Botany

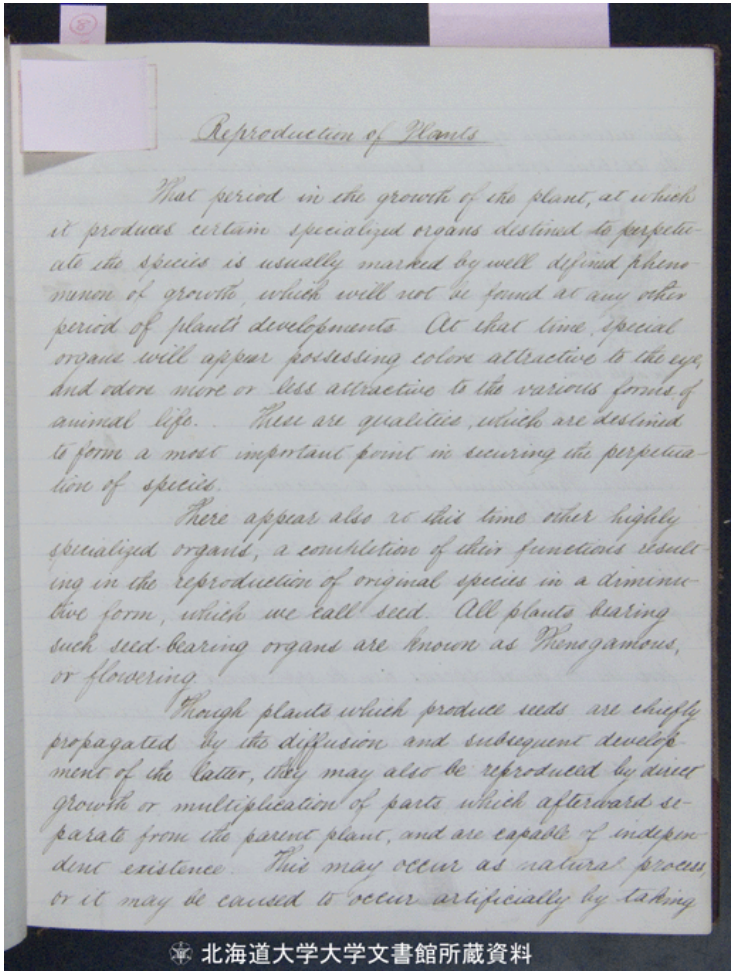
（植物学）

表紙が欠けている

Prof. Penhallow

によるものと推定されている。

宮部金吾著



Reproduction of Plants

That period in the growth of the plant, at which it produces certain specialized organs destined to perpetuate the species is usually marked by well defined phenomenon of growth, which will not be found at any other period of plants developments. At that time, special organs will appear possessing colors attractive to the eye, and odors more or less attractive to the various forms of animal life. These are qualities, which are destined to form a most important point in securing the perpetuation of species.

There appear also at this time other highly specialized organs, a completion of their functions resulting in the reproduction of original species in a diminutive form, which we call seed. All plants bearing such seed-bearing organs are known as Phensgamous, or flowering.

Though plants which produce seeds are chiefly propagated by the diffusion and subsequent development of the latter, they may also be reproduced by direct growth or multiplication of parts which afterward separate from the parent plant, and are capable of independent existence. This may occur as natural process, or it may be caused to occur artificially by taking

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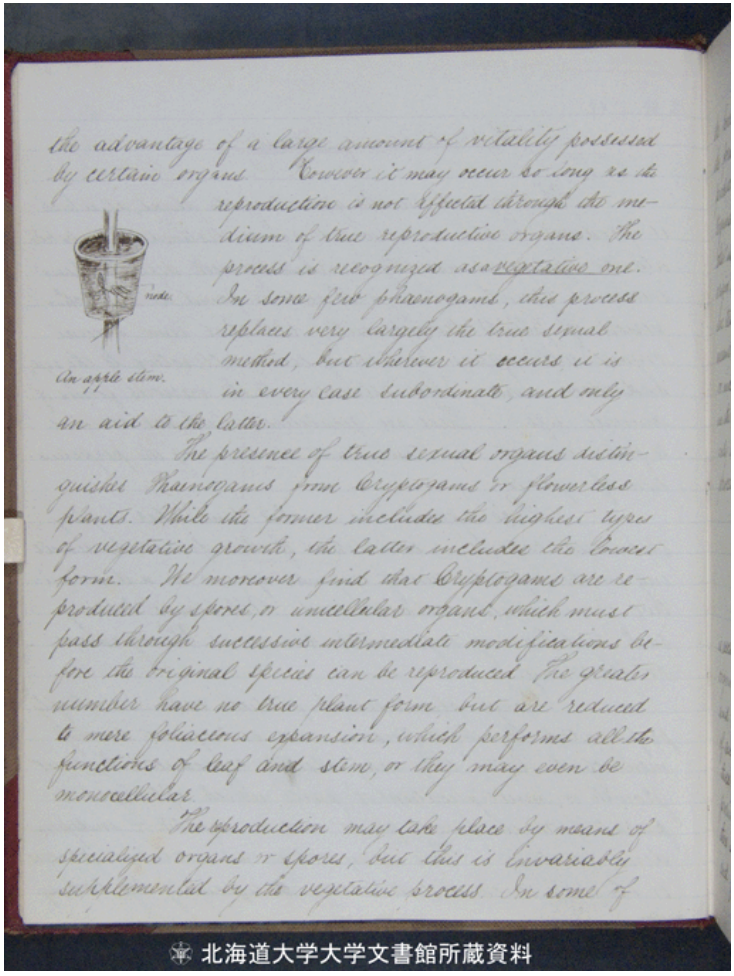
Phensgamous: Phanerogamous（顕花植物）か？

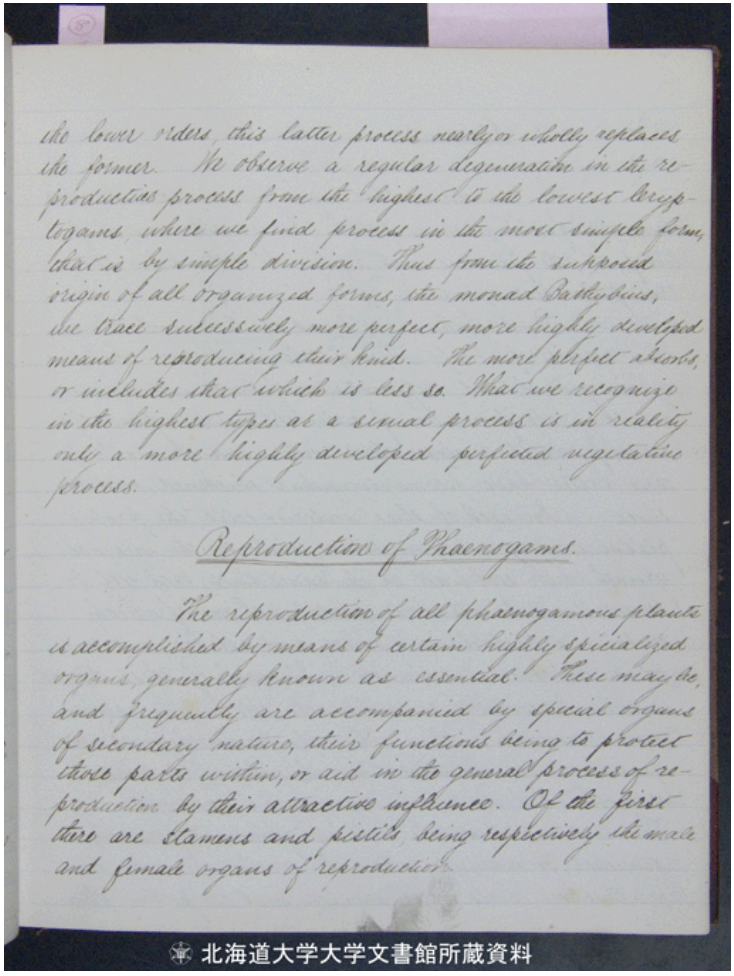


the advantage of a large amount of vitality possessed by certain organs. However it may occur so long as the reproduction is not effected through the medium of true reproductive organs. The process is recognized as a vegetative one. In some few phaenogams, this process replaces very largely the true sexual method, but wherever it occurs it is in every case subordinate, and only an aid to the latter.

An apple stem

The presence of true sexual organs distinguishes Phaenogams from Cryptogams or flowerless plants. While the former includes the highest types of vegetative growth, the latter includes the lowest form. We moreover find that Cryptogams are reproduced by spores, or unicellular organs, which must pass through successive intermediate modifications before the original species can be reproduced. The greater number have no true plant form but are reduced to mere foliaceous expansion, which performs all the functions of leaf and stem, or they may even be monocellular.

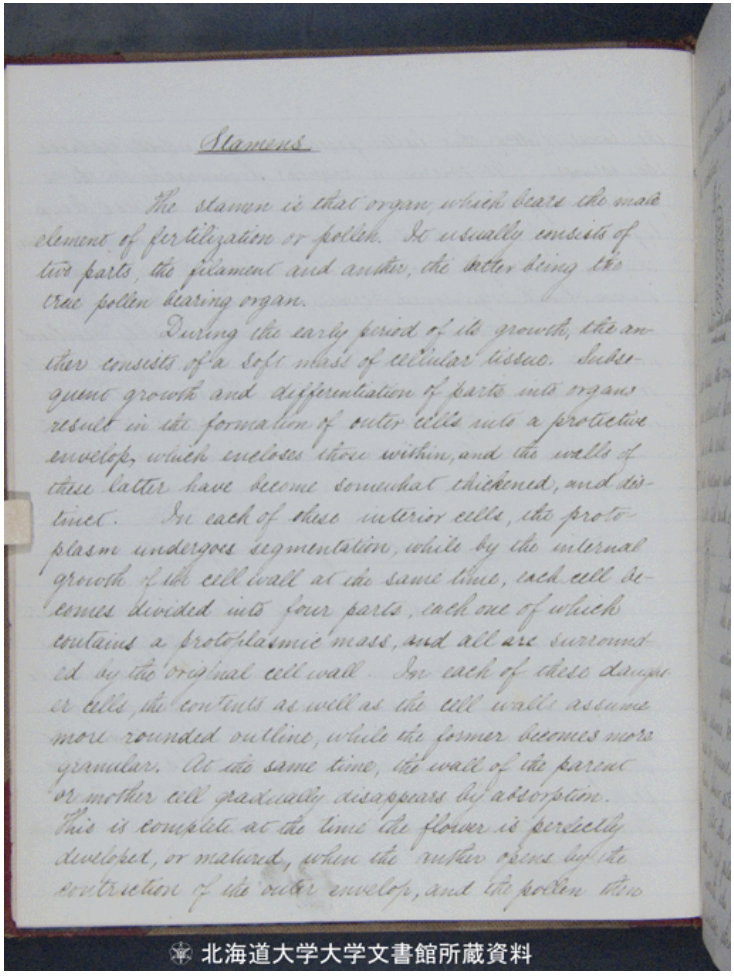
The reproduction may take place by means of specialized organs or spores, but this is invariably supplemented by the vegetative process. In some of



the lower orders this latter process nearly or wholly replaces the former. We observe a regular degeneration in the reproductive process from the highest to the lowest Cryptogams where we find process in the most simple form, that is by simple division. Thus form the supposed origin of all organized forms, the monad Bathybius, we trace successively more perfect, more highly developed means of reproducing their kind. The more perfect absorbs, or includes that which is less so. What we recognize in the highest types as a sexual process is in reality only a more highly developed perfected vegetative process.

Reproduction of Phaenogams.

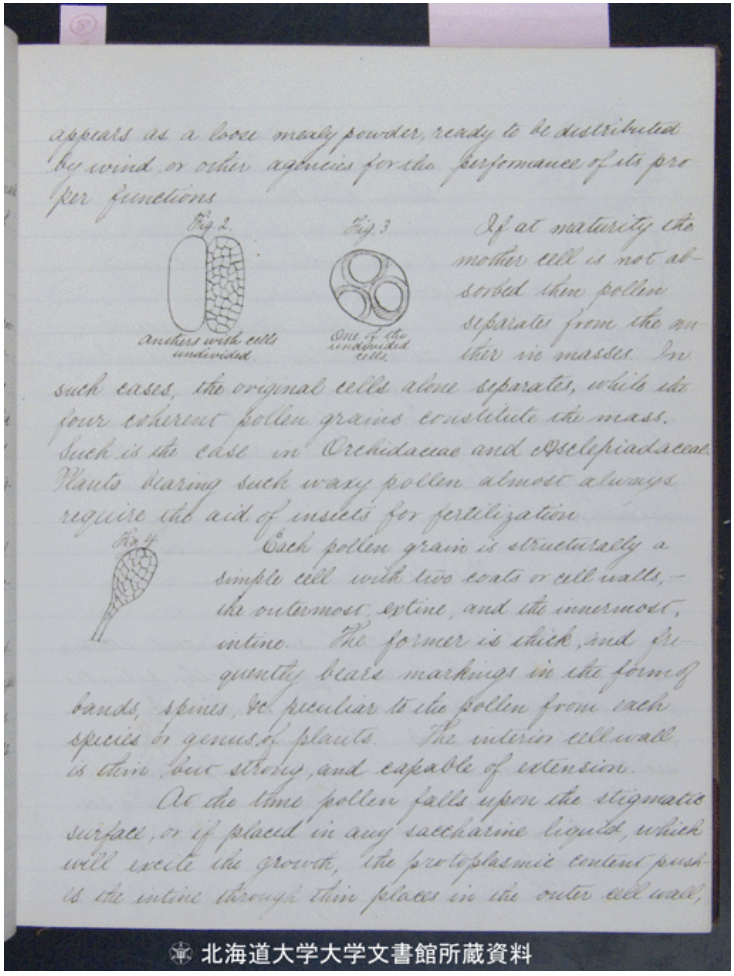
The reproduction of all phaenogamous plants is accomplished by means of certain highly specialized organs generally known as essential. These may be, and frequently are accompanied by special organs of secondary nature, their functions being to protect those parts within, or aid in the general process of reproduction by their attractive influence. Of the first there are stamens and pistils being respectively the male and female organs of reproduction.



Stamens

The stamen is that organ which bears the male element of fertilization or pollen. It usually consists of two parts the filament and anther, the latter being the true pollen bearing organ.

During the early period of the growth, the anther consists of a soft mass of cellular tissue. Subsequent growth and differentiation of parts into organs result in the formation of outer cells into a protective envelop, which encloses those within, and the walls of these latter have become somewhat thickened, and distinct. In each of these interior cells, the protoplasm undergoes segmentation, while by the internal growth of the cell wall at the same time, each cell becomes divided into four parts each one of which contains a protoplasmic mass, and all are surrounded by the original cell wall. In each of these daughter cells, the contents as well as the cell walls assume more rounded outline, while the former becomes more granular. At the same time, the wall of the parent or mother cell gradually disappears by absorption. This is complete at the time the flower is perfectly developed, or matured, when the anther opens by the contraction of the outer envelop, and the pollen then



appears as a loose mealy powder, ready to be distributed by wind or other agencies for the performance of its proper functions.

Fig. 2: Anthers with cells undivided

Fig. 3: One of the undivided cells

If at maturity the mother cell is not absorbed then pollen separates from the anther in masses. In such cases, the original cells alone separates, while the four coherent pollen grains constitute the mass. Such is the case in Orchidaceae and Asclepiadaceae. Plants bearing such waxy pollen almost always require the aid of insects for fertilization.

Each pollen grain is structurally a simple cell with two coats or cell walls, the outermost extine, and the innermost, intine. The former is thick, and frequently bears markings in the form of bands, spines, &c. peculiar to the pollen from each species or genus of plants. The interior cell wall is thin, but strong, and capable of extension.

Fig. 4

At the time pollen falls upon the stigmatic surface, or if placed in any saccharine liquid, which will excite the growth, the protoplasmic content pushes the intine through thin places in the outer cell wall,

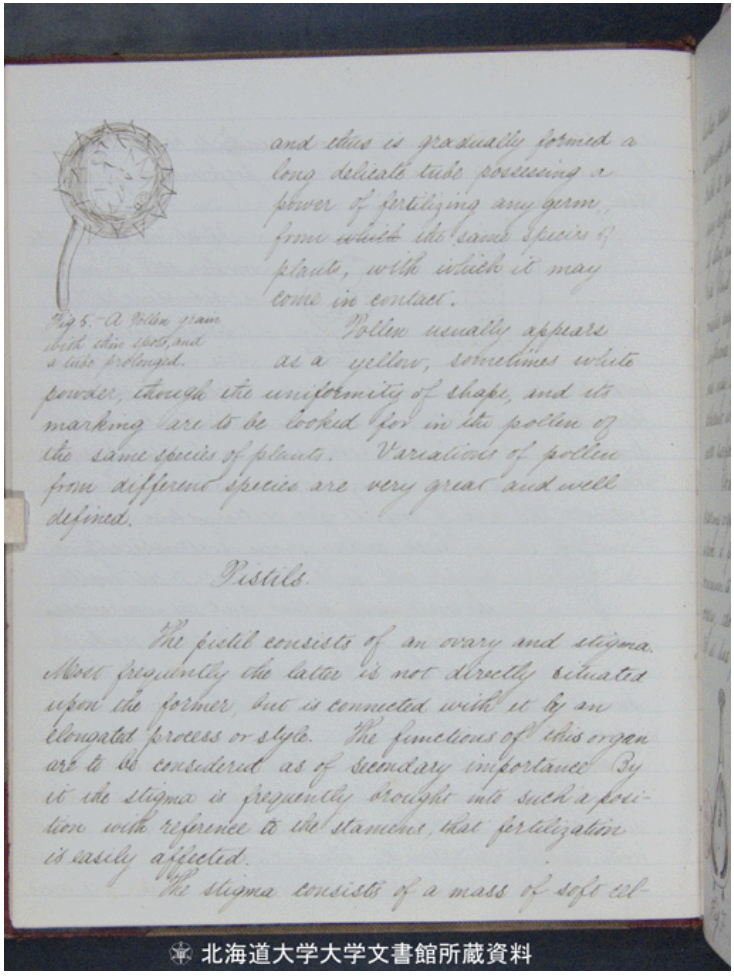


Fig. 5: A Pollen grain with thin spots, and a tube prolonged.

