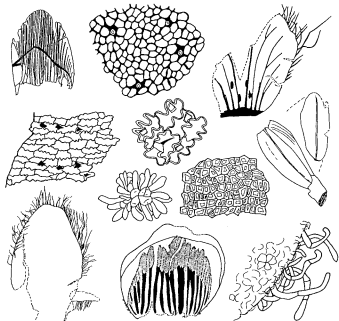


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This Issue: Bud-scale identification guide

The Bulletin of the
Association for
Environmental Archaeology

CIRCAEA is the Bulletin of the Association for Environmental Archaeology, and is published three times a year. It contains news and short articles as well as more substantial papers and notices of forthcoming publications and conferences. Editorial policy is to include material of a controversial nature where important issues are involved. Although a high standard will be required in scientific contributions, the Editors will be happy to consider material the importance or relevance of which might not be apparent to the editors of scientific and archaeological journals, such as papers which consider in detail methodological problems like the identification of difficult bioarchaeological remains. Circaea is edited and assembled by Allan Hall, Harry Kenward and Terry O'Connor, and is printed at the Printing Unit of the University of York. Circaea is distributed free to members of the AEA and available to institutions and non-members at £6.00 per annum. At present, copyright resides with individual authors. Circaea is published by the Association for Environmental Archaeology, c/o Environmental Archaeology Unit, University of York, Heslington, York, YO1 5DD. Enquiries concerning membership of the AEA should be sent to Bruce Levitan, City Museum and Art Gallery, Queen's Road, Bristol.

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Copy dates: Spring issue - 15th November; Summer issue - 15th March; Autumn issue - 1st July.

The Editors, CIRCAEA, c/o Environmental Archaeology Unit, University of York, York YO1 5DD, U.K.

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AEA

circaea

 Editorial

Circaea is now respectable - at least as a serial publication - since we recently acquired an ISSN (International Standard Serial Number), which may be found on the front cover. We are also in the process of sending complete runs of Circaea to copyright libraries and certain libraries and institutions abroad. This has necessitated the reprinting of several issues, and copies of these will be available to members who wish to complete their sets. Prices are given on the inside front cover.

Incidentally, nobody has identified the mystery structure on the front cover of the last issue; neither have we received a summons for sending indecent literature through the mails. We really DO, very earnestly, want to know what these weird things are - it might make all the difference in the interpretation of invertebrate remains from Anglo-Scandinavian Coppergate.

Unlike previous issues, this one has been given over entirely to a single paper. We are pleased to be able to do this since it is an example of a paper which considers 'in detail methodological problems like the identification of difficult bioarchaeological remains', consistent with our stated editorial policy from the first. Naturally we welcome similar oeuvres covering material in other areas of the subject, whilst not wishing to discourage the shorter communications that have been our mainstay so far.

 Miscellany

The Editors have received notification of the formation of the Committee for Early Coastal Archaeology, a body seeking to promote research into shell midden sites in Scotland. Details may be had from the Secretary, C.E.C.A., 34 Dovecot Park, Linlithgow, Scotland.

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Derek Yalden has apprised us of the publication of his guide The Identification of British Bats. This work, which is based both on external features and on skulls and teeth, contains 14 pages of text and diagrams and is obtainable from the Publications Officer of the Mammal Society, Miss R. Harper, Moss Bank, Eskdale Green, via Holm Rock, Cumbria, price £1 (75p to Mammal Society members), post and packing extra. The copy sent to the Editors has been attracting favourable comment amongst colleagues and there is no doubt that the guide is a useful work of reference for osteologists and natural historians.

Data Protection Act

In order to comply with the Data Protection Act (1984), the Editors of Circaea hereby inform members of the Association for Environmental Archaeology that a computer file of names and addresses is and will be used exclusively to produce address labels for the distribution of Circaea and other AEA literature. The list will not be available to any person other than Circaea editors and AEA officers. Any members objecting to their names appearing on this file are asked to contact the Editors and to send a supply of large self-addressed envelopes in order that they may receive further mailings from the AEA. We trust that the present arrangements will be satisfactory for all members.

An aid to the identification of fossil buds, bud-scales
and catkin-bracts of British trees and shrubs

Philippa Tomlinson *

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PREFACE

Bud-scales are found frequently in waterlogged deposits and their identification may assist considerably in the interpretation of plant macrofossil assemblages. This guide is intended for use in identifying buds, bud-scales and catkin-bracts primarily from waterlogged archaeological and Quaternary deposits. It may also help in identifying charred material. Most British trees and shrubs are included, together with a few exotic taxa which might occur in interglacial deposits or be recognised from late Flandrian archaeological sites. It is intended as a first step in the identification of buds and should not be thought of as a definitive version. Comments on the usefulness, or not, of the guide, and particularly of the key, will be welcomed.

INTRODUCTION

The majority of publications on buds (e.g. Foster 1928a; 1928b) deal with bud-scale morphology and morphogenesis, but give few detailed descriptions of anatomy. A good general introduction to bud-scale biology is given by Priestley *et al.* (1950), whilst Ward (1904) provides detailed descriptions of buds and twigs, including a key which uses both twig and bud characters. It is a useful guide to field and laboratory identification, but does not give enough details of individual scales for determination of fossil material. There are good drawings and descriptions of catkins and catkin-bracts in Edlin (1975).

Dickson (1970, 243-4) gives a general review of records of bud-scales and catkin-bracts from natural Quaternary deposits. A few authors have dealt with buds and bud-scale material from particular Quaternary sites (e.g. Hasmer 1935; Rabien 1953); the taxa which they recognised

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are noted in the text. Attwater (1972) describes, and gives a key to selected species, using fossil and modern reference material: her thesis is available on microfiche. Of the twelve buds she studied from the Bronze Age fills of the Wilsford shaft, Wiltshire, only three were identified (two as Quercus and one Alnus).

Methods and materials

Methods used in the preparation of modern and fossil material for this guide follow Tomlinson (1984). Jeffrey's solution was used for clearing specimens and lactic acid for clearing and mounting. Permanent slide mounts were later made with 'Aquamount', because semi-permanent mounts in lactic acid, with a nail varnish seal, did not survive well. Reference material was taken from at least two individuals of each taxon (from different locations where possible). Fossil specimens were studied from a range of different sites, but this was limited to what could be obtained in the time available. Slides and herbarium material are held at the Environmental Archaeology Unit, University of York, and are available for consultation there.

Bud recognition

At first sight buds may easily be overlooked during sorting, especially if one is looking primarily for seeds and fruits. Quercus buds, for example, may be passed over as small fragments of wood, until dissection reveals the many overlapping scales. Salix buds, having only one scale, look like an empty sac that may erroneously be included with unidentified seeds and fruits.

Modern and fossil buds

A wide range of species is included in this guide although it is perhaps unlikely that some of them will ever be found or recognised as fossils. It is not always possible to predict from modern material which characters will be best preserved in the fossils. All characters noted on modern material have been included in as much detail as possible, although these may not necessarily be preserved in fossil specimens. Where fossils have been examined, information on the best key characters is given.

Hairs and glands (trichomes) are often lost or become invisible in fossil specimens. The only indications left on the epidermis of the former presence of hairs or glands are the cicatrices. These are the cells at the base of the trichome, where it attaches to the epidermis, which remain visible after the trichome has fallen off. Glands may become dark patches or are visible as areas of thicker-walled raised cells. Very often the edges of the scales become eroded so that marginal features such as the shape of the tip disappear. If the whole bud is preserved, it is important to make a note of its size and shape before dissecting out the scales, counting them and noting the variation within the bud. The outer scales will often have fallen off, so that the number of scales counted in the bud should be regarded as a minimum.

Crystals

Crystals, absent or obscure in modern bud-scales, may sometimes be observed in fossils. This presumably depends on conditions of burial and preservation and perhaps the age of the bud or scale when buried.

Cells and cell walls

The shape and appearance of cells and cell walls are useful characteristics in some cases. As scales with oblong to long and narrow shaped cells are easily recognisable, this character can be used in the key. The sinuous-shaped cell character must be used with caution, because although some species have sinuous cells clearly visible both in modern and fossil specimens (Ulmus, for example), in other scales cell walls only become markedly sinuous when fossilised (e.g. Betula). With most other cell types, however, there is a great range in shape from very rounded to angular, subrectangular and polygonal, both within individual scales and between different species. Cell shape and cell wall thickness often differ on the adaxial and abaxial surfaces of the scales as well as across each surface. Cell shape and wall thickness may also alter with burial, the walls often becoming thickened. Because of such problems, details of these cells are given in the descriptions, but not used in the key. With careful use of reference material it may be possible to recognise small fragments of scales from their cell characteristics alone.

Trichomes

Features broadly known as trichomes are divided here into two groups: glands and hairs. This is for simplicity as there are not necessarily any functional differences. Thus the multicellular trichomes on Alnus may function as glands but are described as hairs. The hair-like trichomes on Fraxinus are probably glands but are called hairs in order to distinguish them from the true glands on this species. When hairs or glands fall off they usually leave a cell attachment point, called a cicatrice, which is often different from surrounding epidermal cells.

Stomata

In some species stomata occur on at least the outer bud-scales and are a good key character. In others, however, stomata only occur very occasionally, are difficult to see and will perhaps be overlooked, especially in fossil material.

Catkin-bracts and catkin bud-scales

Descriptions of the catkin-bracts are included within the bud-scale descriptions or, if more detail is required, on a separate page. Female catkins, in such species as Alnus, have bracts or bracteoles, which on maturity of the fruit form cone-scales.

Catkin bud-scales are generally similar to the leaf bud-scales and therefore are not described separately, but differences are noted.

Arrangement of each description

Each description is divided into five sections as follows:

A WHOLE BUD

Description of modern buds, using hand lens, in the field, including:

Size and size variation, mean length and width in mm, colour, shape, hairiness, arrangement on stem and other distinguishing features

B TYPE AND ARRANGEMENT OF SCALES

Arrangement of scales within the bud and information on the number and type of scales visible under the dissecting microscope, including:

Type, arrangement, number of scales (including inner scales or stipules), variation of scales within bud, scale shape

C INDIVIDUAL SCALES

Details of cells and other features on individual scales as seen under the transmission microscope, including:

Cells and cell walls, crystals, hairs, prickles, glands, stomata, veins and any other features

CATKIN-BRACTS

These are described where appropriate

D FOSSIL PRESERVATION

Notes on the likelihood of preservation in waterlogged deposits, which may depend on softness and size of the buds

References to records from archaeological and Quaternary deposits

E FOSSIL KEY CHARACTERS

List of the main characteristic features and including:

Possible confusion with other species

Problems of lost features in archaeological material

Variations between buds (terminal/lateral/flower)

Taxa not included in the guide

Some species have naked buds and others have bud-scales so fragile as to be very unlikely to preserve. These taxa are not included in the descriptions. Viburnum lantana, Cornus sanguinea and Frangula alnus have naked buds. In Frangula alnus the buds are densely covered in brownish hairs. Lonicera periclymenum has green bud scales which are very unlikely to preserve. Betula nana has minute buds, essentially like Betula pendula/B. pubescens but very dark in colour. The catkin-bracts, however, are useful to distinguish this species. Juniperus communis, which also has naked buds is included in the descriptions because the stipules are very like bud-scales.

The buds of dwarf shrubs, such as the Ericales, have not been included. The young, unopened Calluna vulgaris flowers, the sepals of which form a conical structure, are readily preserved and easily recognised. The identification can be confirmed by dissecting out the anthers, which are relatively long, narrow and pointed, with two backward projecting spinose lobes.

Descriptions and illustrations

Each written description is accompanied by a set of illustrations, which includes drawings of the cells, hairs, glands and crystals, the whole scale and the bud-scale spectrum, whichever is thought necessary to aid identification.

Photographs, mainly of fossil bud-scales, are also included. They were taken using a Wild MPS microphotography system mounted on Wild M5A or Leitz Laborlux 11 microscopes. Most of the drawings were made using a drawing tube attachment to either microscope.

Modern reference slides were used for the majority of the drawings, but some drawings of fossil material are also included. Some parts of the scales are very dark, and this is shown by solid black shading. The bud-scale spectrum is an outline drawing of the range of scales in one bud with outermost on the left, showing their relative size and variation in shape. Differences between flower and leaf buds and terminal and lateral buds (usually variations in size and shape of the bud) have also been recorded. Nomenclature follows Tutin et al. (1964-80).

ILLUSTRATED GLOSSARY

Figures 7-14 are provided to illustrate terms frequently used in the descriptions.

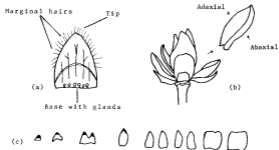


Figure 7. a) anatomy of a bud-scale; b) sketch showing location of abaxial and adaxial surfaces; c) bud-scale spectrum.

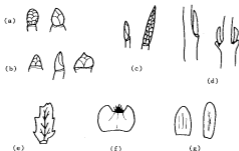


Figure 8. Bud shape: a) ovoid; b) conical, short-pointed; c) long-pointed; d) adpressed, flattened. Scale type: e) reduced leaf bases; f) reduced leaf bases; g) stipules.

