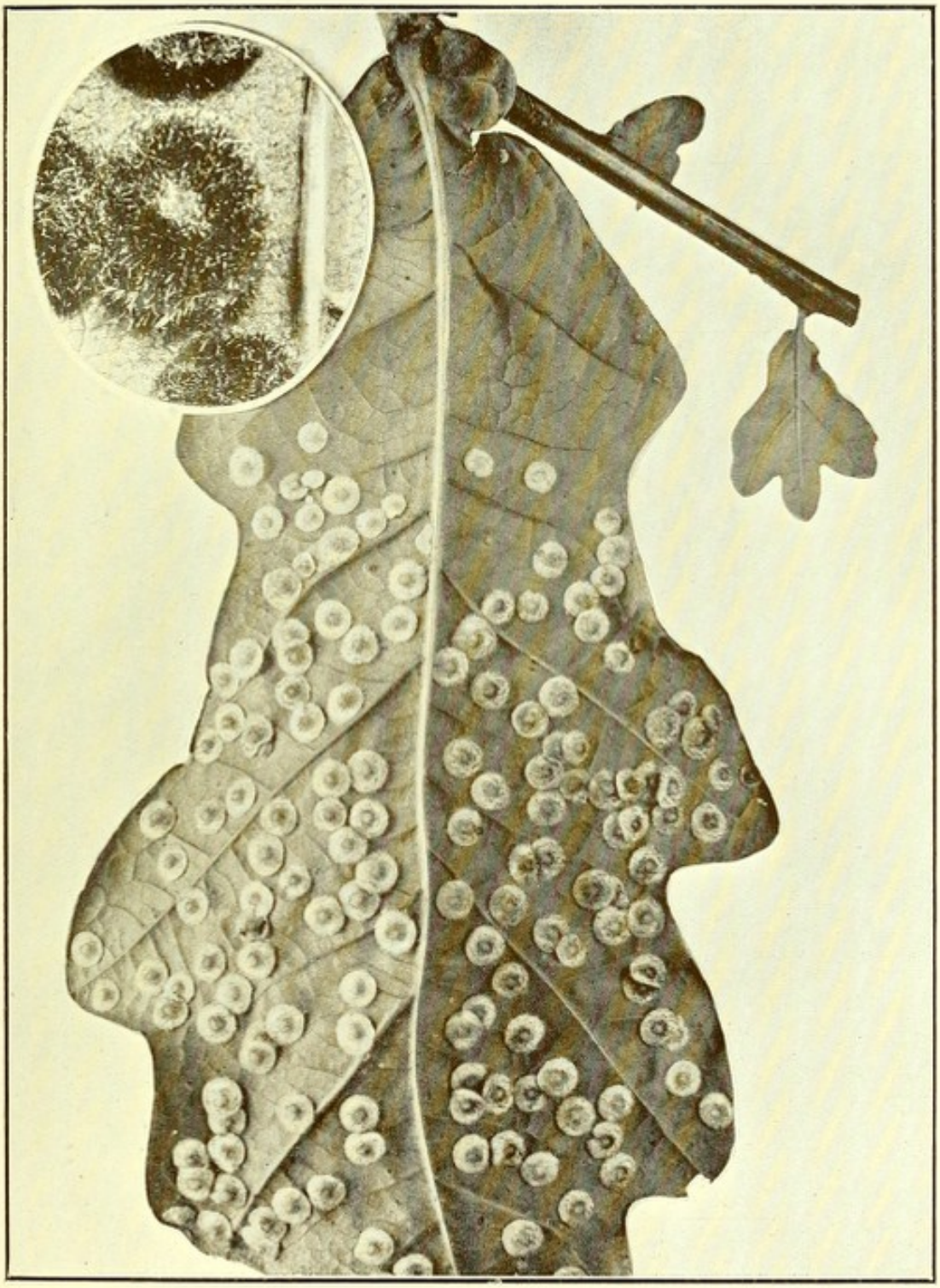
Galls caused by NEUROTERUS LÆVIUSCULUS on under-surface of leaves of *Q. pedunculata*.

The inset is of galls on leaf marked *

Four-fifths nat. size.

*Adlard & Son, Impr.*

# PLATE XLVIII.



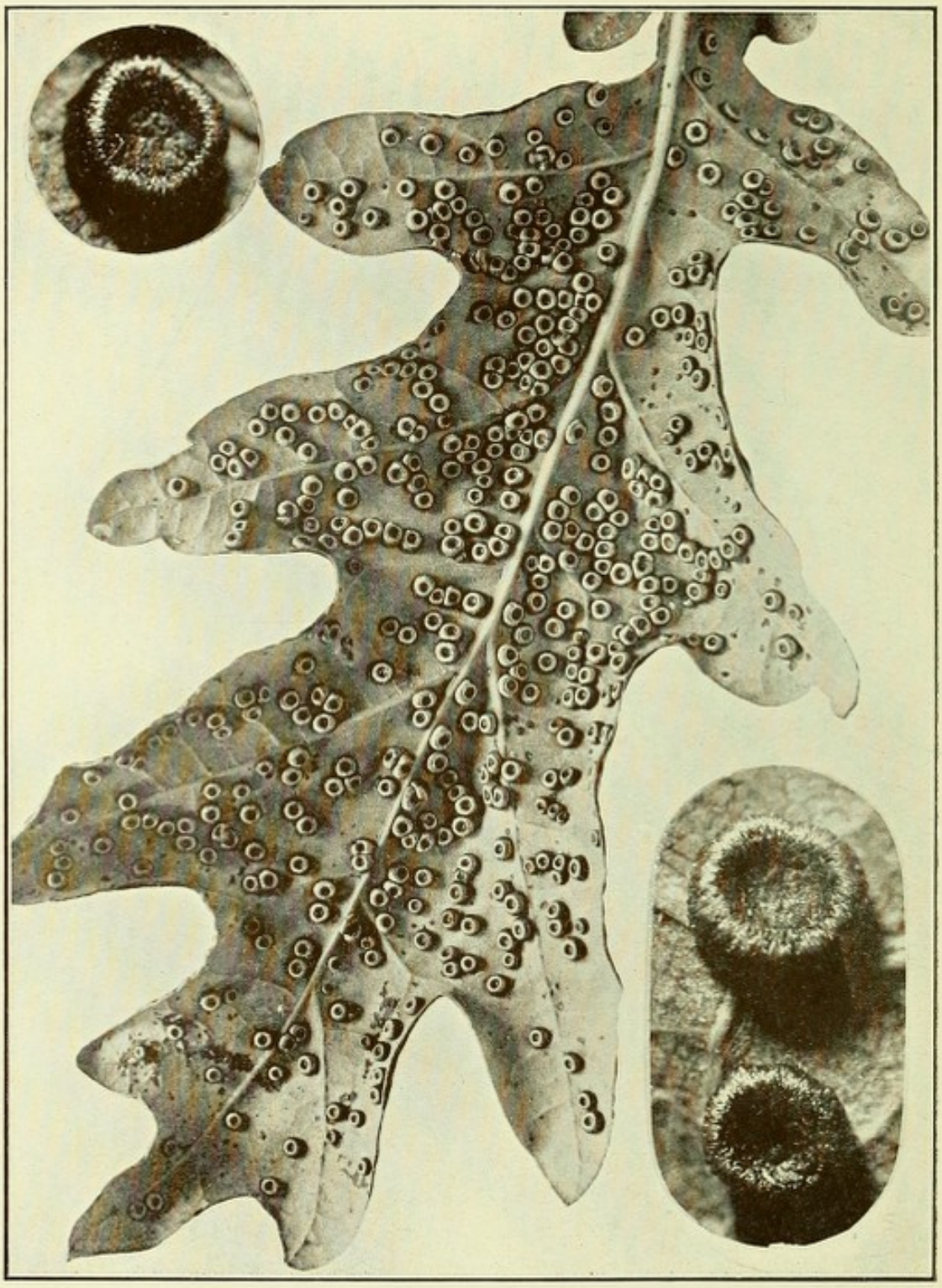
Galls caused by NEUROTERUS LENTICULARIS on under-surface of leaf of *Q. pedunculata*.