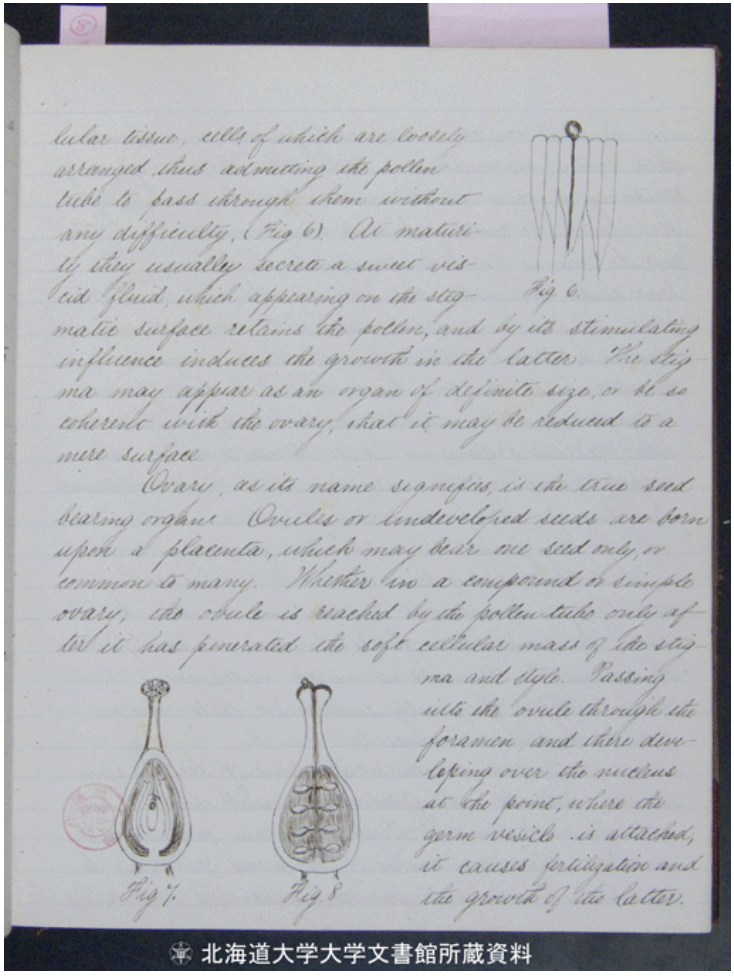
and thus is gradually formed a long delicate tube possessing a power of fertilizing any germ, from the same species of plants, with which it may come in contact.

Pollen usually appears as a yellow, sometimes white powder, though the uniformity of shape, and its marking are to be looked for in the pollen of the same species of plants. Variations of pollen from different species are very great and well defined.

Pistils

The pistil consists of an ovary and stigma. Most frequently the later is not directly situated upon the former, but is connected with it by an elongated process or style. The functions of this organ are to be considered as of secondary importance. By it the stigma is frequently brought into such a position with reference to the stamens, that fertilization is easily affected.

The stigma consists of a mass of soft cellular



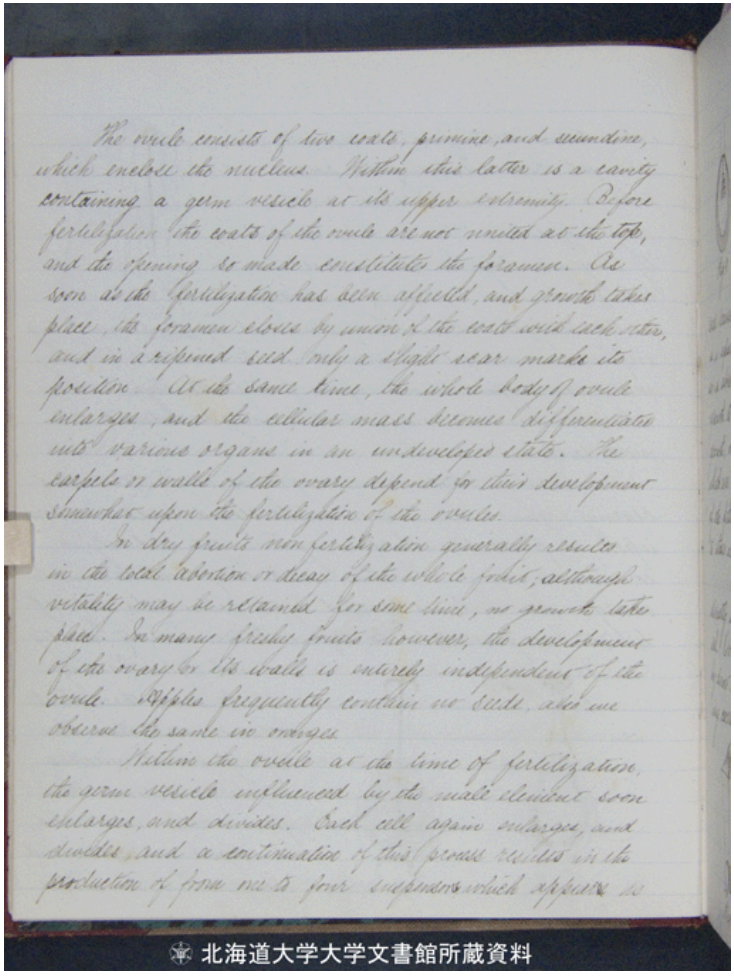
tissue, cells of which are loosely arranged thus admitting the pollen tube to pass through them without any difficulty, (Fig. 6). At maturity they usually secrete a sweet viscid fluid, which appearing on the stigmatic surface retains the pollen, and by its stimulating influence induces the growth in the latter. The stigma may appear as an organ of definite size, or be so coherent with the ovary, that it may be reduced to a mere surface.

Fig. 6

Ovary, as its name signifies, is the true seed bearing organs. Ovules or undeveloped seeds are born upon a placenta, which may bear one seed only, or common to many. Whether in a compound or simple ovary, the ovule is reached by the pollen tube only after it has penerated the soft cellular mass of the stigma and style. Passing into the ovule through the foramen and there developing over the nucleus at the point, where the germ vesicle is attached, it causes fertilization and the growth of the latter.

Fig. 7

Fig. 8



The ovule consists of two coats, primine, and secundine, which enclose the nucleus. Within this latter is a cavity containing a germ vesicle at its upper extremity. Before fertilization the coats of the ovule are not united at the top, and the opening so made constitutes the foramen. As soon as the fertilization has been affected, and growth takes place, the foramen closes by union of the coats with each other, and in a ripened seed only a slight sear marks its position. At the same time, the whole body of ovule enlarges, and the cellular mass becomes differentiates into various organs in an undeveloped state. The carpels or walls of the ovary depend for their development somewhat upon the fertilization of the ovules.

In dry fruits non fertilization generally results in the total abortion or decay of the whole fruit; although vitality may be retained for some time, no growth takes place. In many freshy fruits however, the development of the ovary or its walls is entirely independent of the ovule. Apples frequently contain no seeds, also we observe the same in oranges.

Within the ovule at the time of fertilization the germ vesicle influenced by the male element soon enlarges, and divides. Each cell again enlarges, and divides, and a continuation of this process results in the production of from one to four suspensors which appear is

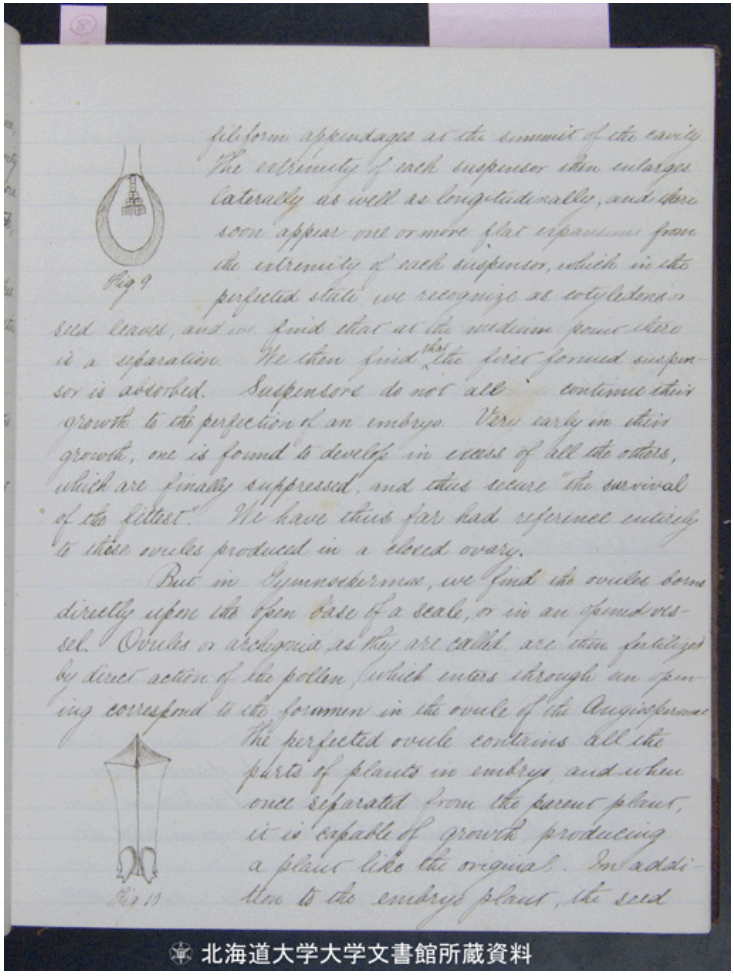


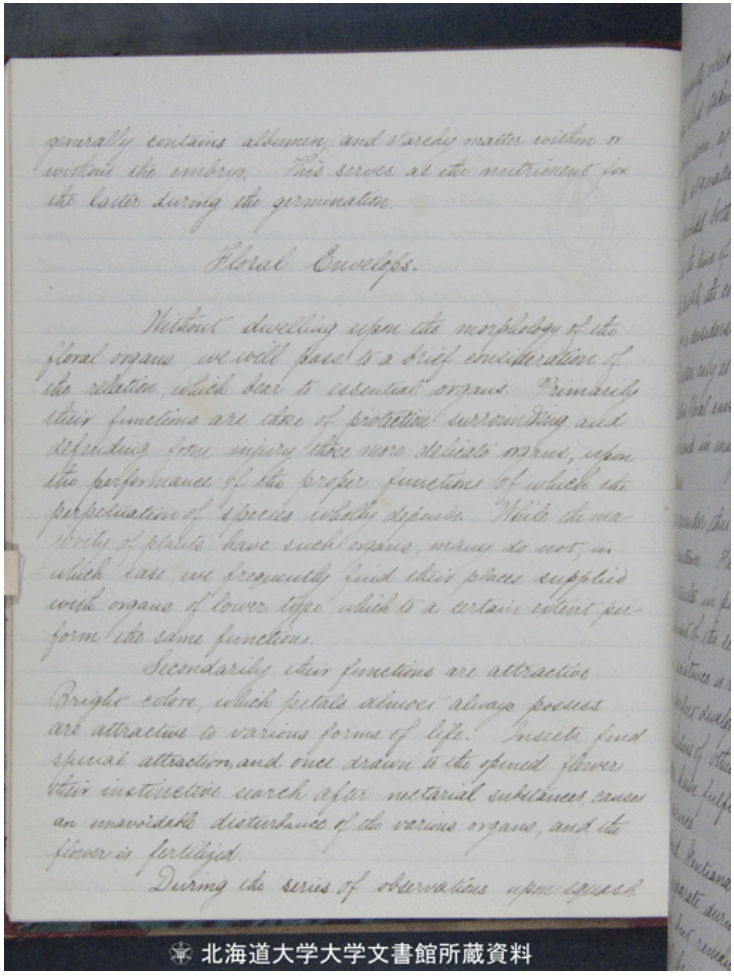
Fig. 9

filiform appendages at the summit of the cavity. The extremity of each suspensor then enlarges laterally as well as longitudinally, and there soon appear one or more flat expansions from the extremity of each suspensor, which in the perfected state we recognize as cotyledons or seed leaves, and we find that at the medium point there is a separation. We then find that the first formed suspensor is absorbed. Suspensors do not all continue their growth to the perfection of an embryo. Very early in their growth, one is formed to develop in excess of all the others, which are finally suppressed, and thus secure "the survival of the fittest". We have thus far had reference entirely to those ovules produced in a closed ovary.

But in Gymnospermae, we find the ovules borne directly upon the open base of a scale, or in an opened vessel. Ovules or archegonia, as they are called, are then fertilized by direct action of the pollen, which enters through an opening correspond to the foramen in the ovule of the Angiospermae.

Fig. 10

The perfected ovule contains all the parts of plants in embryo and when once separated from the parent plant, it is capable of growth producing a plant like the original. In addition to the embryo plant, the seed



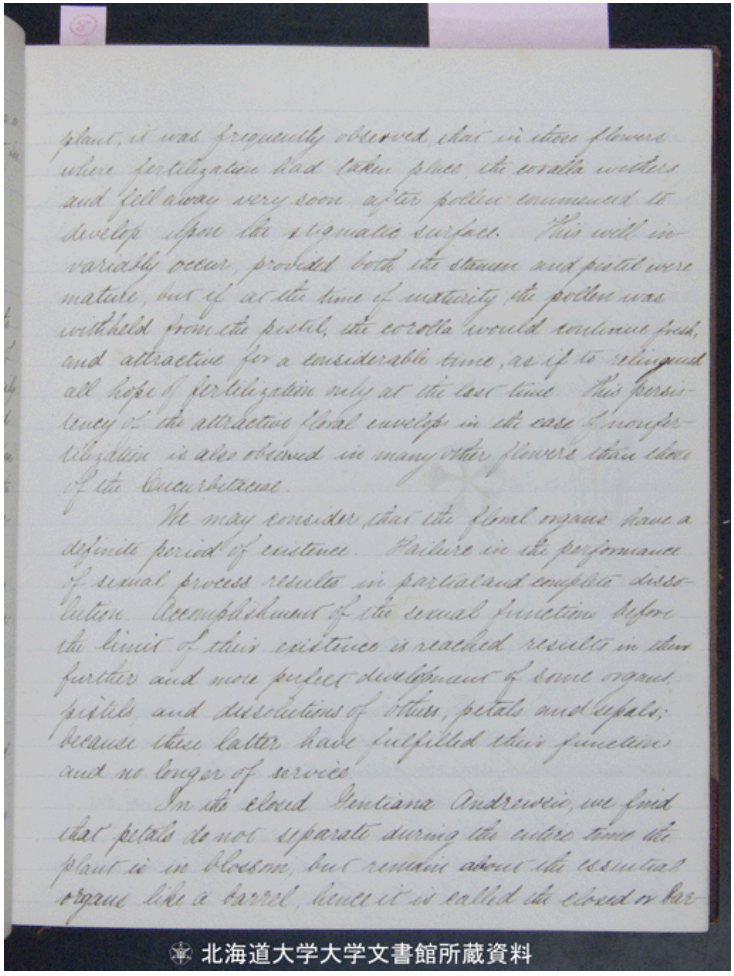
generally contains albumen, and starchy matter within or without the embryo. This serves at the nutriment for the latter during the germination.

Floral Envelops.

Without dwelling upon the morphology of the floral organs we will pass to a brief consideration of the relation, which bear to essential organs. Primarily their functions are those of protection surrounding and defending from injury those more delicate organs, upon the performance of the proper functions of which the perpetuation of species wholly depends. While the majority of plants have such organs, many do not, in which case we frequently find their places supplied with organs of lower type, which to a certain extent perform the same functions.

Secondarily their functions are attractive. Bright colors, which petals almost always possess are attractive to various forms of life. Insects found special attraction, and once drawn to the opened flower their instinctive search after nectarial substances causes an unavoidable disturbance of the various organs, and the flower is fertilized.

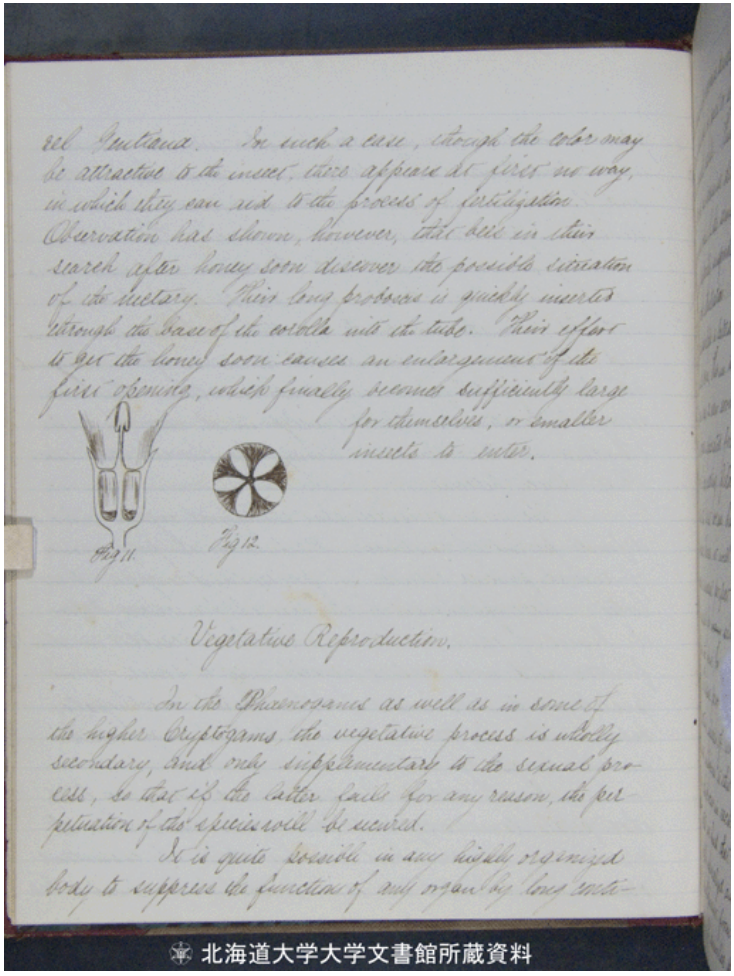
During the series of observations upon squash



plant, it was frequently observed, that in those flowers where fertilization had taken place, the coralla withers and fell away very soon after pollen commenced to develop upon the stigmatic surface. This will invariably occur, provided both the stamen and pistil were mature, but if at the time of maturity the pollen was withheld from the pistil, the corolla would continue fresh, and attractive for a considerable time, as if to relinquish all hope of fertilization only at the lost time. This persistency of the attractive floral envelops in the case of nonfertilization is also observed in many other flowers than those of the Cucurbitaceae.