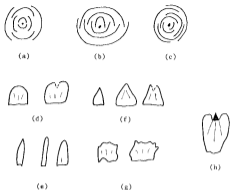


Figure 9. Scale arrangement in bud: a) decussate; b) distichous; c) spiral. Scale shape: d) rounded; e) long and narrow; f) pointed tip; g) irregular; h) Rosaceae type.

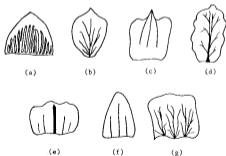


Figure 10. Vein patterns: a) finger-like thickenings; b) branching up from single base; c) branching up to single tip; d) leaf-like; e) one main central vein with or without parallel subsidiaries; f) parallel, mainly unbranched; g) many veins such branched from a multi-base.

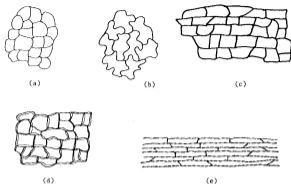


Figure 11. Cell shape and cell wall types: a) rounded to angular, thin-walled; b) jigsaw-shaped, medium thick-walled; c) subrectangular, thick-walled; d) subrectangular, double thick-walled; (e) oblong to long and narrow, thick and pitted walls.

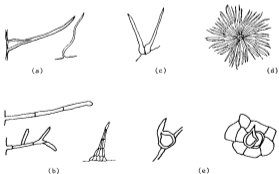


Figure 12. Hairs and prickles: a) single-celled hairs; b) multicellular hairs; c) paired hairs; d) peltate hair; e) prickles.

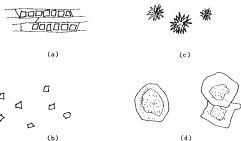


Figure 13. Crystals: a) rows of angular crystals; b) scattered angular or square crystals; c) star-shaped, d) sclereids.

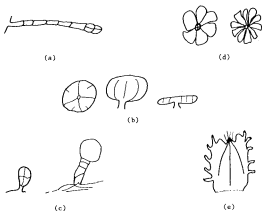
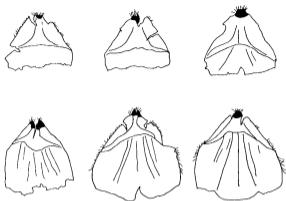
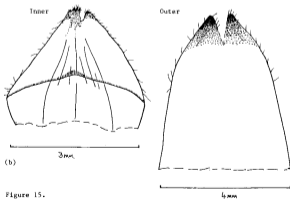


Figure 14. Gland-type: a) multicellular, hair-like; b) round-headed to peltate; c) club-shaped, three-celled or multicellular; d) star-like; e) multicellular, large and conspicuous on margin of scale:- Rosaceae-type.



(a)

3mm



(b)

Figure 15.

4mm

Acer campestre L.

FIELD MAPLE

A WHOLE BUD

Figs. 15-16

5-10 x 3-5 mm

Red-brown with grey pubescence; finely hairy

Ovoid shape, rather loosely fabricated

Buds opposite

B TYPE AND ARRANGEMENT OF SCALES

Scales are reduced leaves

Arrangement decussate

Number of scales 6-8

Increasingly hairy and becoming larger, longer, and thinner within bud

Scale shape: triangular, with a single-pointed tip, but with several small protrusions (see below)

C INDIVIDUAL SCALES

Irregular and variable cell shape: rounded to angular

Cell walls medium thick

Abaxial surface, tip and margins hairy; hairs single-celled

Glands multicellular, club-shaped with rounded head, on margin and both surfaces

Veins joining at tip or parallel, not easily visible

Crystals scattered, angular, may not always be visible

Apex of scale has a number of small protrusions (similar to the three-pointed tips of Rosaceae, but with more than three points)

D FOSSIL PRESERVATION

likely to preserve

Interglacial peat: Hall (1980)

Clands unlikely to preserve

Crystal cells may become visible in some scales

Outermost scales not very hairy

E FOSSIL KEY CHARACTERS

Pointed tip with several protrusions and triangular shape of scale, hairiness (cicatrices may occur where hairs have fallen)

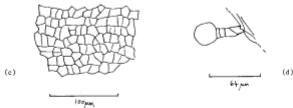


Figure 15. (opposite and above): *Acer campestre*: (a) bud-scale spectrum; (b) outer and inner scales; (c) cell pattern, abaxial; (d) marginal gland; (see also Fig. 16).

Acer pseudoplatanus L.

SYCAMORE

(not illustrated)

A WHOLE BUD

8-12 x 8 mm, terminal larger than laterals
 Green with brownish to reddish margins to scales
 Shape: ovoid, acute
 Hairy near tip
 Stems opposite

B TYPE AND ARRANGEMENT OF SCALES

Scales are reduced leaf bases
 Scale arrangement is decussate
 6-12 scales
 Inner scales larger and thinner than outer
 Scale shape: single-pointed tip

C INDIVIDUAL SCALES

Cells fairly rounded to subrectangular, irregular
 Densely hairy at tip of scales and along margin, outer scales have dense hair covering all over inner surface
 Multicellular, relatively large, club-shaped glands at base of inner surface of outer scales
 Crystals angular, scattered
 Cell walls medium thick, some pitted
 Parallel veins joining at tip, unbranched

D FOSSIL PRESERVATION

Might preserve but green and rather soft

E FOSSIL KEY CHARACTERS

Glands unlikely to preserve

(a)



(b)



Figure 16. Acer campestre: (a) fossil bud-scale, identified by shape and arrangement of the tip; (b) cell pattern showing thickening.

Aesculus hippocastanum L.

HORSE CHESTNUT

Fig. 17

A WHOLE BUD

25 x 15 mm, terminal buds extra large (max 32 mm)

Dark brown, shiny, reddish, viscid

Shape: ovoid acute

Glabrous

Buds opposite

B TYPE AND ARRANGEMENT OF SCALES

Scales are reduced leaf bases

Arrangement decussate

Approx 12-14 scales

Scales become leaf-like within bud, transitional to leaves

C INDIVIDUAL SCALES

Cells rather rounded, fairly thick-walled or double thick

Hairs along edge of scale single-celled

Multicellular rounded glands densely cover adaxial surface with a few on abaxial

Veins have simple arrangement, parallel, joining at tip

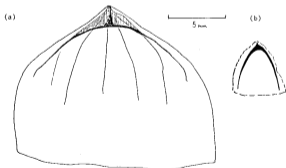
D FOSSIL PRESERVATION

Large size and sticky surface might help preservation

E FOSSIL KEY CHARACTERS

Large size, glands on the inner scales

Glands may be lost leaving rather obscure cicatrices

Figure 17: Aesculus hippocastanum: (a) outer scale; (b) inner scale.

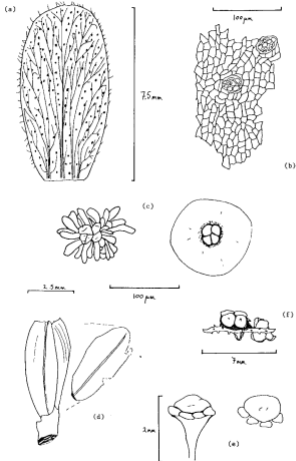


Figure 18.

Alnus glutinosa (L.) Gaertn.

ALDER

A WHOLE BUD

Figs. 18, 50(below) and 51(a)

8-10 x 4-5 mm

Green at first, turning purple towards tip

Glabrous, glaucous or viscid - waxy bloom

Buds on a short stalk or pedicel 3 mm long adpressed to stem and flattened

Shape: obtuse to long-pointed

Spiral arrangement on stem

Outermost scale large and hiding the inner ones

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules, arrangement is spiral

Each young leaf has two stipules, the outermost forming the bud-scales (two or four scales), the outer scale being largest and almost hiding the inner ones

Scale shape: rounded tip, long and narrow; not much variation within bud

C INDIVIDUAL SCALES

Abaxial cells subrectangular, moderately thick-walled, adaxial cells not easily visible, irregular

Hairs mainly around the margin (many may be broken, with squared-off ends), multicellular and single-celled

Glands frequent on adaxial and abaxial surfaces, evenly distributed over whole area; shape indistinct in fossils, but multicellular and peltate

Veins much branched from multi-base

Stomata occasionally on outer scales

CATKIN-BRACTS

Each male flower has a long central stalk, from which groups of flowers (dichasia) spring off at intervals. A single dichasium has a stalk, one large bract and four smaller bracteoles

Female catkins have a similar arrangement of bract and bracteoles. The bract becomes thickened to protect the fruits at maturity, and has a characteristic protrusion on the top. Female catkins preserve well and even the cone axes are easily recognised

D FOSSIL PRESERVATION

Interglacial: Hall (1980), Jessen *et al.* (1959); Flandrian: Hesner (1935); Urban archaeological: Hall (York)

E FOSSIL KEY CHARACTERS

The glands, the arrangement of veins and the overall shape and cell shape are characteristic

The glands look more like crystal clusters after fossilization (resemble flower-like glands)

Figure 18. (opposite): *Alnus glutinosa*: (a) bud-scale showing vein arrangement, marginal hairs and glands (dark blobs); (b) cell pattern, abaxial, showing gland attachment points (glands in higher focal plane); (c) glands, left fossil, right modern; (d) fossil whole bud, showing arrangement of scales; (e) male catkin-bract and four bracteoles, top and side view; (f) female cone, fossil fragment.

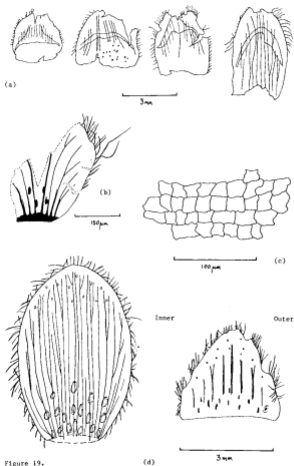


Figure 19.

(d)

Betula pendula Roth. and B. pubescens Ehrh.

BIRCH

A WHOLE BUD Figs. 19, 48(a) and 50(above)
 5 x 3 mm
 Reddish brown, or flecked with green, B. pendula not viscid, B. pubescens
 usually viscid
 Conical, short-pointed to ovoid, somewhat adpressed
B. pendula glabrous, B. pubescens hairy
 Arrangement on stem alternate

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules
 Arrangement is spiral
 Seven or eight scales plus inner (green) stipules
 Scale shape: inner scales have rounded tip, and are fairly long; outer
 scales triangular with pointed tip
 Inner scales are larger than outer with more stomata and more hairs and
 glands on the abaxial surface

C INDIVIDUAL SCALES

Cells subrectangular with fairly thick, pitted walls and becoming
 sinuous towards the margin
 Crystals angular, scattered
 Hairs long, all round the margin and some on abaxial and adaxial
 surfaces, single-celled
 Glands quite large, multicellular, round shape (peltate), adaxial and
 basal only
 Stomata few, towards edges of outer scales (surrounded by a ring of
 small subsidiary cells - not always easily visible), showing clearly as
 a pale patch in fossils
 Veins many, branching once or twice from base, parallel, close together

CATKIN-BRACTS

Description of catkin-bracts on following page

D FOSSIL PRESERVATION

Likely to preserve well
 Interglacial: Rabien (1953), Hall (1980); Flandrian: Besmer (1935);
 Urban archaeological: Hall (York)

E FOSSIL KEY CHARACTERS

Hairy margin, stomata towards edge of scales
 Glands at the base unlikely to be visible as they tend to lose their
 shape; stomata do not occur on inner scales
 Unlikely to be able to distinguish the two species, as it would only be
 on hairiness. Betula nana has essentially similar buds to these two
 species, but they are minute and very dark in colour.

Figure 19. (opposite): Betula pendula: (a) bud-scale spectrum; (b)
 fossil bud-scale fragment; (c) cell pattern, abaxial surface; (d) outer
 and inner scales, showing location of stomata, glands and marginal
 hairs.

FEMALE CATKINS

Female catkins have one bract and two bracteoles (floral scales) which become thickened and enlarged to form a characteristic three-lobed structure at maturity which protects the fruits. The shape of *B. pendula* and *B. pubescens* female catkin-bracts is very similar and, because the shape varies considerably within a single catkin, it is not easy to distinguish the two species, although some authors have tried to separate them. *B. pendula* bracts tend to have broadly spreading and downward curving lobes; in *B. pubescens* the lobes are more spreading but not descending or reflexed. *Betula nana* bracts are easily recognised as they have three upward pointing lobes. Bracts of *B. nana* x *pubescens* (x *intermedia*) can also be distinguished as they have intermediate characters (Godwin 1975, 255).

MALE CATKINS

Male catkins have many dichasia set along the familiar 'lamb's tail' drooping stalk. A single dichasium consists of three flowers each with one bract and two bracteoles. These bracts are more or less rounded in shape with a pointed tip. Cells are similar to those of the bud-scales. Stomata occur towards the margin. Bracteoles are smaller, have an irregular shape and branching veins, but the bract has no veins visible.

