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(Major Professor)

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75 families and 220 genera of higher plants of Oregon are reported as visited by honey bees. This list includes native, naturalized and cultivated forms. Bees are reported as working 128 genera for pollen. 48 of these genera are considered as dominant pollen sources. The range, time of flowering, and a short description of the pollen grains is given for a representative species from each dominant source. A key to the 48 representative species is included along with photomicrographs of the pollen grains.

This report is the result of a cooperative study carried out under the supervision and aid of the botany and entomology departments of Oregon State College.

A CONTRIBUTION TO THE STUDY OF OREGON PLANTS VISITED BY HONEY BEES, WITH SPECIAL REFERENCE TO THOSE UTILIZED AS A SOURCE OF POLLEN

by

HOWARD RAY YOUSE

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APPROVED:

[redacted]

Professor of Botany

In Charge of Major

[redacted]

Head of Department of Botany

[redacted]

Chairman of School Graduate Committee

[redacted]

Chairman of State College Graduate Council

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CONTENTS

A CONTRIBUTION TO THE STUDY OF OREGON PLANTS VISITED BY HONEY BEES, WITH SPECIAL REFERENCE TO THOSE UTILIZED AS A SOURCE OF POLLEN

Introduction

In order to raise honey bees successfully it is necessary to have an adequate supply of nectar and pollen. Nectar is the chief source of carbohydrates in the diet of the honey bee. Pollen is the chief source of other foodstuffs required by bees. Pollen grains are rich in proteins, fats, and vitamins. Some plants are visited primarily for pollen, some are visited for pollen and nectar, some are visited primarily for nectar. A large number of plants are necessary to furnish sufficient quantities of pollen and nectar to provide for the normal growth and development of the honey bee colony throughout the year.

Beekeepers are very much interested in the sources of pollen and nectar as the success of their business is determined by locating in a region where bees are able to store large surpluses of honey and still maintain their normal growth and development. This has led to a great number of investigations by a host of workers throughout the United States. Lovell (1926) and Pellett (1930) have reported a large number of important honey and pollen plants for the United States. Richter (1911) published a list of honey plants of California. A more complete bulletin of

the nectar and pollen plants of California was published by Vansell (1931).

Investigations relating to the honey and pollen plants of Oregon were carried on from 1910-1920 by Professor Lovett at Oregon State College. These investigations were continued from 1918-1934 by Dr. H. A. Scullen. In 1935 the Oregon Experiment Station and the Pacific States Bee Culture Laboratories undertook a cooperative project to study the nectar and pollen plants more intensively. This work was under the direction of Dr. H. A. Scullen and Dr. G. H. Vansell. A large number of individual beekeepers have assisted in keeping records of the nectar and pollen plants in their locality. A complete report of these investigations is in manuscript form and will be published soon.

The investigations by the author were started in the spring of 1939 and have been continued until the present time. The primary objective was to discover the available pollen sources utilized by honey bees in Oregon and to study the pollen grains, the range and frequency, and time of flowering of some of the dominant pollen sources.

Pollen may enter the hive in three ways. The major source of pollen in the hive is collected by pollen-collecting bees. Honey bees collect the pollen grains from the anthers and pack them into small balls on their hind legs. These balls or pellets of pollen are then carried

to the hive where they are stored or used as food. Bees may become dusted with pollen in their quest for nectar, and thus they return to the hive covered with pollen. It has been observed many times that these bees are always cleaned up before they return to the field; thus they contribute some to the pollen supply. In addition, pollen grains are abundant in nectar, and hence the bees naturally collect some pollen as they collect nectar.

Since bees come in contact with pollen when visiting most plants and may on certain occasions use pollen from any one of them, the author has prepared a list of all the families and genera of flowering plants in Oregon upon which honey bees have been observed. The genera upon which bees were observed or reported collecting pollen are marked with an *. Those genera considered as dominant pollen sources for Oregon are marked thus: **. The author wishes to acknowledge the help of numerous workers in preparing this list, and he wishes to thank Dr. H. A. Scullen in particular for permission to use his files and records. The families and genera include those listed as native or naturalized to Oregon (Peck, 1941) as well as cultivated forms (Bailey, 1937).

FAMILIES AND GENERA VISITED BY HONEY BEES IN OREGON

1. ACERACEAE (Maple Family)

   ** 1. Acer (Maple)

2. ALISMACEAE (Water Plantain Family)

   1. Alisma (Water Plantain)
   * 2. Sagittaria (Arrowhead)

3. AMARANTHACEAE (Amaranth Family)

   * 1. Amaranthus (Amaranth)

4. AMARYLLIDACEAE (Amaryllis Family)

   * 1. Narcissus (Daffodil)

5. ANACARDIACEAE (Cashew Family)

   1. Rhus (Sumac)

6. APOCYNACEAE (Dogbane Family)

   1. Apocynum (Dogbane)

7. AQUIFOLIACEAE (Holly Family)

   1. Ilex (Holly)

8. ARACEAE (Arum Family)

   ** 1. Lysichitum (Skunk Cabbage)

9. ASCLEPIADACEAE (Milkweed Family)

   1. Asclepias (Milkweed)

10. BALSAMINACEAE (Jewel-weed Family)

    1. Impatiens (Jewel-weed)

11. BERBERIDACEAE (Barberry Family)

    ** 1. Berberis (Oregon Grape)

12. BETULACEAE (Birch Family)

* 1. Alnus (Alder)
* 2. Betula (Birch)
** 3. Corylus (Hazel)

13. BIGNONIACEAE (Catalpa Family)

** 1. Catalpa (Catalpa)

14. BORAGINACEAE (Borage Family)

* 1. Amsinckia (Fiddle-neck)
2. Cynoglossum (Hound's Tongue)
3. Myosotis (Forgetmenot)
4. Plagiobothrys (Plagiobothrys)

15. BUXACEAE (Box Family)

1. Buxus (Box Tree)

16. CACTACEAE (Cactus Family)

* 1. Opuntia (Prickly Pear)

17. CAMPANULACEAE (Campanula Family)

** 1. Campanula (Blue-bell)

18. CAPPARIDACEAE (Caper Family)

** 1. Cleome (Cleome)

19. CAPRIFOLIACEAE (Honeysuckle Family)

** 1. Lonicera (Honeysuckle)
* 2. Sambucus (Elderberry)
* 3. Symphoricarpus (Snowberry)
* 4. Viburnum (Viburnum)

20. CARYOPHYLLACEAE (Pink Family)

* 1. Silene (Silene)
2. Spergula (Spurry)
** 3. Stellaria (Chickweed)

21. CHENOPODIACEAE (Goosefoot Family)

* 1. Atriplex (Salt-bush)
* 2. Salsola (Russian Thistle)
* 3. Sarcobatus (Greasewood)

22. COMPOSITAE (Sunflower Family)

* 1. Ambrosia (Ragweed)
* 2. Anaphalis (Pearly Everlasting)
3. Anthemis (Dog Fennel)
4. Arctium (Burdock)
* 5. Artemisia (Sagebrush)
6. Aster (Aster)
7. Baccharis (Wine Bush)
* 8. Balsamorhiza (Balsam Root)
9. Bidens (Beggar's Tick)
** 10. Centaurea (Bachelor's Button)
* 11. Centromadia (Alkali Weed)
12. Chrysanthemum (Daisy)
13. Chrysothamnus (Rabbitbrush)
** 14. Cichorium (Chicory)
** 15. Cirsium (Thistle)
** 16. Crocidium (Gold-star)
* 17. Grindelia (Gum Weed)
18. Helenium (Sneezeweed)
* 19. Helianthus (Sunflower)
20. Hieracium (Hawkweed)
* 21. Hypochaeris (False Dandelion)
22. Lactuca (Lettuce)
23. Rudbeckia (Black-eyed Susan)
* 24. Senecio (Senecio)
* 25. Solidago (Goldenrod)
26. Sonchus (Milk Thistle)
** 27. Taraxacum (Dandelion)
* 28. Xanthium (Cocklebur)
* 29. Wyethia (Dwarf Sunflower)

23. CONVOLVULACEAE (Morning-glory Family)

* 1. Convolvulus (Morning Glory)
2. Cuscuta (Dodder)

24. CORNACEAE (Dogwood Family)

** 1. Cornus (Dogwood)
2. Garrya (Silk Tassel)

25. CRUCIFERAE (Mustard Family)

** 1. Brassica (Mustard)
2. Cardamine (Bitter Cress)
* 3. Draba (Whitlow Grass)
* 4. Raphanus (Radish)
5. Streptanthus (Streptanthus)
6. Thelypodium (Thelypodium)

26. CUCURBITACEAE (Gourd Family)

* 1. Cucumis (Cucumber)
* 2. Cucurbita (Pumpkin)
** 3. Echinocystis (Wild Cucumber)