We may consider that the floral organs have a definite period of existence. Failure in the performance of sexual process results in partial and complete dissolution. Accomplishment of the sexual functions before the limit of their existence is reached results in their further and more perfect development of some organs, pistils and dissolutions of others, petals and sepals; because these latter have fulfilled their functions and no longer of service.

In the closed Gentiana Andrewsii, we find that petals do not separate during the entire time the plant is in blossom, but remain about the essential organs like a barrel, hence it is called the closed or barrel



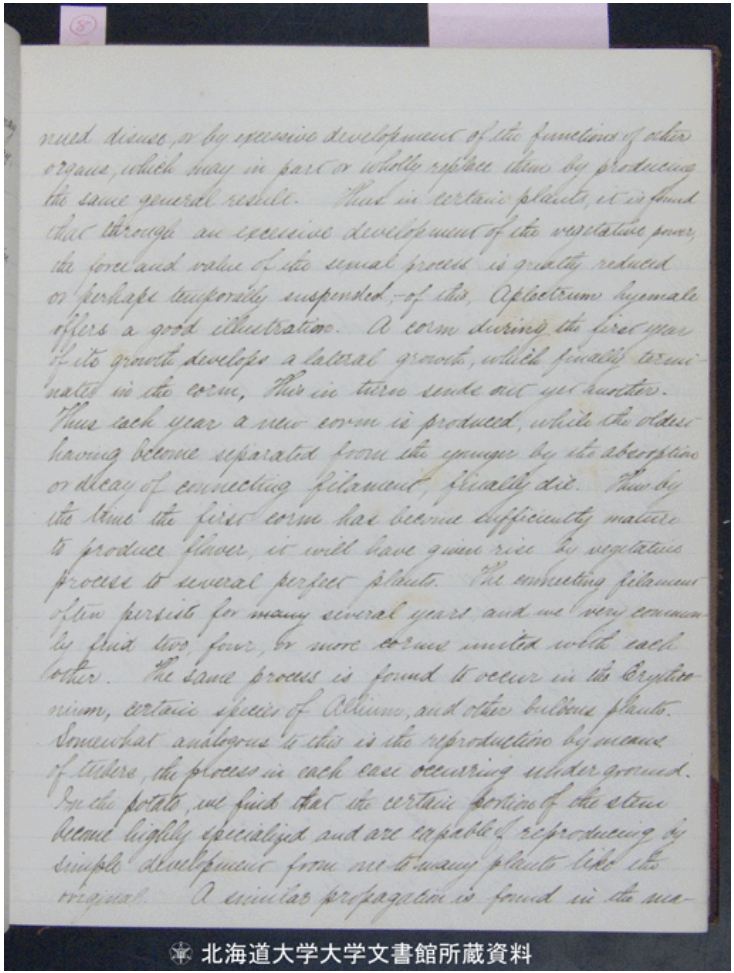
Gentiana. In such a case, though the color may be attractive to the insect, there appears at first no way, in which they can aid to the process of fertilization. Observation has shown, however, that bees in their search after honey soon discover the possible situation of the nectary. Their long proboscis is quickly inserted through the base of the corolla into the tube. Their effort to get the honey soon causes an enlargement of the first opening, which finally becomes sufficiently large for themselves, or smaller insects to enter.

Fig. 11	Fig. 12

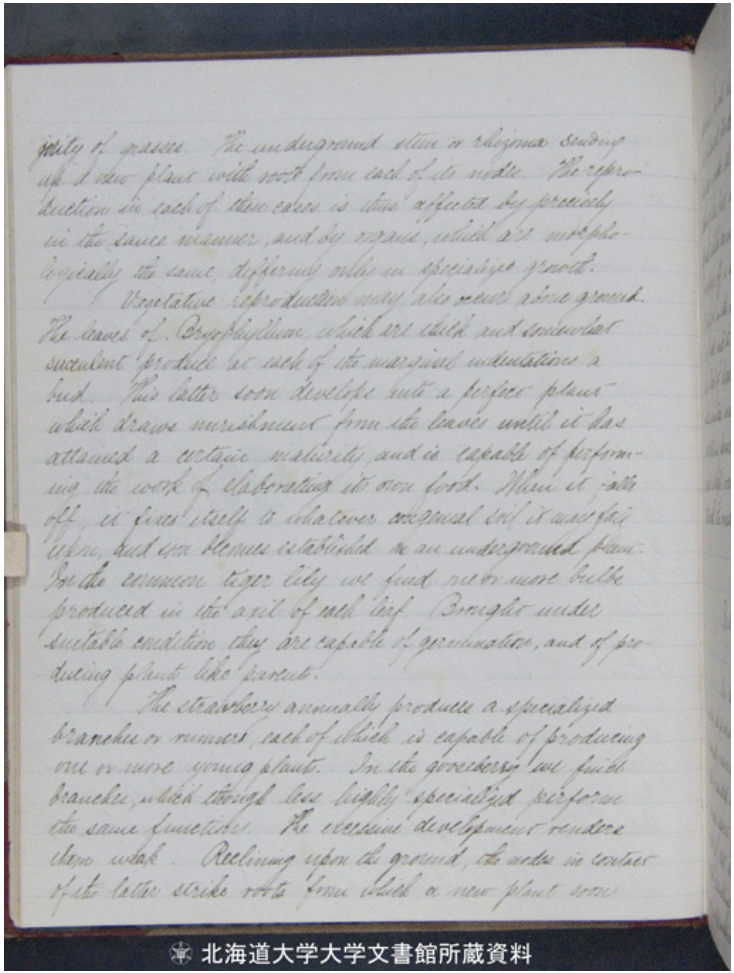
Vegetative Reproduction.

In the Phaenogams as well as in some of the higher Cryptogams the vegetative process is wholly secondary, and only supplementary to the sexual process, so that if the latter fails for any reason, the perpetuation of the species will by secured.

It is quite possible in any highly organized body to suppress the functions of any organ by long continued



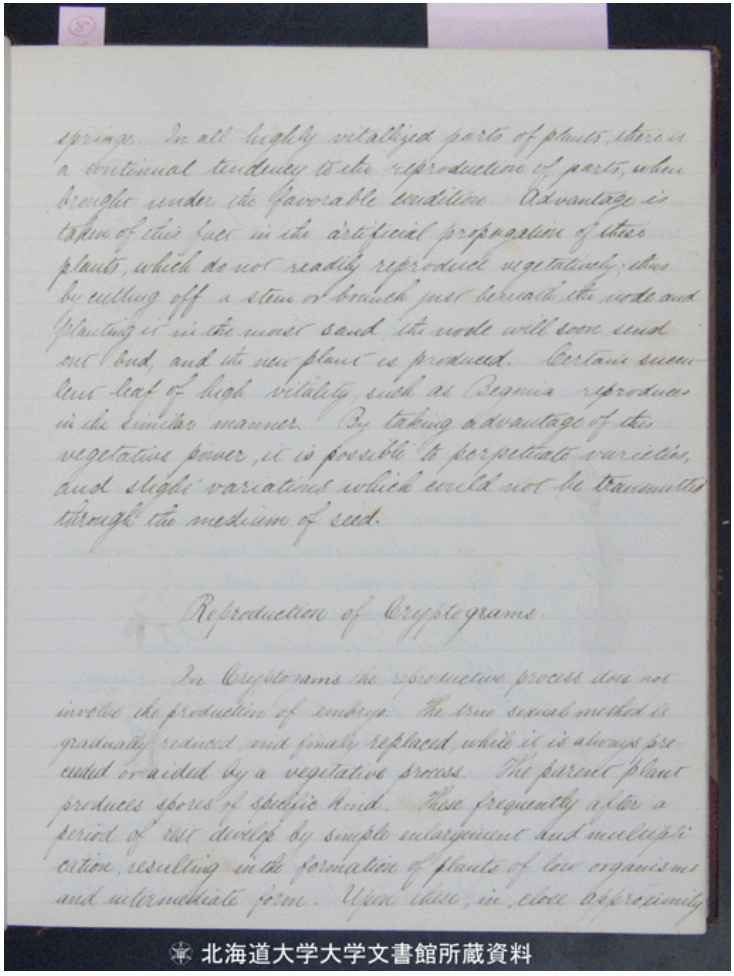
disuse, or by excessive development of the functions of other organs, which may in part or wholly replace them by producing the same general result. This in certain plants, it is found that through an excessive development of the vegetative power, the force and value of the sexual process is greatly reduced or perhaps temporally suspended; of this, Aplectrum hyemale offers a good illustration. A corm during the first year of its growth develops a lateral growth, which finally terminates in the corm. This in turn sends out yet another. Thus each year a new corm is produced, while the oldest having become separated from the younger by the absorption or decay of connecting filament, finally die. Thus by the time the first corm has become sufficiently mature to produce flower, it will have given rise by vegetative process to several perfect plants. The connecting filament often persist for several years and we very commonly find two four, or more corms united with each other. The same process is found to occur in the Erythoronium, certain species of Allium, and other bulbous plants. Somewhat analogous to this is the reproduction by means of tubers, the process in each case occurring under ground. In the potato, we find that the certain portion of the stem become highly specialized and are capable of reproducing by simple development from one to many plants like the original. A similar propagation is found in the majority



of grasses. The underground stem or rhizoma sending up a new plant with roots from each of its nodes. The reproduction in each of these cases is thus affected by precisely in the sauce manner, and by organs, which are morphologically the same, differing only in specialized growth.

Vegetative reproduction may also occur above ground. The leaves of Bryophyllum, which are thick and somewhat succulent produce at each of the marginal indentations a bud. This latter soon develops into a perfect plant which draws nurishment from the leaves until it has attained a certain maturity, and is capable of performing the work of elaborating its own food. When it falls off, it fixes itself to whatever congenial soil it may fall upon, and soon becomes established as an underground plant. In the common tiger lily we find one or more bulbs produced in the axil of each leaf. Brought under suitable condition they are capable of germination, and of producing plants like parents.

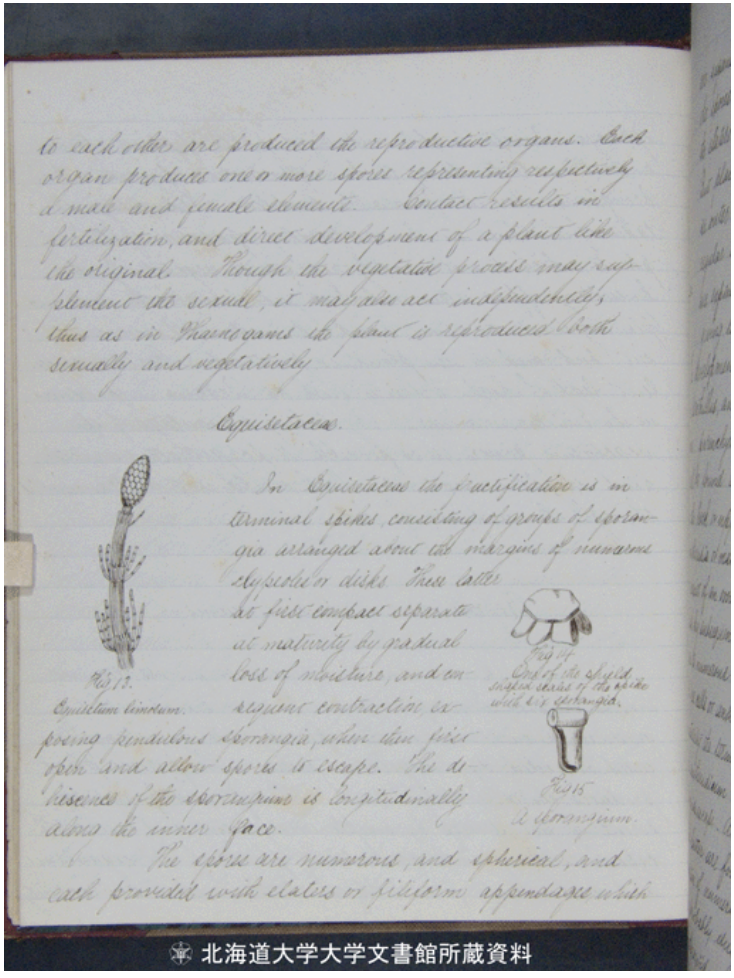
The strawberry annually produces a specialized branches or runners each of which is capable of producing one or more young plants. In the gooseberry we find braches, which though less highly specialized perform the same functions. The excessive development renders them weak. Reclining upon the ground, the nodes in contact of the latter strike roots from which a new plant soon



springs. In all highly vitallized parts of plants, there is a continual tendency to the reproduction of parts, where brought under the favorable condition. Advantage is taken of this fact in the artificial propagation of these plants, which do not readily reproduce vegetatively; thus by cutting off a stem or branch just beneath the node and planting it in the moist sand, the node will soon send out bud, and the new plant is produced. Certain succulent leaf of high vitality such as Begonia reproduces in the similar manner. By taking advantage of this vegetative power, it is possible to perpetuate varieties, and slight variations which could not be transmitted through the medium of seed.

Reproduction of Cryptogams.

In Cryptogams the reproductive process does not involve the production of embryo. The true sexual method is gradually reduced, and finally replaced, while it is always preceded or aided by a vegetative process. The parent plant produces spores of specific kind. These frequently after a period of rest develop by simple enlargement and multiplication, resulting in the formation of plants of low organisms and intermediate form. Upon these, in close approximity



to each other are produced the reproductive organs. Each organ produces one or more spores representing respectively a male and female elements. Contact results in fertilization, and direct development of a plant like the original. Though the vegetative process may supplement the sexual, it may also act independently, thus as in Phaenogams the plant is reproduced both sexually and vegetatively.

Equisetaceae.

Fig. 13: Equisetum limosum.

In Equisetaceae the fructification is in terminal spikes consisting of groups of sporangia arranged about the margins of numerous clypeoles or disks. These latter at first compact separate at maturity by gradual loss of moisture, and consequent contraction exposing pendulous sporangia, when then first open and allow spores to escape. The dehiscence of the sporangium is longitudinally along the inner face.

Fig. 14: One of the shield shaped scales of the spike with six sporangia. Fig.15: A sporangium.

The spores are numerous, and spherical, and each provided with elaters or filiform appendages which

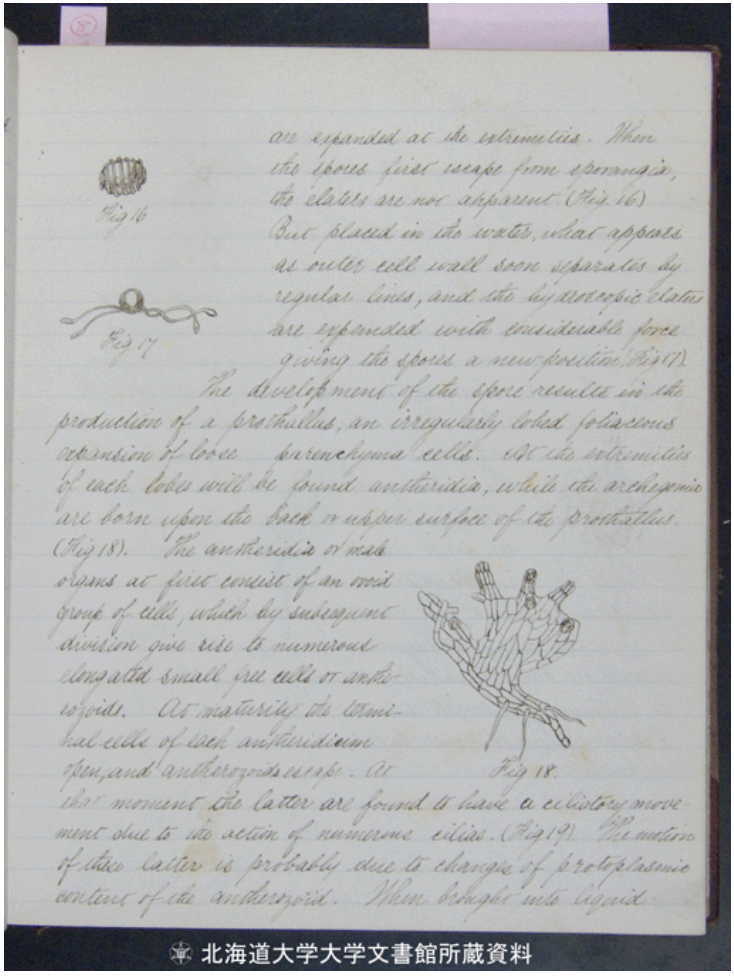
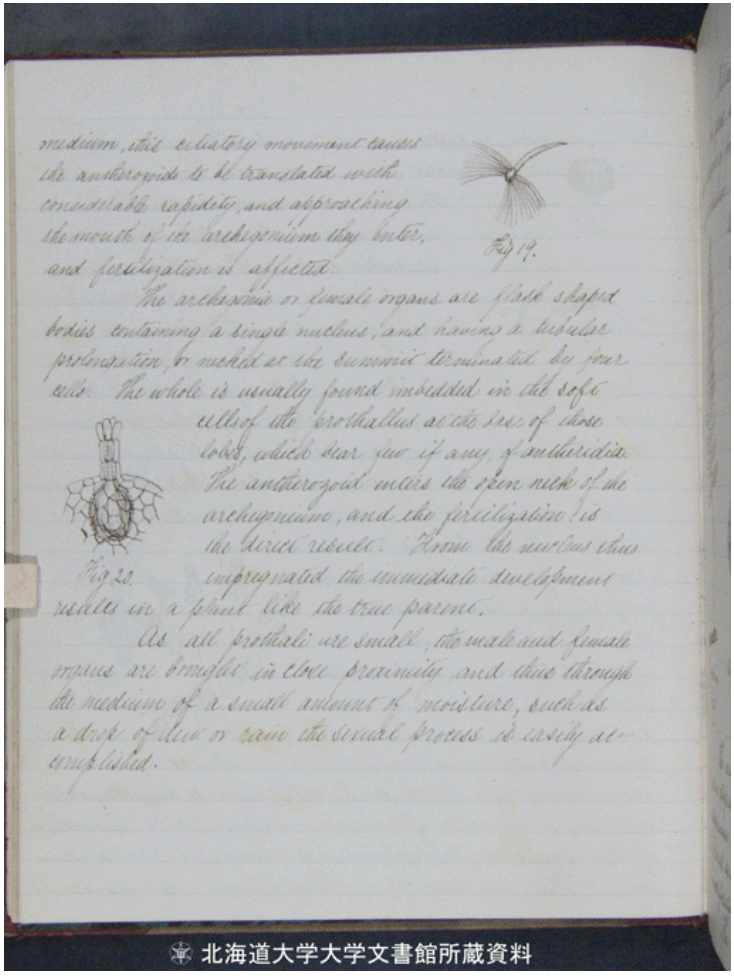


Fig. 16
Fig. 17

are expanded at the extremities. When the spores first escape from sporangia, the elaters are not apparent. (Fig. 16) But placed in the water, what appears as outer cell wall soon separates by regular lines, and the hydroscopic elaters are expanded with considerable force giving the spores a new position (Fig. 17).