FOSSIL PRESERVATION AND KEY CHARACTERS

The overall shapes of the various scales are characteristic, as are the cell features which are generally similar to those of the bud-scales. *Betula* catkin-bracts are recorded from many interglacial and Flandrian sites.

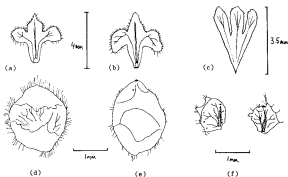


Figure 20.

Buxus sempervirens L.

A WHOLE BUD

1-3 x 3 mm

Ovoid

Pale orange brown

Densely pubescent

Buds usually hidden by leaves

Fig. 21

B SCALE TYPE AND ARRANGEMENT

Scales are stipules

Arrangement is opposite

Number of scales 2 or 4

Scale shape triangular, with pointed tip

C INDIVIDUAL SCALES

Cells oblong rectangular, irregular shape, fairly thick-walled

Hairy tip and hairs on abaxial and adaxial surfaces, mostly on the one central fairly broad vein

D FOSSIL PRESERVATION

Very small and soft and therefore unlikely to preserve except perhaps with twigs

E FOSSIL KEY CHARACTERS

Hairs on central vein, overall shape and small size are characteristic

Figure 21. Buxus sempervirens: bud-scale spectrum.

Figure 20 (opposite): Betula spp., female catkin-bracts at maturity: (b) B. pendula; (c) B. pubescens; (d) B. nana. Male catkin-bracts: (e) B. pubescens; (f) B. pendula; (g) two bracteoles.

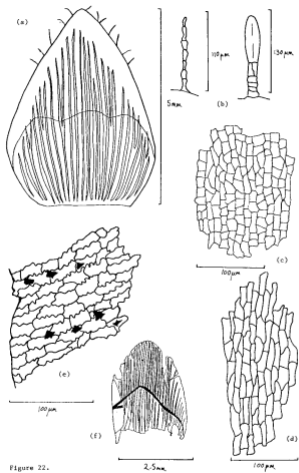


Figure 22.

Carpinus betulus L.

HORNBEAM

A WHOLE BUD Figs. 22, 48(b) and 49(above)
 5-10 x 3 mm
 Pale brown
 Ciliate, pubescent at tip
 Short- to long-pointed, sharp-pointed, adpressed to twig, oblong
 acuminate, very slender
 Similar shape to Fagus sylvatica but more pubescent
 Arrangement on stem alternate

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules
 Arrangement doubly distichous to spiral inside
 12-20 scales
 Scale shape: pointed tip

C INDIVIDUAL SCALES

Cells mostly rectangular to polygonal, arranged in fairly regular rows
 Cell walls moderately thick, sinuous shape towards margins
 Crystal cells may be seen within the scale (i.e. below the epidermis);
 they occur mainly within the veins, sometimes in rows (cf. Quercus)
 Hairs occur particularly towards the base of the margin and densely
 cover the inner scales; these are single-celled, relatively long hairs
 Glands are multicellular, hair-like (or somewhat club-shaped) and occur
 in similar position to hairs - margin and base of all scales and surface
 of inner scales
 Veins are parallel and very broad (almost like the finger-like veins of
Populus spp.) joining into a solid band in places, with thickened cells
 Stomata occur very occasionally, towards the base of margin

CATKIN-BRACTS

See description on following page

D FOSSIL PRESERVATION

Interglacial: Rabien (1953), Hall (1980); Flandrian: Hemmer (1935)
 Thickened cells make preservation likely

E FOSSIL KEY CHARACTERS

Main features: vein arrangement, hairs and multicellular hair-like
 glands, sinuous cell shapes at margin
 May be confused with Quercus at microscopic level, especially if the
 crystal cells are visible, but note different cell shape; easy to
 confuse the specimens in the hand with Fagus
 Hairs and glands are likely to be lost

Figure 22. (opposite): Carpinus betulus: (a) bud-scale showing broad
 veins; (b) hair-like and club-shaped glands; (c) cells from abaxial
 surface, central part of scale; (d) cells from centre of abaxial
 surface of fossil scale, showing rather oblong shape; (e) cells from margin
 of fossil scale, showing sinuous walls and location of crystals, visible in
 lower focal plane; (f) fossil scale: note glands and hairs have not
 survived as the margin has been eroded; crystals not shown.

MALE CATKIN-BRACTS

Basically rounded shape with a sharp-pointed, darkened tip. Single-celled hairs around the margin and multicellular glands. Veins branching from a multi-base. Cells sinuous to jig-saw shaped, especially towards the margin. Rather thin and unlikely to preserve; pale except for the tip.

FRUIT BRACTS

Each dichasium on the female catkins consists of a long, slender, pointed bract and six tiny bracteoles enclosing two flowers. As the fruit develops the bract disappears, but the bracteoles enlarge enormously and fuse, to form a papery, pale green wing composed of three arms.

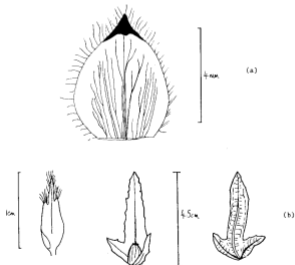


Figure 23. *Carpinus betulus*: (a) catkin-bract showing darkened tip and the vein arrangement; (b) fruit-bracts: left immature, right mature.

Castanea sativa Mill.

SWEET CHESTNUT

Fig. 24

A WHOLE BUD

4-10 x 4 mm

Red brown to yellowish green

Ovoid, obtuse

Alternate or spiral on stem

Only two outer scales visible

B TYPE AND ARRANGEMENT OF SCALES

First two scales are each two fused stipules, the rest are unfused stipules

Distichous arrangement

Total number of scales 8-10

C INDIVIDUAL SCALES

Cells rectangular, polygonal shape, thick-walled on abaxial surface

No crystals as such but conspicuous sclereids of various shapes occur beneath epidermis)

Hairs single-celled, long, occasionally paired; abaxial surface: scattered, more towards the base; adaxial: frequent

Glands multicellular, hair-like, mainly adaxial and frequent at the base with the hairs (may be somewhat club-shaped)

Veins parallel, unbranched

D FOSSIL PRESERVATION

May possibly preserve

E FOSSIL KEY CHARACTERS

The sclereids are characteristic

Glands and hairs might not preserve, veins will become invisible

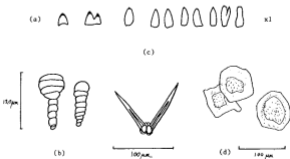


Figure 24. Castanea sativa: (a) bud-scale spectrum; (b) glands; (c) paired hairs; (d) sclereids.

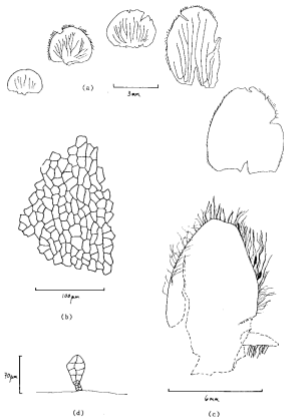


Figure 25. (above and opposite): *Corylus avellana*: (a) bud-scale spectrum; (b) cell pattern near centre of abaxial surface; (c) fossil scale (note some of the glands have preserved); (d) individual gland; (e) whole scale showing vein pattern, marginal hairs and glands.

Corylus avellana L.

HAZEL

Fig. 25

A WHOLE BUD

4-8 x 4-5 mm

Tawny or greenish to brownish

Smooth ciliate scales

Ovoid, obtuse

Alternate

B TYPE AND ARRANGEMENT OF SCALES

Stipules

Arrangement distichous to spiral inside

8-10 scales

Scale shape: rounded, not much variation within bud

C INDIVIDUAL SCALES

Cells irregular, rounded to angular, thick-walled

Hairs single-celled, along the margin and on abaxial surface frequent, few at base of the adaxial surface

Glands multicellular, club-shaped, along margin and at base of adaxial surface and dotted elsewhere

Veins much branched from multibase

CATKIN-BRACTS

See descriptions on the following page

D FOSSIL PRESERVATION

May be too soft to preserve well except in very good conditions

Urban archaeological: Hall (York)

E FOSSIL KEY CHARACTERS

Glands and hairs, vein arrangement and rounded shape are all characteristic features

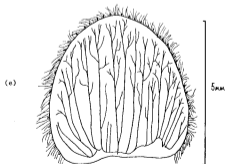
Alnus is superficially similar but glands are different

Figure 25 (continued).

MALE CATKIN-BRACTS

Each catkin consists of a series of bracts each with two small bracteoles and a single flower. The bracts are rounded with a sharp-pointed tip. Bracteoles are smaller and round in shape. All are densely covered in hairs on both surfaces and especially at the tip. Veins are branched from a single base. Cells very variable in shape, with thick and pitted walls. The tips of the bracts are darkened. Might be difficult to distinguish from Salix catkin-bracts.

FEMALE CATKINS

The female catkins are enclosed in the bud-scales, which are similar to the leaf bud-scales and therefore not described separately. The bracts and bracteoles are unlikely to be preserved or recognised on their own as they remain within the bud until the fruit ripens. The two small bracteoles then develop to form the large leafy structures - the cupules - which enclose the ripe fruit.

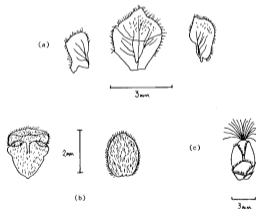


Figure 26. Corylus avellana, catkin-bracts: (a) male catkin-bract and two bracteoles; (b) arrangement of the male catkin-bract and bracteoles; (c) female catkin and one catkin bud-scale (b and c re-drawn from Ross-Craig, 1948-73).

Crataegus L.
comprising C. laevigata (Poiret) DC. and C. monogyna Jacq.

HANTHORN

A WHOLE BUD

Fig. 27

Very small, minute
Reddish brown or greenish at base
Shape: ovoid or short-pointed to conic
Spiral

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules
Arrangement is spiral
Number of scales 6-12
Outer scales are smaller than inner
Scale shape is rounded with an irregular three-pointed tip

C INDIVIDUAL SCALES

Cells rounded, irregular, with medium thick walls
A few scattered angular crystals may be visible
Single-celled hairs around the margin few, more towards the tip; hairs rather fat
Glands are Rosaceae-type, multicellular, marginal; conspicuous in C. laevigata, with rounded ends; only on the inner scales and then not always present in C. monogyna
Veins parallel, unbranched, not always visible in the outer scales; three main central veins, the laterals terminating in the glands in C. laevigata

D FOSSIL PRESERVATION

Small size, but might preserve

E FOSSIL KEY CHARACTERS

Main features are the marginal hairs and the Rosaceous-type glands

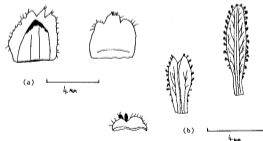


Figure 27. Crataegus spp., bud-scale spectra: (a) C. monogyna; (b) C. laevigata.

Euonymus europaeus L.

SPINDLE

A WHOLE BUD

2-4 x 3 mm

Green, touched with red at the tips

Ovoid, four-angled, adpressed, tip pointed

Buds opposite

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Decussate arrangement

4-6 scales

Very variable shapes of scales within bud

Scale shape: long-pointed tip, irregular

C INDIVIDUAL SCALES

Rounded to irregular shaped cells

Walls fairly thick and pitted

No hairs seen, but the glands are multicellular and hair-like; they occur around the margins of inner scales, and only at the base of outer scales

A few stomata on adaxial surface of inner scales only

Veins branching, leaf-like, one central vein with branching subsidiaries forming a characteristic arrangement

Thickened tip of scale has long-pointed shape

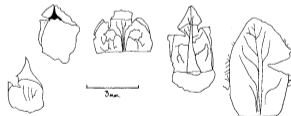
D FOSSIL PRESERVATION

Might preserve under favourable conditions

E FOSSIL KEY CHARACTERS

Vein arrangement, scale shape, and thickened tip are characteristic

Might confuse with Rosaceae types because of the multicellular marginal glands on the inner scales

Figure 28. *Euonymus europaeus*: bud-scale spectrum.Figure 29. (opposite): *Fagus sylvatica*: (a) bud-scale spectrum; (b) inner scale; (c) cell pattern showing rows of crystals and long narrow cells.

Fagus sylvatica L.

BEECH

A WHOLE BUD

10-20 x 4-6 mm

Red-brown

Long and narrow (fusiform or spindle-shaped)

Glossy

Alternate arrangement on stem

Fig. 29

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Spiral, distichous arrangement

15-20 scales plus inner stipules

Scales with pointed tips: irregular-shaped outer scales; inner scales long and narrow

C INDIVIDUAL SCALES

Cell shape long and narrow, fairly irregular and not always very clear; very thick walls

Crystals in rows on both surfaces (cf. Quercus)

Hairs along margin of scale and at base and tip, multicellular, hair-like

Glands along margin multicellular, hair-like

Veins simple, parallel, unbranched, about 12 per scale

CATKIN-BRACTS

Basically the same as the bud-scales, but rather thin and less likely to preserve. Larger than the bud-scales, up to 23 mm long x 7 mm wide

D FOSSIL PRESERVATION

Flandrian: Huxner (1935)

Likely to preserve well

E FOSSIL KEY CHARACTERS

Long thick-walled cells and rows of crystals characteristic

Might confuse with Quercus because of cell shape and crystal rowsNote cell arrangement and overall scale shape to distinguish the two (also, veins run most of the way up the scale, unlike Quercus)

Glands and hairs may not preserve

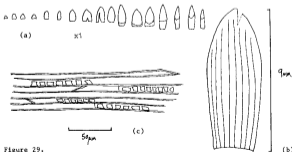


Figure 29.