27. CUPRESSACEAE (Cypress Family)

* 1. Juniperus (Juniper)
* 2. Libocedrus (Incense Cedar)

28. DIPSACACEAE (Teasel Family)

* 1. Dipsacus (Teasel)

29. ELAEAGNACEAE (Oleaster Family)

* 1. Elaeagnus (Elaeagnus)

30. ERICACEAE (Heath Family)

** 1. Arbutus (Madroño)
2. Arctostaphylos (Manzanita)
3. Calluna (Heather)
4. Cassiope (Cassiope)
5. Erica (Heath)
6. Gaultheria (Salal)
7. Kalmia (Mountain Laurel)
8. Ledum (Labrador Tea)
9. Phyllodoce (Mountain Heath)
10. Rhododendron (Rhododendron)
11. Vaccinium (Huckleberry)

31. EUPHORBIACEAE (Spurge Family)

* 1. Eremocarpus (Turkey-mullein)

32. FAGACEAE (Beech Family)

* 1. Castanea (Chestnut)
* 2. Castanopsis (Chinquapin)

* 3. Lithocarpus (Tan Oak)
** 4. Quercus (Oak)

33. GENTIANACEAE (Gentian Family)

1. Frasera (Frasera)

34. GERANIACEAE (Geranium Family)

** 1. Erodium (Filaree)
2. Geranium (Geranium)

35. GRAMINEAE (Grass Family)

** 1. Phleum (Timothy)

36. HIPPOCASTANACEAE (Horse-Chestnut Family)

* 1. Aesculus (Horse-Chestnut)

37. HYDROPHYLLACEAE (Waterleaf Family)

1. Eriodictyon (Yerba Santa)
2. Hydrophyllum (Waterleaf)
3. Phacelia (Phacelia)

38. HYPERICACEAE (St. John's-wort Family)

** 1. Hypericum (St. John's-wort)

39. IRIDACEAE (Iris Family)

1. Crocus (Crocus)

40. JUGLANDACEAE (Walnut Family)

** 1. Juglans (Walnut)

41. LABIATAE (Mint Family)

1. Agastache (Giant Hyssop)
2. Lamium (Dead Nettle)
3. Lycopus (Water Hoarhound)
* 4. Marrubium (Hoarhound)
5. Mentha (Mint)
6. Micromeria (Oregon Tea)
* 7. Nepeta (Catnip)
8. Prunella (Heal-all)
9. Salvia (Sage)
10. Stachys (Hedge Nettle)

* 11. Trichostema (Blue-curls)

42. LAURACEAE (Laurel Family)

* 1. Umbellularia (Western Laurel)

43. LEGUMINOSAE (Pea Family)

1. Astragalus (Milk Vetch)
** 2. Cytisus (Scotch Broom)
* 3. Gleditsia (Honey Locust)
4. Lathyrus (Flowering Pea)
5. Lotus (Lotus)
** 6. Lupinus (Lupine)
** 7. Medicago (Alfalfa)
** 8. Melilotus (Sweet-clover)
9. Parosela (Dalea)
10. Petalostemum (Prairie Clover)
11. Phaseolus (Bean)
12. Psoralea (California Tea)
13. Robinia (Black Locust)
** 14. Trifolium (Clover)
15. Vicia (Vetch)
16. Wisteria (Wisteria)

44. LILIACEAE (Lily Family)

1. Allium (Onion)
* 2. Asparagus (Asparagus)
3. Camassia (Camass)
4. Chlorogalum (Soap Root)
** 5. Erythronium (Erythronium)
6. Maianthemum (Lily-of-the-valley)
7. Veratrum (False Hellebore)
8. Zygadenus (Death Camas)

45. LINACEAE (Flax Family)

* 1. Linum (Flax)

46. LOBELIACEAE (Lobelia Family)

1. Downingia (Downingia)

47. LORANTHACEAE (Mistletoe Family)

* 1. Phoradendron (Mistletoe)

48. MAGNOLIACEAE (Magnolia Family)

1. Liriodendron (Tulip Tree)

49. MALVACEAE (Malva Family)

* 1. Althaea (Hollyhock)
2. Malva (Mallow)
** 3. Sidalcea (Wild Hollyhock)

50. MORACEAE (Mulberry Family)

* 1. Humulus (Hop)
2. Morus (Mulberry)

51. MYRICACEAE (Sweet Gale Family)

** 1. Myrica (Wax Myrtle)

52. NYMPHAEACEAE (Water-lily Family)

* 1. Nymphaea (Yellow Pond-lily)

53. OLEACEAE (Olive Family)

** 1. Fraxinus (Ash)
* 2. Ligustrum (Privet)

54. ONAGRACEAE (Evening Primrose Family)

* 1. Epilobium (Willow-herb)
2. Godetia (Godetia)
* 3. Oenothera (Evening Primrose)

55. OXALIDACEAE (Oxalis Family)

* 1. Oxalis (Oxalis)

56. PAPAVERACEAE (Poppy Family)

** 1. Eschscholtzia (California Poppy)

57. PINACEAE (Pine Family)

* 1. Abies (Fir)
** 2. Pinus (Pine)
* 3. Pseudotsuga (Douglas Fir)

58. PLANTAGINACEAE (Plantain Family)

** 1. Plantago (Plantain)

59. POLEMONIACEAE (Phlox Family)

* 1. Gilia (Gilia)

60. POLYGONACEAE (Knotweed Family)

* 1. Eriogonum (Wild Buckwheat)
* 2. Fagopyrum (Buckwheat)
* 3. Polygonum (Knotweed)
** 4. Rumex (Sorrel)

61. PORTULACACEAE (Purslane Family)

* 1. Calandrinia (Red Maids)
* 2. Spraguea (Pussy's-paws)

62. RANUNCULACEAE (Buttercup Family)

* 1. Anemone (Anemone)
* 2. Aquilegia (Columbine)
* 3. Clematis (Clematis)
** 4. Ranunculus (Buttercup)
5. Thalictrum (Meadow-rue)

63. RHAMNACEAE (Buckthorn Family)

** 1. Ceanothus (Buckbrush)
* 2. Rhamnus (Cascara)

64. ROSACEAE (Rose Family)

** 1. Amelanchier (Serviceberry)
2. Aruncus (Goat's Beard)
3. Cercocarpus (Mountain Mahogany)
4. Cotoneaster (Cotoneaster)
5. Crataegus (Hawthorn)
6. Cydonia (Quince)
* 7. Fragaria (Strawberry)
8. Holodiscus (Ocean Spray)
9. Osmaronia (Indian Peach)
* 10. Physocarpus (Ninebark)
11. Potentilla (Cinquefoil)
** 12. Prunus (Cherry-plum)
** 13. Pyrus (Apple-Pear)
** 14. Rosa (Rose)
** 15. Rubus (Blackberry-Raspberry- etc.)

* 16. Spiraea (Spiraea)

65. SALICACEAE (Willow Family)

* 1. Populus (Cottonwood)
** 2. Salix (Willow)

66. SAXIFRAGACEAE (Saxifrage Family)

** 1. Ribes (Currant)
* 2. Philadelphus (Syringa)

67. SCROPHULARIACEAE (Figwort Family)

1. Collinsia (Innocence)
2. Digitalis (Foxglove)
* 3. Linaria (Toadflax)
* 4. Scrophularia (Figwort)
* 5. Verbascum (Mullein)
6. Veronica (Speedwell)

68. SIMARUBACEAE (Tree of Heaven Family)

* 1. Ailanthus (Tree of Heaven)

69. SOLANACEAE (Nightshade Family)

1. Datura (Jimson Weed)
2. Solanum (Nightshade)

70. TAMARICACEAE (Tamarisk Family)

* 1. Tamarix (Tamarisk)

71. TILIACEAE (Linden Family)

** 1. Tilia (Basswood)

72. ULMACEAE (Elm Family)

** 1. Ulmus (Elm)

73. UMBELLIFERAE (Parsley Family)

1. Apium (Celery)
** 2. Daucus (Carrot)
3. Eryngium (Eryngo)
4. Heracleum (Cow Parsnip)
* 5. Lomatium (Spring Gold)
6. Pastinaca (Parsnip)

74. VERBENACEAE (Verbena Family)

1. Verbena (Verbena)

75. VITACEAE (Grape Family)

* 1. Parthenocissus (Virginia Creeper)
* 2. Vitis (Grape)

DOMINANT POLLEN PLANTS OF OREGON

In order to determine the major pollen sources, two lines of investigations were used. First, observations were made of bees working on various flowers to determine if they were collecting pollen; secondly, pollen was collected at several hives by means of pollen traps. The pollen collected from the hive was then compared microscopically with grains from the anthers on which the bees were working. Since pollen grains of the same or closely related species tend to be alike if the environmental factors are uniform (Wodehouse, 1935), no attempt was made in most cases to check the hive pollen more than to genera.