The development of the spore results in the production of a prothallus, an irregularly lobed foliaceous expansion of loose parenchyma cells. At the extremities of each lobes will be found antheridia, while the archegonia are born upon the back or upper surface of the prothallus. (Fig. 18). The antheridia or male organs at first consist of an ovoid group of cells, which by subsequent division give rise to numerous elongated small free cells or antherozoids. At maturity the terminal cells of each antheridium open, and antherozoids escape. At that moment the latter are found to have a ciliatory movement due to the action of numerous ciliae. (Fig. 19). The motion of these latter is probably due to changes of protoplasmic content of the antherozoid. When brought into liquid

Fig. 18



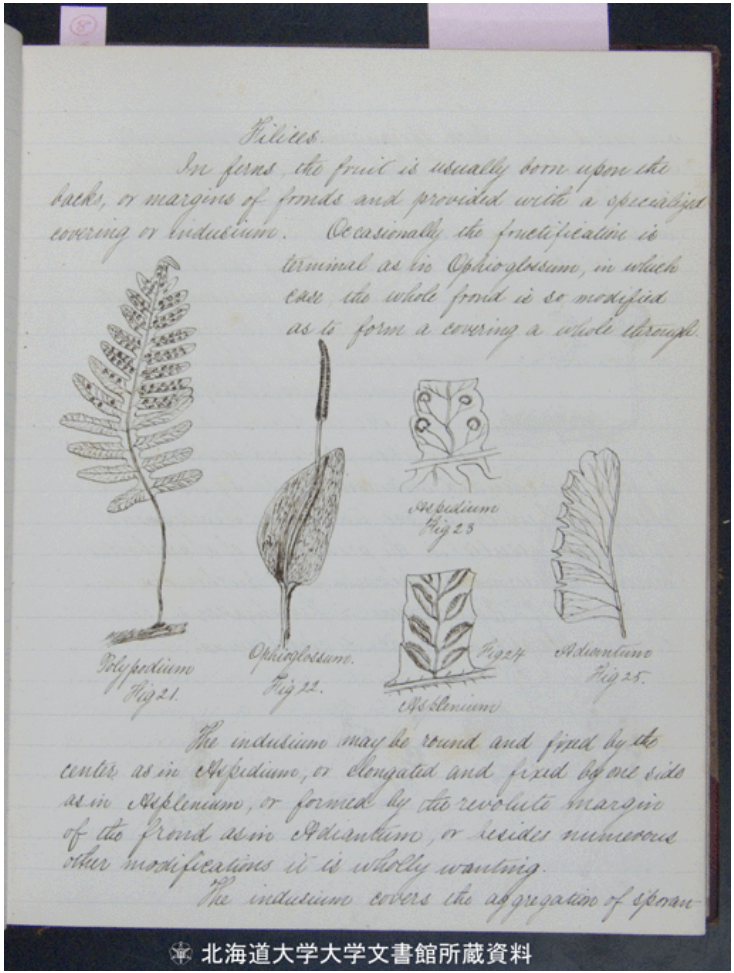
medium, this ciliatory movement causes the antherozoids to be translated with considerable rapidity, and approaching the mouth of the archegonium they enter, and fertilization is affected.

Fig. 19

The archegonia or female organs are flask shaped bodies containing a single nucleus, and having a tubular prolongation, or necked at the summit terminated by four cells. The whole is usually found imbedded in the soft cells of the prothallus at the base of those lobes, which bear few if any of antheridia. The antherozoid enters the open neck of the archegonium, and the fertilization is the direct result. From the nucleus thus impregnated the immediate development results in a plant like the true parent.

Fig. 20

As all prothali are small, the male and female organs are brought in close proximity and thus through the medium of a small amount of moisture, such as a drop of dew or rain the sexual process is easily accomplished.



Filices.

In ferns, the fruit is usually born upon the backs, or margins of fronds and provided with a specialized covering or indusium. Occasionally the fructification is terminal as in Ophioglossum, in which case the whole frond is so modified as to form a covering a whole through.

Fig. 21: Polypodium

Fig. 22: Ophioglossum

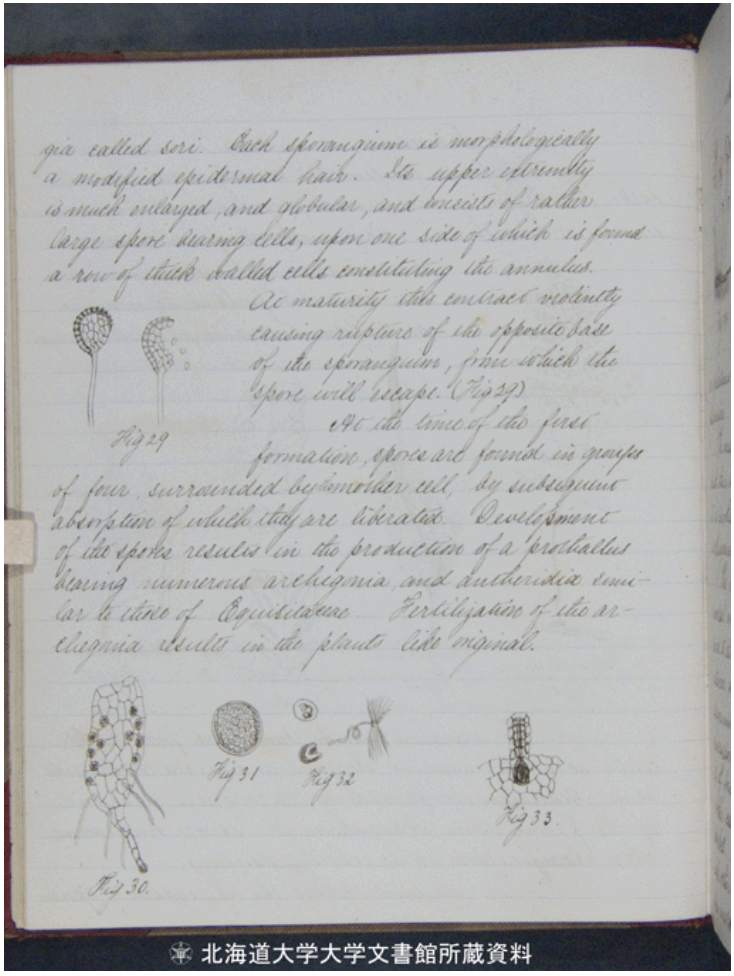
Fig. 23: Aspidium

Fig. 24: Asplenium

Fig. 25: Adiantum

The indusium may be round and fixed by the center as in Aspidium, or elongated and fixed by one side as in Asplenium, or formed by the revolute margin of the frond as in Adiantum, or besides numerous other modifications it is wholly wanting.

The indusium covers the aggregation of sporangia



called sori. Each sporangium is morphologically a modified epidermal hair. Its upper extremity is much enlarged, and globular, and consists of rather large spore bearing cells, upon one side of which is found a row of thick walled cells constituting the annulus.

Fig. 29

At maturity this contract violently causing rupture of the opposite base of the sporanguim, from which the spore will escape. (Fig. 29)

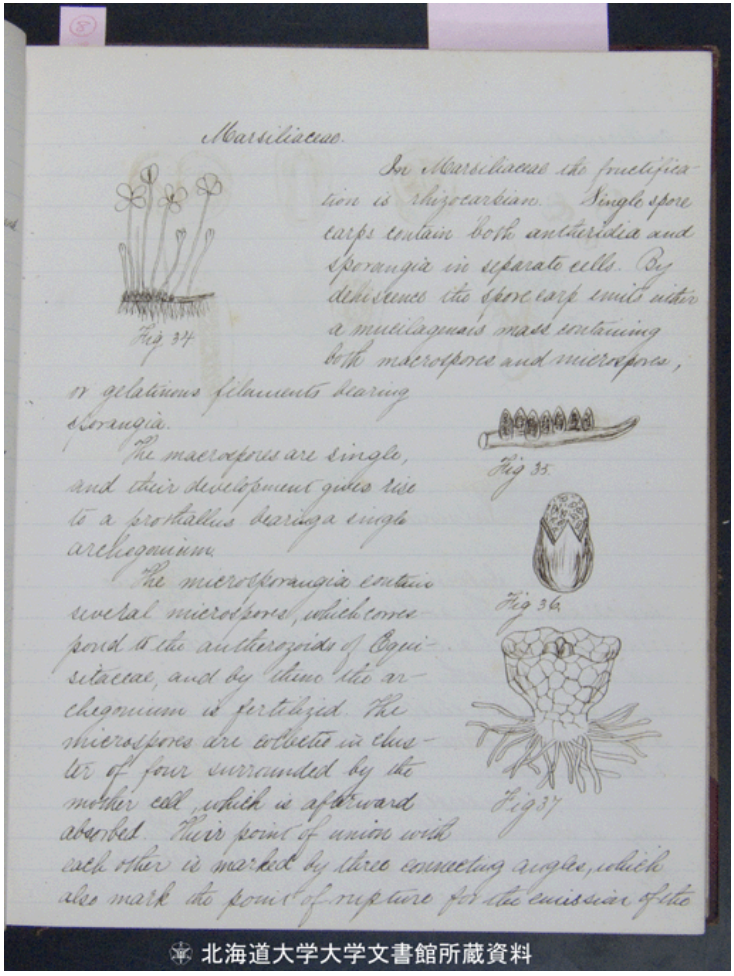
At the time of the first formation, spores are found in groups of four, surrounded by the mother cell, by subsequent absorption of which they are liberated. Development of the spores results in the production of a prothallus bearing numerous archegonia and antheridia similar to those of Equisitaceae. Fertilization of the archegonia results in the plants like original.

Fig. 30

Fig. 31

Fig. 32

Fig. 33



Marsiliaceae.

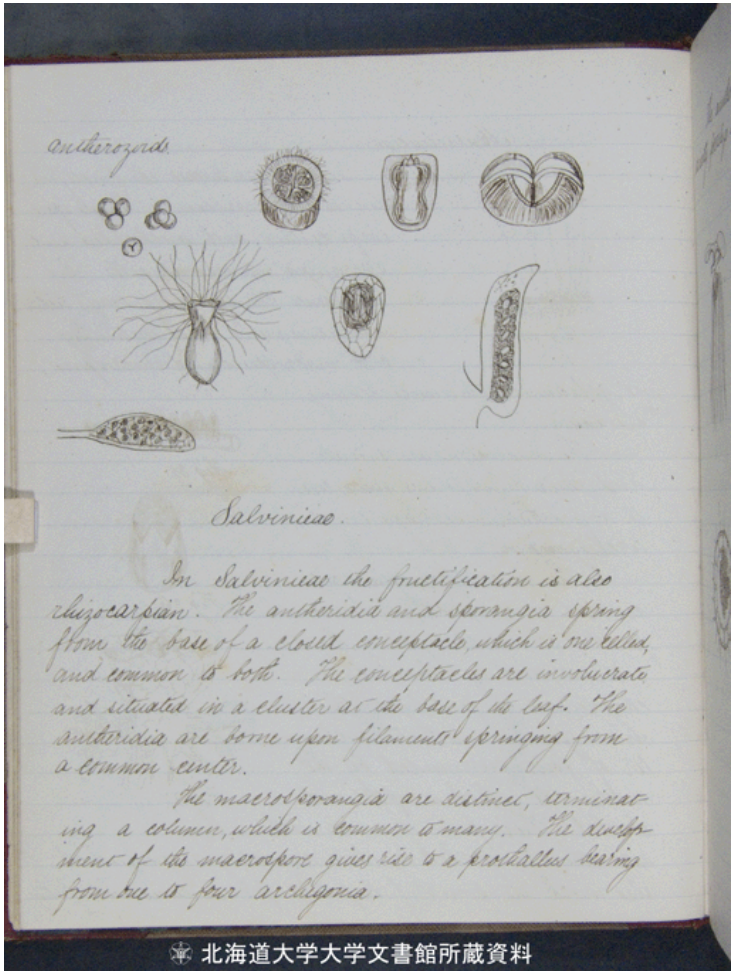
Fig. 34

In Marsiliaceae the fructification is rhizocarpian. Single spore carps contain both antheridia and sporangia in separate cells. By dehiscence the spore carp emits either a mucilagenais mass containing both macrospores and microspores, or gelatinous filaments bearing sporangia.

Fig. 35
Fig. 36
Fig. 37

The macrospores are single, and their development gives rise to a prothallus bearing a single archegonium.

The microsporangia contain several microspores, which correspond to the antherozoids of Equisitaceae, and by them the archegonium is fertilized. The microspores are collected in cluster of four surrounded by the mother cell, which is afterward absorbed. Their point of union with each other is marked by three connecting angles, which also mark the point of rupture for the emission of the



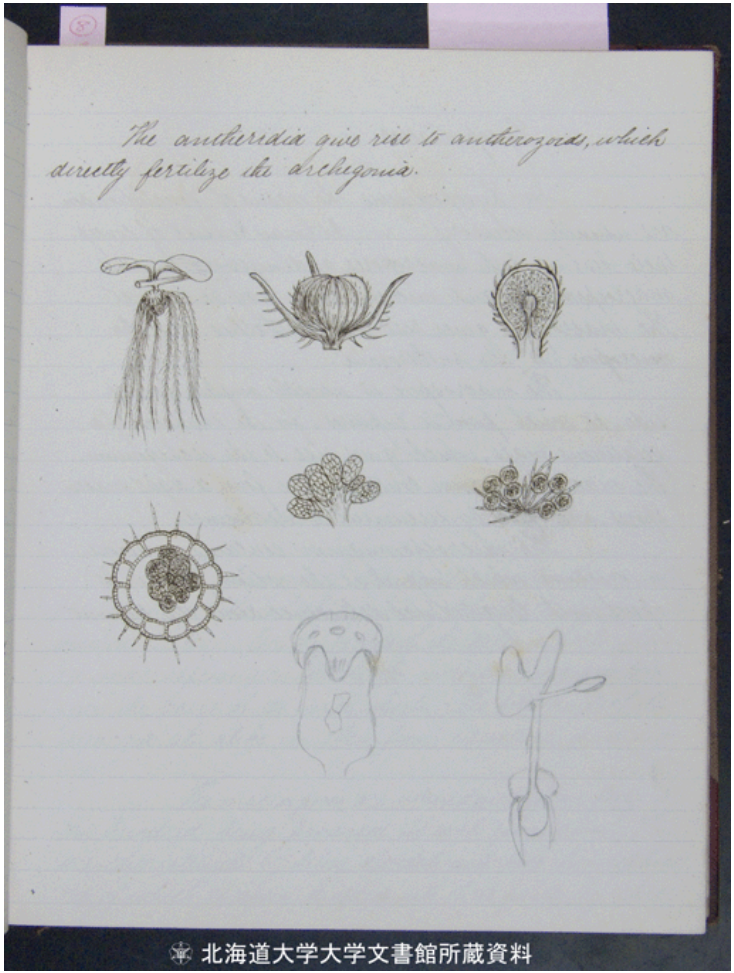
antherozoids.

Figures

Salvinieae

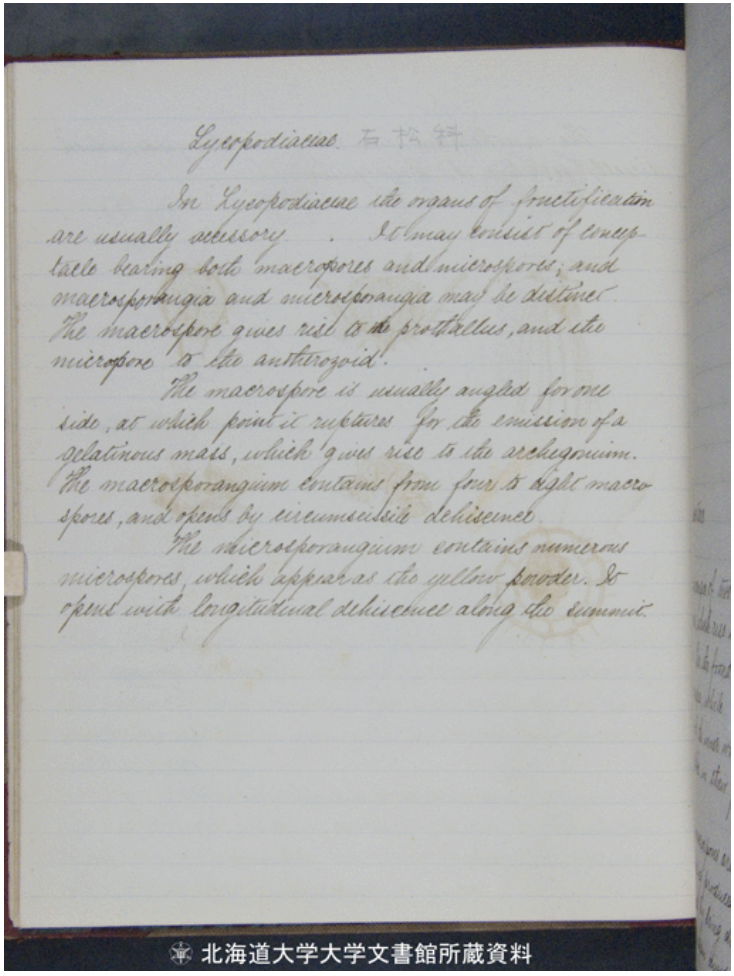
In Salvinieae the fructification is also rhizocarpian. The antheridia and sporangia spring from the base of a closed conceptacle, which is one celled, and common to both. The conceptaeles are involucrate and situated in a cluster at the base of the leaf. The antheridia are borne upon filaments springing from a common center.