(b)

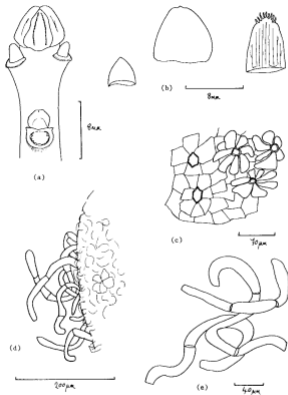


Figure 30. (above and opposite): *Fraxinus excelsior*: (a) twig showing difference in size between terminal and lateral buds; (b) bud-scale spectrum; note inner scale becoming leaf-like; (c) cell pattern showing glands on the right and gland cicatrices on the left; (d) fossil scale fragment, showing multicellular hairs, glands just visible; (e) multicellular hairs; (f) male inflorescence bracts; (g) gland from inflorescence bract.

Fraxinus excelsior L.

ASH

Fig. 30

A WHOLE BUD

Terminal bud medium, 6 x 6 mm, lateral buds small, 2 x 2 mm
 Sooty black, velvety
 Squat conic, angled; laterals adpressed to stem
 Buds opposite, terminal buds in whorls
 Leaf- and flower-buds similar, but flower-buds larger

B TYPE AND ARRANGEMENT OF SCALES

Scales are reduced leaf bases (becoming leaf-like within bud)
 Opposite, decussate arrangement
 Few scales visible, the larger terminal bud showing four scales the lateral ones two or three
 Scales of the larger, terminal bud have a distinct keel
 Scale shape: rounded to irregular; some scales have a pointed tip

C INDIVIDUAL SCALES

Cells subrectangular, irregular, obscured by hairs and glands
 Hairs: a dense layer of multicellular hairs (1-4 cells per hair) forming a complete covering on adaxial surface
 Glands multicellular, 'flower-like', densely covering abaxial surface
 Veins parallel, not easily visible, from multibase, occasionally branched

INFLORESCENCE BRACTS

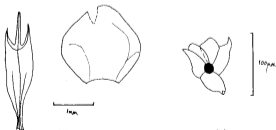
The outer scales of the inflorescence are the same as the leaf bud-scales. The inner bracts are very unlikely to preserve being very thin, but they have similar flower-like glands and multicellular hairs to the bud-scales

D FOSSIL PRESERVATION

Medieval moat: Tomlinson and Kenward (in prep)
 May be preserved under favourable conditions

E FOSSIL KEY CHARACTERS

Glands and multicellular hairs characteristic; hairs may preserve in clumps



(f)

Figure 30 (continued).

(h)

Hippophæ rhamnoides L.

SEA BUCKTHORN

Fig. 31

A WHOLE BUD

3-6 x 3-4 mm, small to medium
 Rusty brown and shining, silvery or coppery
 Obovoid, lobed or depressed at apex (heart shaped)
 Spiral arrangement of buds on stem

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules
 Arrangement is opposite, decussate
 6-10 scales
 Scale shape: more or less rounded

C INDIVIDUAL SCALES

Cell shape mainly rectangular but irregular
 Cell walls medium thick to thin
 Both abaxial and adaxial surfaces covered with stellate, peltate hairs
 Glands multicellular, peltate, also on both surfaces
 Veins branched, in a leaf-like arrangement

D FOSSIL PRESERVATION

Rather unlikely to preserve
 Hairs may preserve on their own: leaf hairs of Hippophæ, with a similar form, have been found in interglacial deposits and are illustrated by Godwin (1975, plate xxvi)

E FOSSIL KEY CHARACTERS

The peltate hairs are unusual, especially as they cover almost the entire surface, though they might not always retain their shape. Glands very unlikely to be visible

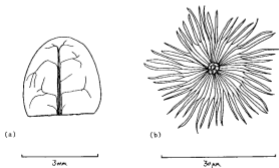


Figure 31. Hippophæ rhamnoides: (a) individual scale showing vein pattern; (b) peltate hair.

Ilex aquifolium L.

A WHOLE BUD

Minute, 2-3 x 1-2 mm
 Ovoid shape with pointed tip
 Green

Buds opposite or whorled

B TYPE AND ARRANGEMENT OF SCALES

Reduced leaves

Spiral arrangement

About four scales show on the outside, enclosing several more

Scales have leaf-like shape with pointed tips

C INDIVIDUAL SCALES

Cells with thick walls, relatively small, shape obscured by the cuticular striations

Hairs: fairly short, with bases, forming dense covering on abaxial surface

Occasional stomata

One main central vein with side branches - leaf-like

D FOSSIL PRESERVATION

Very small, green buds without thickening and rather soft, very unlikely to preserve on their own, except in unusual circumstances

None found to date, but note that Ilex leaf epidermis fragments preserve quite well and are easy to identify

E FOSSIL KEY CHARACTERS

The shape of the scales and leaf-like nature, as well as the presence of stomata and cuticular striations, are characteristic features

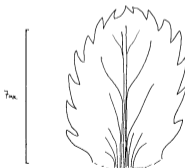


Figure 32. Ilex aquifolium: individual scale showing leaf-like shape and vein-pattern.

Juglans regia L.

WALNUT

A WHOLE BUD

Fig. 33

Terminal: 3-6 x 4-5 mm; flower bud: 4-5 x 3-4 mm

Bud glabrous, the terminal one sometimes greyish and tomentose

Bud dark almost black, purplish

Bud shape: rounded and blunt; catkin bud more pointed

Arrangement on stem spiral

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules, arrangement is decussate

Number of scales 2-4; catkin buds have many scales

Scale shape: rounded with a blunt tip and thickened rib; catkin bud-scales are smaller and sharply pointed

C INDIVIDUAL SCALES

Cells rectangular, cell walls medium thick

Hairs very short and stubby, in some areas very dense, some joining at the base to form pairs, threes or fours; some longer hairs single

Glands of two types: peltate (with large round heads) and club-shaped

Stomata occur but not very easy to see

CATKIN-BRACTS

Male catkins have numerous flowers around a central stalk. Each flower has a bract and two small bracteoles. The bracts are thick in the middle and may be preserved. They are of similar shape to the bud-scales and are densely hairy

Each female catkin consists of one to four flowers, shaped like small flasks. They are not hairy. Each flask is composed of two fused bracts

D FOSSIL PRESERVATION

Could be preserved in suitable deposits

E FOSSIL KEY CHARACTERS

Hairs, glands and the overall shape of the bud are characteristic

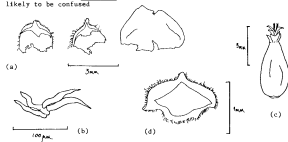
Fairly similar to Fraxinus which is the only species with which it is likely to be confused

Figure 33. Juglans regia: (a) bud-scale spectrum; (b) hairs; (c) female catkin; (d) male catkin-bract

Juniperus communis L.

JUNIPER

A WHOLE BUD

Buds are naked (as with all Cupressaceae)
 The scales are true leaves, but reduced in size
 Buds are sharp-pointed

Fig. 34

B TYPE AND ARRANGEMENT OF SCALES

Leaf scales are in whorls of three
 6-12 scales per bud
 Scale shape is sharp-pointed

C INDIVIDUAL SCALES

Cells rectangular to fairly long and narrow (underlying cells show more clearly and are rounded)
 Cell walls are medium but thick at the margin
 Veins: one central thickish vein
 Stomata on abaxial surface, fairly frequent, aligned in same direction along the scale

D FOSSIL PRESERVATION

Interglacial: Rabien (1953)
 The individual leaf-scales could well preserve, although they are rather small (the leaves are similar to the scales but larger)

E FOSSIL KEY CHARACTERS

The rather distinctive shape and cell shape and the presence of stomata are characteristic

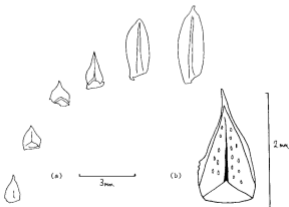


Figure 34. Juniperus communis: (a) bud-scale spectrum; (b) individual scale showing location of stomata.

A WHOLE BUD

3-5 x 3 mm

Shining, deep red

Short-pointed, narrow ovoid-conic

Probably spiral arrangement of buds on stem

B TYPE AND ARRANGEMENT OF SCALES

Scales are reduced leaves

Opposite arrangement

Number of scales about four

Scale shape: rounded (sometimes with a pointed tip)

C INDIVIDUAL SCALES

Cells angular to subrectangular to rounded

Thick walls, some cells with very thin lumen

A few hairs on abaxial and adaxial surfaces, but mainly on abaxial surface of the outermost scale

A very few stomata seen: scattered towards the tip

Veins have a leaf-like arrangement

D FOSSIL PRESERVATION

Might preserve as they are shiny and tannin-rich

E FOSSIL KEY CHARACTERS

Main features are the leaf-like veins and the small number of scales; might be difficult to distinguish from other taxa

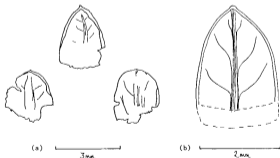


Figure 35. *Laurus nobilis*: (a) bud-scale spectrum; (b) individual scale showing shape and vein pattern.

Ligustrum vulgare L.

COMMON PRIVET

Fig. 36

A WHOLE BUD

1-4 x 1.5 mm

Greenish with brown tips to scales

Slightly ciliate

Bud shape is short-pointed

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Distichous arrangement

Inner scales becoming leaf-like

4 to 6 scales

Scale shape: inner scales are more or less rounded, outer scales more pointed, irregular

C INDIVIDUAL SCALES

Cells: subrectangular, irregular

A few single-celled and multicellular-branching hairs present around the margin

Glands multicellular, club-shaped, around margin and on adaxial surface

Veins leaf-like

Stomata few, on inner scales towards tip of abaxial surface

Cuticular striations on hairs and surface of inner scales

D FOSSIL PRESERVATION

Very small size and greenness suggests preservation or recovery unlikely

E FOSSIL KEY CHARACTERS

Main features are the antler-type branching hairs and the club-shaped glands, but neither of these are likely to be preserved easily. Small size and cuticular striations are also characteristic

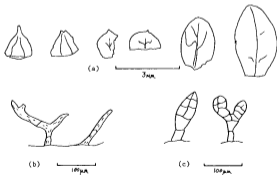


Figure 36. Ligustrum vulgare: (a) bud-scale spectrum; (b) hairs; (c) glands.

Malus sylvestris Mill. and M. domestica Borkh. CRAB & CULTIVATED APPLE

A WHOLE BUD

Fig. 37

4-5 x 4-5 mm

Dark purple to red brown

Ovoid, broad and depressed, hemispherical or conical and somewhat triangular or flattened in section

Terminal bud larger than laterals

Malus sylvestris ssp. sylvestris glabrous or sparsely hairy

M. sylvestris ssp. mitis hairy

Arrangement on stem spiral

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement distichous, doubly distichous to spiral

6-12 scales

Scale shape: rounded, irregular or sometimes three-pointed Rosaceae type tip

C INDIVIDUAL SCALES

Cells subrectangular to rounded, variable, with medium or double thick walls

Hairs: with a clearly visible ring of thickened cells at their base

M. domestica: densely hairy on abaxial and adaxial surfaces, especially at the base and tip (inner scales more hairy than outer); cicatrices occur on outer scales

M. sylvestris: long hairs at margin, base and tip, or just on tip of outer scales

Veins: three, joining at tip, or three to four, parallel-sided

Glands: Rosaceae type, occasionally at tips

D FOSSIL PRESERVATION

Likely to be difficult to identify

E FOSSIL KEY CHARACTERS

Main features are hairs with thickened cells at base

Variable characters like the veins, three-pointed tip and Rosaceae type glands are not reliable here



Figure 37. Malus sylvestris: bud-scale spectrum.

Myrica gale L.

