rays to pass much more readily than others. Flaws in instruments, especially those made of aluminum, might be detected by these rays. Experiment alone will decide whether bacteria will be influenced by the rays in the same manner as certain colonies of organisms are injured by exposure to the direct action of the sun. Park, of New York, has exposed a culture of the diphtheria bacillus for thirty minutes to the rays from a Crookes tube without any result being noted. He who is able to secure a picture of the brain will accomplish more than can be expected from the present state of our knowledge of the X-rays.

The suggestion has been made that in our large cities skiagraphic institutions should be erected and equipped, to which physicians or surgeons could send patients, and where, under their direction, pictures of the desired portion of the body could be prepared, just as a physician now writes a prescription which is sent to the druggist to be compounded. Our large hospitals where numerous accident cases are brought should have in the near future a plant sufficient to prepare skiagraphic reproductions at short notice.

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CURRENT PROBLEMS IN PLANT MORPHOLOGY.

ON SOME CHARACTERS OF FLORAL GALLS.

The growing interest in ecology which is so marked a feature of botanical investigation during the last five years has occasioned new and valuable work on galls, so that now for the first time compendious works have begun to appear, in which a really scientific and adequate account of these curious structures is attainable. An excellent resumé in popular style is that given in Kerner and Oliver's *Natural History of Plants*, Vol. II., pp. 518–554. That upward of 1,600 different kinds of galls have been described is noted, and an attempt is made to classify them. With characteristic looseness Kerner divides galls into fungus galls and insect galls, but this is quite inadequate, for algæ, among plants, also produce galls, *e. g.*, Phytophysa treubii W. v. B.,* which attacks the leaves of Pilea at Buitenzorg. And "insects," under which Kerner includes Arachnoidea, are not at all the only gall-producing animals, for nematodes (afterwards mentioned by Kerner) and rotifera are well known as efficient causes in cediciogenesis.

Kerner's classification of galls from a plant anatomical point of view is, however, excellent and is reproduced with some slight modifications in Ludwig's *Lehrbuch der Biologie der Pflanzen.*† Fundamentally galls are either simple or compound, as one or several organs take part in their production. Each class is divided into a number of subclasses, but the details need not be gone into here. The account given by Ludwig is compact and clear.

The changes produced in flowers and inflorescences when they are subjected to stimulus from a cecidiogenic organism may be classified as: 1. Chlorosis. 2. Multiplication of parts. 3. Metamorphosis of parts. 4. Suppression of parts. 5. Hypertrophy, general or restricted. 6. Antholysis. 7. Fusion of parts. 8. Fasciation. Examples of these are as follows: 1. Green flowers of Veronica. 2. Double flowers of Rhododendron. 3. Flowers of Valerianella in which petals are substituted for stamens. 4. Flowers of Anemone nemorosa inhibited by *Puccinia fusca.* 5. Flowers of Lychnis in which a parasitic Ustilago stimulates the growth of the vestigial stamens of pistillate flowers until they rival in structure the normal stamens of staminate flowers. 6. Flowers of gentians in which the carpels

* Weber: Zoolog. Erg. Reis. Niederl. Ost-Ind. Hft. I. 48–71. Leiden, 1890.

† Ludwig: l. c., pp. 98–110. 1895.

are separated under the stimulus of the wound. 7 and 8. Inflorescences showing both fusion and fasciation as when the Ash is attacked by Phytoptus.

The list of papers upon galls is a long one, including such names as De Lacaze-Duthiers, Prillieux, Courchet, Wakker, Fenzling, Frank, Massalongo, Sorauer, Frauenfeld, Loew, Kieffer, Rubsaamen, Schlechtendahl, Delpino, Thomas, Nalepa, Giard, Julin, Van Tubeuf, Magnus, Schroeter, Peyritsch and many others. A recent writer, Molliard,* has brought together in a systematic way the important facts concerning anthoceçidia, and has in several instances added materially to our knowledge of the intimate changes effected in flowers by gall producers. The following is a brief resumé of his paper.

Molliard classifies anthocecidia as follows:

I. Phytocecidia: Galls produced by plants.
   1. Peronospora galls: Produced by mildews.
   2. Uredineous galls: Produced by rusts.
   3. Ustilagineous galls: Produced by smuts.
II. Zoöcecidia: Galls produced by animals.
   1. Hemiptera galls: Produced by Aphides.
   2. Diptera galls: Produced by flies.
   3. Phytoptus galls: Produced by mites.