Four-fifths nat. size.

The inset is of a very pilose specimen, × 8. Photo. by A. W. BAWTREE.

*Adlard & Son, Impr.*

# PLATE XLIX.



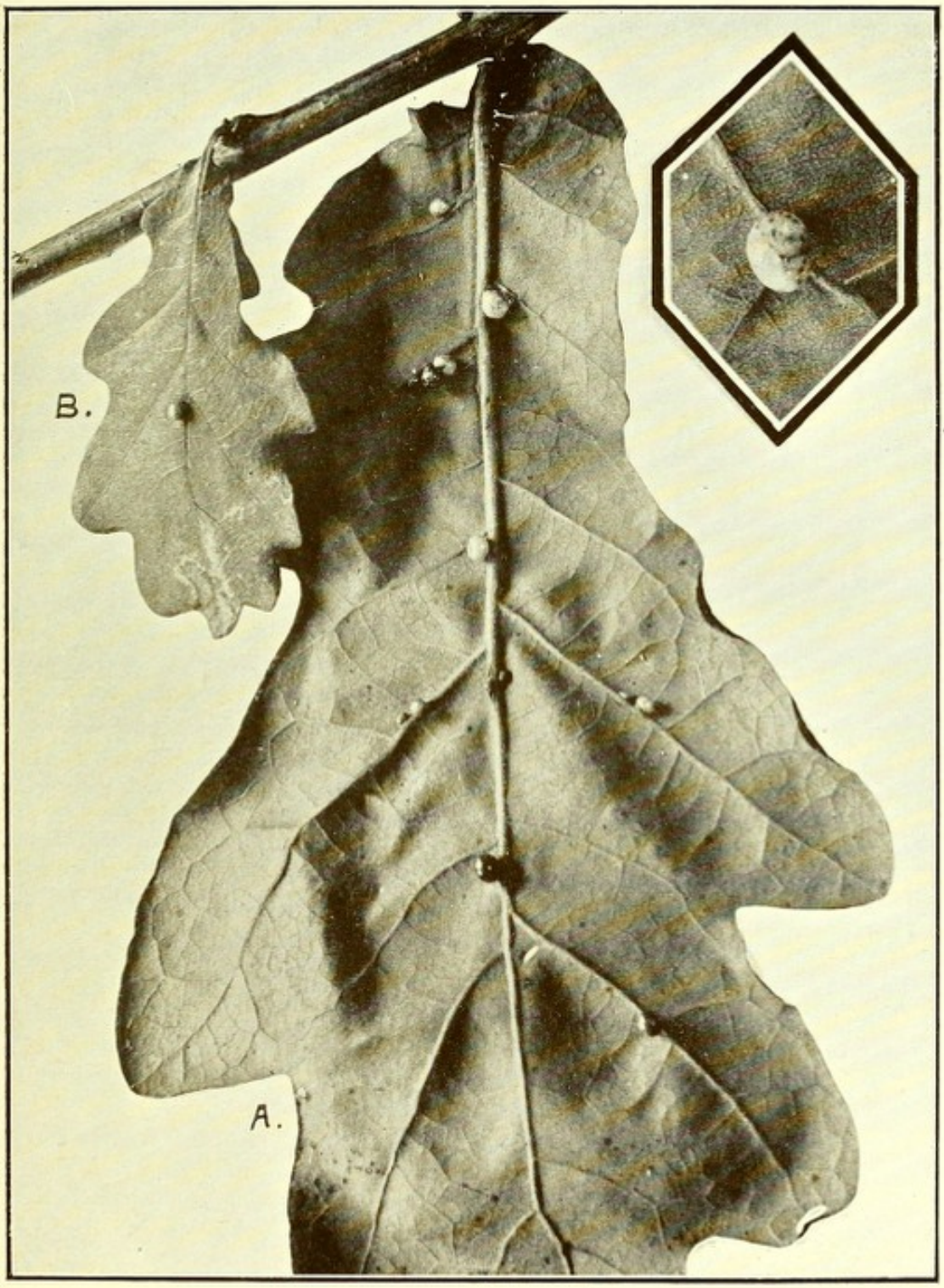
Galls caused by NEUROTERUS NUMISMATIS on under-surface of leaf of *Q. pedunculata*.

Four-fifths nat. size.

The insets are of specimens × 12. Photos. by A. W. BAWTREE.

*Adlard & Son, Impr.*

# PLATE L.




Galls caused by NEUROTERUS OSTREUS on leaves of *Q. pedunculata*.
A. On under-surface. B. On upper surface.
The inset is of a specimen × $2\frac{1}{2}$.
Four-fifths nat. size.