The macrosporangia are distinct, terminating a column, which is common to many. The development of the macrospore gives rise to prothallus bearing from one to four archegonia.



The antheridia give rise to antherozoids, which directly fertilize the arehegonia.

Figures

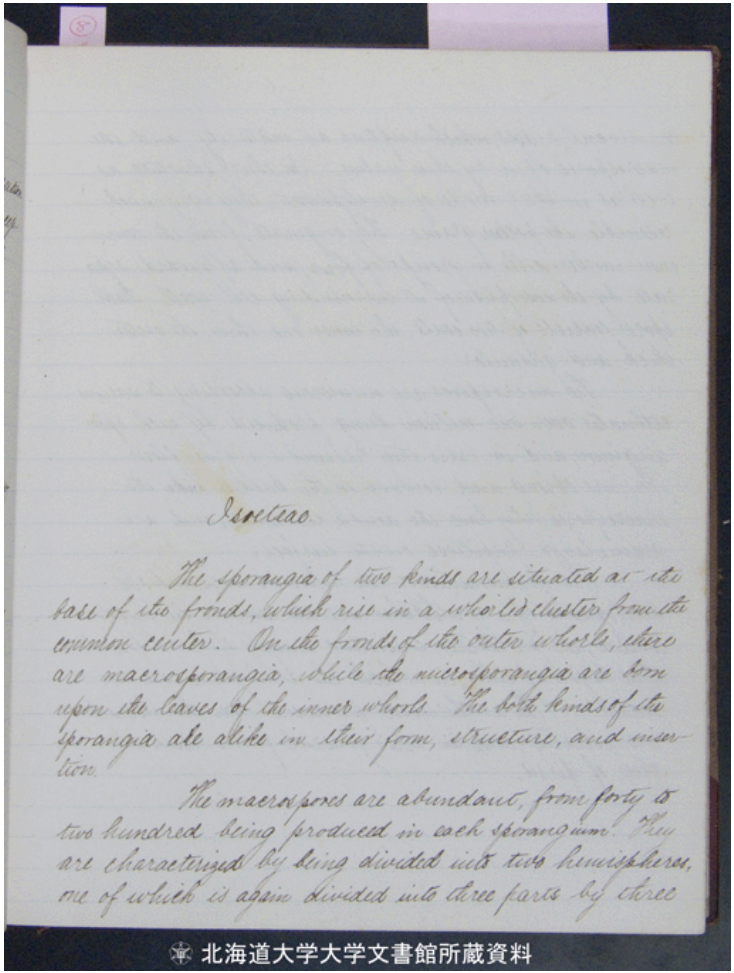


Lycopodiaceae.

In Lycopodiaceae the organs of fructification are usually accessory. It may consist of conceptacle bearing both macrospores and microspores, and macrosporangia and microsporangia may be distinct. The macrospore gives rise to the prothallus, and the microspore to the antherozoid.

The macrospore is usually angled for one side, at which point it ruptures for the emission of a gelatinous mass, which gives rise to the archegonium. The macrosporangium contains from four to eight macrospores, and opens by circumscissile dehiscence.

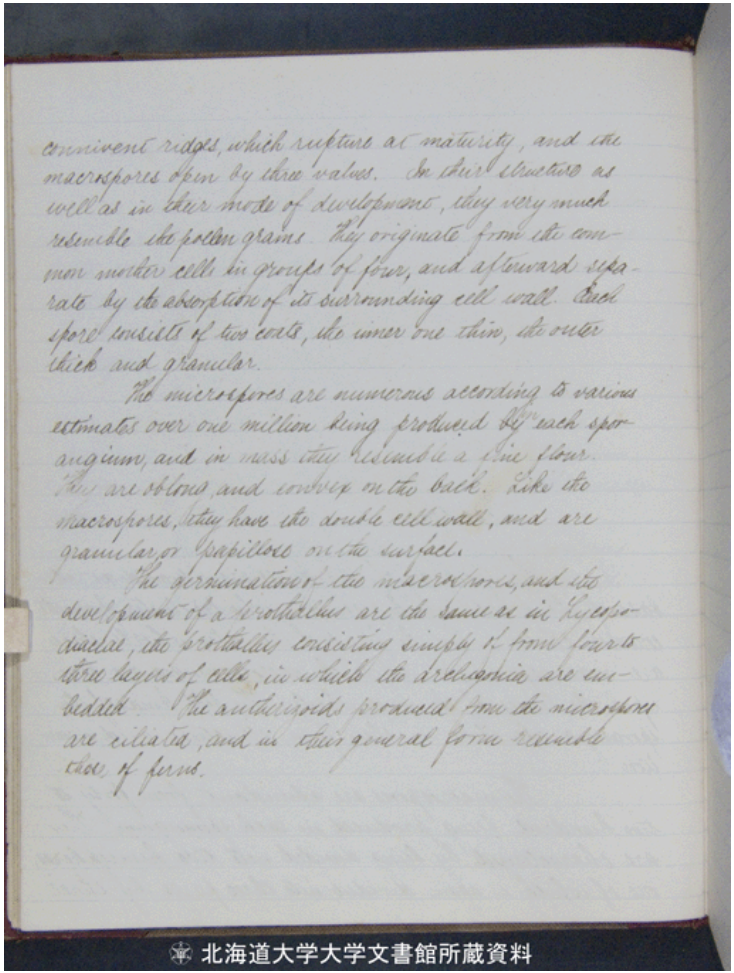
The microsporangium contains numerous microspores, which appear as the yellow powder. So opens with longitudinal dehiscence along the summit.



Isoeteae

The sporangia of two kinds are situated at the base of the fronds, which rise in a whorled cluster from the common center. On the fronds of the outer whorls, there are macrosporangia, while the microsporangia are born upon the leaves of the inner whorls. The both kinds of the sporangia are alike in their form, structure, and insertion.

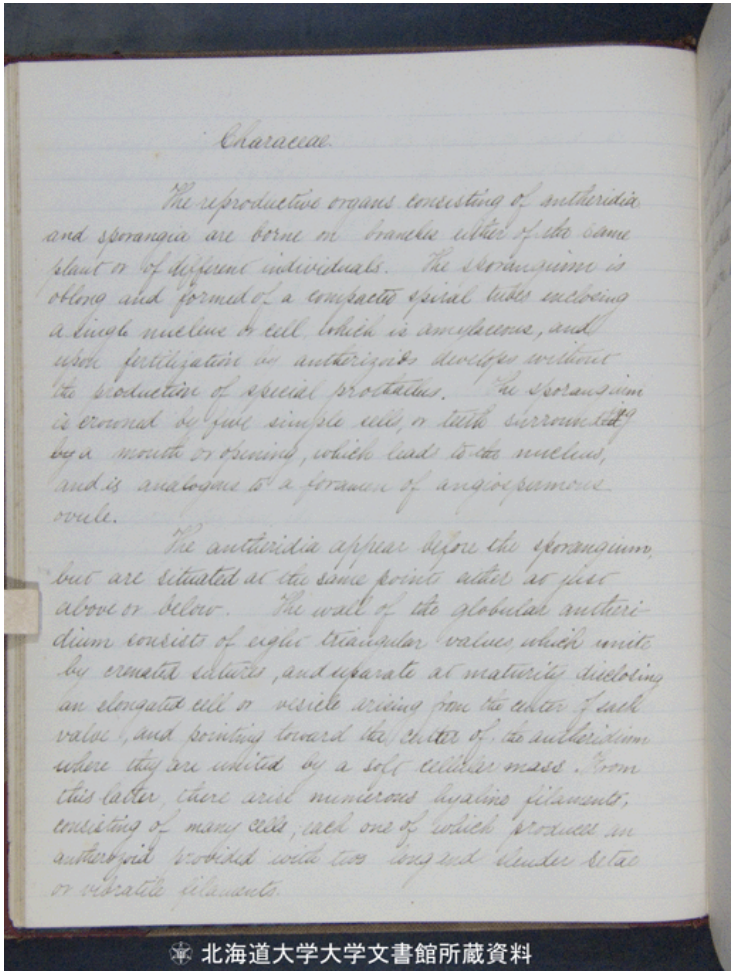
The macrospores are abundant, from forty to two hundred being produced in each sporangium. They are characterized by being divided into two hemispheres, one of which is again divided into three parts by three



connivent ridges, which rupture at maturity, and the macrospores open by three values. In their structure as well as in their mode of development, they very much resemble the pollen grams. They originate from the common mother cells in groups of four, and afterward separate by the absorption of its surrounding cell wall. Each spore consists of two coats, the inner one thin, the outer thick and granular.

The microspores are numerous according to various estimates over one million being produced in each sporangium, and in mass they resemble a fine flour. They are oblong, and convey on the back. Like the macrospores, they have the double cell wall, and are granular or papillose on the surface.

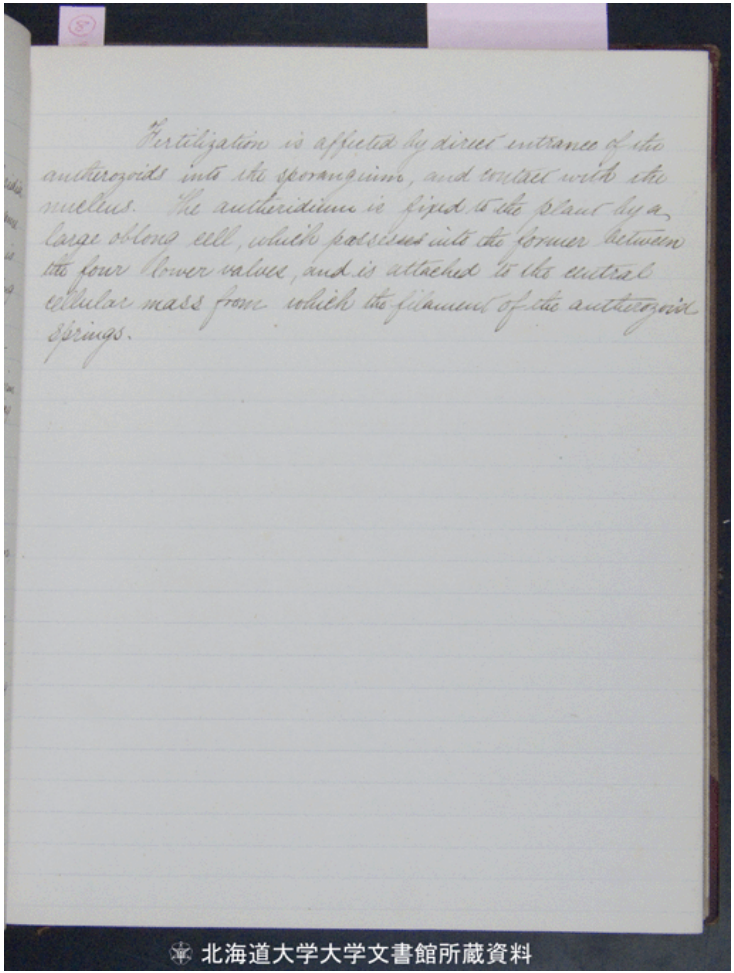
The germination of the macrospores, and the development of a prothallus are the sauce as in Lycopodiaceae, the prothallus consisting simply of from four to three layers of cells, in which the arechegonia are embedded. The antherizoids produced from the microspores are ciliated, and in their general form resemble that of ferns.



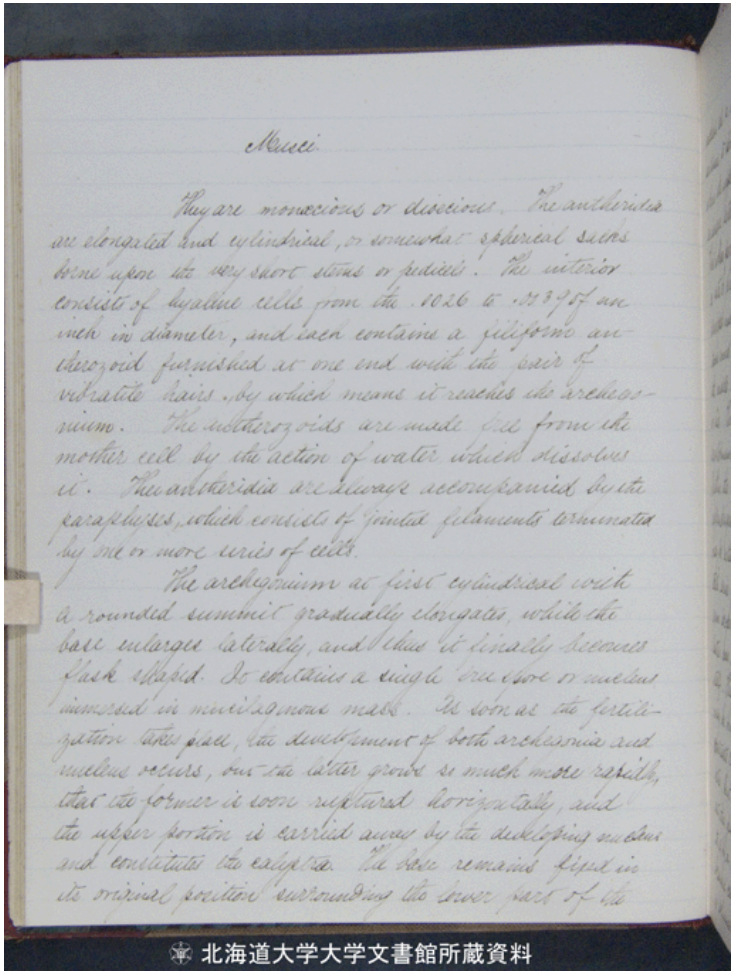
Characeae.

The reproductive organs consisting of antheridia and sporangia are borne on branches either of the same plant or of different individuals. The sporangium is oblong and formed of a compacted spiral tubes enclosing a single nucleus or cell which is amylaceous, and upon fertilization by antherizoids develops without the production of special prothallus. The sporangium is crowned by five simple cells, or teeth surrounding a mouth or opening , which leads to the nucleus, and is analogous to a foramen of angiospermous ovule.

The antheridia appear before the sporangium, but are situated at the same points either at just above or below. The wall of the globular antheridium consists of eight triangular values, which unite by crenated sutures, and separate at maturity disclosing an elongated cell or vesicle arising from the center of each value, and pointing toward the center of the antheridium where they are united by a soft cellular mass. From this later, there arise numerous hyaline filaments, consisting of many cells, each one of which produces an antherozoid provided with two long and slender setae or vibratile filaments.



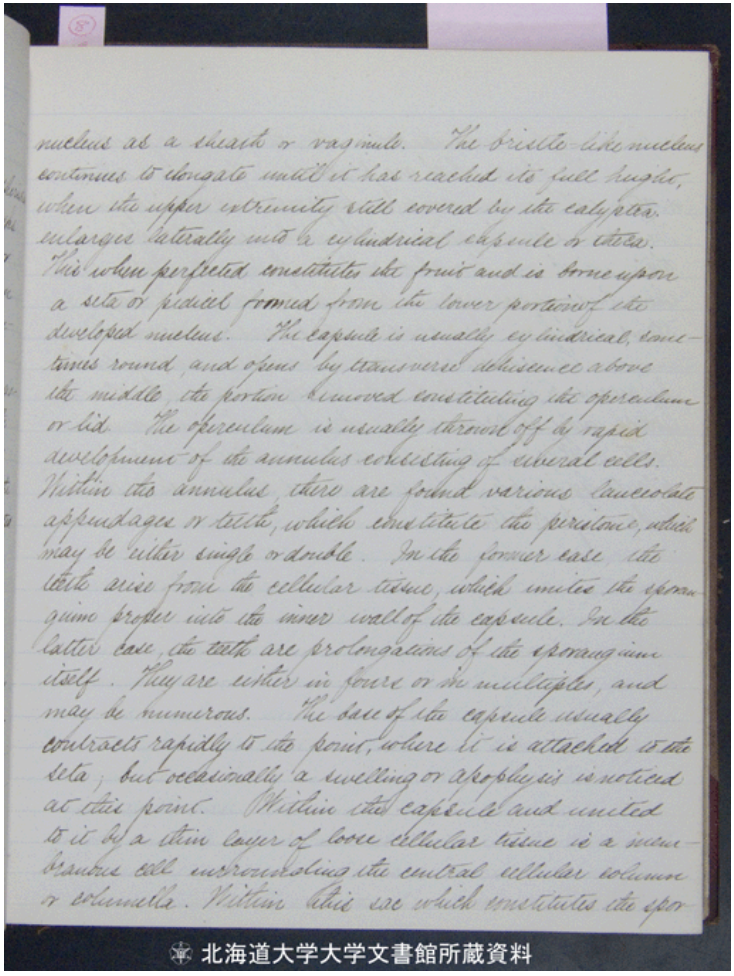
Fertilization is affected by direct entrance of the antherozoids into the sporangium, and contact with the nucleus. The antheridium is fixed to the plant by a large oblong cell, which passes into the former between the four lower values, and is attached to the central cellular mass from which the filament of the antherozoid springs.