From the 128 genera upon which honey bees were observed or reported collecting pollen, the author has selected 48 genera from 36 different families which he considers as dominant pollen sources for Oregon. The selection of these genera was based on the following factors:

1. Frequency and range of members of the genus.
2. Time, length of blossoming period, and quantity of pollen produced.

3. Frequency of visits and preference shown by honey bees for members of the genus in the presence of other pollen sources.

No attempt has been made to evaluate the relative importance of each genus, as it varies in different years and different localitites.

Under each genus the number of native and naturalized species found in Oregon is given and a species, which is a dominant pollen source, is selected for further study. The range, the time of flowering, and a short description of the pollen grains is given for each of the dominant pollen sources selected.

The descriptions of the pollen grains were obtained from slides prepared in the following manner. Fresh pollen grains from a ripe anther were dehydrated in tertiary butyl alcohol and then mounted in lactophenol. The lactophenol was prepared according to the formula given by Johansen (1940) except that glycerine jelly was used in place of glycerine. In some cases pollen was obtained from herbarium specimens. These grains were processed in the same manner. The size of the pollen is based on averages of 10 grains or more.

Microphotographs of the polar views of the pollen grains which appear on plates I, II, III, IV were made with a "Makam" attachment on a Leitz microscope. Eastman Pan-

chromatic Process film was used, and it was developed in D-72. The grains were photographed at 571 X in all cases to show the comparative size of the various grains.

The 48 genera, whose species the author considers dominant pollen sources, are arranged in alphabetical order, as follows:

1. Acer (Maple) Aceraceae

Native species: 3

Naturalized species: 1

Dominant pollen source: Acer macrophyllum Pursh. (Oregon Maple)

Range: Mostly west of the Cascades

Flowers: March-April

Pollen: Plate 1, Fig. 1

Size: 49 microns

Shape: Oblately spheroidal

Pores: 3

Sculpturing: Exine granular

2. Amelanchier (Serviceberry) Rosaceae

Native species: 4 or 5

Naturalized species: 0

Dominant pollen source: Amelanchier florida Lindl. (Western Serviceberry)

Range: Woods and thickets, widely distributed

Flowers: April

Pollen: Plate 1, Fig. 2

Size: 28 microns

Shape: Angular

Pores: 3

Sculpturing: Exine finely granular

3. Arbutus (Madrono) Ericaceae

Native species: 1

Naturalized species: 0

Dominant pollen source: Arbutus Menziesii Pursh. (Madrono)

Range: Open woods west of the Cascades

Flowers: April

Pollen: Plate 1, Fig. 3

Size: Tetrad 49 microns

Shape: Tetrad spheroidal

Pores: 3 on each grain

Sculpturing: Exine smooth

4. Berberis (Oregon Grape) Berberidaceae

Native species: 4 or 5

Naturalized species: 0

Dominant pollen source: Berberis Aquifolium Pursh. (Oregon Grape)

Range: Woods and thickets mainly west of Cascades

Flowers: March-April

Pollen: Plate 1, Fig. 4

Size: 54 microns

Shape: Spheroidal

Pores: 4 or more, usually 4 visible in polar view

Sculpturing: Exine granular

5. Brassica (Mustard) Cruciferae

Native species: 0

Naturalized species: 4

Dominant pollen source: Brassica campestris L. (Wild Mustard)

Range: A very abundant weed in fields

Flowers: March-July

Pollen: Plate 1, Fig. 5

Size: 28 microns X 22 microns

Shape: Ellipsoidal

Pores: None, furrows 3

Sculpturing: Exine reticulate

6. Campanula (Campanula) Campanulaceae

Native species: 5

Naturalized species: 0

Dominant pollen source: Campanula Medium L.
(Canterbury Bells)
(Cultivated species)

Range: A common garden flower

Flowers: June

Pollen: Plate 1, Fig. 6

Size: 47 microns

Shape: Spheroidal

Pores: 3, conspicuous

Sculpturing: Exine covered with narrow, conical spines 5 microns long arising from the surface of the exine

7. Catalpa (Catalpa) Bignoniaceae

Native species: 0

Naturalized species: 0

Dominant pollen source: Catalpa Bignonioides Walt.
(Catalpa) (Cultivated species)

Range: An ornamental tree planted for shade in cities

Flowers: May-June

Pollen: Plate 1, Fig. 7

Size: Tetrad 70 microns

Shape: Tetrad spheroidal

Pores: Not visible

Sculpturing: Exine thick and reticulate

8. Ceanothus (Buckbrush) Rhamnaceae

Native species: 7 or 8

Naturalized species: 0

Dominant pollen source: Ceanothus velutinus Dougl. (Sticky Laurel or Mountain Balm)

Range: Thickets and dry slopes, Cascades and Coast Range

Flowers: March-April

Pollen: Plate 1, Fig. 8

Size: 28 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Exine smooth, one layer

9. Centaurea (Bachelor's Button) Compositae

Native species: 0

Naturalized species: 6

Dominant pollen source: Centaurea Cyanus L. (Bachelor's Button or Corn Flower)

Range: Weed in grain fields and waste places, especially west of Cascade Mts.

Flowers: May-July

Pollen: Plate 1, Fig. 9

Size: 44 microns X 33 microns

Shape: Ellipsoidal

Pores: 3, 2 conspicuous in polar view

Sculpturing: Exine reticulate

10. Cichorium (Chicory) Compositae

Native species: 0

Naturalized species: 1

Dominant pollen source: Cichorium Intybus L. (Chicory)

Range: Common along roadsides and waste ground

Flowers: June-August

Pollen: Plate 1, Fig. 10

Size: 38 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Exine with vertical ridges about 5 microns high topped with spines about 3 microns long

11. Cirsium (Thistle) Compositae

Native species: 12

Naturalized species: 1

Dominant pollen source: Cirsium arvense (L.) Scop. (Canada Thistle)

Range: A troublesome weed in fields

Flowers: June-August

Pollen: Plate 1, Fig. 11

Size: 44 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Exine about 5 microns thick with stout spines as wide at the base as they are long

12. Cleome (Cleome) Capparidaceae

Native species: 3

Naturalized species: 0

Dominant pollen source: Cleome lutea Hook. (Tall Yellow Cleome)

Range: Sagebrush areas of eastern Oregon

Flowers: June

Pollen: Plate 1, Fig. 12

Size: 19 microns

Shape: Oblately spheroidal

Pores: 3, openings slightly sunken in exine

Sculpturing: Exine smooth

13. Cornus (Dogwood) Cornaceae

Native species: 5

Naturalized species: 0

Dominant pollen source: Cornus pubescens Nutt. (Western Red Dogwood)

Range: Moist thickets, mainly west of the Cascade Mts.

Flowers: April

Pollen: Plate 2, Fig. 13

Size: 64 microns

Shape: Spheroidal

Pores: 3

Sculpturing: Exine granular

14. Corylus (Hazel) Betulaceae

Native species: 1

Naturalized species: 0

Dominant pollen source: Corylus rostrata Ait. var. californica A. DC. (Western Hazel)

Range: Woods and thickets west of Cascades

Flowers: March

Pollen: Plate 2, Fig. 14

Size: 28 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Exine smooth, slightly expanded at the pores, 5 layered

15. Crocidium (Gold-star) Compositae

Native species: 1

Naturalized species: 0

Dominant pollen source: Crocidium multicaule Hook. (Gold-star)

Range: Moist banks and about pools along the Columbia River and Southern Lane County southward to California

Flowers: March

Pollen: Plate 2, Fig. 15

Size: 21 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Short, sharp spines about 2-3 microns long scattered over the surface of exine

16. Cytisus (Scotch Broom) Leguminosae

Native species: 0

Naturalized species: 3

Dominant pollen source: Cytisus scoparius L. (Scotch Broom)

Range: Abundant in western Oregon, especially in the Willamette Valley and along the coast

Flowers: April-May

Pollen: Plate 2, Fig. 16

Size: 29 microns

Shape: Angular

Pores: 3

Sculpturing: Exine smooth

17. Daucus (Wild Carrot) Umbelliferae

Native species: 1

Naturalized species: 1

Dominant pollen source: Daucus Carota L. (Wild Carrot)

Range: An abundant and troublesome weed, especially west of the Cascades

Flowers: June-August

Pollen: Plate 2, Fig. 17

Size: 28 microns X 18 microns

Shape: Ellipsoidal

Pores: 3, one or two visible in polar section

Sculpturing: Exine granular

18. Echinocystis (Wild Cucumber) Cucurbitaceae

Native species: 1

Naturalized species: 0

Dominant pollen source: Echinocystis oreganus Cogn. (Western Wild Cucumber)

Range: Common, mostly west of the Cascade Mts.