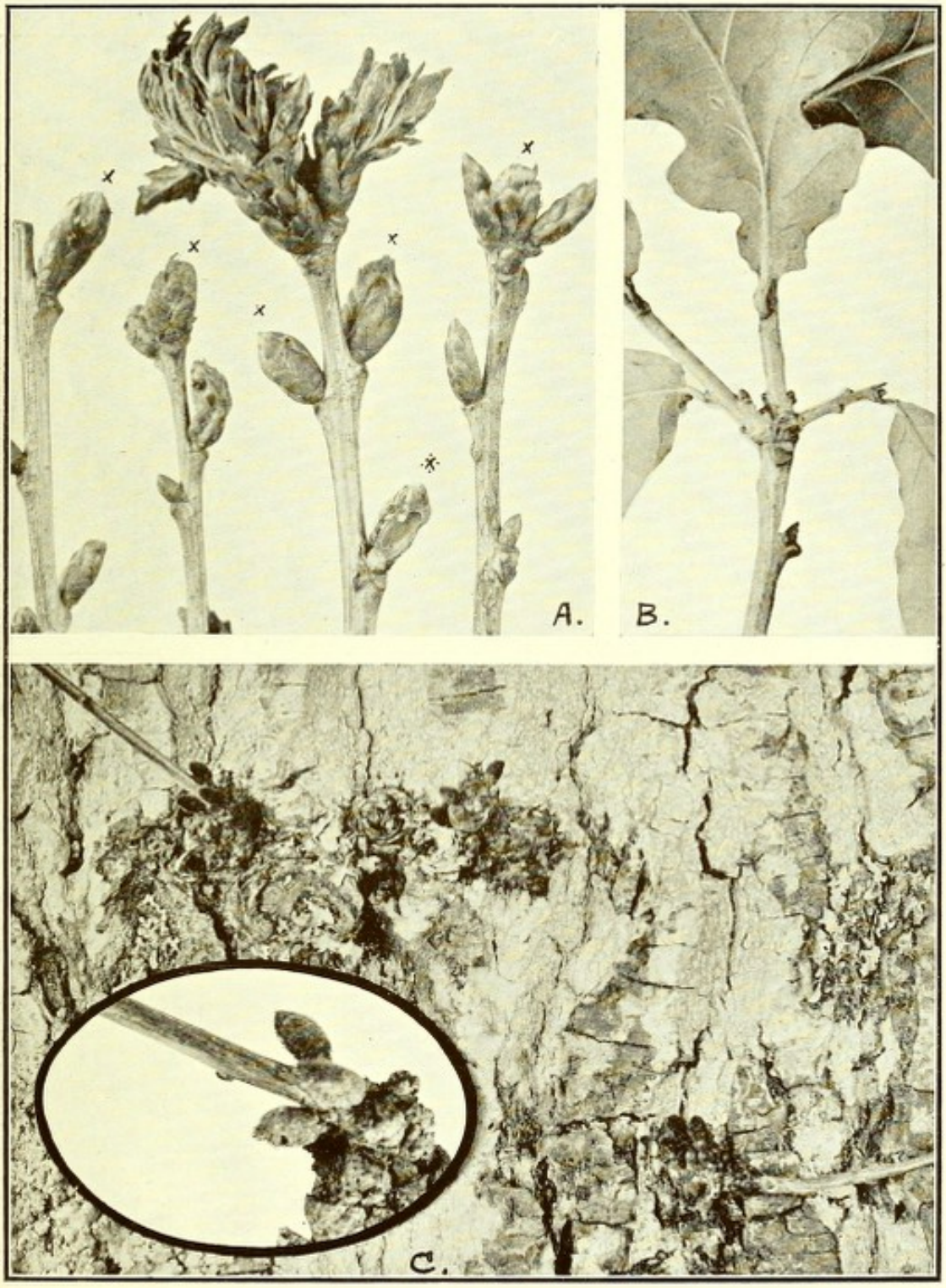
*Adlard & Son, Impr.*

# PLATE LI.

Galls caused by SPATHEGASTER ALBIPES on leaves of *Q. pedunculata*.
Arrows indicate the positions of six galls.
The inset is of a specimen × 2½.
Four-fifths nat. size.

*Adlard & Son, Impr.*

# PLATE LII.




Galls caused by:

A. SPATHEGASTER APRILINUS, in buds of *Q. pedunculata*; × indicates a galled bud, * longitudinal section.

B. S. SIMILIS, hairless and dry.

C. S. TASCHENBERGI on adventitious buds of *Q. pedunculata*. The inset is of those specimens immediately above it, × 2½.

Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE LIII.


Galls caused by SPATHEGASTER BACCARUM.
A. On leaves. B. On staminate catkins of *Q. pedunculata*.

*Adlard & Son, Impr.*

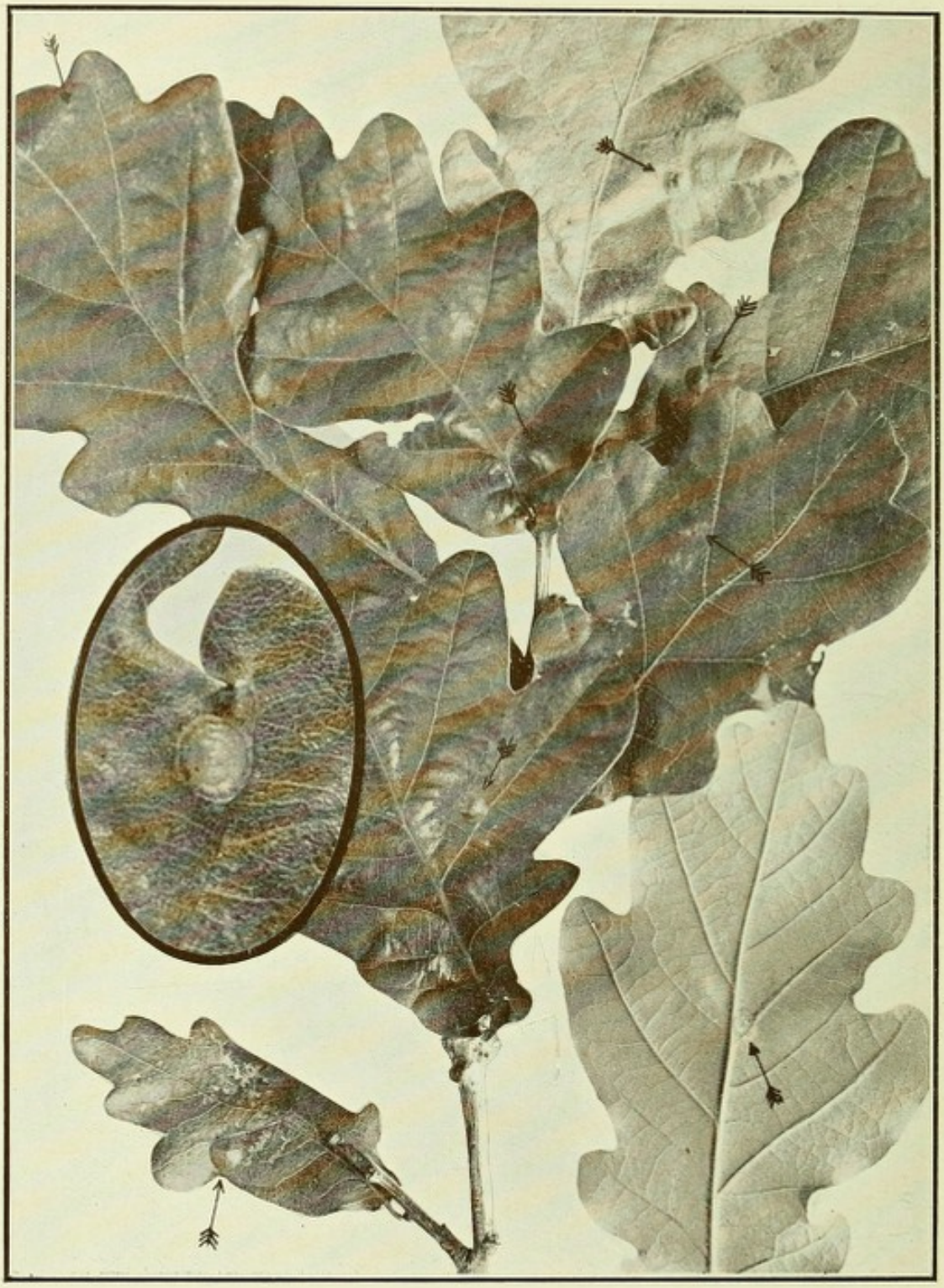
# PLATE LIV.