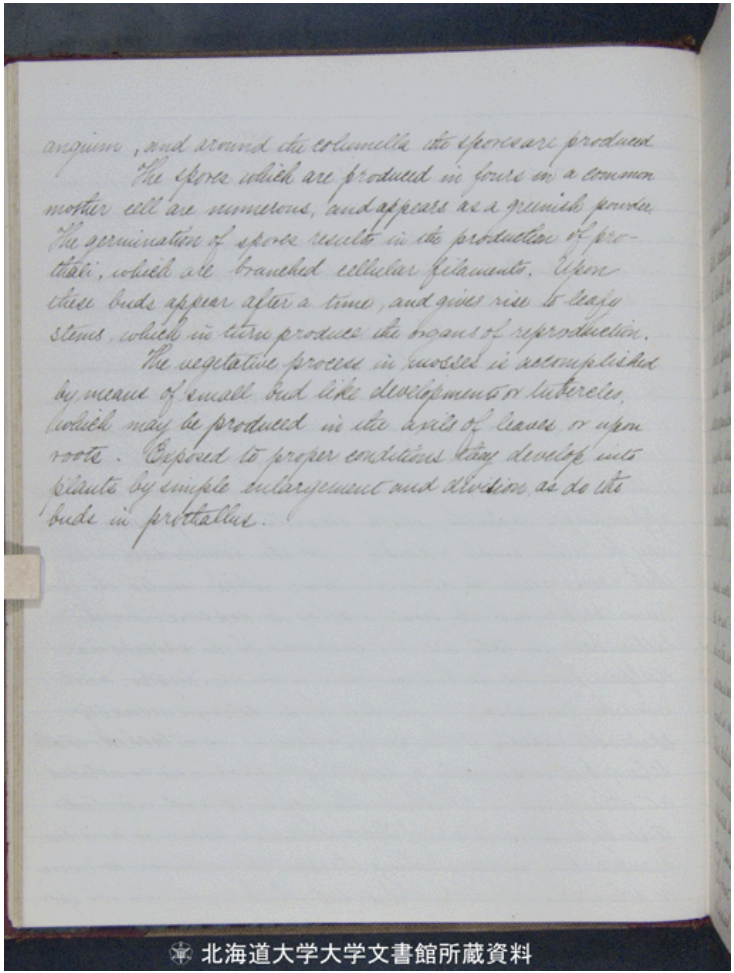
Musci

They are monoecious or dioecious. The antheridia are elongated and cylindrical, or somewhat spherical sacks borne upon the very short stems or pedicels. The interior consists of hyaline cells from the .0026 to .0039 of an inch in diameter, and each contains a filiform antherozoid furnished at one end with the pair of vibratile hairs by which means it reaches the archegonium. The uctherozoids are made free from the mother cell by the action of water which dissolves it. The antheridia are always accompanied by the paraphyses, which consists of jointed filaments terminated by one or more series of cells.

The archegonium at first cylindrical with a rounded summit gradually elongates, which the base enlarges laterally, and thus it finally becomes flask shaped. It contains a single free spore or nucleus immersed in mucilaginous mass. As soon as the fertilization takes place, the development of both archegonia and nucleus occurs, but the latter grows so much more rapidly, that the former is soon ruptured horizontally, and the upper portion is carried away by the developing nucleus and constitutes the calyptra. The base remains fixed in its original position surrounding the lower parts of the



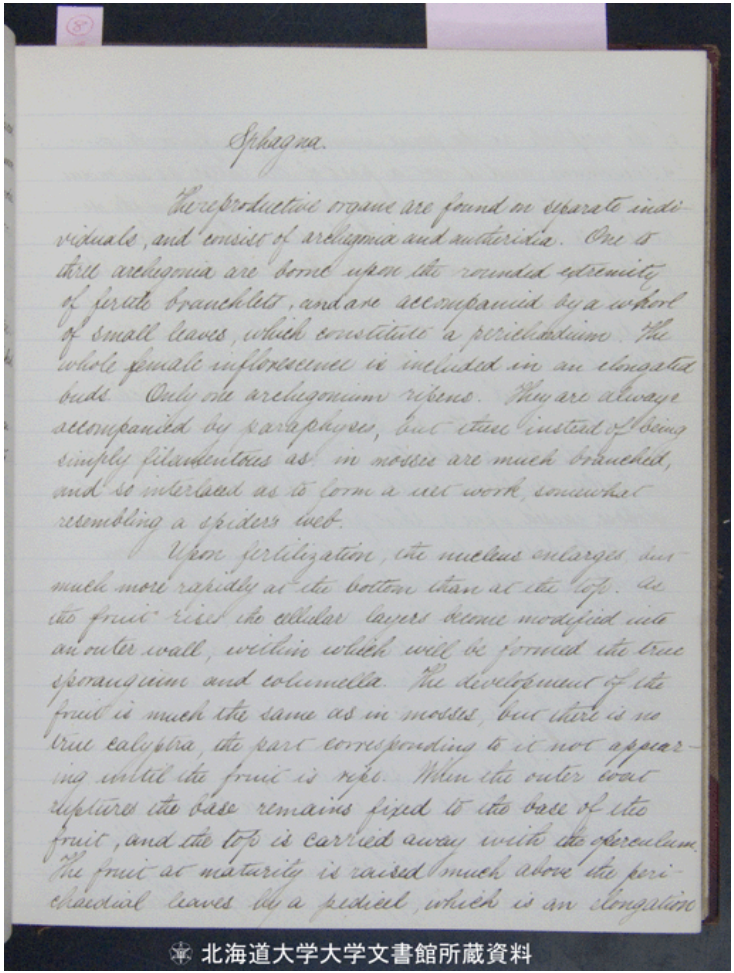
nucleus as a sheath or vaginule. The bristle like nucleus continues, it elongate until it has reached its full height, when the upper extremity still covered by the calyptra, enlarges laterally into a cylindrical capsule or theca. This when perfected constitutes the fruit and is borne upon a seta or pedicel formed from the lower portion of the developed nucleus. The capsule is usually cylindrical, sometimes round, and opens by transverse dehiscence above the middle the portion removed constituting the operculum or lid. The operculum is usually thrown off by rapid development of the annulus consisting of several cells. Within the annulus, there are found various lanceolate appendages or teeth, which constitute the peristome, which may be either single or double. In the former case the teeth arise from the cellular tissue, which unites the sporangium proper into the inner wall of the capsule. In the latter case, the teeth are prolongations of the sporangium itself. They are either in fours or in multiples, and may be numerous. The base of the capsule usually contracts rapidly to the point, where it is attached to the seta; but occasionally a swelling or apophysis is noticed at this point. Within the capsule and united to it by thin layer of loose cellular tissue is a membranous cell surrounding the central cellular column or columella. Within this sac which constitutes the sporangium,



and around the columella the spores are produced.

The spores which are produced in fours in a common mother cell are numerous, and appears as a greenish powder. The germination of spores results in the production of prothali, which are branched cellular filaments. Upon there buds appear after a time, and gives rise to leafy stems, which in turn produce the organs of reproduction.

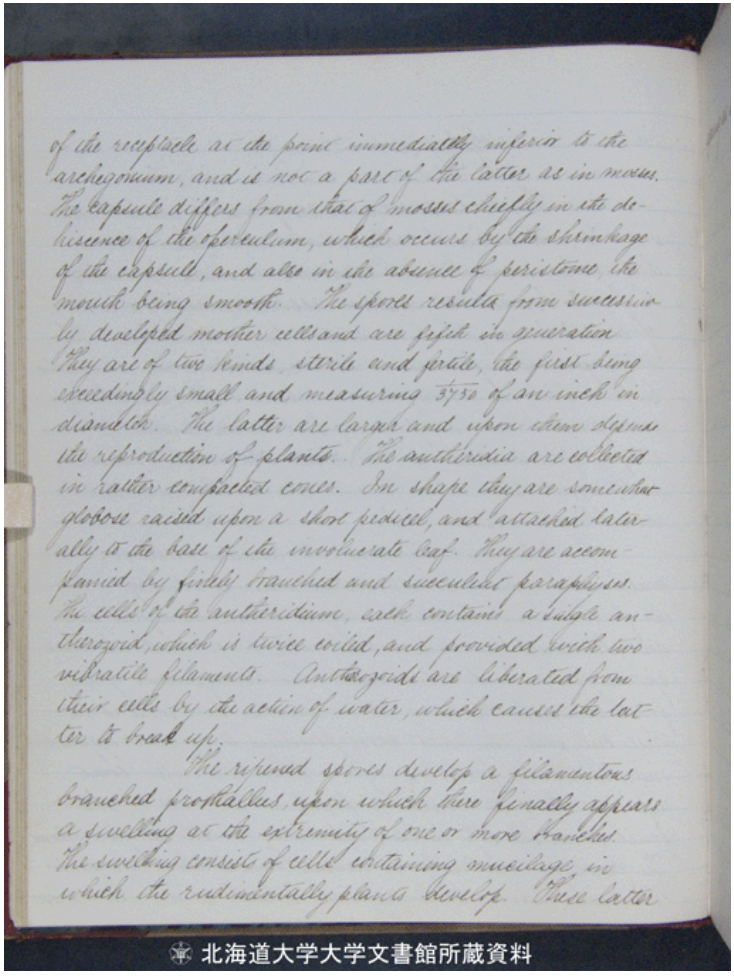
The vegetative process in mosses is accomplished by means of small bud like development or tubercles. which may be produced in the axils of leaves or upon roots. Exposed to proper conditions they develop into plants by simple enlargement and division as do the buds in prothallus.



Sphagna.

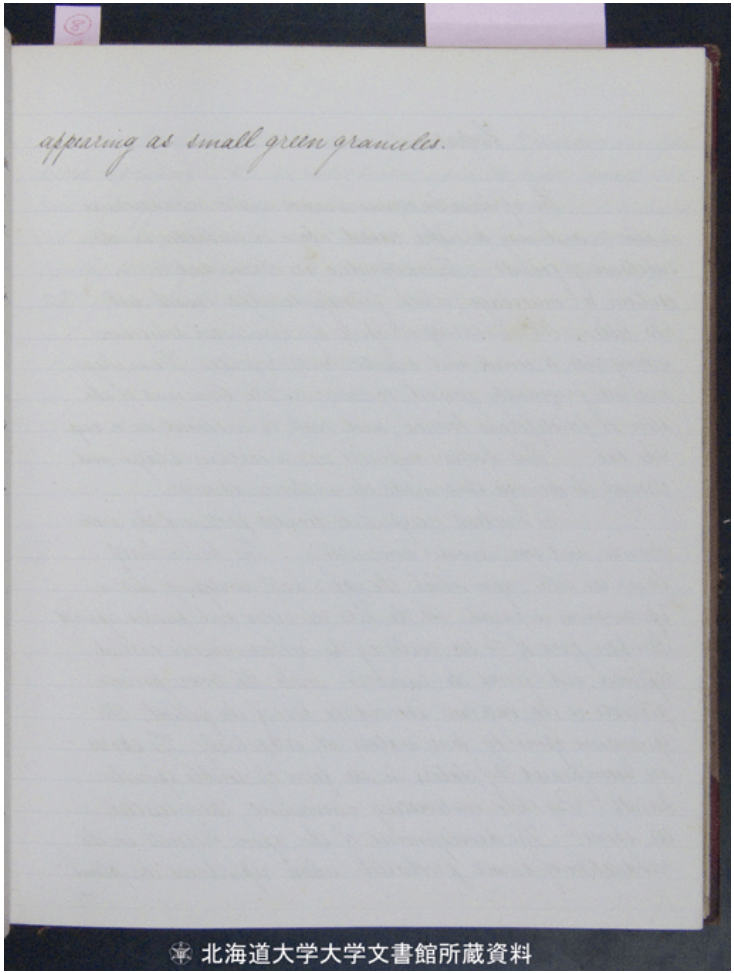
The reproductive organs are found on separate individuals, and consist of archegonia and antheridia. One to three archegonia are borne upon the rounded extremity of fertile branchlets, and are accompanied by a whorl of small leaves, which constitute a perichaedium. The whole female inflorescence is included in an elongated buds. Only one archegonium ripens. They are always accompanied by paraphysis, but these instead of being simply filamentous as in mosses are much branched, and so interlaced as to form a net work, somewhat resembling a spiders web.

Upon fertilization, the nucleus enlarges but much more rapidly at the bottom than at the top. As the fruit rise the cellular layers become modified into an outer wall, within which will be formed the true sporangium and columella. The development of the fruit is much the same as in mosses, but there is no true calyptra, the part corresponding to it not appearing until the fruit is ripe. When the outer coat ruptures the base remains fixed to the base of the fruit, and the top is carried away with the operculum. The fruit at maturity is raised much above the perichaedial leaves by a pedicel, which is an elongation

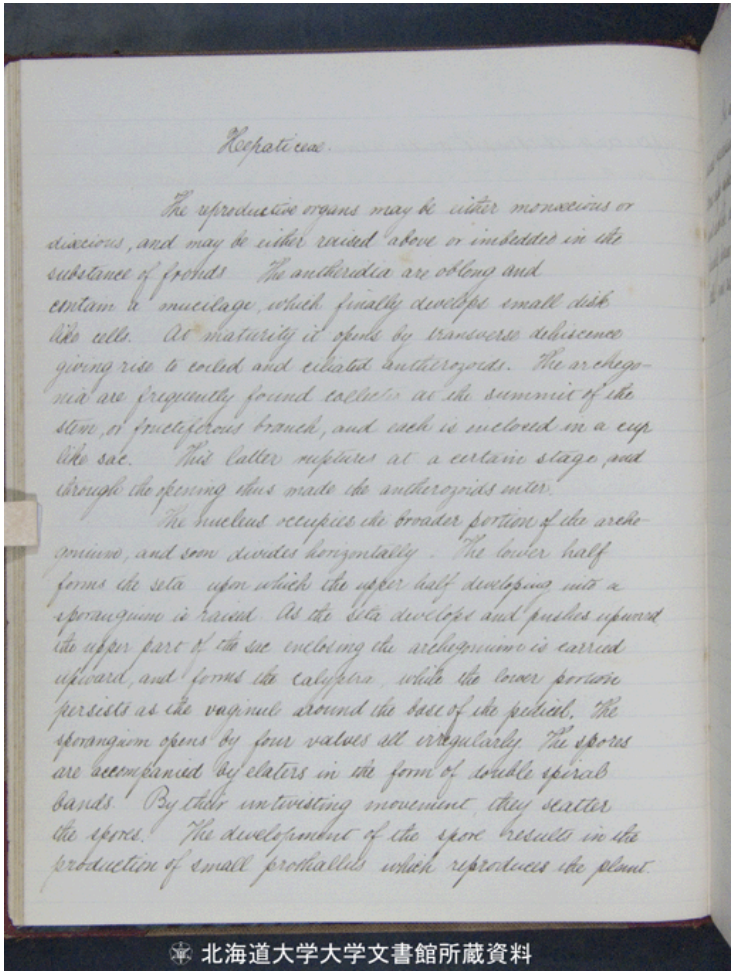


of the receptacle at the point immediately inferior to the archegonium, and is not a part of the latter as in mosses. The capsule differs from that of mosses chiefly in the dehiscence of the operculum, which occurs by the shrinkage of the capsule, and also in the absence of peristome the mouth being smooth. The spores result from successively developed mother cells and are fifth in generation. They are of two kinds sterile and fertile, the first being exceedingly small and measuring 1/3750 of an inch in diameter. The latter are larger and upon them depend the reproduction of plants. The antheridia are collected in rather compacted cones. In shape they are somewhat globose raised upon a short pedicel, and attached laterally to the base of the involucrate leaf. They are accompanied by finely branched and succulent paraphyses. The cells of the antheridium, each contains a single antherozoid, which is twice coiled, and provided with two vibratile filaments. Antherozoids are liberated from their cells by the action of water, which causes the latter to break up.

The ripened spores develop a filamentous branched prothallus, upon which there finally appears a swelling at the extremity of one or more branches. The swelling consists of cells containing mucilage in which the rudimentally plants develop. These latter



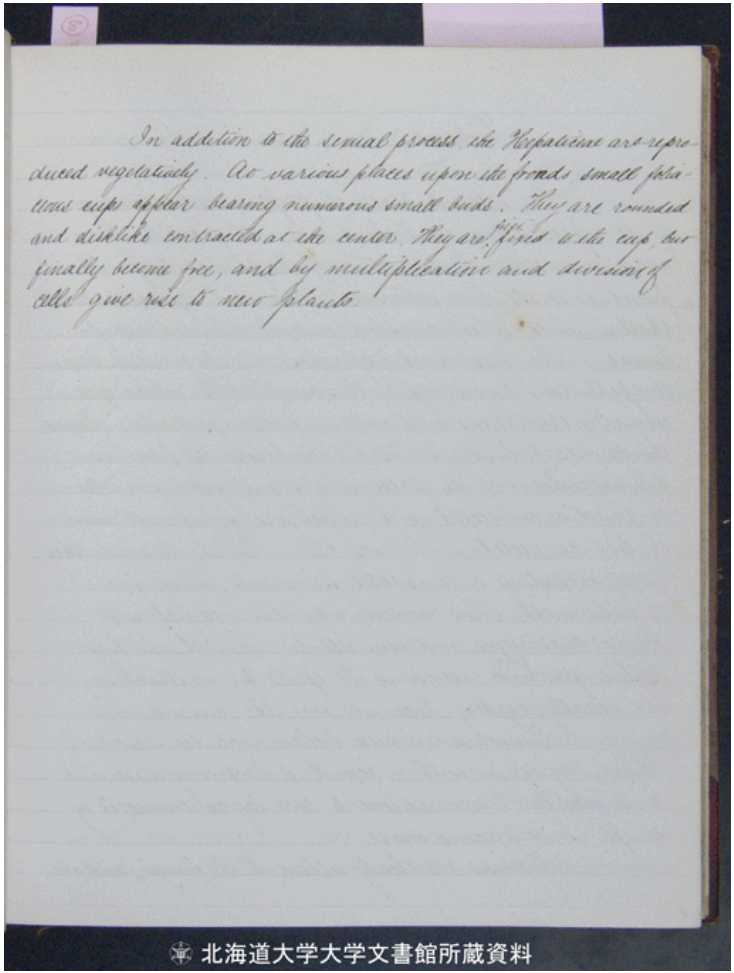
appearing as small green granules.