The galls produced in flowers of Dipsacus pilosus by Peronospora violacea show that (1) the pollen-sacs have been atrophied and the pollen mother-cells converted into parenchyma; (2) the embryo sac has been atrophied; (3) the sepals have been hypertrophied.

Knautia arvensis, attacked by the same mildew, shows (1) atrophy of the stamens, due to indirect influence, however, for the mycelium does not penetrate them; (2) atrophy of the ovules, also indirectly produced; (3) metamorphosis and hypertrophy of the corolla; (4) incomplete metamorphosis of the stamens into petals.

Matricaria inodora attacked by Peronospora radii shows (1) coalescences (fusions) of pedicels and flower tubes; (2) torsion of the flower pedicels resulting from a secondary tissue which reacts against the mycelium; (3) atrophy of the sexual organs; (4) metamorphosis of ligulate into tubular flowers and antholysis of the pistil.

Molliard defines three types of Peronospora cecidiogenic effects:

1. The flower is not modified. Example, P. calotheca De By on Sherardia.
2. The flower is suppressed. Example, P. arborescens on Papaver.
3. The flower is metamorphosed and its essential functions inhibited. Example, P. radii on Matricaria.

The action of various species of Cystopus is summarized to show the quite different effects produced by this genus when compared with the closely related Peronospora. It appears that:

1. There are notable changes in the form, dimensions and contents of the individual cells of the floral organs.
2. New types of cell arrangement are produced.
3. The myrosin (in mustards) is translocalized.
4. The pollen-spore mother cells are converted into vegetative cells.

The action of Uromyces scutellatus on the flowers of Euphorbia cyparissias recalls the well-known case of Lychnis attacked by Ustilago antherarum,* which is discussed anew by Molliard. In Euphorbia cyparissias the effect of the rust is (1) to transform the staminate flowers into pistillate or monoclinous and the monoclinous flowers into pistillate; (2) to cause atrophy of the pollen and embryo sac spores; (3) to cause hypertrophy of the parenchyma in all organs.

The most notable result of smut attacks upon flowers is the so-called parasitic cas-

* Ann. Sci. Nat. Bot. VIII., 1: 67-245. 1895.

* Giard and Mangin. Notes sur la castration parasitaire du Lychnis dioica, L.—Bull. Sc. Nat. de Fr. et Belg. II. 150; also Vuillemin: Sur les effets du parasitism de l'ustilago antherarum, Comptes Rend. Hebd. CXIII. 662, 1891, and review of this paper in Botan. Gazette. 17: 17. 1891.

tration, of Giard. This is known in Lychnsi dioica, Saponaria officinalis, Dianthus sinensis, Knautia arvensis and Scabiosa succisa. Parasitic castration arises from the substitution of sterile cells or fungal spores for the ordinarily present pollen-mother cells of the stamens. It is distinguished as *indirect parasitic castration*, by Giard, from the case of Claviceps growing as a substitutionary form and quite destroying the ovary of the rye, where the pseudomorph is said to produce direct parasitic castration.

Flowers attacked by aphides show the following characters:

1. Complete chlorosis in which all the organs of the flower assume the external and internal characters of foliage leaves (Phyllody), example, Sinapis and Torilis.

2. Complete chlorosis with hypertrophy, but the resultant structures differing from foliage leaves (Aphyllody), example, Cerastium, Silene, Valerianella.

The most marked characteristic of flowers converted into cecidia by gall flies is a negative one, viz: the generally slight structural change that they undergo. Hypertrophy is the principal reaction—seen well in flowers of Raphanus, Sisymbrium, Lotus and Daucus. The flowers of Veronica and Cerastium are, however, not particularly enlarged, but become concealed in a mass of cecidial leaves. The fly-cecidia of Lychnis and Scabiosa are distinguished by the formations of numerous hairs, while those of Tanacetum and Spiræa are remarkable for the general substitution of sclerenchyma for parenchyma and might be classed as *sclerotocecidia*.

Phytoptus galls are chiefly remarkable for the cytic changes which take place in them. Epidermal and hypodermal cells partake in the modification. The cytoplasm becomes highly granular, the nucleus acquires large dimensions and is highly chromatophilic. The formation of epidermal hairs is abundant and numerous modifications of the cell contents (chlorophyll, calcium oxylate, etc.) are noteworthy. Doubling, chlorosis, antholysis, atrophy and hypertrophy characterize special cases. On the whole, the Phytoptus galls in floral regions are comparable best with the Aphis galls, though differing in the greater stimulation of epidermal tracts, and the conspicuous formation of hairs which, in Stachys betonica, are even produced in the embryo-sac.