Galls caused by SPATHEGASTER TRICOLOR on under-surface of leaves of *Q. pedunculata*.

Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE LV.



Galls caused by SPATHEGASTER VESICATRIX on leaves of *Q. pedunculata*.
Arrows indicate the positions of eight galls.
The inset is a specimen × 2½.
Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE LVI.

Galls caused by TERAS TERMINALIS ontwigs of *Q. pedunculata*.
Early summer condition.
Two-thirds nat. size.

*Adlard & Son, Impr.*

# PLATE LVII.

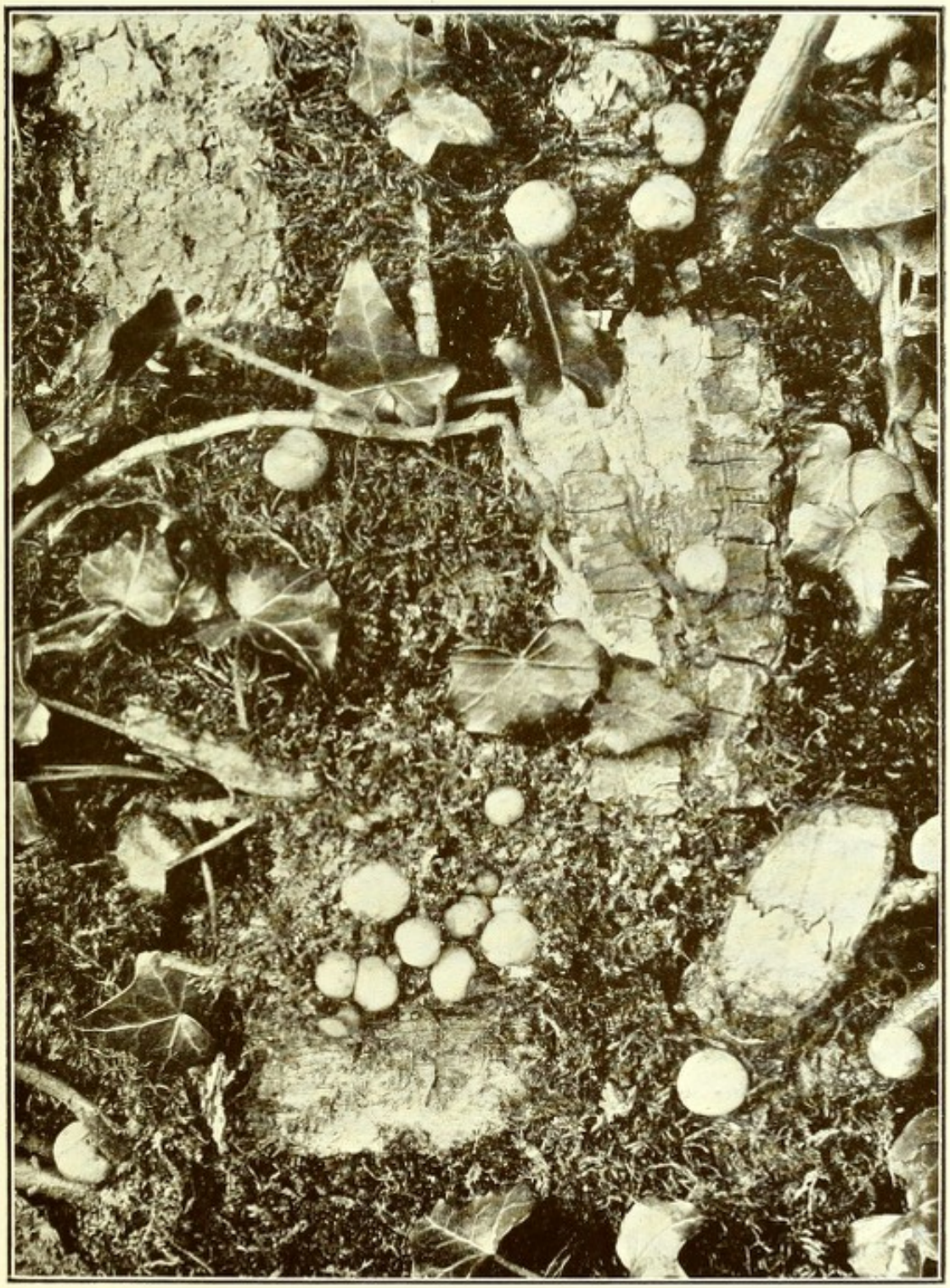

Galls caused by TERAS TERMINALIS.