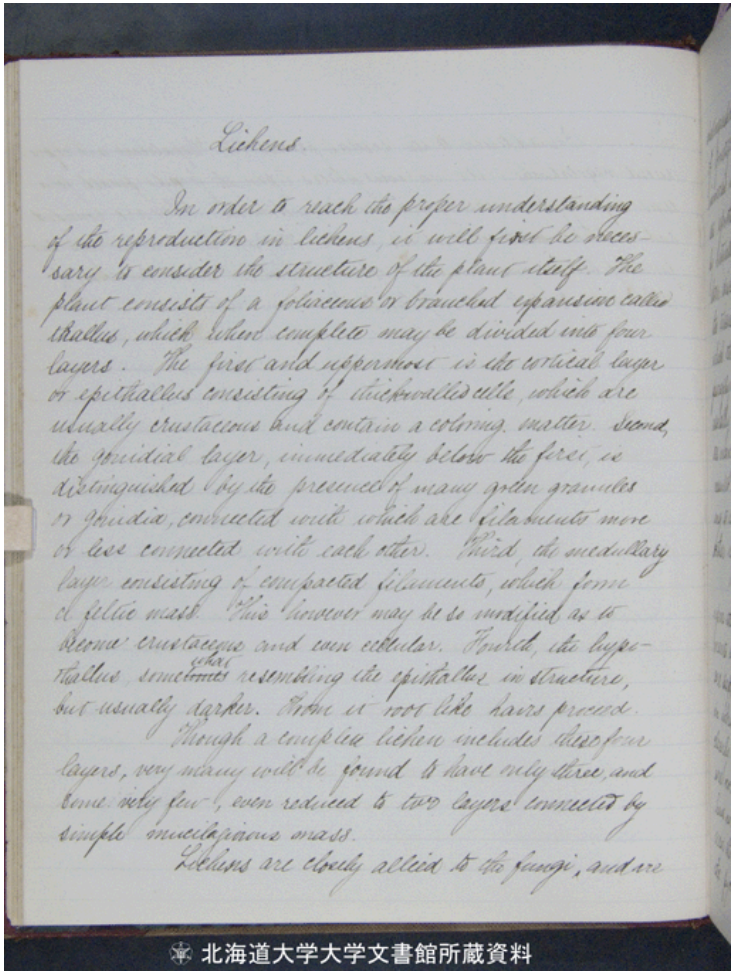
Hepaticeae.

The reproductive organs may be either monocious or dioecious, and may be either raised above or imbedded in the substance of fronds. The antheridia are oblong and contain a mucilage, which finally develops small disk like cells. At maturity it opens by transverse dehiscence giving rise to coiled and ciliated antherozoids. The archegonia are frequently found collected at the summit of the stem, or fructiferous branch, and each is enclosed in a cup like sac. The latter ruptures at a certain stage, and through the opening thus made the antherozoids enter.

The nucleus occupies the broader portion of the archegonium, and soon divides horizontally. The lower half forms the seta upon which the upper half developing into a sporangium is raised. As the seta develops and pushes upward the upper part of the sac enclosing the archegonium is carried upward, and forms the calyptra, while the lower portion persists as the vaginule around the base of the pedicel. The sporangium opens by four values all irregularly. The spores are accompanied by elaters in the form of double spiral bands. By their untwisting movement they scatter the spores. The development of the spore results in the production of small prothallus which reproduces the plant.



In addition to the sexual process the Hepaticeae are reproduced vegetatively. At variours places upon the fronds small foliaceous cups appear bearing numerous small buds. They are rounded and disklike contracted at the center. They are first fixed to the cup, but finally become free, and by multiplication and division of cells give rise to new plants.

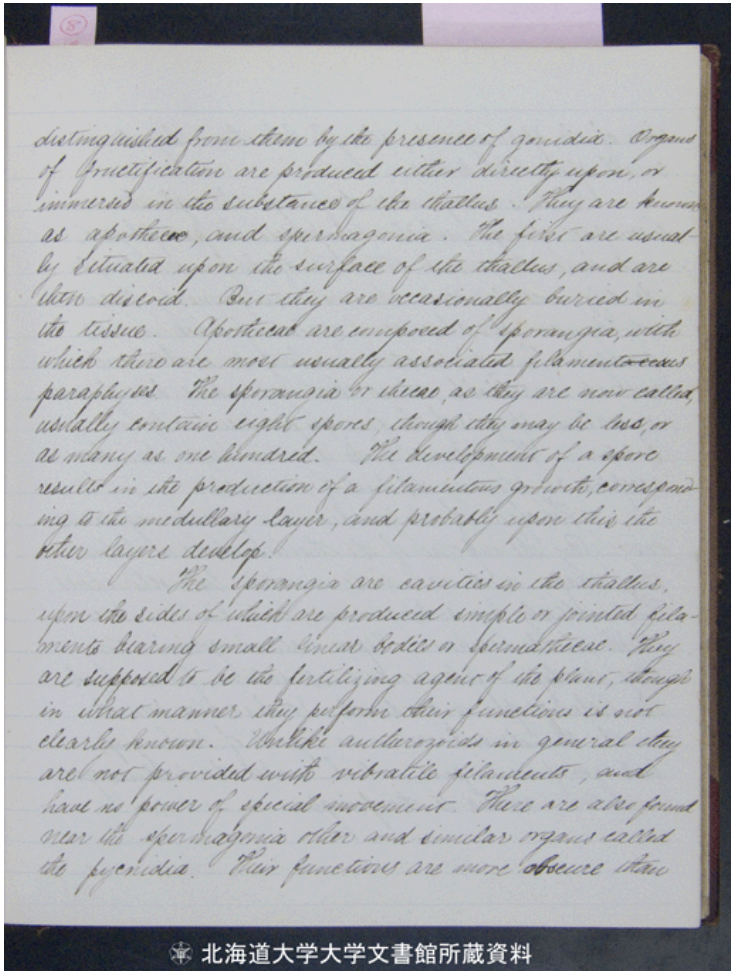


Lichens

In order to reach the proper understanding of the reproduction in lichens, it will first be necessary to consider the structure of the plant itself. The plant consists of a foliaceous or branched e expansion called thallus, which when complete may be divided into four layers. The first and uppermost is the cortical layer or epithallus consisting of thick-walled cells, which are usually crustaceous and contain a coloring matter. Second, the gonidial layer, immediately below the first, is distinguished by the presence of many green granules or gonidia, connected with which are filaments more or less connected with each other. Third the medullary layer consisting of compacted filaments, which form a feltic mass. This however may be so modified as to become crustaceous and even cellular. Fourth, the hypothallus somewhat resembling the epithallus in structure, but usually darker. From it root like hairs proceed.

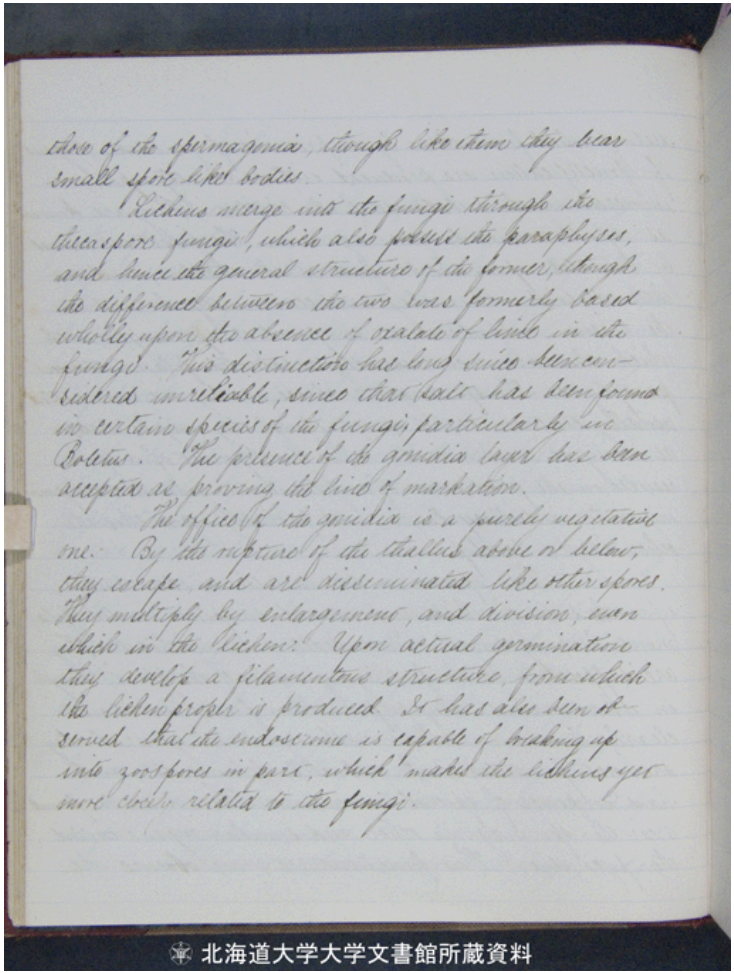
Though a complete lichen includes these four layers, very many will be found to have only three, and some very few, even reduced to two layers connected by simple mucilaginous mass.

Lichens are closely allied to the fungi, and are



distinguished from them by the presence of gonidia. Organs of fructification are produced either directly upon, or immersed in the substance of the thallus. They are known as apothecae, and spermagonia. The first are usual by situated upon the surface of the thallus, and are then discoid. But they are occasionally buried in the tissue. Apothecae are composed of sporangia, with which there are most usually associated filaments paraphyses. The sporangia or thecae, as they are now called, usually contain eight spores, though they may be less, or as many as one hundred. The development of a spore results in the production of a filamentous growth, corresponding to the medullary layer, and probably upon this the other layers develop.

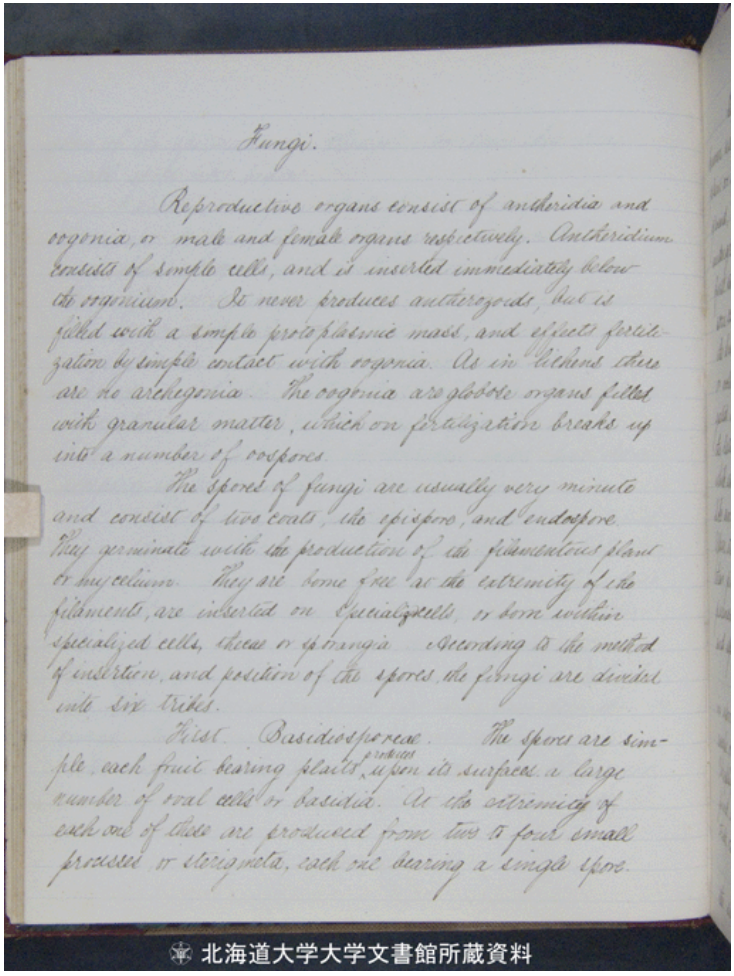
The sporangia are cavities in the thallus, upon the sides of which are produced simple or jointed filaments bearing small linear bodies or spermathecae. They are supposed to be the fertilizing agent of plant, though in what manner they perform their functions is not clearly known. Unlike antherozoids in general they are not provided with vibratile filaments, and have no power of special movement. There are also found near the spermagonia other and similar organs called the pycnidia. Their functions are more obscure than



those of the spermagonia, though like them they bear small spore like bodies.

Lichens merge into the fungi through the thecaspore fungi, which also possess the paraphyses, and hence the general structure of the former, though the difference between the two was formerly based wholly upon the absence of oxalate of lime in the fungi. This distinction has long since been considered unreliable, since that salt has been found in certain species of the fungi, particularly in Boletus. The presence of the gonidia layer has been accepted as proving the line of markation.

The office of the gonidia is a purely vegetative one. By the rupture of the thallus above or below, they escape and are disseminated like other spores. They multiply by enlargement, and division, even which in the lichen. Upon actual germination they develop a filamentous structure, from which the lichen proper is produced. It has ales been observed that the endoscrome is capable of breaking up into zoospores in part, which makes the lichens yet more closely related to the fungi.

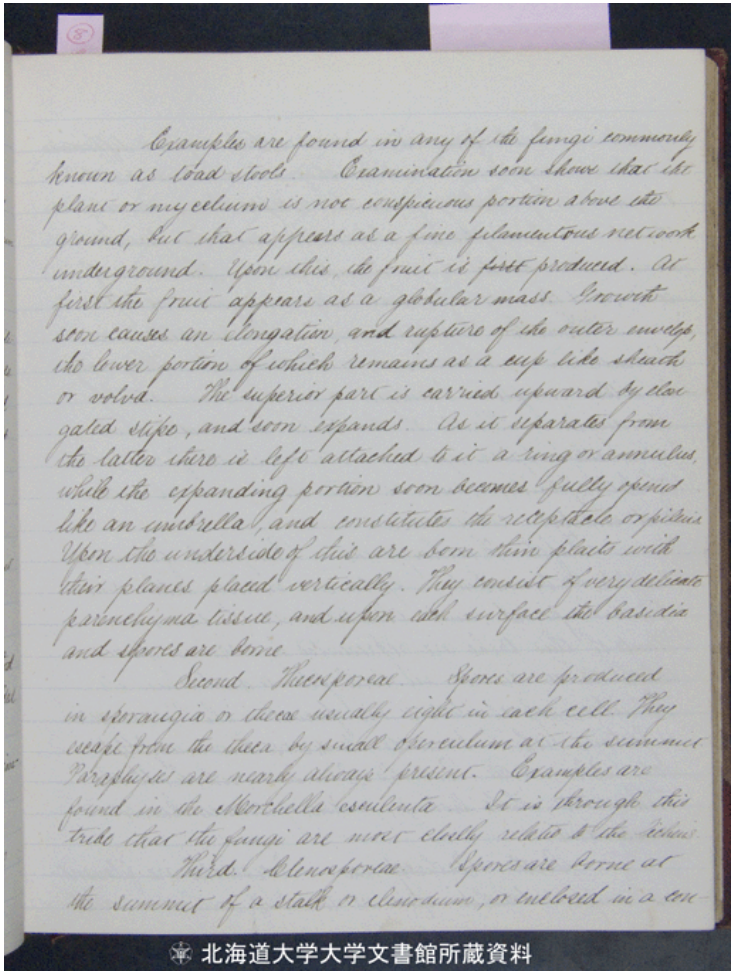


Fungi.

Reproductive organs consist of antheridia and oogonia, or male and female organs respectively. Antheridium consists of simple cells, and is inserted immediately below the oogonium. It never produces antherozoids, but is filled with a simple protoplasmic mass, and effects fertilization by simple contact with oogonia. As in lichens there are no archegonia. The oogonia are globose organs filled with granular matter, which on fertilization breaks up into a number of oospores.

The spores of fungi are usually very minute and consist of two coats, the epispore, and endospore. They germinate with the production of the filamentous plant or mycelium. They are borne free at the extremity of the filaments, are inserted on specialized cells, or born within specialized cells, thecae or sporangia. According to the method of insertion, and position of the spores, the fungi are divided into six tribes.

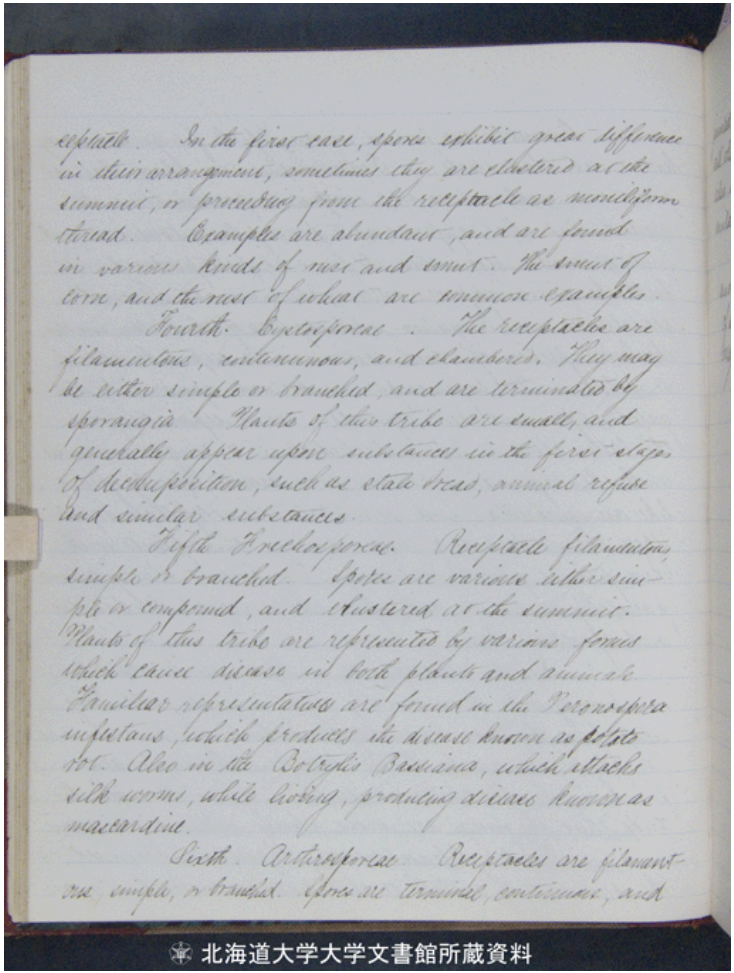
First. Basidiosporeae. The spores are simple, each fruit bearing plaits produces upon its surfaces a large number of oval cells or basidia. At the extremity of each one of these are produced from two to four small processes or sterigmeta, each one bearing a simple spore.