Flowers: April-May

Pollen: Plate 2, Fig. 18

Size: 64 microns

Shape: Spheroidal

Pores: 4 or more scattered over grain

Sculpturing: Exine about 3 microns thick, reticulate

19. Erodium (Filaree) Geraniaceae

Native species: 0

Naturalized species: 4

Dominant species: Erodium cicutarium (L.) L.'Her. (Filaree)

Range: Dry open ground nearly throughout the state

Flowers: March-May

Pollen: Plate 2, Fig. 19

Size: 59 microns

Shape: Oblately spheroidal

Pores: 3

Sculpturing: Exine about 7 microns thick, reticulate

20. Erythronium (Erythronium) Liliaceae

Native species: 8

Naturalized species: 0

Dominant pollen source: Erythronium oregonum Appleg. (Giant Adder's-tongue)

Range: Open woods and fields west of Cascades

Flowers: March

Pollen: Plate 2, Fig. 20

Size: 85 microns X 67 microns

Shape: Ellipsoidal

Pores: None

Sculpturing: Exine about 5 microns thick, reticulate

21. Eschscholtzia (California Poppy) Papaveraceae

Native species: 2

Naturalized species: 0

Dominant pollen source: Eschscholtzia californica Cham. (California Poppy)

Range: Roadsides and waste ground, Willamette Valley and southward

Flowers: April-July

Pollen: Plate 2, Fig. 21

Size: 35 microns

Shape: Spheroidal

Pores: 4 or more scattered over the grain

Sculpturing: Exine reticulate

22. Fraxinus (Ash) Oleaceae

Native species: 1

Naturalized species: 0

Dominant pollen source: Fraxinus oregona Nutt.
(Oregon Ash)

Range: Low woods and along streams west of the Cascades

Flowers: April

Pollen: Plate 2, Fig. 22

Size: 29 microns

Shape: Angular

Pores: Not conspicuous, usually 4 furrows present

Sculpturing: Exine reticulate

23. Hypericum (St. John's Wort) Hypericaceae

Native species: 2

Naturalized species: 1

Dominant pollen source: Hypericum calycinum L.
(Rose of Sharon)
(Cultivated species)

Range: An ornamental shrub used in border plantings, cities of western Oregon

Flowers: May-July

Pollen: Plate 2, Fig. 23

Size: 23 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Exine smooth

24. Juglans (Walnut) Juglandaceae

Native species: 0

Naturalized species: 0

Dominant pollen source: Juglans regia L. (English Walnut) (Cultivated species)

Range: Orchards in western Oregon

Flowers: April

Pollen: Plate 2, Fig. 24

Size: 46 microns

Shape: Spheroidal

Pores: 4 or more, scattered usually over one hemisphere of the grain

Sculpturing: Exine granular

25. Lonicera (Honeysuckle) Caprifoliaceae

Native species: 8

Naturalized species: 0

Dominant pollen source: Lonicera tatarica L. (Honeysuckle) (Cultivated species)

Range: An ornamental vine grown around homes in towns of western Oregon

Flowers: April-May

Pollen: Plate 3, Fig. 25

Size: 56 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Exine covered with small sharp spines about 2-3 microns long

26. Lupinus (Lupine) Leguminosae

Native species: 40 to 50

Naturalized species: 0

Dominant pollen source: Lupinus polyphyllus Lindl. (Large-leaved Lupine)

Range: Dry or moist ground at moderate altitudes from the eastern base of the Cascades westward and in the Blue Mts. and mountains of Lake County

Flowers: May

Pollen: Plate 3, Fig. 26

Size: 34 microns

Shape: Spheroidal

Pores: 3

Sculpturing: Exine reticulate

27. Lysichitum (Skunk Cabbage) Araceae

Native species: 1

Naturalized species: 0

Dominant pollen source: Lysichitum americanum St. John (Yellow Skunk Cabbage)

Range: Bogs mostly from Cascades westward

Flowers: February-April

Pollen: Plate 3, Fig. 27

Size: 43 microns X 35 microns

Shape: Ellipsoidal

Pores: None, one furrow

Sculpturing: Exine reticulate

28. Medicago (Alfalfa) Leguminosae

Native species: 0

Naturalized species: 4 or 5

Dominant pollen source: Medicago sativa L. (Alfalfa)

Range: Freely escaped from cultivation and well established

Flowers: May-July

Pollen: Plate 3, Fig. 28

Size: 45 microns X 42 microns

Shape: Ellipsoidal

Pores: 3, one or two appearing in polar sections

Sculpturing: Exine finely granular

29. Melilotus (Sweet-clover) Leguminosae

Native species: 0

Naturalized species: 3

Dominant pollen source: Melilotus alba Desr. (White Sweet-clover)

Range: Abundant in moist places east of Cascades; less so in western Oregon

Flowers: June-July

Pollen: Plate 3, Fig. 29

Size: 31 microns X 28 microns

Shape: Ellipsoidal

Pores: 3, one or two appearing in polar sections

Sculpturing: Exine granular

30. Myrica (Wax Myrtle) Myricaceae

Native species: 2

Naturalized species: 0

Dominant pollen source: Myrica californica Cham. (Western Wax Myrtle)

Range: Thickets and bogs along the coast to Wash. and Calif.

Flowers: April

Pollen: Plate 3 Fig. 30

Size: 30 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Exine smooth, three layered

31. Phleum (Timothy) Gramineae

Native species: 1

Naturalized species: 1

Dominant pollen source: Phleum pratense L. (Timothy)

Range: Generally established; escaped from cultivation

Flowers: June

Pollen: Plate 3, Fig. 31

Size: 42 microns

Shape: Spheroidal

Pores: 1

Sculpturing: Exine thin, granular

32. Pinus (Pine) Pinaceae

Native species: 8

Naturalized species: 0

Dominant pollen source: Pinus contorta Dougl. (Coast Pine)

Range: Common along the sea coast

Flowers: April-May

Pollen: Plate 3, Fig. 32

Size: 78 microns X 52 microns including wings, grain not including wings 53 microns X 42 microns

Shape: Ellipsoidal with two wings on opposite sides of grain

Pores: 0

Sculpturing: Exine very reticulate

33. Plantago (Plantain) Plantaginaceae

Native species: 6 or 7

Naturalized species: 5 or 6

Dominant pollen source: Plantago lanceolata L. (English Plantain)

Range: An abundant weed in lawns and waste ground, especially west of the Cascades

Flowers: May-August

Pollen: Plate 3, Fig. 33

Size: 26 microns, grains with great range in size

Shape: Spheroidal

Pores: 4 or more scattered over the surface

Sculpturing: Exine smooth

34. Prunus (Plums, Cherry) Rosaceae

Native species: 3

Naturalized species: 1

Dominant pollen source: Prunus cerasus L. (Cherry) (Cultivated species)

Range: Abundant in orchards of western Oregon

Flowers: April

Pollen: Plate 3, Fig. 34

Size: 43 microns

Shape: Angular, many abortive and irregular grains present in pollen sample

Pores: 3

Sculpturing: Exine granular

35. Pyrus (Apple, Pear) Rosaceae

Native species: 2

Naturalized species: Several

Dominant pollen source: Pyrus Malus L.
(Apple) (Cultivated species)

Range: Abundant in orchards of western Oregon

Flowers: April-May

Pollen: Plate 3, Fig. 35

Size: 38 microns

Shape: Angular, many abortive and irregular grains present in pollen sample

Pores: 3

Sculpturing: Exine granular

36. Quercus (Oak) Fagaceae

Native species: 6 or 7

Naturalized species: 0

Dominant pollen source: Quercus Garryana Dougl.
(Oregon Oak)

Range: From the western base of the Cascades to the eastern base of the Coast Mts.

Flowers: April-May

Pollen: Plate 3, Fig. 36

Size: 35 microns

Shape: Oblately spheroidal

Pores: 3, conspicuous

Sculpturing: Exine thick, granular

37. Ranunculus (Buttercup) Ranunculaceae

Native species: 15 to 18

Naturalized species: 5

Dominant pollen source: Ranunculus occidentalis Nutt. (Western Buttercup)

Range: Dry open ground mainly west of Cascades

Flowers: March-April

Pollen: Plate 4, Fig. 37

Size: 37 microns

Shape: Spheroidal

Pores: 3

Sculpturing: Exine granular

38. Ribes (Currant) Saxifragaceae

Native species: 27

Naturalized species: 0

Dominant pollen source: Ribes sanguineum Pursh. (Red-flowering or Oregon Currant)

Range: Thickets west of Cascades to Wash. and Calif.