BOG MYRTLE

A WHOLE BUD

2-5 x 1-3 mm

Rounded ovoid, blunt shape

Reddish brown, waxy, scales brown with pale whitish margins

Spiral arrangement on stem

Fig. 38

B TYPE AND ARRANGEMENT OF SCALES

Scales are reduced leaf bases

Arrangement is decussate

Number of scales 8-10

Scale shape: pointed tip

C INDIVIDUAL SCALES

Cells subrectangular, irregular, with double thick walls in places, becoming sinuous at the margins

Hairs around the margin, single-celled, few, mainly on the inner scales

Glands small, mainly at the base of the adaxial surface, round-headed to club-shaped (N.B. the catkin-bracts and leaves have large prominent peltate yellow glands, but these have not been seen on the leaf buds)

Veins branching from a multi-base, usually three

CATKIN-BRACTS

Similar to bud-scales in having branching veins, hairs along the margin, and subrectangular to irregular shaped cells with fairly thick walls, but also have prominent multicellular, peltate glands

D FOSSIL PRESERVATION

Could well preserve (leaves and stems and fruits from excavations in Beverley and York; leaves identified by presence of glands)

Very small size; they could easily be overlooked

E FOSSIL KEY CHARACTERS

Small size, marginal hairs, vein pattern, are key characters, but no really good distinguishing features

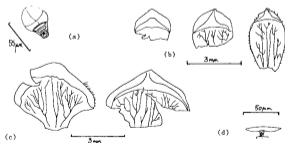


Figure 38. Myrica gale: (a) gland; (b) bud-scale spectrum; (c) catkin-bracts; (d) peltate gland from catkin-bracts.

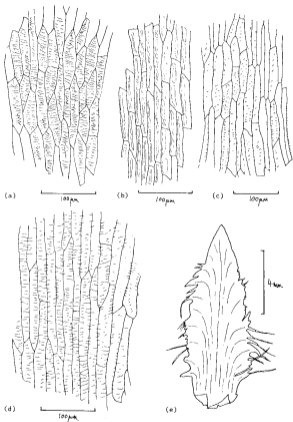


Figure 39. (above and opposite): Pinaceae cell patterns; (a) *Pinus sylvestris*; (b) *Abies alba*; (c) *Larix decidua*; (d) *Picea abies*; *Pinus sylvestris*; (e) individual scale; (f) scale showing cell arrangement and margin; (g) part of margin with thin layer of cells and marginal hairs.

Pinaceae (*Pinus sylvestris*, with notes on *Abies alba*, *Larix decidua* and *Picea abies*)

Pinus sylvestris L.

SCOTS PINE

A WHOLE BUD

Figs. 39 and 40(c)

6-12 x 4-6 mm

Oblong-ovoid, long-pointed, cylindrical

Reddish brown to pale chestnut brown

Resinous, whitish resin

Upper scales free at the tips (cf. other species of *Pinus*, where tips are reflexed)

Buds aggregated in threes or fours beneath the terminal bud

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Spiral arrangement

Scales more than 20

Outer scales are fairly small, becoming larger within the bud

Inner scales are longer and thinner and more parallel-sided than outer

All scales are narrow, pointed, and with a 'fringed' margin

C INDIVIDUAL SCALES

Cells long and thin with very thick, pitted walls with narrow lumen

Hairs not present except at the margin of the scale where the cells become very thin and long and look like hairs; on the inner scales these are very long and form a fringe

Resin canals are only visible in cross-section, one on each side of the middle

D FOSSIL PRESERVATION

Flandrian: Hesmer (1935)

E FOSSIL KEY CHARACTERS

Cell shape, scale shape and fringed or jagged margin, cell wall thickness and pitting are all characteristic (note also the resin canals, which may be a useful feature)

The fringe around the margin easily becomes eroded but usually it is still possible to see the 'frayed edge' formed by these cells

Probably not distinguishable from other *Pinus* spp.

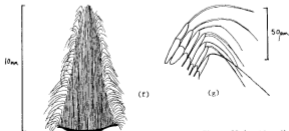


Figure 39 (continued).

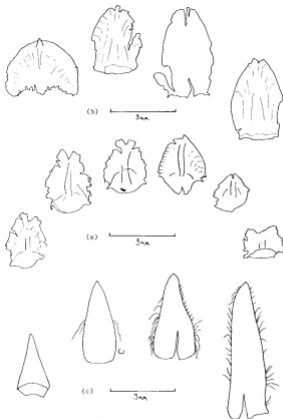


Figure 40. (above and opposite): Pinaceae bud-scale spectra: (a) *Abies alba*; (b) *Picea abies*; (c) *Pinus sylvestris*; (d) *Larix decidua*.

Abies alba Mill.SILVER FIR
Fig. 40(a)Differs from Pinus as follows:Bud red-brown, rather resinous, smaller than Pinus or PiceaScale shape rounded to triangular, margins thin and somewhat fringed with hairs (shorter than Pinus)Cells more or less rectangular, irregular towards margin, not so long and narrow as Pinus or Picea

Cell walls fairly thick and pitted

Larix decidua Mill.LARCH
Fig. 40(d)Differs from Pinus as follows:Buds small, 'tubercle-like', ovoid, a ring of many scales around the bud
Outer scales are more ciliate and membranous, triangular-ovate, irregular shape

Inner scales are broader, more rounded and delicate: they fall as development continues, while the outer scales persist

The scales are very small and scarious (thin) and very unlikely to be preserved on their own; whole buds might be recognisable by their size and shape

Cells are slightly shorter and broader than the other Pinaceae

Picea abies (L.) Karst.SPRUCE
Fig. 40(b)Differs from Pinus as follows:

Buds dark brown, ovoid, conical, approx. 5 mm.

Scale shape rounded to triangular, with weakly rounded margins, the size varying within the bud, becoming longer and thinner inside the bud

Margins thin, but not fringed like Pinus (or Abies)

Interglacial record: Rabien (1953)

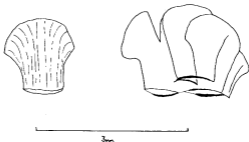


Figure 40 (continued).

(d)

Platanus hybrida Brot.

PLANE

A WHOLE BUD

Fig. 41

6-10 x 4 mm medium

Bud brown

Conical shape, slightly curved at tip, large protruding base

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

One cap-like scale (of two fused stipules) almost enclosing a second scale; inner scales becoming increasingly delicate

Scales more or less twisted, striate, with more or less sticky pubescence

Scale shape triangular with pointed tip

C INDIVIDUAL SCALES

Cells angular and irregular

Cell walls thickened and pitted

Densely hairy on adaxial surface, the hairs being very characteristic: multicellular, ostenolate (walls thickened and bulging at the ends, like a long-bone), long and sometimes branched

Glands small, round-headed, stalked, club-shaped: towards tip of abaxial surface

Veins many and parallel, giving the impression of being closely-packed

A few stomata on the abaxial surface

D FOSSIL PRESERVATION

The outermost scale might be preserved

E FOSSIL KEY CHARACTERS

Shape of bud and hairs are characteristic

Only the bases of the glands are easily visible.

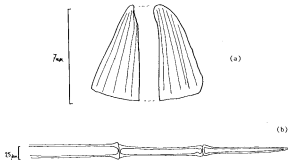


Figure 41. Platanus hybrida: (a) individual scale flattened out, in two fragments; (b) multicellular hair (note the thick walls).

POPULUS (Figs. 42-4 and 52(above))

Populus spp. have essentially very similar bud-scales (and the catkin-bracts differ in characters that may not be preserved in fossils). Material identified to the genus has been reported from various sites: Flandrian: Hall (in Gilbertson, 1984) medieval: Hall (York)

Populus alba L.

WHITE POPLAR

A WHOLE BUD

Size medium

White-cottony, orange-brown, not viscid

Shape ovoid to long ovoid-acute not adpressed

Few ciliate scales covered in loose cottony white tomentum

Arrangement on stem is spiral

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Spiral arrangement

Several scales

Scale shape rounded

C INDIVIDUAL SCALES

Cells irregular subrectangular shape, thick-walled over the finger-like veins

Crystals rectangular, scattered in the finger-like veins

Hairs single-celled, very dense on outer surface, a few at the base of the inner surface

Veins have finger-like thickenings arising from the base

D FOSSIL PRESERVATION

Probably will not be preserved easily; scales smaller and less tough than other species

E FOSSIL KEY CHARACTERS

Finger-like veins are a feature of the genus

Buds are very similar to P.tremula but not viscid

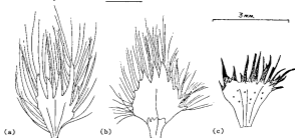


Figure 42. Populus spp. catkin-bracts: (a) P. tremula; (b) P. canescens; (c) P. nigra.

Populus canescens (Ait.) Sn.

GREY POPLAR

A WHOLE BUD

9-10 x 3-4 mm

Shiny green to red brown, with lighter tip

Thinly tomentose or becoming glabrous, not viscid

Sharp-pointed or ovoid and short pointed, rather adpressed

Spiral arrangement on stem

Fig. 43(a)

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement is spiral

About 6-10 scales

Scale shape: rounded, usually jagged and irregular, though may have pointed tip

C INDIVIDUAL SCALES

Cells subrectangular to irregular and sometimes sinuous

Medium thick walls but thick over veins and somewhat pitted

Hairs single-celled, long, mostly adaxial and towards base and in 'furrows' between the veins

Veins broad, finger-like, running whole length of scale

CATKIN-BRACTS

Fig. 42(b)

Laciniate shape with lanceolate divisions, not reaching half-way to base

Long hairs around the margin

Rather larger than the other two Populus sp. catkin-bracts described

D FOSSIL PRESERVATION

Could be preserved

E FOSSIL KEY CHARACTERS

Finger-like veins, as in other spp. of genus

Very similar to P. alba and P. tremula, but less hairy and bud shape more sharp-pointed

Figure 43. (above and opposite): (a) Populus canescens: individual scale showing finger-like thickenings; (b) Populus nigra: outer and inner scales.

Populus nigra L.

BLACK POPLAR

A WHOLE BUD

Fig. 43(b)

10-15 x 3-6 mm variable

Reddish-brown to pale brown

Ovoid to long pointed; terminal bud narrowly ovoid conic and lateral buds closely adpressed

Spiral arrangement on stem

Shiny

Flower buds are less adpressed, large glossy, bright green

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement is spiral

5-12 scales in bud

Scales more or less rounded, irregular; may have pointed tip

Scales broad, short-pointed and leathery

C INDIVIDUAL SCALES

Cell shape rounded to subrectangular, irregular

No hairs seen

Scattered angular crystals may occur

Veins with 'finger-like' thickenings (but these not clearly visible), many, close together, running from top to bottom, or sometimes fused into one thick wide band in centre (cf. Populus nigra ssp. italica)

(Note the catkin buds do not have these thickenings, but are otherwise similar)

CATKIN-BRACTS

Fig. 42(c)

Laciniate shape, but no hairs,

A few stigmata, veins parallel

Cells oblong, cell walls fairly thick and pitted

Bracts darkened towards tip, size variable

D FOSSIL PRESERVATION

Could be preserved

E FOSSIL KEY CHARACTERS

Finger-like veins, as in other spp. of Populus

Lack of hairs distinguishes it from other species, but this character may not apply to fossil material where hairs can be lost

Note variations between terminal and lateral and catkin buds: difference in size, shape and presence of thickenings

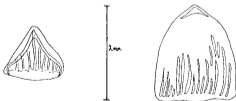


Figure 43 (continued).

(b)

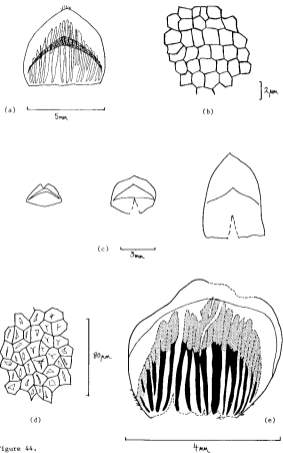


Figure 44.

Populus tremula L.

ASPEN

A WHOLE BUD

Fig. 44

7-10 x 2 mm; catkin buds 10-12 mm long, prominent

Lateral buds long-ovoid, acute or nearly acuminate, hardly adpressed, tips often incurved

Terminal bud ovoid, conic, larger

Glabrous and viscid, somewhat ciliate

Glistening, light brown

Spirally arranged

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Spiral arrangement

About four outer scales and up to about 10 inner stipules

Scale shape rounded with a pointed tip, becoming longer and thinner within bud

C INDIVIDUAL SCALES

Cells subrectangular to rounded, walls medium thick to very thick especially over the veins

Crystals sometimes visible in the vein fingers

Hairs single-celled, at the base and a few around the margin

Veins 12 to 15, with finger-like thickenings, running from base to tip of scale

CATKIN-BRACTS

Fig. 42(a)

Bracts variable in size; deeply lacinate, the divisions reaching more than half-way down, but variable in number

Very long hairs all around the margin

Veins simple, unbranched

Cells oblong, moderately thick-walled

Whole bract rather dark

D FOSSIL PRESERVATION

Easily preserved, probably better than the other Populus speciesInterglacial: Rabien (1953); Coxon et al. (1980; P. cf. tremula);

Flandrian: Hesmer (1935); CATKIN-BRACTS: Pennington (1947)

E FOSSIL KEY CHARACTERS

Overall bud shape and presence of thickenings under veins are characteristic features, but may be difficult to distinguish from other species

Figure 44. (opposite): Populus tremula: (a) individual scale showing 'fingers'; (b) cell pattern, abaxial; (c) bud-scale spectrum; (d) fossil cell pattern (note very characteristic thickening of cell lumina); (e) fossil scale.