A. Spring condition. Arrows indicate bud apices.

B. Autumn-winter condition on twigs of *Q. pedunculata*.

*Adlard & Son, Impr.*

# PLATE LVIII.



Galls caused by TRIGONASPIS CRUSTALIS on adventitious buds on bole of *Q. pedunculata*.

Three-fourths nat. size.

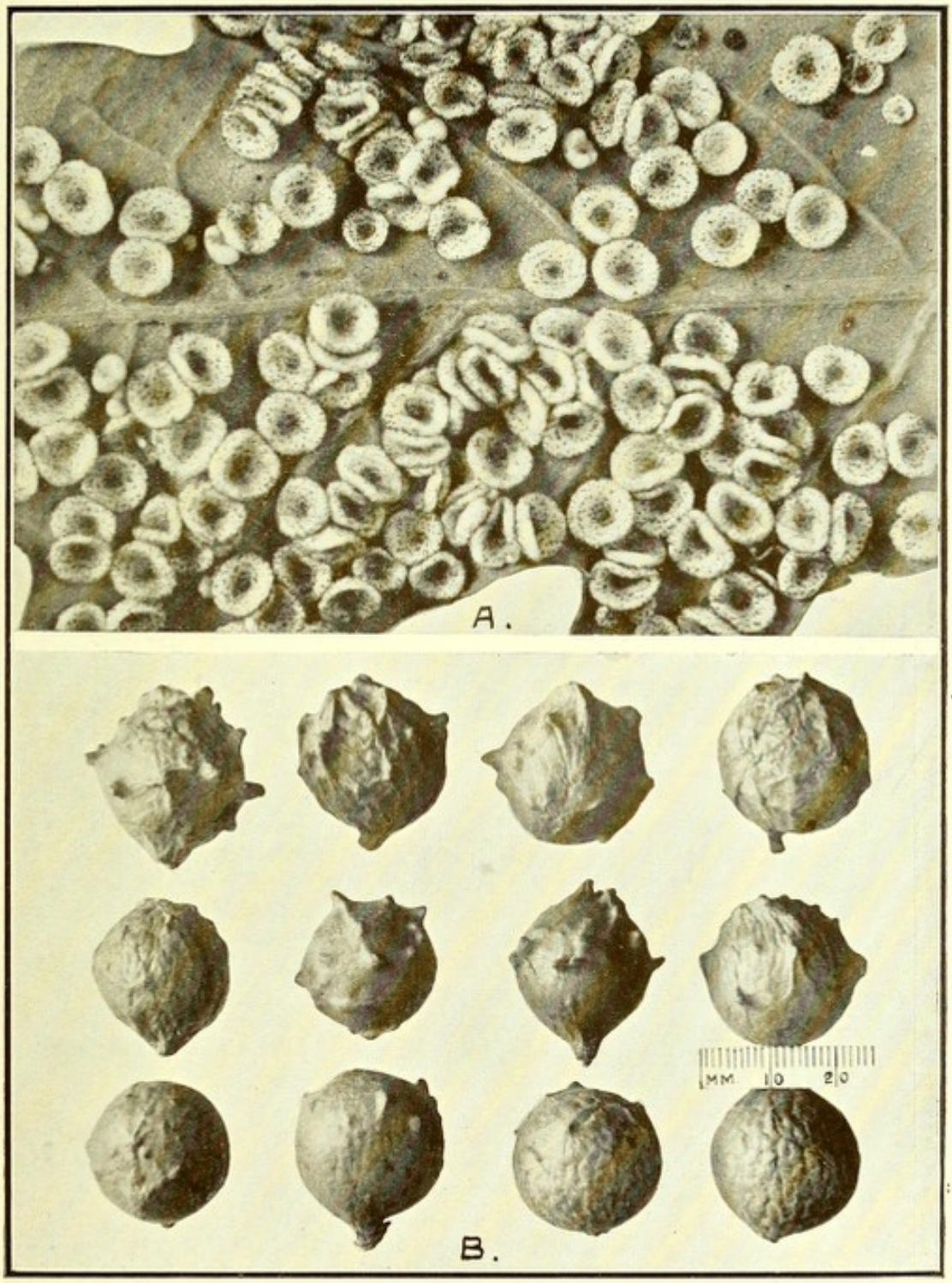
*Adlard & Son, Impr.*

# PLATE LIX.

Galls caused by TRIGONASPIS CRUSTALIS on twigs of *Q. pedunculata*.
Five-sixths nat. size.