Flowers: March-April

Pollen: Plate 4, Fig. 38

Size: 37 microns

Shape: Spheroidal

Pores: 4 or more, scattered over surface of grain

Sculpturing: Exine smooth

39. Rosa (Rose) Rosaceae

Native species: 5 or 6

Naturalized species: 2

Dominant pollen source: Rosa rubiginosa L. (Sweetbriar Rose)

Range: Abundant along roadsides and in pastures and open woods west of the Cascades Mts.

Flowers: May-August

Pollen: Plate 4, Fig. 39

Size: 39 microns

Shape: Spheroidal

Pores: 3

Sculpturing: Exine granular

40. Rubus (Blackberry, Raspberry) Rosaceae

Native species: 10

Naturalized species: 2 or more

Dominant pollen source: Rubus leucodermis Dougl. (Western Blackcap)

Range: Open woods, burns, and logged-over lands, widely distributed in Oregon

Flowers: May-June

Pollen: Plate 4, Fig. 40

Size: 31 microns

Shape: Angular

Pores: 3

Sculpturing: Exine granular

41. Rumex (Dock) Polygonaceae

Native species: 5 or 6

Naturalized species: 5 or 6

Dominant pollen source: Rumex Acetosella L. (Red Sorrel)

Range: An abundant and widely distributed weed

Flowers: May-July

Pollen: Plate 4, Fig. 41

Size: 25 microns

Shape: Spheroidal

Pores: 3

Sculpturing: Exine granular

42. Salix (Willow) Salicaceae

Native species: 38 to 40

Naturalized species: 0

Dominant pollen source: Salix lasiandra Benth. (Red Willow)

Range: Streambanks, widely distributed

Flowers: March-April

Pollen: Plate 4, Fig. 42

Size: 20 microns

Shape: Spheroidal

Pores: 3

Sculpturing: Exine heavily reticulate

43. Sidalcea (Sidalcea) Malvaceae

Native species: 10 to 13

Naturalized species: 0

Dominant pollen source: Sidalcea campestris Greene. (Meadow Sidalcea)

Range: Meadows and roadsides, western Oregon particularly in the Willamette Valley

Flowers: June-July

Pollen: Plate 4, Fig. 43

Size: 88 microns

Shape: Spheroidal

Pores: Not visible

Sculpturing: Exine about 5 microns thick, topped with spines about 9 microns long

44. Stellaria (Chickweed) Caryophyllaceae

Native species: 10 or 11

Naturalized species: 1

Dominant pollen source: Stellaria media (L.) Cyr. (Common Chickweed)

Range: Generally distributed at low and moderate altitude

Flowers: March-May

Pollen: Plate 4, Fig. 44

Size: 41 microns

Shape: Spheroidal

Pores: 4 or more, scattered over surface of grain

Sculpturing: Exine thick, granular

45. Taraxacum (Dandelion) Compositae

Native species: 1

Naturalized species: 2

Dominant pollen source: Taraxacum officinale L. (Dandelion)

Range: Lawn, roadsides, and waste places throughout Oregon

Flowers: April-August

Pollen: Plate 4, Fig. 45

Size: 32 microns

Shape: Spheroidal

Pores: 3, conspicuous

Sculpturing: Exine with vertical ridges about 3.5 microns, topped with spines about 2 microns long

46. Tilia (Basswood) Tiliaceae

Native species: 0

Naturalized species: 0

Dominant pollen source: Tilia americana L. (Basswood) (Cultivated species)

Range: Planted in cities of Oregon as ornamental shade trees

Flowers: June

Pollen: Plate 4, Fig. 46

Size: 41 microns

Shape: Oblately spheroidal

Pores: 3, sunken in surface of exine

Sculpturing: Exine reticulate

47. Trifolium (Clover) Leguminosae

Native species: 30

Naturalized species: 7

Dominant pollen source: Trifolium pratense L. (Red Clover)

Range: Escaped from cultivation, widely distributed in Oregon

Flowers: May-July

Pollen: Plate 4, Fig. 47

Size: 52 microns X 47 microns

Shape: Ellipsoidal

Pores: 3

Sculpturing: Exine rough granular

48. Ulmus (Elm) Ulmaceae

Native species: 0

Naturalized species: 0

Dominant pollen source: Ulmus americana L. (American Elm) (Cultivated species)

Range: An ornamental shade tree planted in many cities of Oregon

Flowers: March

Pollen: Plate 4, Fig. 48

Size: 37 microns X 33 microns

Shape: Ellipsoidal

Pores: 4 or more, usually 5, appearing in polar sections

Sculpturing: Exine granular

KEY TO THE MAJOR POLLEN SOURCES

The following key was prepared as an aid in the study of the pollen grains brought into the hive by honey bees in Oregon. It is based on the descriptions of the pollen of the 48 dominant pollen sources discussed in the previous section. It is therefore limited to this group of plants and closely related species in each genus used.

1. Grains winged - - - - - - - - - - - - - *Pinus contorta*

   Grains not winged - 2

2. Grains in tetrads - 3

   Grains single - 4

3. Exine smooth, pores visible, tetrad 49 microns - - - - - - - - - - - - *Arbutus Menziesii*

   Exine reticulate, pores not visible, tetrad 70 microns - - - - - - - *Catalpa Bignonioides*

4. Exine spiny - 5

   Exine smooth, granular, or reticulate - - - - - - - - - 11

5. Pores not visible, grains about 88 microns - - - - - - - - - - - *Sidalcea campestris*

   Pores 3, grains under 60 microns - - - - - - - - - - - - 6

6. Spines arising from vertical ridges on grain - - - - 7

   Spines arising from all over the surface of the grain - 8

7. Vertical ridges about 5 microns high, topped with spines about 3 microns long, grains 38 microns - - - - *Cichorium Intybus*

   Vertical ridges about 3.5 microns high, topped with spines about 2 microns long, grains 32 microns - - - - - - - - - - - - - *Taraxacum officinale*

8. Grains small,21 microns - - - *Crocidium multicaule*

   Grains 30 microns and larger - - - - - - - - - - - - - - 9

9. Exine about 5 microns thick, spines as long as wide at the base, grains 44 microns - - - - - - - - *Cirsium arvense*

   Exine less than 3 microns thick, spines narrow and conical - - - - - - - - - - - - - 10

10. Grain 56 microns, oblately spheroidal, spines 2 microns long - - - - - *Lonicera tatarica*

    Grains 47 microns, spheroidal, spines 5 microns long - - - - - - *Campanula Medium*

11. Grains angular, or irregular - - - - - - - - - - - - - 12

    Grains ellipsoidal - - - - - - - - - - - - - - - - - - - 17

    Grains spheroidal or oblately spheroidal - - - - - - 24

12. Pores not conspicuous, usually 4 furrows present, exine reticulate, grain 29 microns - - - - - - - - *Fraxinus oregona*

    Pores 3, exine smooth or granular - - - - - - - - - - 13

13. Exine smooth, grains 29 microns - -*Cytisus scoparius*

    Exine granular - 14

14. Grains under 35 microns, few abortive grains in pollen sample - - - - - - - - - - - - - - - 15

Grains over 35 microns, many abortive and irregular grains in pollen sample - - - - - - - 16

15. Grains 28 microns, finely granular - - - - - - - - - - - - - *Amelanchier florida*

Grains 31 microns, granular - - - *Rubus leucodermis*

16. Grains 43 microns - - - - - - - - - - - *Prunus cerasus*

Grains 38 microns - - - - - - - - - - - - - *Pyrus Malus*

17. Pores 4 or more - - - - - - - - - - - *Ulmus americana*

Pores absent - 18

Pores 3 - 20

18. Grains large, 85 microns X 67 microns - - - - - - - - - - *Erythronium oregonum*

Grains under 50 microns - - - - - - - - - - - - - - - - 19

19. Furrows 3, grain 28 microns X 22 microns - - - - - - - - - - - *Brassica campestris*

Furrow 1, grain 43 microns X 35 microns - - - - - - - - - - *Lysichitum americanum*

20. Exine reticulate, grains 44 microns X 33 microns - - - - - *Centaurea Cyanus*

Exine granular - 21

21. Grains small, 35 microns X 31 microns or under - 22

Grains larger, 40 microns X 36 microns or larger - 23

22. Grains much longer than wide, 28 microns X 18 microns - - - - - - - Daucus Carota

Grains almost as long as wide, 31 microns X 28 microns - - - - - - - Melilotus alba

23. Grains 45 microns X 42 microns, exine thin, finely granular - - - - - - - Medicago sativa

Grains 52 microns X 47 microns, exine thick, rough granular - - Trifolium pratense