A WHOLE BUD

Buds small 2-3 x 2-3 mm, flower buds are larger
 Bud shape conical, short-pointed
 Dark grey to brown
 Ciliate
 Spirale arrangement on stem

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules
 Arrangement is distichous
 About 10 scales
 Outer scales more or less rounded, inner scales larger and with characteristic three-pointed tip

C INDIVIDUAL SCALES

Cells rounded to subrectangular, variable
 Medium thick walls
 Hairs few; around margin, at tip, and on abaxial surface
 Hairs are single-celled
 Glands multicellular, finger-like; flower bud-scales: occur around margins; leaf bud-scales: only occasionally at tip and on inner scales
 Veins three; in flower bud-scales: joining at tip; on leaf bud-scales: rather faint with only one central vein clearly visible (more visible on inner scales)

D FOSSIL PRESERVATION

Could well be preserved, but not easy to identify

E FOSSIL KEY CHARACTERS

Features characteristic of Rosaceae such as the three-pointed tip and multicellular glands occur, but not on all scales
 There are differences between the Prunus species but these may not be distinctive enough
Prunus domestica subspecies would not be distinguishable in archaeological material

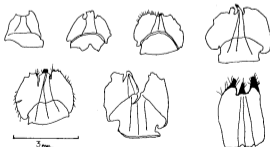


Figure 45. Prunus domestica: bud-scale spectrum.

Prunus spinosa L.

BLACKTHORN

Fig. 46

A WHOLE BUD

1.5 x 1.3 mm

Pale or dark brown to red

Subglobular, ovoid, obovate

Nearly glabrous or hairy, flower buds less hairy, less distinct in shape and smaller than leaf buds

Spiral arrangement on stem

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement spiral or aggregated into groups of three

About 10 scales

Outer scales very small

Scale shape very irregular or single-pointed tip

C INDIVIDUAL SCALES

Cells subrectangular, irregular

Cell walls not very distinct, sometimes pitted, medium thick

Hairs around margin and tip or tip only, or no hairs

Stomata sometimes occur towards tip

Glands around the margin, Rosaceae type, not always present

D FOSSIL PRESERVATION

Probably too small to be recognised

E FOSSIL KEY CHARACTERS

Small size, hairs, glands and stomata are characteristic

Figure 46. Prunus spinosa: bud-scale spectrum.

Pyrus communis L.

PEAR

Fig. 47

A WHOLE BUD

5-10 x 5 mm

Glistening dark brown to yellowish-brown

Conical or short-pointed

Glabrous or slightly pubescent, ciliate

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement is distichous

About 10 scales

Scale shape rounded, with a pointed tip

C INDIVIDUAL SCALES

Irregular, fairly small cells

Cell walls medium or thin

Crystals scattered, squarish, mostly in central vein area, fairly frequent

Hairs on adaxial surface and around margin

Veins three, joining at the tip, forming a triangle of darker cells

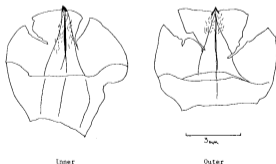
D FOSSIL PRESERVATION

Might be preserved, but difficult to identify

E FOSSIL KEY CHARACTERS

Overall shape, and size of bud, and the presence of lots of crystals are the only distinctive characters

Easy to confuse with other Rosaceae

Figure 47. *Pyrus communis*: outer and inner scales.

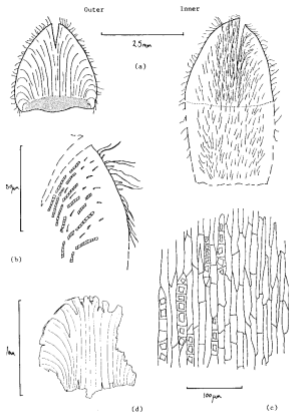


Figure 53. (above and opposite): *Quercus*: (a) outer and inner scales; (b) part of scale showing crystals, hairs and glands (cell walls not shown); (c) cell pattern, showing rows of crystals; (d) fossil scale, showing arrangement of cells (crystals not shown); (e) bud-scale spectrum.

Quercus L.

OAK

comprising Q. robur L. and Q. petraea (Mattuschka) Liebl.

A WHOLE BUD

Figs. 52(b) and 53

2-5 x 2-3 mm. (Q. petraea buds may be slightly larger - up to 6mm)

Tawny brown

Stout, blunt and ovoid, slightly 5-angled

Glistening and glabrous

Ciliate scales (Q. petraea slightly hairier)

Buds alternate and clustered at tip of shoot

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Spiral arrangement

Numerous scales (more than 20 per bud)

Scales more or less rounded or triangular, with rounded or pointed tip

Scales increasingly long and thin towards centre

C INDIVIDUAL SCALES

Cells oblong, fairly long and narrow; may have more rounded shape towards margins

Cell wall medium thick

Crystals square, in long rows

Hairs single-celled, at margins and on some surfaces; Q. robur: morefrequent on inner scales than outer; Q. petraea: scattered on bothsurfaces; Q. petraea more hairy than Q. robur

Glands two- or three-celled, hair-like: scattered over both surfaces in

Q. petraea; mainly around margins and at tip of Q. robur

Veins not easy to see except on inner scales: parallel, unbranched and short, as many as 18

D FOSSIL PRESERVATION

Many records in Godwin (1975). Interglacial: Rabien (1953), Hall

(1980); Flandrian: Hesner (1935); Urban archaeological: Hall (York);

Bronze Age: Attwater (1972); Medieval: Tomlinson and Kenward (in prep).

Quercus petraea: Flandrian: Mitchell (1951).

Easily preserved, both as individual scales and whole buds; easy to recognise.

E FOSSIL KEY CHARACTERS

The rows of square crystals are the most characteristic feature (though

they are not always visible); also the shape and arrangement of the cells

May be confused with Carpinus

Hairs generally fall off; crystals less frequent on inner scales

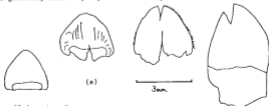


Figure 53 (continued).

Rhamnus catharticus L.

BUCKTHORN

A WHOLE BUD

Fairly small, 1-4 x 2-3 mm

Dark brown to blackish

Ovate, acute

Smooth, slightly ciliate

Buds sub-opposite, adpressed

Fig. 54

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement primarily opposite but becoming spiral within bud

4-5 pairs of scales showing, total about 8-10

Scale shape blunt or slightly pointed

Slightly keeled

C INDIVIDUAL SCALES

Cell shape polygonal, subrectangular to oblong, in rows

Fairly thick-walled

Hairs single-celled, around the margin only

Veins not distinct, two or three, short, unbranched, parallel, not visible on outer scales

D FOSSIL PRESERVATION

May possibly be preserved, although rather small

E FOSSIL KEY CHARACTERS

Characteristic features are marginal hairs and cell shape and arrangement

Could be confused with Corylus, although Rhamnus has no glands

Figure 54. Rhamnus catharticus: (a) bud-scale spectrum; (b) individual scale showing the two main veins and marginal hairs;

Figure 55. (opposite): Rhododendron ponticum: (a) marginal gland; (b) bud-scale spectrum (far right is an inner scale from the densely hairy flower-bud); (c) bract from beneath the bud.

Rhododendron ponticum L.

RHODODENDRON

Fig. 55

A WHOLE BUD

20-25 x 10-14 mm

Greenish, sticky, waxy

Bud shape: ovoid with pointed tip

B TYPE AND ARRANGEMENT OF SCALES

Scales are reduced leaves

Scales spirally arranged

20+ scales

Scale shape: variable, but sharp-pointed tip

C INDIVIDUAL SCALES

Cells irregular on abaxial surface, jig-saw pattern on adaxial

Cell walls medium-thick

Hairy, mainly on abaxial surface and tip of outer scales; inner scales densely hairy

Hairs variable in length, some hairs at base very long and paired

Glands relatively large, multicellular, club-shaped, on abaxial surface and around margin

Veins: one main, relatively broad, central vein with thinner laterals branching towards tip

Stomata: a few on abaxial surface

Cuticular striations quite pronounced on abaxial surface

D FOSSIL PRESERVATION

Could well be preserved, as waxy and large

Interglacial: Jessen et al. (1959) recorded 'probable bracts below the buds' which look very similar to bud-scales

E FOSSIL KEY CHARACTERS

Shape, large size, glands around the margin (could confuse with Rosaceae type glands), hairs and vein arrangement are characteristic

Cell pattern unlikely to be visible

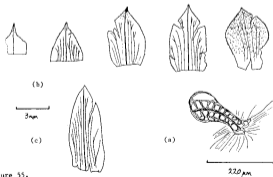


Figure 55.

Ribes L.

CURRANT

(material examined: R. rubrum L. (R. sylvestre (Lam.) Mert. & Koch) and R. nigrum L.)

A WHOLE BUD

Fig. 56

6 x 2 mm approx

Shortly stalked

Greenish or pale brown

Bud scales loosely imbricated in R. nigrum but closely imbricated in R. sylvestre

Bud shape ovoid

Arrangement on stem spiral

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Spirally arranged

6-8 scales

Scale shape: rounded, irregular in R. nigrum; pointed tip in R. sylvestre

C INDIVIDUAL SCALES

Cells very irregular, rounded

Thin walls pitted with irregular thickenings

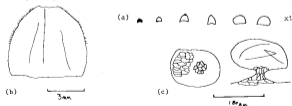
R. sylvestre has star-like crystals (not present in R. nigrum)R. nigrum has large round yellow peltate glands on outer surface in furrows and towards base, occasionally on inner surface (not present in R. sylvestre)R. sylvestre has no hairs; R. nigrum has a few single-celled relatively short hairs on abaxial surface and more on adaxial and marginVeins simple, parallel, mainly unbranched or sometimes branched towards the tip (R. nigrum), or joining at tip (R. sylvestre)R. nigrum has a few stomata on both surfaces (R. sylvestre has no stomata)

D FOSSIL PRESERVATION

Might possibly be preserved

E FOSSIL KEY CHARACTERS

Thin pitted walls are the main feature

The crystals in R. sylvestre and the large glands in R. nigrum are also characteristic (note the glands survived boiling in Jeffrey's solution, so might be preserved in fossils)Figure 56. Ribes nigrum: (a) bud-scale spectrum; (b) individual scale; (c) glands, shown from top and side view.

Rosa L.

ROSE

(material examined: R. arvensis Huds.)

A WHOLE BUD

2-5 x 1-3 mm, variable

Greenish to reddish

Long-pointed or fat ovoid, variable, blunt

Glabrous

Arrangement on stem spiral

Fig. 57

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement is apiral

6-12 scales per bud

Scale shape: more or less rounded but with three-pointed tip (Rosaceae type)

C INDIVIDUAL SCALES

Rectangular to square cells, variable, some sinuous

Cell walls medium- to thick-walled

Glands around the margin of inner scales (Rosaceae type), and some along the veins

Veins joining at the tip, unbranched except towards the tip; central vein may be slightly thicker

Veins sometimes fused in the outer scales

Stomata occur towards the tip of abaxial side

Crystals occasionally present, beneath the epidermis, angular and scattered

D FOSSIL PRESERVATION

Rather small and soft, unlikely to be preserved

E FOSSIL KEY CHARACTERS

Lack of hairs one of the main characters distinguishing Rosa from other Rosaceae

The three-pointed tip may not show very clearly if at all

Figure 57. Rosa arvensis: bud-scale spectrum (note marginal glands).

Rubus L.

BRAMBLE

(material examined: R. fruticosus agg. and R. caesius L.)

A WHOLE BUD

Fig. 58

3-6 x 4 mm, but variable

Greenish or reddish

Shape: long-pointed, with loosely imbricated hairy scales

Bud arrangement spiral

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement is spiral

6-12 scales

Scale shape: more or less rounded with typical Rosaceae three-pointed tip

C INDIVIDUAL SCALES

Cells irregular to subrectangular

Cell walls medium to thick

Hairs (if present) dense on abaxial surface and scattered on adaxial, some extra long hairs at the tip and margin

Vein arrangement variable; three main veins sometimes branching towards tip or unbranched, joining at tip

D FOSSIL PRESERVATION

Rather unlikely to be preserved except perhaps attached to stems

E FOSSIL KEY CHARACTERS

Main characters are the hairs, vein arrangement and the three-pointed tip

Difficult to distinguish from other Rosaceae

Figure 58. Rubus: bud-scale spectrum.

Salix L.
(includes all British lowland species)

WILLOW

A WHOLE BUD

Figs. 59-60

Variable size depending on species (see below)

Pale brown reddish, yellowish or greenish

May be glabrous or pubescent, depending on the species and time of year
Rounded to flattened, ovoid, conic, pointed tip (varies according to species)Generally arranged spirally on stem (except S. purpurea which has subopposite buds)

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

One scale per bud (formed from two fused stipules)

Scale shape more or less rounded

C INDIVIDUAL SCALES

Cells irregular, rounded to angular, walls fairly thick

Some hairs on abaxial surface, or glabrous (depending on species)

No other features except veins on the inner surface of the scales

CATKIN-BRACTS

See description on following page

D FOSSIL PRESERVATION

Interglacial: Rabin (1953); Urban archaeological: Hall (York);
Medieval: Tomlinson and Kenward (forthcoming); see also Godwin (1975)
for records of Salix caprea, S. cinerea and S. repens identified from
buds associated with other parts Salix buds are preserved frequently, in
all types of deposits

E FOSSIL KEY CHARACTERS

Single scale per bud and lack of other features

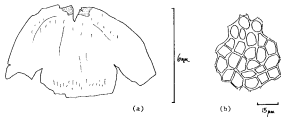
Veins unlikely to preserve, cell walls may appear thickened after
preservation of scalesUnlikely to distinguish the different species in preserved material,
unless preserved with leaves as well

Figure 59. Salix: (a) scale, flattened out; (b) cell pattern, abaxial surface.