*Adlard & Son, Impr.*

# PLATE LX.

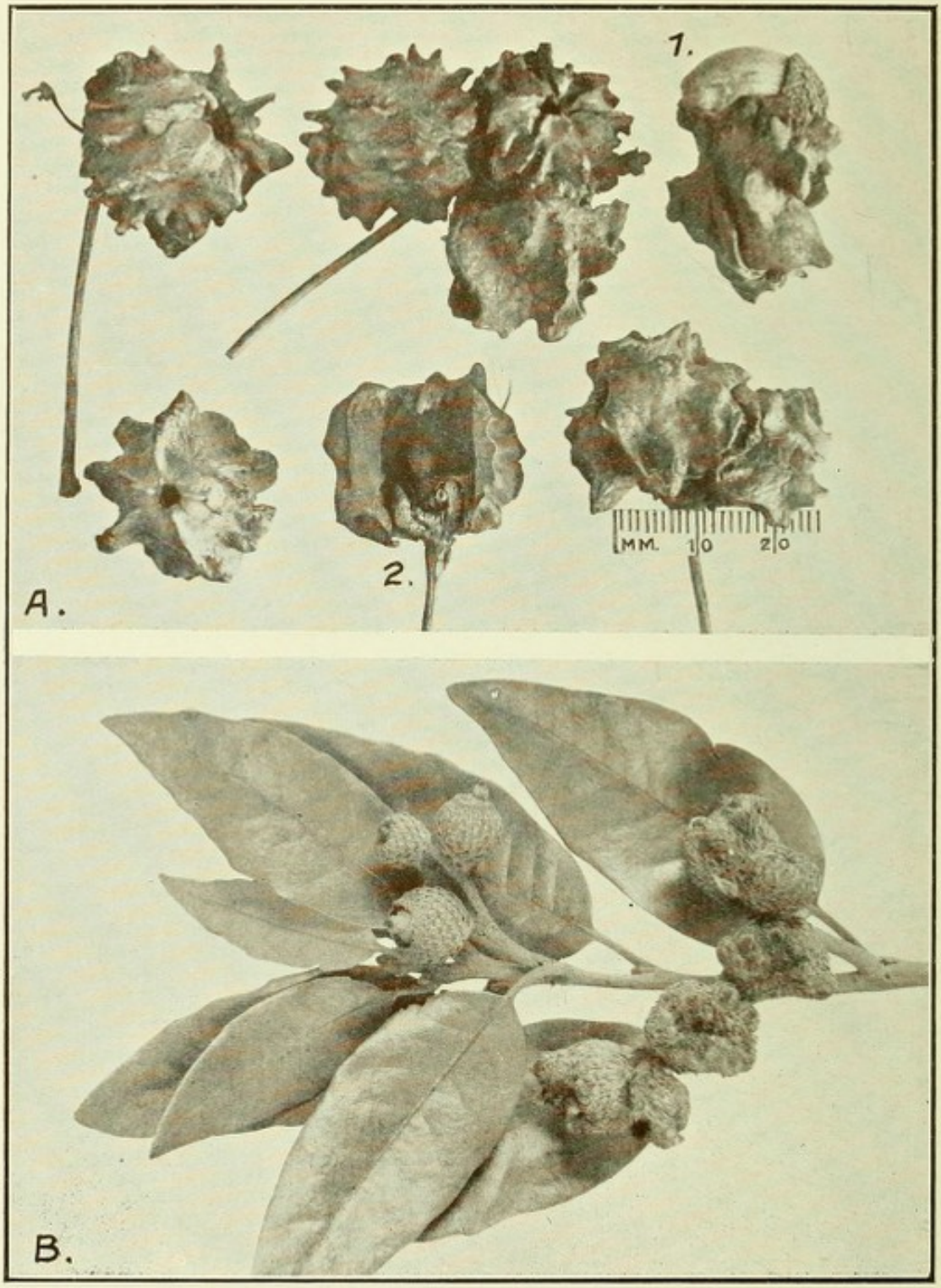



Galls caused by

A. NEUROTERUS FUMIPENNIS × 2½ (see p. 117). B. CYNIPS TINCTORIA.
Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE LXI.




Galls caused by CYNIPS CALICIS:

A. On capsules of *Q. pedunculata*. 1. Acorn. 2. Larva cell in centre of cavity. From Jersey.

B. — ? — ? on cupules of *Q. Ilex*.

Both nearly nat. size.

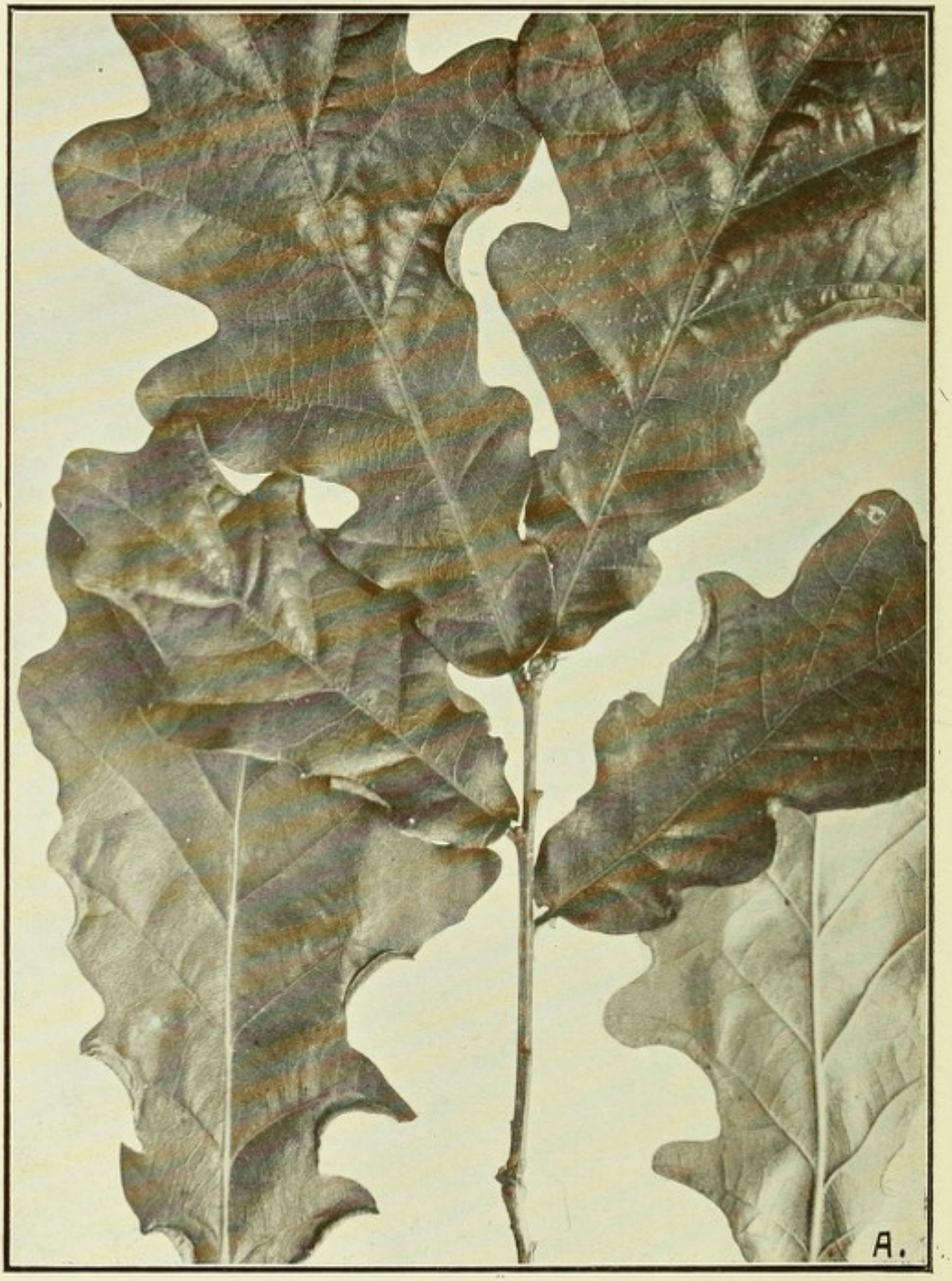
*Adlard & Son, Impr.*

# PLATE LXII.

Gall-pits caused by ASTEROLECANUM VARIOLOSUM on twigs of *Q. pedunculata*.
The inset is the portion of the twig between transverse lines, × 2½.
Nearly nat. size.