24. Pore 1 - - - - - - - - - - - - - - - - - - Phleum pratense

Pores typically 4 or more, rarely 3 - - - - - - - - - 25

Pores 3 - 31

25. Exine reticulate - - - - - - - - - - - - - - - - - - 26

Exine smooth or granular - - - - - - - - - - - - - - 27

26. Grains 64 microns - - - - - - - - Echinocystis oregana

Grains 35 microns - - - - Eschscholtzia californica

27. Exine smooth, grains under 40 microns - - - - - - - - 28

Exine granular, grains over 40 microns - - - - - - - 29

28. Grains averaging 26 microns, quite variable in size Plantago lanceolata

Grains averaging 36 microns, quite constant in size - - - - - Ribes sanguineum

29. Pores scattered mainly over one hemisphere of grain - - - - - - - - - Juglans regia

Pores scattered over both hemispheres of grain - 30

30. Grains 54 microns - - - - - - - - *Berberis Aquifolium*

Grains 41 microns - - - - - - - - - - *Stellaria media*

31. Pores and furrows sunken in exine - - - - - - - - - - 32

Pores even with surface or raised - - - - - - - - - - 34

32. Grains large, 41 microns, pores deeply sunken in exine - - - - - - *Tilia americana*

Grains small, 30 microns or under, pores or furrows slightly sunken - - - - - - - - - - 33

33. Exine smooth, grains oblately spheroidal - - - - - - - - - - - - - *Cleome lutea*

Exine very reticulate, grains spheroidal - - - - - - - - - - - - *Salix lasiandra*

34. Exine reticulate - 35

Exine granular or smooth - - - - - - - - - - - - - - - - 36

35. Grains 59 microns, exine about 7 microns thick - - - - - - - - - *Erodium cicutarium*

Grains 34 microns, exine much thinner - - - - - - - - - - - - *Lupinus polyphyllus*

36. Grains large, 64 microns - - - - - *Cornus pubescens*

Grains smaller, under 60 microns - - - - - - - - - - - 37

37. Pores not conspicuous - - - - - - - - - - - - - - - - - 38

Pores conspicuous - 41

38. Grain 49 microns, oblately spheroidal - - - - - - - - - - - *Acer macrophyllum*

Grains smaller, 40 microns and under, spheroidal - 39

39. Grains 25 microns - - - - - - - - - - *Rumex Acetosella*

Grains 35 microns or larger - - - - - - - - - - - - - 40

40. Grains 37 microns, exine rough granular - - - - - - - - - - *Ranunculus occidentalis*

Grains 39 microns, exine finely granular - - - - - - - - - - *Rosa rubiginosa*

41. Exine thick, granular, grains 35 microns - - - - - - - - - - - - *Quercus Garryana*

Exine thin, smooth, grains under 30 microns - 42

42. Grains 23 microns - - - - - - - *Hypericum calycinum*

Grains 28 microns or larger - - - - - - - - - - - - - - 43

43. Exine one-layered - - - - - - - - -*Ceanothus velutinus*

Exine three-layered - - - - - - - - *Myrica californica*

Exine five-layered - *Corylus rostrata* var. *californica*

SUMMARY

These investigations indicate that bees have been reported or observed thus far on 75 families and 220 genera of higher plants found in Oregon. Bees have been reported or observed collecting pollen on 128 genera. Most of the pollen is secured from members of 36 different families and 48 genera. The genera in Compositae, Leguminosae, and Rosaceae represent the dominant bee plants of Oregon, as they are visited most frequently for both pollen and nectar.

Bees collect pollen from flowers and carry it to the hive where it is stored or used immediately for food. Pollen may enter the hive in the nectar, on the body hairs, or in the form of pellets carried in pollen baskets. One can determine the quantity of pollen entering the hive in the form of pellets by means of a pollen trap. Methods for measuring the quantity of pollen entering by other ways are being experimented with, but they have not been perfected.

The majority of species visited by bees yield both nectar and pollen. The bees apparently prefer to utilize such sources first, but in the absence of sufficient numbers of these plants they may freely work plants that yield pollen only. Insect-pollinated plants seem to be chosen in preference to wind-pollinated plants.

Closely related species in a genus are not worked with equal frequency, and the frequency of visits to the same species varies in different locations and different seasons. Since the nectar concentration varies also in different locations and seasons, the author believes that some sort of pollen-nectar relationship exists that may account in part for the frequency of visits by the bees.

Pollen collecting is limited to the flowering period of the plant. Bees apparently gather pollen at all times when it is available whether or not it is needed for immediate consumption. Variations in relative humidity and temperature cause the pollen from the same or different species to become available at different times of the day under a different set of conditions. Hence a pollen shortage in the hive could result from unfavorable temperature and humidity in the presence of adequate numbers of potential pollen sources. Several pollen shortages reported thus far for Oregon may be due to this combination of limiting factors, although there are some areas where there is a definite lack of pollen plants. Dominant pollen sources appear to be quite adequate for most of Oregon, particularly those sections west of the Cascades.

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PLATE I

Fig. 1 *Acer macrophyllum* Pursh.

Fig. 2 *Amelanchier florida* Lindl.

Fig. 3 *Arbutus Menziesii* Pursh.

Fig. 4 *Berberis Aquifolium* Pursh.

Fig. 5 *Brassica campestris* L.

Fig. 6 *Campanula Medium* L.

Fig. 7 *Catalpa Bignonioides* Walt.

Fig. 8 *Ceanothus velutinus* Dougl.

Fig. 9 *Centaurea Cyanus* L.

Fig. 10 *Cichorium Intybus* L.

Fig. 11 *Cirsium arvense* L.

Fig. 12 *Cleome lutea* Hook.

PLATE I

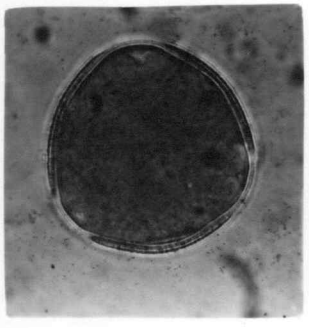


Fig. 1

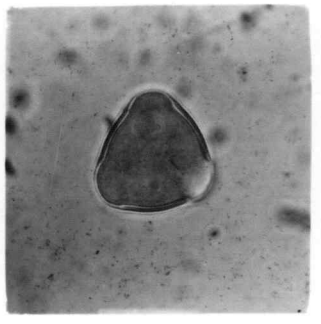


Fig. 2

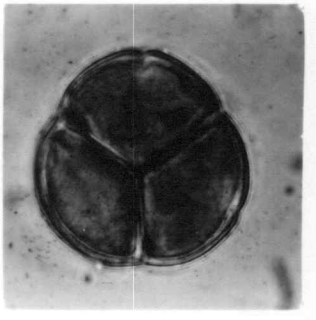


Fig. 3

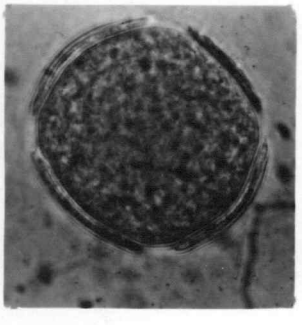


Fig. 4

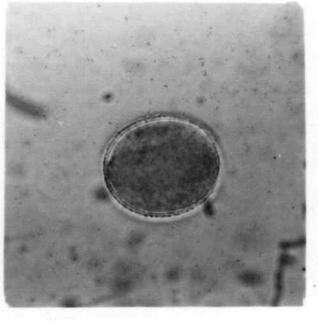


Fig. 5

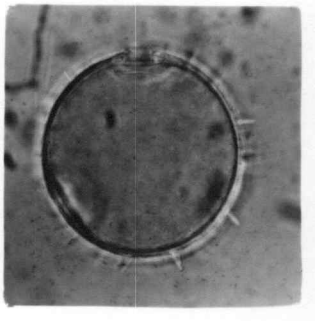


Fig. 6

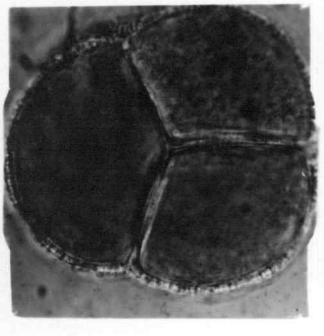


Fig. 7

Fig. 8

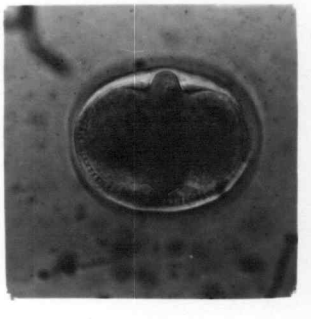
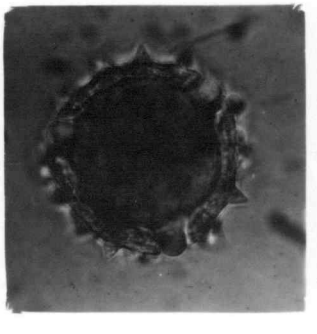


Fig. 9

Fig. 10



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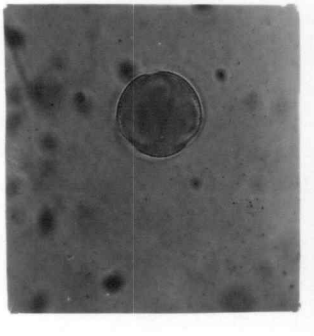


Fig. 12

PLATE II

Fig. 13 Cornus pubescens Nutt.