NOTES ON INDIVIDUAL SALIX SPECIES BUDS

<u>Salix alba</u>	Buds very small 2 mm; pubescent; oblong with narrow curved beak to ovoid, pointed
<u>S. aurita</u>	Buds oval, subobtuse; glabrous or hairy
<u>S. caprea</u>	3-10 long x 4-8 mm wide, pubescent at first, soon glabrous; ovoid to conic, bluntly ovoid, trigonous shape
<u>S. cinerea</u>	Buds glabrous pubescent or tomentose; ovoid
<u>S. fragilis</u>	Becoming hairless and viscid; long pointed, conic to ovoid, closely adpressed to stem, 'duckbill shaped'
<u>S. pentandra</u>	Ovoid, conic; 5 mm; viscid, glabrous
<u>S. purpurea</u>	Oblong, acute; glabrous, sometimes pruinose
<u>S. triandra</u>	Ovoid; soon glabrous; dorsally compressed generally tapering to a rather slender apex
<u>S. viminalis</u>	Ovoid, obtuse or subacute, 3-7 long x 2-5 mm wide; densely pubescent at first, becoming glabrous

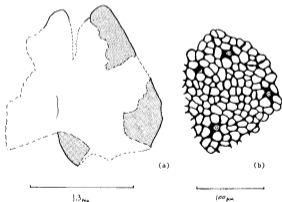


Figure 60. Salix: (a) fossil scale (note notched tip - this is probably Salix viminalis); (b) cell pattern and hair cicatrices in fossil scale (drawn from several focal planes).

SALIX CATKIN-BRACTS

Fig. 61(a-g)

Shape variable (depending on species): mostly more or less rounded to oblong

Glabrous, or hairy, often with long silky hairs; *SS. alba*, *fragilis*, *triandra*, *pentandra* have fairly short hairs and sometimes a glabrous tip. *SS. aurita*, *caprea*, *cinerea*; *repens* and *viminalis* and *purpurea* have long hairs, often twice as long as the bract

Veins sometimes visible: three, parallel

Cells in a loose irregular pattern, cell walls fairly thick

Unlikely to be able to distinguish different species on catkin-bracts alone.

SALIX FRUIT CAPSULES

Fig. 61(h-l)

Variable size, 5-8 mm long

Shape ovoid-conic, variable (depending on species)

Glabrous or tomentose

Unlikely to be able to distinguish different species

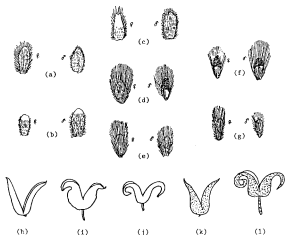


Figure 61. *Salix*, catkin-bracts (re-drawn from Ross-Craig (1948-73)); (a) *S. pentandra*; (b) *S. triandra*; (c) *S. fragilis*; (d) *S. viminalis*; (e) *S. aurita*; (f) *S. cinerea*; (g) *S. repens* (all $\times 4.5$).

Salix fruit capsules: (h) *S. pentandra*; (i) *S. triandra*; (j) *S. fragilis/alba*; (k) *S. viminalis*; (l) *S. caprea* (all $\times 3.3$).

Sambucus nigra L.

ELDER

A WHOLE BUD

Fig. 62

Buds open and irregularly elongated, exposing the tips of the young green leaves
 Long-pointed shape
 Buds opposite

B TYPE AND ARRANGEMENT OF SCALES

About 10 pairs of olive-greenish or reddish or purple brown dry membranous scales
 Reduced leaf bases, in opposite pairs

C INDIVIDUAL SCALES

Rounded subrectangular or irregular cells; walls may appear double thick
 Long multicellular hair-like glands up to 1 mm long with rounded or pointed head occur all over the surface
 Broad-based (almost prickle-like) hairs occur along the margin
 Veins parallel, unbranched, joining at tip

D FOSSIL PRESERVATION

Rather unlikely to be preserved, except perhaps the tip (which is thickened)

E FOSSIL KEY CHARACTERS

Long hair-like glands and prickle-like hairs are characteristic
 Glands probably would not be readily preserved

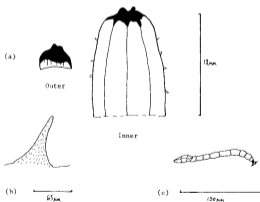


Figure 62. Sambucus nigra: (a) outer and inner scales; (b) hair (note cuticular sculpturing); (c) hair-like gland.

Sorbus aucuparia L.

MOUNTAIN ASH, ROMAN

(and notes on S. aria (L.) Crantz, WHITEBEAM)

A WHOLE BUD

Figs. 63-4

Terminal buds 10-15 mm, laterals smaller

Shiny, dark purple, somewhat pubescent with long dense adpressed grey, hairs, not viscid

S. aria less hairy or glabrous, viscid at apex, olive-greenish with brownish base and whitish tip

Terminal buds ovoid-conical, laterals smaller and flatter, sometimes adpressed

S. aria has somewhat keeled scales making the bud four-angled

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules, arrangement is spiral

5-6 scales per bud

Scale shape: more or less rounded, becoming longer and narrower within bud, with three-pointed tip

C INDIVIDUAL SCALES

Cells rounded to subrectangular and irregular, fairly thick-walled

Hairs, single-celled: around margin, and at tip and base of outer scales; inner scales densely hairy

Cells at base of hairs have extra thick walls and stand out clearly as cicatrices (which are frequent on abaxial surface of outer scales where the hairs have rubbed off)

Large, finger-like, multicellular glands at the base of adaxial side, in a distinct row, 30 or more

One central vein plus one or two pairs of subsidiaries, joining at tip

Veins may branch towards the tip in S. aria

D FOSSIL PRESERVATION

S. aria unlikely to be easily preserved as rather soft and green, although the outer scales are somewhat stickyS. aucuparia might be preserved

E FOSSIL KEY CHARACTERS

The row of glands, which would easily be preserved in whole buds, but might fall off individual scales, are the best character; three-pointed tip and vein arrangement may also help

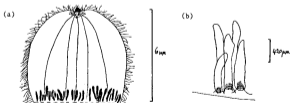


Figure 63. Sorbus spp.: (a) individual scale showing shape of tip and the finger-like glands at the base; (b) glands.

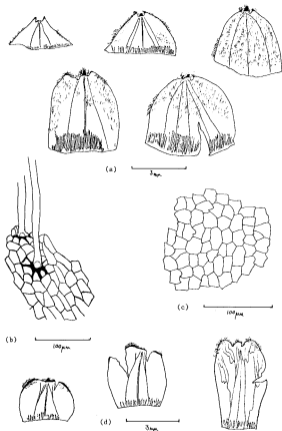


Figure 64. *Sorbus aucuparia*: (a) bud-scale spectrum; (b) cell pattern showing thickened cells at hair base; (c) abaxial cell pattern; *Sorbus aria*: (d) bud-scale spectrum.

Sorbus domestica L. and

SERVICE AND WILD SERVICE

S. torminalis (L.) Crantz

Fig. 65

A WHOLE BUD

Bud ovoid, globular, with pointed tip, glossy, resinous

Bright green

S. domestica hairy, S. torminalis nearly glabrous

5-10 x 5-6 mm

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

About 4-6 scales

Scales are green with narrow brown margins

C INDIVIDUAL SCALES

Abaxial cells rounded to subrectangular, irregular; adaxial irregular

Cell walls medium thick

Hairs long; S. domestica: frequent on margin and at tip; S. torminalis:at or near base, fewer than S. domestica

Row of large finger-like glands at base of adaxial surface (also from

base to tip in S. torminalis)

Veins parallel, joining at tip, three or four from base, sometimes branched

D FOSSIL PRESERVATION

Could well be preserved as resinous, but green

E FOSSIL KEY CHARACTERS

The glands, which may be a characteristic feature, can easily be dislodged and are unlikely to be preserved unless the bud is intact

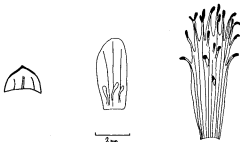
Probably not possible to distinguish from other Sorbus species

Figure 65. Sorbus torminalis: bud-scale spectrum (note inner scale with developed glands).

Taxus baccata L.

YEN

A WHOLE BUD

2-4 x 1-2 mm

Green to dark chestnut brown

Ovoid

Fig. 66

B TYPE AND ARRANGEMENT OF SCALES

Overlapping rounded scales which are reduced leaves

Arrangement subopposite

Leaf buds: 16-20 scales; flower buds: 6-10 scales

Scale shape: rounded

C INDIVIDUAL SCALES

Cells oblong, variable cell wall thickness

Margins of scales scarios

A few stomata (which are typical coniferous type, with characteristically bulging subsidiary cells and sunken guard cells) on adaxial surface of inner scales

One central main vein, not always visible

D FOSSIL PRESERVATION

Very small and soft, unlikely to be preserved easily

Interglacial: Rabien (1953)

E FOSSIL KEY CHARACTERS

Small, rounded shape of scales with scarios margin, cell shape and lack of hairs or glands are probably the only reliable characters

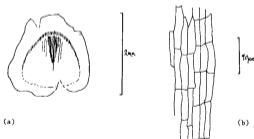


Figure 66. Taxus baccata: (a) individual scale showing thickened cells in centre; (b) cell pattern.

Tilia L.

LIME

(material examined: T. cordata Mill., T. platyphyllos Scop. and T. x vulgaris Hayse)

A WHOLE MUD

Figs. 67-8

8 x 5 mm approx

Ovoid, shiny, smooth

Dark reddish

B TYPE AND ARRANGEMENT OF SCALES

Scales are fused pairs of stipules arranged in a spiral

2 or 3 scales are exposed, the 2nd or 3rd scale completely encloses the rest, the 1st or 2nd scale very small and bulging

3 outer scales, 6 or more inner scales which are green

Scale shape more or less rounded

C INDIVIDUAL SCALES

Cells subrectangular to irregular

Abaxial cells thick-walled, adaxial thin-walled

Star-like, angular crystals within the scales (may need to focus up and down to see)

Hairs single-celled, around the margin or at tip only, or none on outer scales; more frequent on inner scales (T. cordata is less hairy)

Some hairs at base of scales are joined at the base in twos or threes

T. x vulgaris has multicellular, hair-like glands at base of adaxial surface only

Veins form characteristic rounded areole pattern (may need to focus up and down to see)

D FOSSIL PRESERVATION

Outer scales or whole buds likely to be preserved

Interglacial: Rabien (1953); Flandrian: Hesmer (1935)

E FOSSIL KEY CHARACTERS

Vein arrangement and the star-like crystals are characteristic

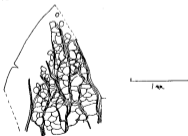
May be able to distinguish the Tilia species on the extent of hairiness in well-preserved material

Figure 67. Tilia sp.: Part of scale showing the areole pattern produced by the veins. (Tilia drawings continued overleaf)

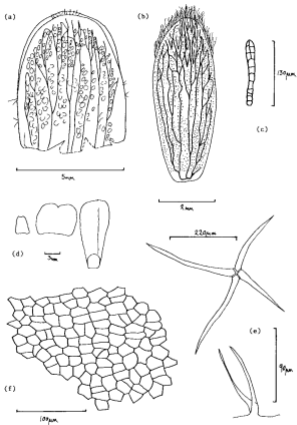


Figure 68. *Tillia*: (a) individual scale of *Tillia cordata*, showing vein pattern; (b) individual scale of *Tillia platyphyllos*, showing crystals (dark dots); (c) gland; (d) bud-scale spectrum; (e) hairs; (f) cell pattern.

Ulex europaeus L.

GORSE

Fig. 69

A WHOLE BUD

Flower buds: 5 x 3.5 mm; leaf buds minute

Ovoid

Green and densely hairy

Leaf buds obscured by the numerous and much-branched green thorns

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement is opposite

2 or 4 scales

Scale shape: pointed tip

C INDIVIDUAL SCALES

Cells irregular, shape obscured by hairs

Densely hairy on both surfaces

Outer scales have stomata on adaxial surface

Veins parallel, with one main central vein plus subsidiaries

D FOSSIL PRESERVATION

Very unlikely to be preserved unless still attached to stem

E FOSSIL KEY CHARACTERS

Dense hairiness



Figure 69. Ulex europaeus: individual scale showing hairs and position of the stomata.