*Adlard & Son, Impr.*

# PLATE LXIII.



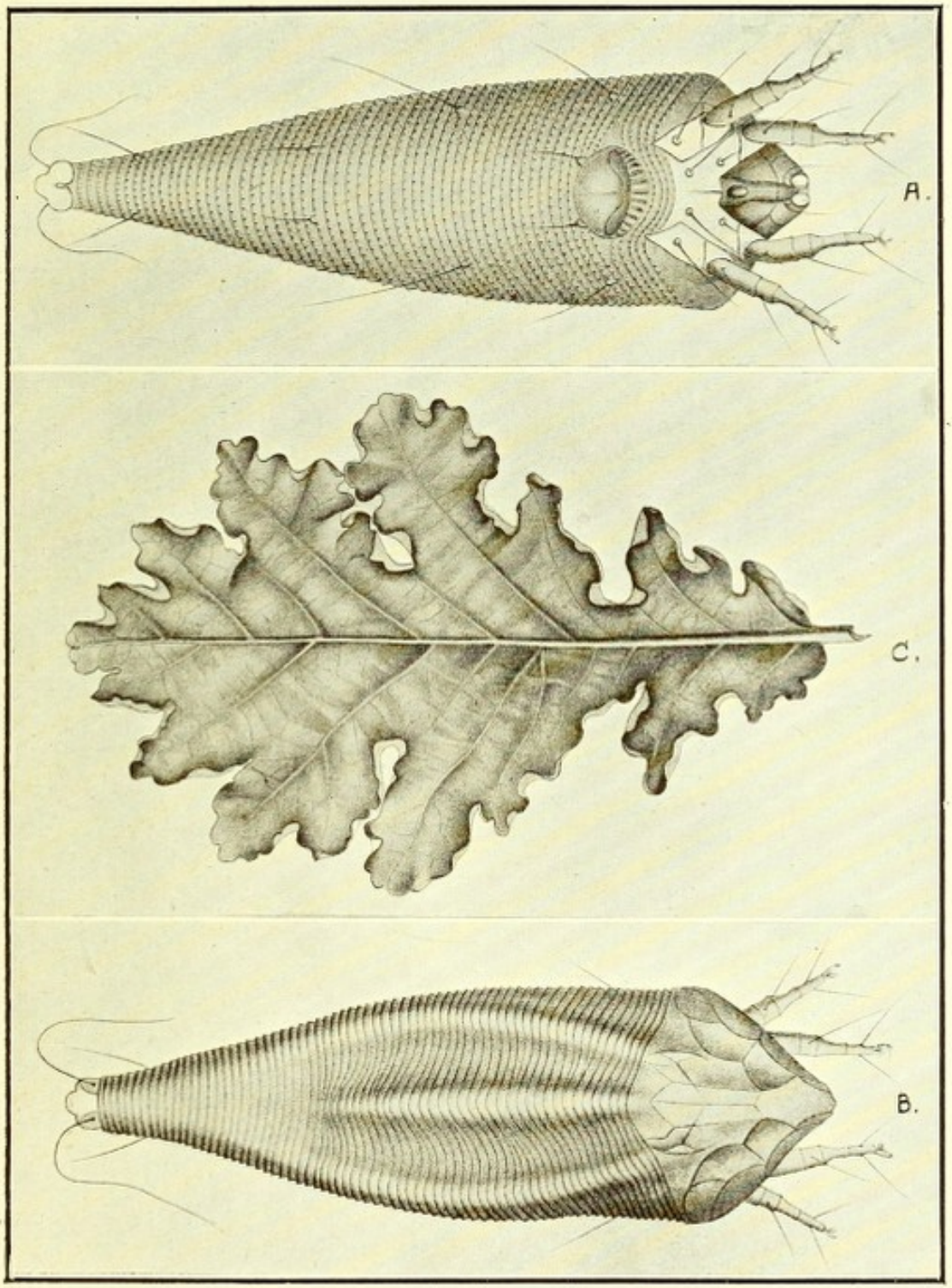

Galls caused by DIPLOSIS DRYOBIA on upper surface of leaves of *Q. pedunculata*.

A. Under-surface of an attacked leaf.

Five-sixths nat. size.