Fig. 14 Corylus rostrata Ait. var. californica A.DC.

Fig. 15 Crocidium multicaule Hook.

Fig. 16 Cytisus scoparius L.

Fig. 17 Daucus Carota L.

Fig. 18 Echinocystis oreganus Cogn.

Fig. 19 Erodium cicutarium (L.) L.'Her.

Fig. 20 Erythronium oregonum Appleg.

Fig. 21 Eschscholtzia californica Cham.

Fig. 22 Fraxinus oregona Nutt.

Fig. 23 Hypericum calycinum L.

Fig. 24 Juglans regia L.

PLATE II

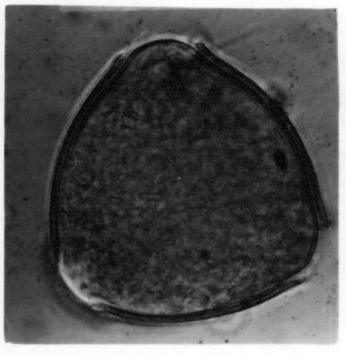
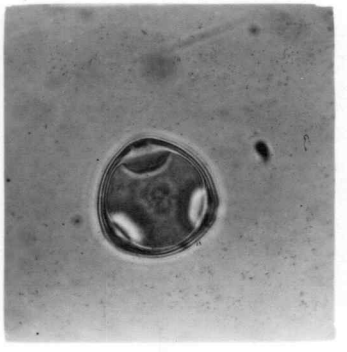


Fig. 13



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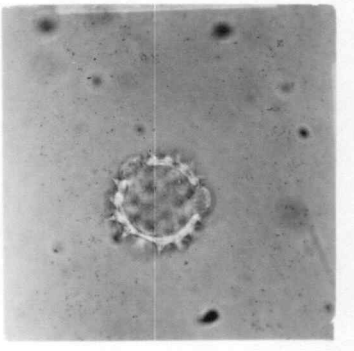

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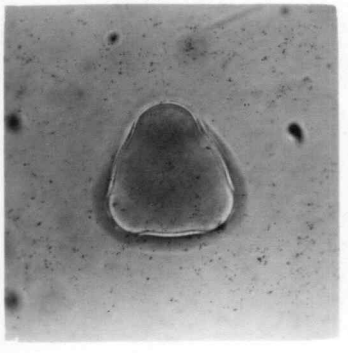

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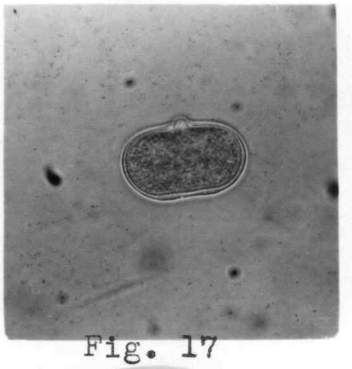

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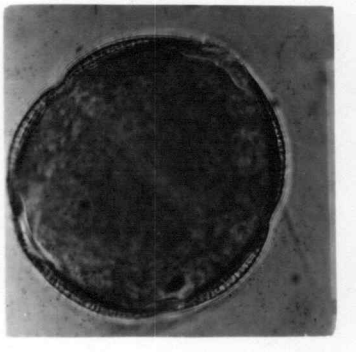

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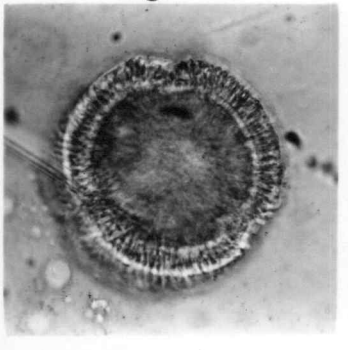

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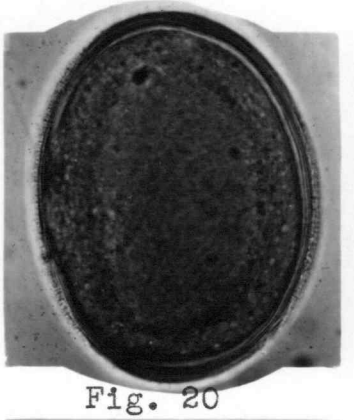
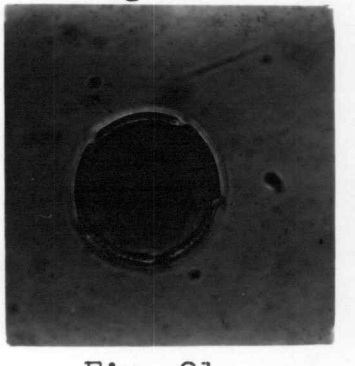


Fig. 20



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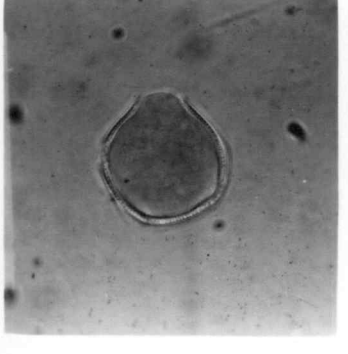

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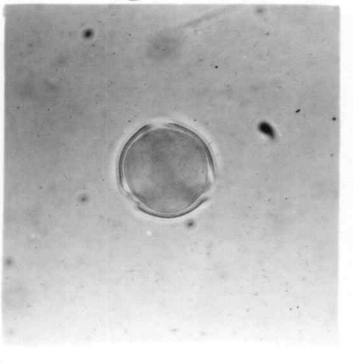

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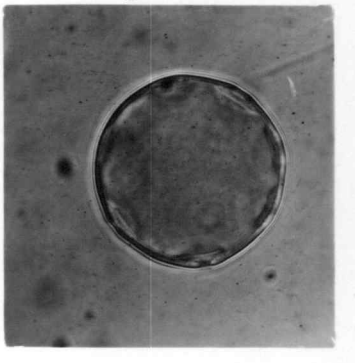


Fig. 24

PLATE III

Fig. 25 *Lonicera tatarica* L.

Fig. 26 *Lupinus polyphyllus* Lindl.

Fig. 27 *Lysichitum americanum* St. John

Fig. 28 *Medicago sativa* L.

Fig. 29 *Melilotus alba* Desr.

Fig. 30 *Myrica californica* Cham.

Fig. 31 *Phleum pratense* L.

Fig. 32 *Pinus contorta* Dougl.

Fig. 33 *Plantago lanceolata* L.

Fig. 34 *Prunus cerasus* L.

Fig. 35 *Pyrus Malus* L.

Fig. 36 *Quercus Garryana* Dougl.

PLATE III

Fig. 25

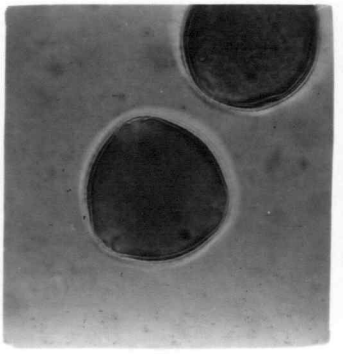


Fig. 26

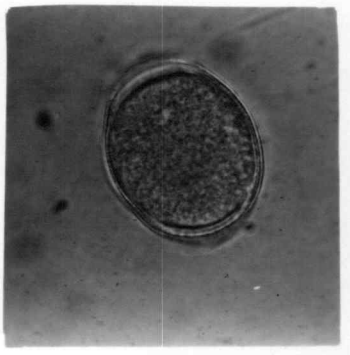


Fig. 27

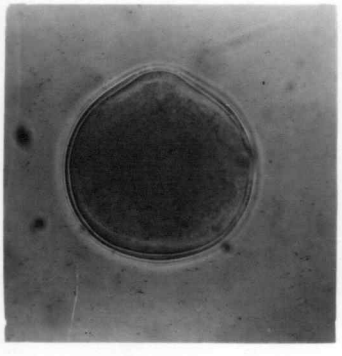
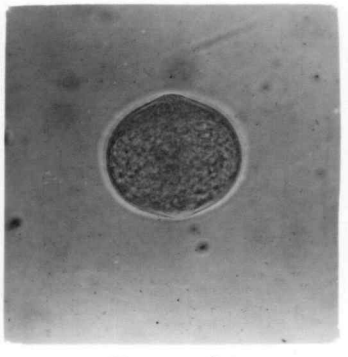