ULMUS (Figs. 49(below), 51(b), 70-2)

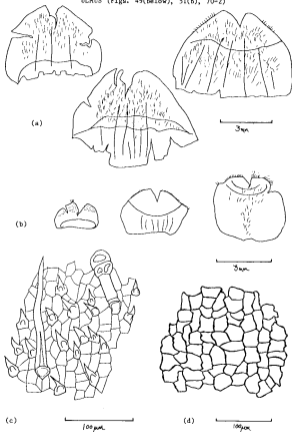


Figure 70. *Ulmus*: (a) *Ulmus glabra* bud-scale spectrum; (b) *Ulmus procera* bud-scale spectrum; (c) *Ulmus glabra* cell pattern, showing hair, gland and prickles (crystals not shown); (d) cell pattern.

Ulmus glabra Buds.

WYOM ELM

A WHOLE BUD

Fig. 70(a,c,d)

4-6 x 3-4 mm; buds larger than U. procera

Obtuse, ovoid

Dull red-brown with rusty-reddish hairs

Buds alternate

Flower buds are very fat and swollen, leaf buds more pointed

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Bistichous arrangement

12 scales (including 4 or 5 inner stipules); these inner stipules are bright red and conspicuous as the bud opens out

Scale shape: rounded but edge more or less jagged

C INDIVIDUAL SCALES

Cells angular, irregular shape but becoming markedly sinuous towards the margin

Cell walls medium thick

Crystals scattered, angular, mainly towards margin, not always visible

Hairs long, on both surfaces

Short prickles mainly towards the base on both surfaces

Glands club-shaped, on both surfaces

Veins short, parallel, unbranched, visible only on inner scales

Cuticular striations visible

D FOSSIL PRESERVATION

Interglacial: Rabien (1953); both the hairs and the prickles were preserved

Other fossil records (identified only to Ulmus sp.: Interglacial: Hall (1980); Flandrian: Hesser (1935); Roman: Wilson (1968)

E FOSSIL KEY CHARACTERS

Main features are the sinuous cell shapes towards the margins and the crystals, hairs, glands and prickles

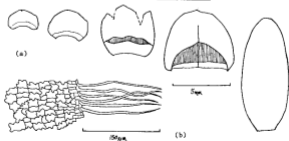
Buds generally larger and hairier than Ulmus procera

Figure 71. Ulmus spp.: (a) bud-scale spectrum; (b) cells at margin showing sinuous to jig-saw pattern and marginal hairs.

Ulmus procera Salisb.

ENGLISH ELM

A WHOLE BUD

2-3 x 2 mm

Pointed, ovoid

Dark brown

Slightly pubescent

Buds alternate

Fig. 70(b)

B TYPE AND ARRANGEMENT OF SCALES

Scales are stipules

Arrangement is distichous or doubly distichous

About 8 outer scales and 4-6 inner scales

Shape irregular, more or less rounded

C INDIVIDUAL SCALES

Cell shape irregular with sinuous to jigsaw shapes at margins

Crystals scattered, rectangular, on abaxial and adaxial surfaces

Hairs around the margin slender, elsewhere wide-based, scattered

Glands club-shaped, multicellular: on margin and scattered on abaxial and adaxial surfaces

Some wide-based prickles present on both surfaces

Veins parallel, sometimes a little branched, on inner scales only

D FOSSIL PRESERVATION

Small size, so may be overlooked, but likely to be preserved

ULMUS sp. fossil records on previous page

E FOSSIL KEY CHARACTERS

Crystals, sinuous cells at margins, hairs, prickles and glands are all characteristics

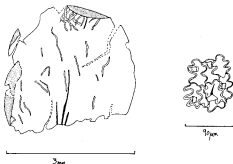
May be difficult to distinguish from U. glabra

Figure 72. Ulmus spp.: fossil scale and detail showing cells, prickles and crystals.

Viburnum opulus L.

GUELDER ROSE

A WHOLE BUD

6-8 x 2-4 mm

Bud shortly stalked, ovoid to short-pointed and somewhat flattened near the stem or bluntly four-angled

Smooth, slightly viscid and shiny

Shiny red-brown or greenish-brown

Buds opposite

Fig. 73

B TYPE AND ARRANGEMENT OF SCALES

Scales are reduced leaves, fairly long and narrow with a pointed tip (inner scales rounded)

One or two opposite pairs of scales (each pair usually fused) which completely envelope the bud

C INDIVIDUAL SCALES

Cell shape varies from rounded or angular to irregular

Cell walls medium-thick

Glands occur on inner scales, multicellular, round-headed (peltate)

Veins are simply-branched, parallel below, joining at the tip in the outer scales

Cuticular striations on abaxial surface of scales

D FOSSIL PRESERVATION

Possibly preservable

E FOSSIL KEY CHARACTERS

Small number of scales, lack of hairs, and presence of glands are characteristic

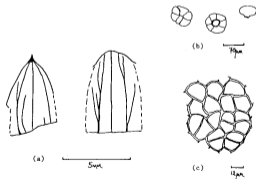
(N.B. Viburnum lantana L. has naked buds)

Figure 73. Viburnum opulus; (a) outer and inner scales; (b) glands top and side view; (c) cell pattern.

KEY FOR THE IDENTIFICATION OF COMMON TAXA

This key has been produced using characters which are likely to be best preserved in fossil material. It should be used in conjunction with the descriptions and as an initial step in the identification process. The key was developed using a computer-based key-producing program (written by R. J. Pankhurst of the British Museum (Natural History); see Pankhurst (1975, 1978)). An interactive, multi-access computer key was also produced; details of this are available from the present author.

List of taxa included in the key

- | | |
|-------------|-------------|
| 1. ACER | 8. PINUS |
| 2. ALNUS | 9. POPULUS |
| 3. BETULA | 10. QUERCUS |
| 4. CARPINUS | 11. SALIX |
| 5. CORYLUS | 12. TAXUS |
| 6. FAGUS | 13. TILIA |
| 7. FRAXINUS | 14. ULMUS |

- | | |
|--|----------|
| 1 CELL SHAPE: long and narrow or oblong | 2 |
| 1 CELL SHAPE: sinuous at margins | 5 |
| 1 CELL SHAPE: angular to rounded and irregular | 7 |
| 2 CRYSTALS: absent; GLANDS: absent | 3 |
| 2 CRYSTALS: rows of squares; STOMATA: none | 4 |
| 3 HAIRS: absent; STOMATA: present on inner scales
SCALE SHAPE: rounded, with scarious margin;
BUD: small <5 mm; CELL WALLS: medium to thick | TAXUS |
| 3 HAIRS: around margin, single-celled; VEINS: not visible (resin canals in cross section); STOMATA: absent; SCALE SHAPE: long and narrow; BUD: large >10mm or medium 5-10 mm; CELL WALLS: thick and pitted with narrow lumen | FINACEAE |
| 4 BUD: large >10 mm; VEINS: parallel, unbranched, about 12 per scale, running from base; HAIRS and GLANDS: a few around margin; BUD SHAPE: long pointed | FAGUS |
| 4 BUD: medium 5-10 mm to small <5 mm; BUD SHAPE: ovoid
VEINS: parallel, unbranched, only running half way | QUERCUS |
| 5 PRICKLES: present; HAIRS: present; GLANDS: present
CRYSTALS: towards margin, angular shape | ULMUS |
| 5 PRICKLES: absent | 6 |

- 6 CRYSTALS: rows of square or angular, or scattered
STOMATA: absent; VEINS: many parallel, very broad and
conspicuous, unbranched; HAIRS: single-celled
SCALES: 12-20+ CARPINUS
- 6 STOMATA: present; CRYSTALS: absent or scattered angular;
VEINS: parallel and mainly unbranched; SCALES 6-12;
GLANDS: basal, showing as dark patches, peltate;
HAIRS: marginal BETULA
- 7 PRICKLES: present; HAIRS: present; GLANDS: present;
CRYSTALS: angular, towards margin ULMUS
- 7 PRICKLES: absent 8
- 8 STOMATA: present, outer scales only BETULA
- 8 STOMATA: absent, or very rare 9
- 9 SCALES: long and narrow with rounded tip;
GLANDS: peltate, scattered, frequent; VEINS:
much branched from a multi-base; HAIRS: marginal,
single and multicellular; BUDS: on pedicels ALNUS
- 9 SCALES: single pointed tip, triangular 10
- 9 SCALES: more or less rounded shape 11
- 10 VEINS: joining at tip;
SCALES: reduced leaves, 6-12 ACER
- 10 VEINS: parallel, unbranched, broad and
conspicuous; SCALE: stipule, 12-20 CARPINUS
- 11 VEINS: finger-like; CRYSTALS: scattered, angular POPULUS
- 11 VEINS: forming rounded, areole pattern
CRYSTALS: star-shaped TILIA
- 11 VEINS: parallel, mainly unbranched, or many much
branched from multi-base or absent/not visible 12
- 12 SCALES: one; VEINS: not easily visible
GLANDS: absent SALIX
- 12 SCALES: 6-12; VEINS: many, much branched
from multi-base; GLANDS: marginal, abaxial and
adaxial, club-shaped CORYLUS

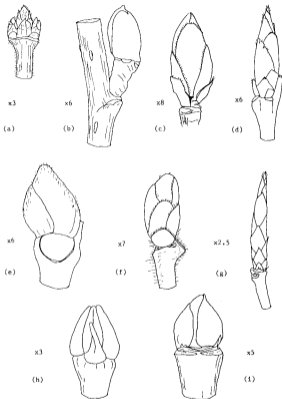


Figure 74. Whole buds (re-drawn from Edlin, 1975): (a) Acer campestre; (b) Alnus glutinosa; (c) Betula pendula; (d) Carpinus betulus; (e) Castanea sativa; (f) Corylus avellana; (g) Fagus sylvatica; (h) Fraxinus excelsior; (i) Juglans regia.

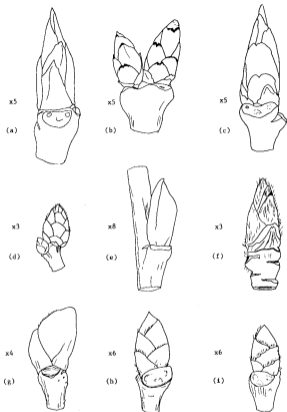


Figure 75. Whole buds (as Figure 73): (a) Populus nigra; (b) Fraxinus avium; (c) Populus tremula; (d) Quercus robur; (e) Salix caprea; (f) Sorbus aucuparia; (g) Tilia cordata; (h) Ulmus glabra; (i) Ulmus procera.

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APPENDIX: SOURCES OF FOSSIL SPECIMENS USED

Material from the following sites was drawn and photographed:

Bewsey Old Hall, Merseyside (medieval moat: Tomlinson and Innes, in prep.): Figs. 30(d) and 52(b).

16-22 Coppergate, York, N. Yorkshire (mainly Anglo-Scandinavian: unpublished): Figs. 18(f), 25(c), 45(e), 52(a), 59(a,b).

Skipsea, N. Humberside (Late Devensian and Flandrian: Gilbertson, 1984): Figs. 18(c,d), 51(a).

Speke Hall, Merseyside (medieval moat Tomlinson and Kenward, forthcoming): Fig. 53(d).

Wing, Leicestershire (Ipswichian interglacial: Hall, 1980): Figs. 16(a), 19(b), 22(d,e), 48(a-c), 49(a,b), 50(a), 51(b) and 71.

Poultry-faeciera' Section

Postscript to 'Chicken Legs Revisited' (Circaea 3(1), 11-14)

Church and Johnson (1964) state that the proximal epiphysis of the male and female tarsometatarsus fuses to the shaft at about four months in their modern New Hampshire/Barred Rock cross-breed. Considering the evidence given by Bull and Payne (1982) for pigs, and Bullock and Rackham (1982) for goats, one would also expect a later fusion time for fowl in archaeological material.

Four examples were given of socket primordia on tarsometatarsi with unfused epiphyses. In order for this to occur, the spur would have to grow quickly enough for the spur core to form and reach the 'critical distance' to induce formation of the socket primordium before the proximal epiphysis fused. In my opinion, only capons would be able to manage this: not only by more rapid growth, but also by delayed epiphysial fusion.

Bull, G. and Payne, S. (1982). 'Tooth eruption and epiphysial fusion in pigs and wild boar', pp. 55-71 in B. Wilson, C. Grigson and S. Payne (eds.) Ageing and sexing animal bones from archaeological sites. British Archaeological Reports British Series 109, Oxford.

Bullock, D. and Rackham, D. J. (1982). 'Epiphysial fusion and tooth eruption of feral goats from Moffatdale, Dumfries and Galloway, Scotland', pp. 73-80 in B. Wilson, C. Grigson and S. Payne (eds.) Ageing and sexing animal bones from archaeological sites. British Archaeological Reports British Series 109, Oxford.

Church, L. E. and Johnson, L. C. (1964). Growth of long bones in the chicken. American Journal of Anatomy 114, 521-38.

Barbara West

Pre-Roman chicken bones - an appeal for records

As some readers will already be aware, Barbara West is conducting a survey of early records of Gallus from the whole world. Anyone having records of domestic fowl from pre-Roman deposits or their chronological equivalent is invited to contact Barbara c/o Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5ED.