Examples are found in any of the fungi commonly known as toad stools. Examination soon shows that the plant or mycelium is not conspicuous portion above the ground, but that appears as a fine filamentous net work underground. Upon this, the fruit is produced. At first the fruit appears as a globular mass. Growth soon causes an elongation, and rupture of the outer envelop, the lower portion of which remains as a cup like sheath or volva. The superior part is carried upward by elongated stipe, and soon expands. As it separates from the latter there is left attached to it a ring or annulus, while the expanding portion soon becomes fully opened like an umbrella, and constitutes the receptacle or pileus. Upon the underside of this are born thin plaits with their planes placed vertically. They consist of very delicate parenchyma tissue, and upon each surface the basidia and spores are borne.

Second. Thecosporeae. Spores are produced in sporangia or thecae usually eight in each cell. They escape from the theca by small operculum at the summit. Paraphyses are nearly always present. Examples are found in the Morchella esculenta. It is through this tribe that the fungi are most closely related to the linchens .

Third. Clenosporeae. Spores are borne at the summit of a stalk or clenodium, or enclosed in a conceptacle.

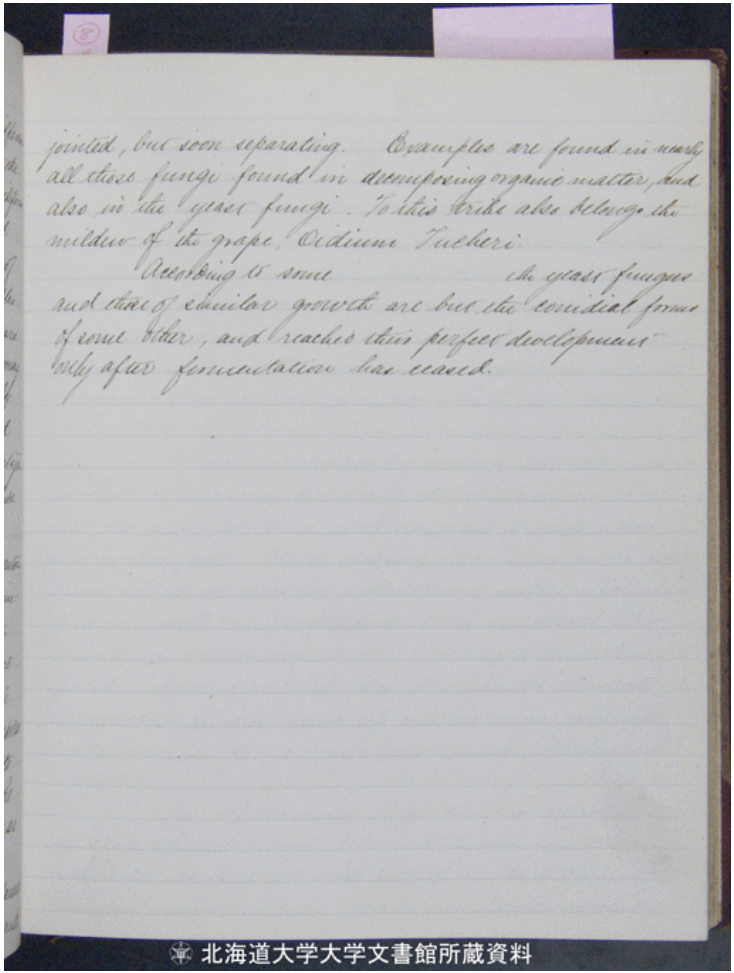


In the first case, spores exhibit great difference in their arrangement, sometimes they are clustered at the summit, or proceeding from the receptacle as moniliform thread. Examples are abundant, and are found in various kinds of rust and smut. The smut of corn, and the rust of wheat are common examples.

Fourth. Cystosporeae. The receptacles are filamentous, continunous, and chambered. They may be either simple or branched, and terminated by sporangia. Plants of this tribe are small, and generally appear upon substances in the first stage of decomposition, such as stale bread, animal refuse and similar substances.

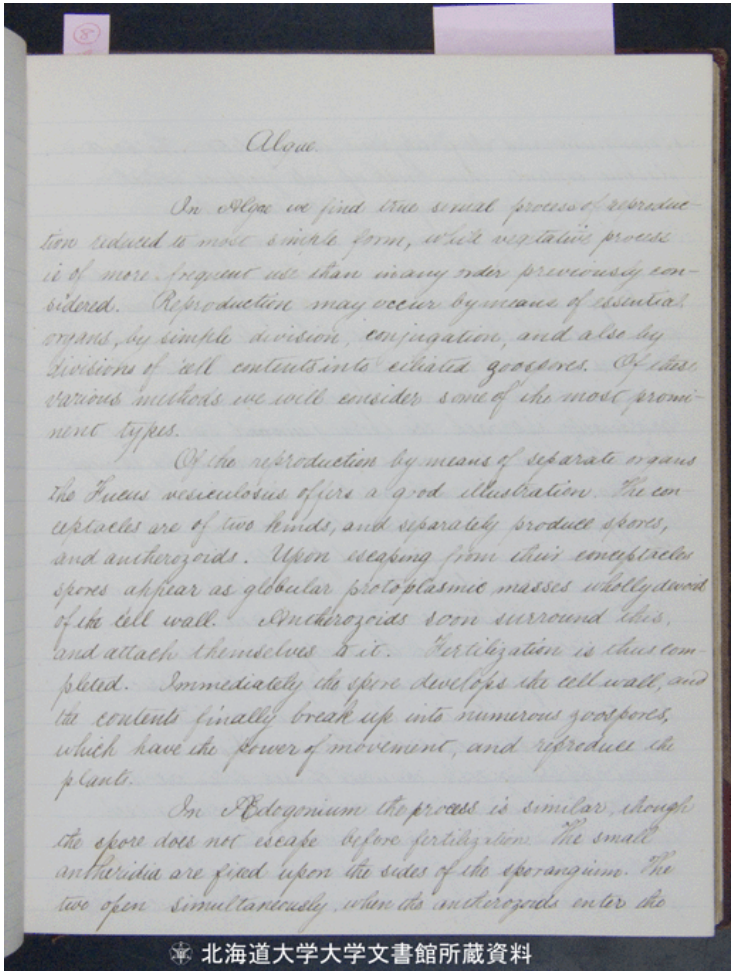
Fifth. Frechosporeae. Receptacle filamentous simple or branched. Spores are various either simple or compound, and clustered at the summit. Plants this tribe are represented by various forms which cause disease in both plants and animals. Familiar representatives are found in the Peronospera infestans, which produces the disease known as potato rot. Also in the Botrylis Bassiana, which attaches silk worms, while living, producing disease known as mascardine.

Sixth. Arthrosporeae. Receptacles are filamentous simple, or branched. Spores are terminal continuous, and



jointed, but soon separating. Examples are found in nearly all those fungi found in decomposing organic matter, and also in the yeast fungi. To this tribe also belongs the mildew of the grape, Oidium Tucheri.

According to some the yeast fungus and those of similar growth are but the conidial forms of some other, and reached their perfect development only after fermentation has ceased.

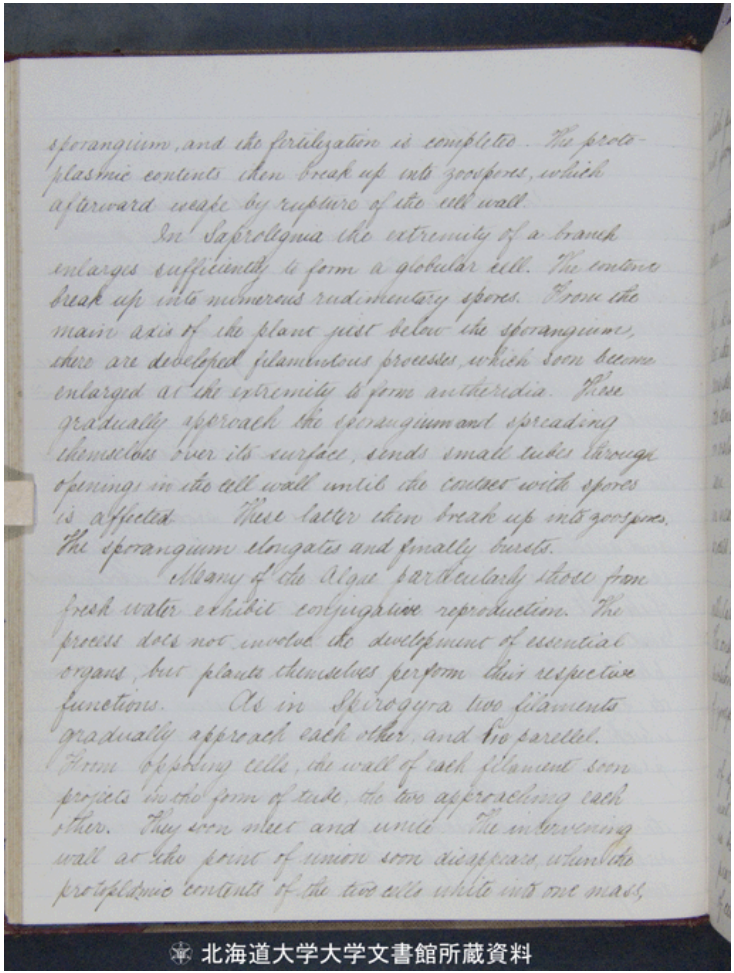


Algae.

In Algae we find true sexual process of reproduction reduced to most simple form, while vegetative process is of more frequent use than in any order previously considered. Reproduction may occur by means of essential organs, by simple division, conjugation, and also by divisions of cell contents into ciliated zoospores. Of these various methods we will consider some of the most prominent types.

Of the reproduction by means of separate organs the Fucus vesiculosus offers a good illustration. The conceptacles are of two kinds, and separately produce spores, and antherozoids. Upon escaping from their conceptacles spores appear as globular protoplasmic masses wholly devoid of the cell wall. Antherozoids soon surround this, and attach themselves to it. Fertilization is thus completed. Immediately the spore develops the cell wall, and the contents finally break up into numerous zoospores, which have the power of movement, and reproduce the plants.

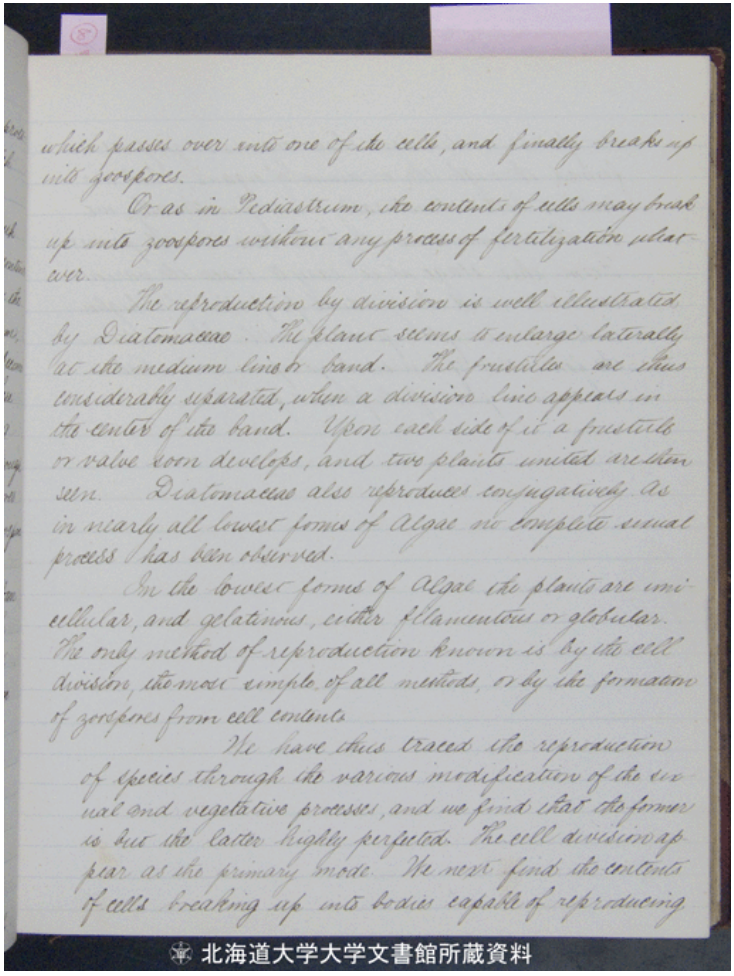
In Edogonium the process is similar, though the spore does not escape before fertilization. The small antheridia are fixed upon the sides of the sporangium. The two open simultaneously, when the antherozoids enter the



sporangium, and the fertilization is completes. The protoplasmic contents then break up into zoospores, which afterward escape by rupture of the cell wall.

In Saprolegnia the extremity of a branch enlarges sufficiently to form globular cell. The contents break up into numerous rudimentary spores. From the main axis of the plant just below the sporangium, there are developed filamentous processes, which soon become enlarged at the extremity to form antheridia. These gradually approach the sporangium and spreading themselves over its surface sends small tubes through openings in the cell wall until the contact with spores is affected. These latter then break up into zoospores. The sporangium elongates and finally bursts.

Many of the Algae particularly those from fresh water exhibit conjugative reproduction. The process does not involve the development of essential organs, but plants themselves perform their respective functions. As in Spirogyra two filaments gradually approach each other, and lie parellel. From opposing cells, the wall of each filament soon projects in the form of tube, the two approaching each other. They soon meet and unite. The intervening wall at the point of union soon disappears, when the protoplasmic contents of the two cells white into one mass,



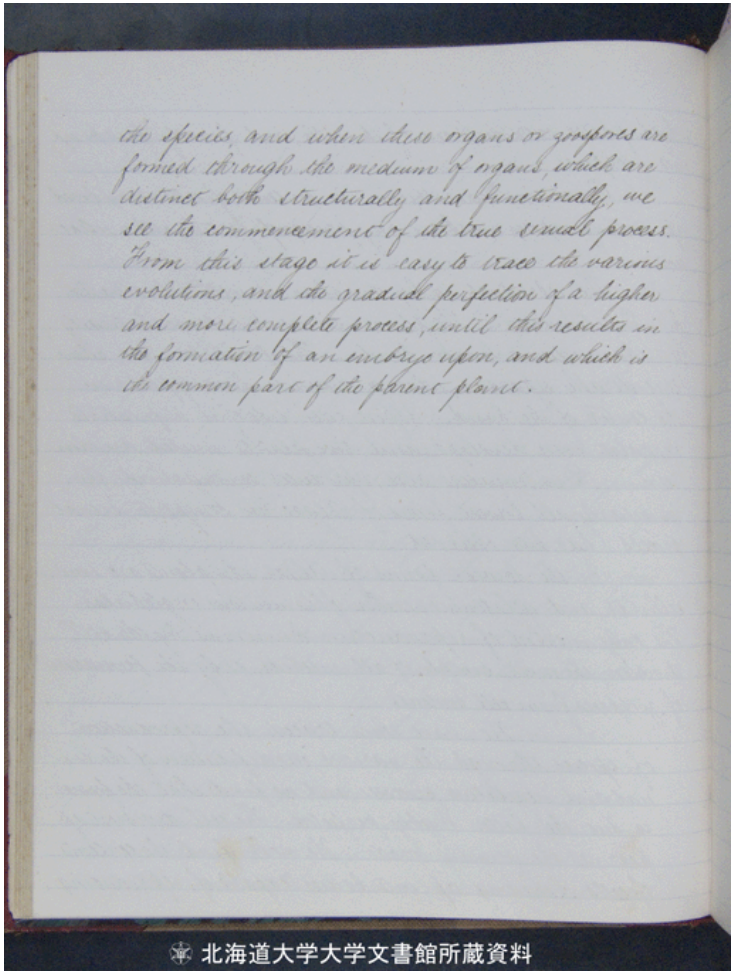
which passes over into one of the cells, and finally breaks up into zoospores.

Or as in Pediastrum , the contents of cells may break up into zoospores without any process of fertilization whatever.

The reproduction by division is well illustrated by Diatomaceae. The plant seems to enlarge laterally at the medium line or band. The frustules are thus considerably separated, when a division line appears in the center of the band. Upon each side of it a frustule or value soon develops, and two plants united are then seen. Diatomaceae also reproduces conjugatively. As in nearly all lowest forms of algae no complete sexual process has been observed.

In the lowest forms of Algae the plants are unicellular, and gelatinous, either filamentous or globular. The only method of reproduction known is by the cell division, the most simple of all methods, or by the formation of zoospores from cell contents.

We have thus traced the reproduction of species through the various modification of the sexual and vegetative processes, and we find that the former is but the latter highly perfected. The cell division appear as the primary mode. We next find the contents of cells breaking up into bodies capable of reproducing



the species, and when these organs or zoospores are formed through the medium of organs, which are distinct both structurally and functionally, we see the commencement of the true sexual process. From this stage it is easy to trace the various evolutions, and the gradual perfection of a higher and more complete process, until this results in the formation of an embryo upon, and which is the common part of the parent plant.