*Adlard & Son, Impr.*

# PLATE LXIV.



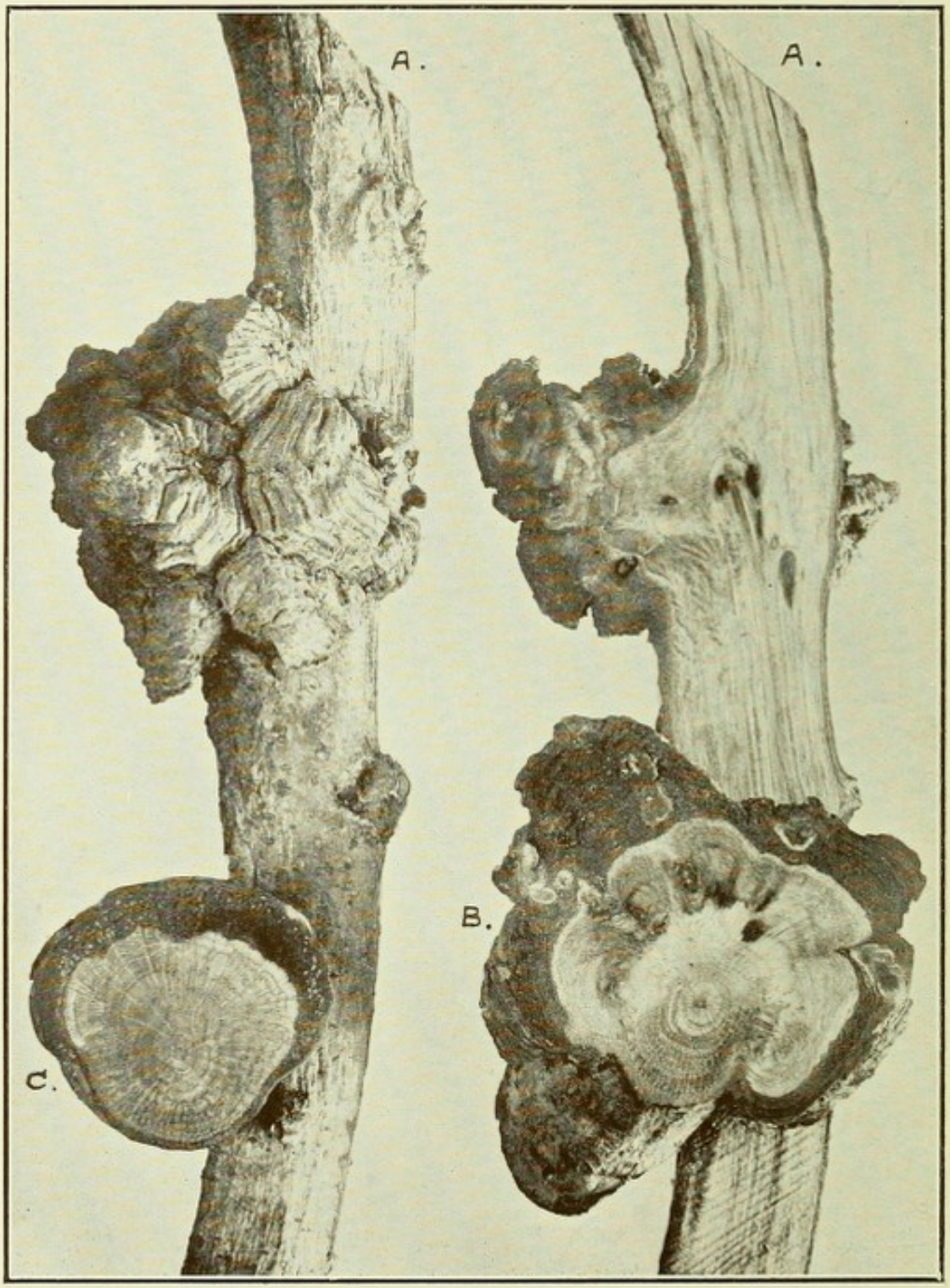

EPITRIMERUS CRISTATUS, Nalepa.

A. Ventral view } very highly magnified.
B. Dorsal view }
C. Under-surface of leaf of *Q. pubescens*.

From drawings by Dr. ALFRED NALEPA, Vienna.

*Adlard & Son, Impr.*

# PLATE LXV.




Galls caused by DICHÆNA QUERCINA on branches of *Q. pedunculata*.

A. A. Branch divided longitudinally.

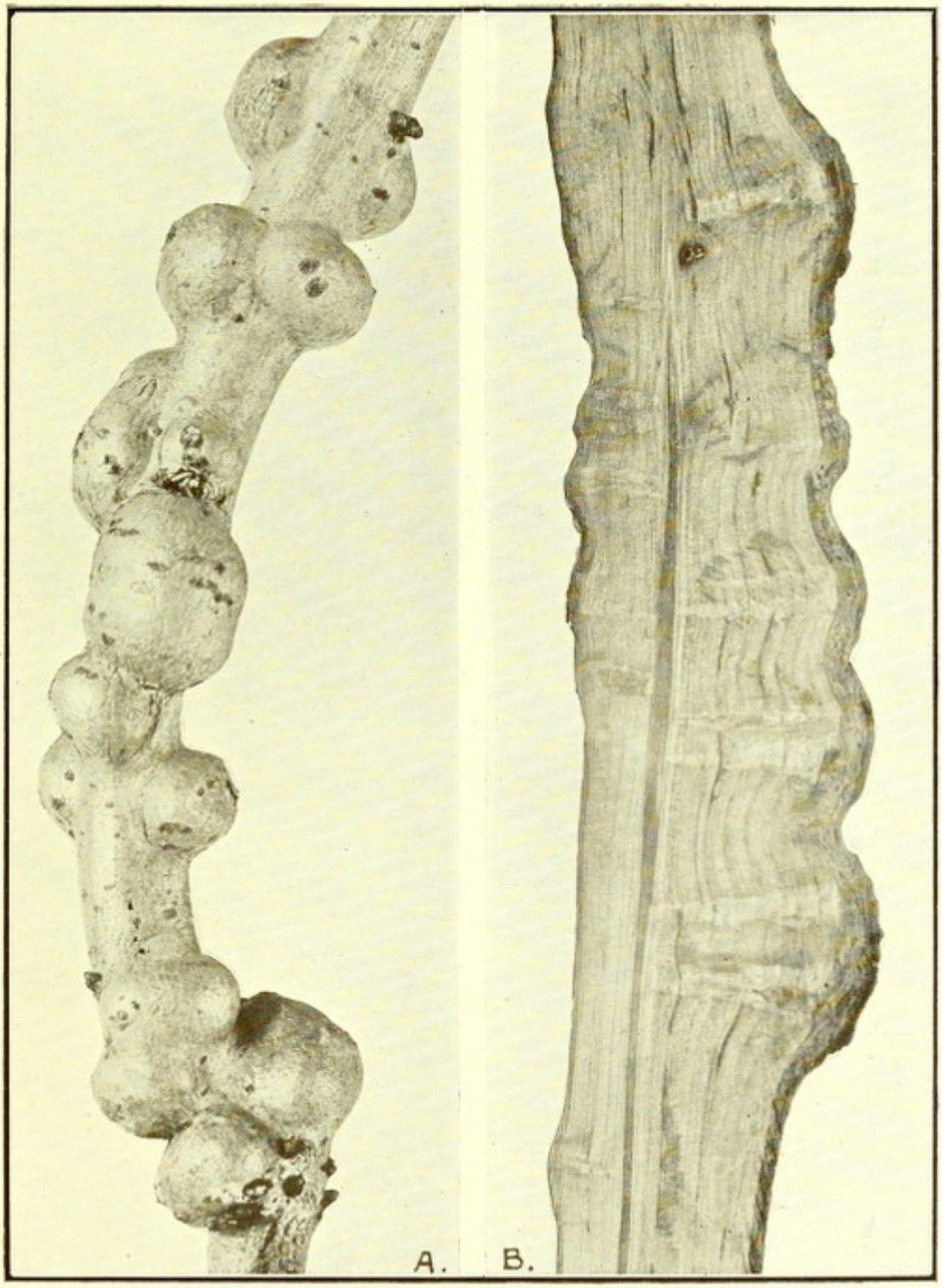
B. Tangential section of a growth similar to that above it.

C. Transverse section of a growth similar to that of B on Plate LXVI.

Two-thirds nat. size.

*Adlard & Son, Impr.*

# PLATE LXVI.




Galls caused by DICHÆNA QUERCINA on branches of *Q. pedunculata*.

A. An early stage of growth.

B. Longitudinal section of a similar specimen to A.

Both three-fourths nat. size.

*Adlard & Son, Impr.*

# PLATE LXVII.

Bole of oak tree in Broomham Park, Guestling, Sussex.
The scale is 30 cm.

*Adlard & Son, Impr.*

# PLATE LXVIII.

Another view of tree of previous Plate.

The scale is 30 cm.

*Adlard & Son, Impr.*