Molliard's general conclusions may be readily condensed into a tabular form, as follows:

I. Modifications undergone by accessory parts of the flower.
- A. Modifications of organs.
  1. Accessory parts wither.
  2. Accessory parts undergo metamorphosis without hypertrophy.
     a. Phyllodic metamorphosis.
     b. Aphyllodic metamorphosis.
  3. Accessory parts hypertrophy.
     a. Total hypertrophy.
     b. Partial hypertrophy.
- B. Modifications of tissues.
  1. Simple modifications, *e. g.*, change in size of parenchyma cells.
  2. Modification of cell arrangement.
  3. Disappearance of tissues.
  4. Appearance of new tissues.
  5. Translocalization of characteristic cell contents.

II. Modifications undergone by essential organs of the flower.
1. No modification, *e. g.* Sherardia.
2. Inhibition of flowers.
3. Development of essential organs, but flower fails to open.
4. Modification of sporangial areas, so that sterile cells are substituted for spores. (Parasitic castration).
   a. Castration of pollen sacs.
   1. Direct castration. Pollen cells digested.
   2. Indirect castration. Pollen cells metamorphosed.
   b. Castration of ovules.
   1. Direct castration. Ovules digested.
   2. Indirect castration, where either the embryo sac fails to develop or the egg nucleus of the embryo sac fails to appear (inhibition of germination). Molliard did not, however, discover a conversion of em-

bryo sac into parenchyma tissue coördinate with the phenomenon so common in stamens.

The synoptical resumé given above, upon examination, indicates that in general the influence of the cecidiogenic stimulus is essentially atavistic in character and results. Chlorosis, antholysis, hypertrophy, all may be considered as reversion phenomena. A peculiarly good example is the conversion in cecidia of ligulate flowers into tubular. The specialized organ becomes more generalized. It is not improbable that cecidia forms, when thoroughly understood, will be found to present a series comparable with the paleontologic or ontogenetic series of organisms, and that they will afford similar ground for speculations concerning descent, if not of species, at least of certain tissues and organs.

CONWAY MACMILLAN.

CURRENT NOTES ON ANTHROPOLOGY.

THE WALL PAINTINGS OF MITLA.

ARCHÆOLOGISTS are well aware of the mystery which has surrounded the ruins of Mitla in Oaxaca, grandiose remains which were found deserted and nigh forgotton when the Spaniards first conquered the country. A handsome large folio volume has recently been published in Berlin (A. Asher & Co.) in which Dr. Eduard Seler presents a study of the singular wall-paintings, portions of which still adorn the inner surfaces on the walls of some of the rooms.

Dr. Seler copied these with fidelity and now reproduces them with an admirable study of their meaning and origin. He is of opinion that the central figure in the religion of the Zapotecs, who are believed to have been the builders of Mitla, was Quetzalcoatl, a familiar and prominent divinity of the Nahuatl tribes. The transfer he explains by the influence which the coast branches of the Nahua exerted upon the Zapotecan priesthood. This thesis is defended with a great deal of learning. Many views of the ruins are given in the full-page plates and numerous mythological figures in the text. The monograph is throughout marked by the thorough scholarship for which the author is so well known among students of American antiquity.

It is a work which our large libraries should not fail to procure.

COMMERCE ACROSS BERING STRAITS.

DR. BENJAMIN SHARP at a recent meeting of the Academy of Natural Sciences, Philadelphia, gave some suggestive information about possible ancient commerce across Bering straits. The distance is about forty miles and in the middle are the Diomede Islands, say twenty miles from each shore.

On the American side there is abundance of wood from which canoes, etc., might be made, but there is none on the Siberian side. The skin boats used by the Siberian natives, made from walrus hide, could not have been sewed sufficiently tight by bone needles to have served to cross the strait. The distance is bridged by ice about once in five years, but the passage across is considered quite dangerous, and nothing but the love of tobacco will induce a native to venture. The inhabitants of the Asian side appear to have been more influenced by the Eskimo arts than the reverse.

These facts and the general bearing of Dr. Sharp's observations are unfavorable to an extended early communication from the Siberian coast to the American.

THE SOCIETY OF AMERICANISTS OF PARIS.

FOR many years French scholars have taken a creditable interest in the study of American subjects, and another evidence in this direction is the formation of a society in Paris devoted especially to this subject. It is entitled the 'Sociétè des Américanistes,' the president being Prof. Hamy, and