Fig. 28



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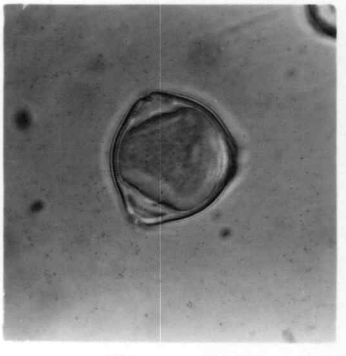

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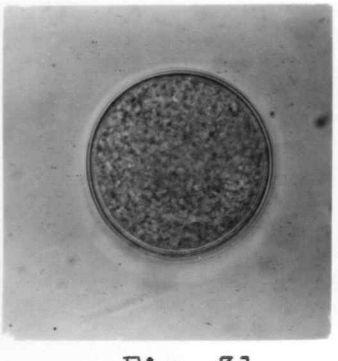

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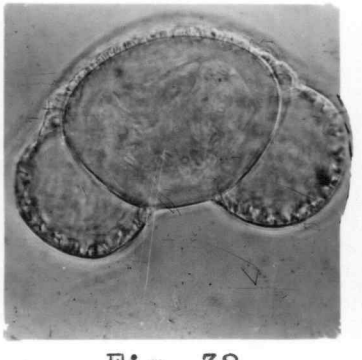
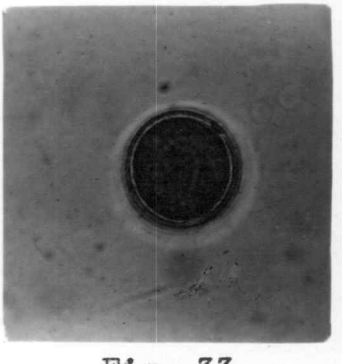


Fig. 32



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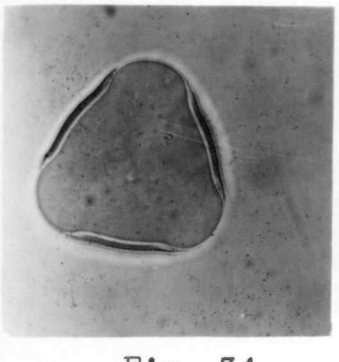

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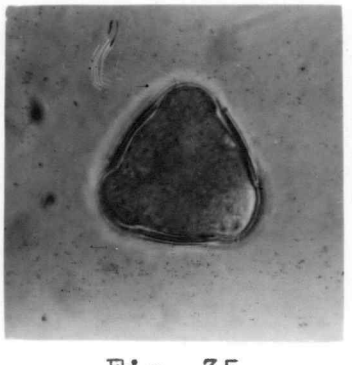


Fig. 35

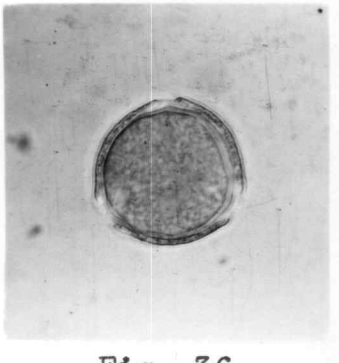


Fig. 36

PLATE IV

Fig. 37 Ranunculus occidentalis Nutt.

Fig. 38 Ribes sanguineum Pursh.

Fig. 39 Rosa rubiginosa L.

Fig. 40 Rubus leucodermis Dougl.

Fig. 41 Rumex Acetosella L.

Fig. 42 Salix lasiandra Benth.

Fig. 43 Sidalcea campestris Greene.

Fig. 44 Stellaria media (L.) Cyr.

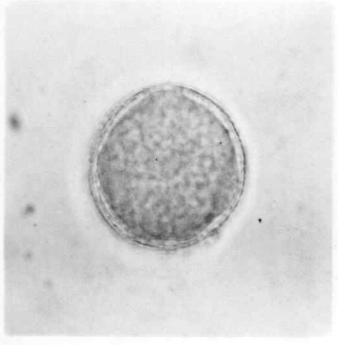
Fig. 45 Taraxacum officinale L.

Fig. 46 Tilia americana L.

Fig. 47 Trifolium pratense L.

Fig. 48 Ulmus americana L.

PLATE IV



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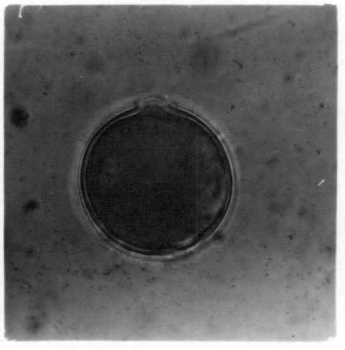


Fig. 38

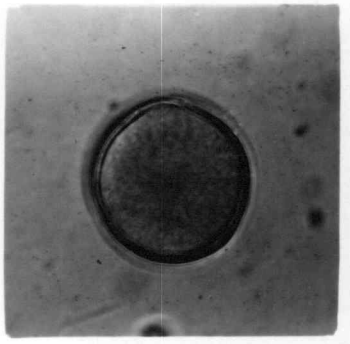


Fig. 39

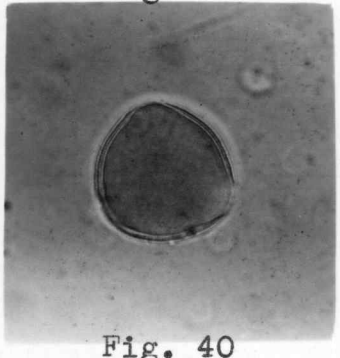
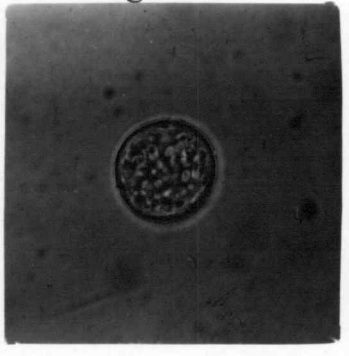


Fig. 40



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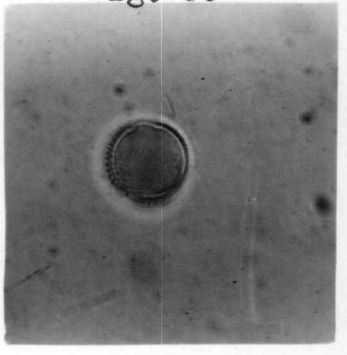

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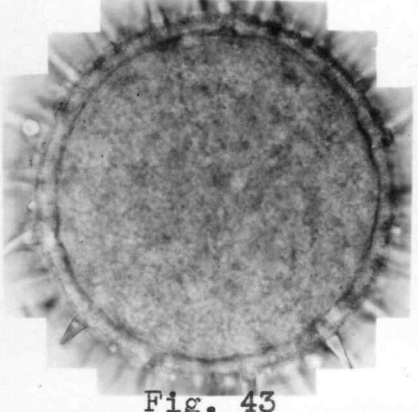

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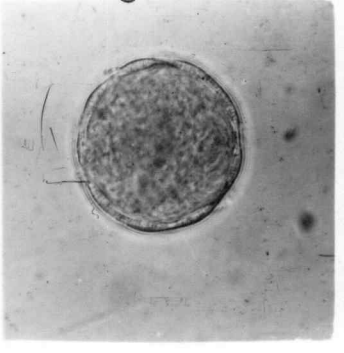

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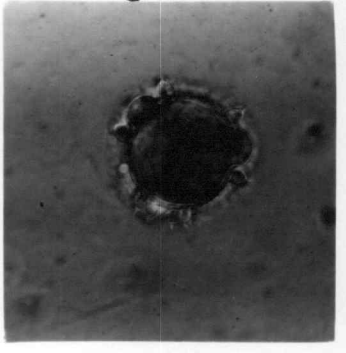

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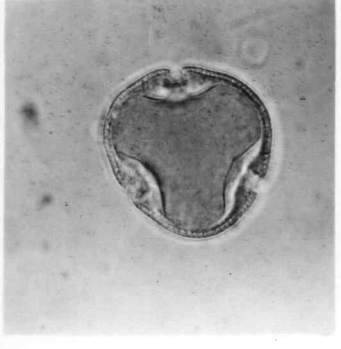

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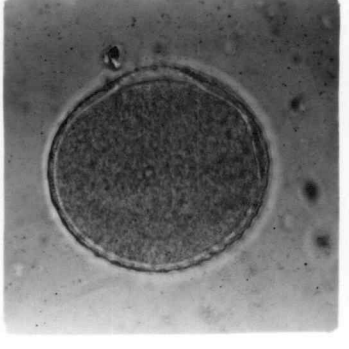

Fig. 47

Fig. 48