of the British Association tables at the Naples and Plymouth biological stations were then submitted.

On Monday the chief papers were:

1. J. S. Kerr, 'The Development of *Lepidosiren paradoxa*,' and a note on the hypothesis of the origin of the vertebrate paired limbs.

2. J. F. Gemmill, 'On Negative Evidence regarding the Influence of Nutrition in Determining Sex.' Dr. Gemmill deals with marine animals fixed in such a position that some individuals get more food than others. This seems to cause no difference in the proportions between the sexes.

3. F. P. Morena and A. Smith Woodward, 'Exhibition of Skull of Extinct Chelonian *Miolania*, and of newly-discovered *Neomylodon* remains from Patagonia,' with remarks.

4. G. E. H. Barrett Hamilton, 'The Fur Seals of Behring Sea.'

On Tuesday Sir John Murray read a paper on Dr. Petersen's experiments on plaice culture in the Limfjord, Denmark. Outside the fjord the plaice are found abundant, but small. When transplanted into the richer feeding ground they rapidly grow larger, and can be sold at such a price that it may be regarded as successful economic fish culture.

Mr. W. Garstang then gave an account of his experiments at Plymouth in rearing young sea-fish. He has used the Butterfly Blenny, kept in 'plunger' jars, not more than five larvæ to a gallon of water, and fed on plankton. The experiments have been very successful, about 50% of the larvæ being reared through the metamorphosis to young adults. Professor McIntosh finally had a paper on the occurrence of the grey gurnard (*Trigla gurnardus*) and its spawning in shore and off shore waters. He shows by a monthly examination of the statistics that this important fish does not begin to migrate in shore for spawning purposes until March, and attains its maximum in May. He does not consider that there is a second spawning migration later (August), as stated by the Fishing Board for Scotland. The spawning extends from April to September.

The reports of the committees to the sections were:

1. Naples Zoological Station, with report by Dr. Jameson on his work at Cephyrea.

2. Plymouth Biological Station, with papers on the embryology of *Polyzoa*, by T. H. Taylor, and on rearing of *Echinid* larvæ, by Professor MacBride.

3. Zoology and Botany of West India Islands, Final Report, with list of publications.

4. Zoology of Sandwich Islands, Exploration and publication both in progress.

5. Bird Migration in Great Britain and Ireland, Records now being worked out.

6. Zoological and Botanical Publication, Committee on Correspondence with Editors.

7. Index Animalium, First section (1758–1800) nearly ready for publication.

8. Pedigree Stock Records, Reliable Records by Photography of Pedigree Stock.

9. Circulatory Apparatus for Marine Organisms, Record of Color Changes in Crustacea.

Most of these committees were reappointed, with grants, for the coming year.

W. A. Herdman.

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*THE DIŒCISM OF THE FIG IN ITS BEARING UPON CAPRIFICATION.**

As is well known, the edible fruit of the fig is morphologically an enlarged, hollow, flowering branch, bearing within the nearly closed cavity thousands of minute flowers. It is therefore not a true fruit in a botanical sense, but a fleshy receptacle.

Two crops of figs are usually produced during the year; first, the *figues fleurs*, or *brebas*, which appear in March or April,

*Read before Section G of the American Association for the Advancement of Science at Columbus.

and the ordinary figs, appearing on the new wood of the year, after the *brebas* mature, in June or July, and ripening in August or September. This second crop may be irregular in season, some Italian sorts not maturing all their fruits until Christmas (the 'Natalino') or Easter (the 'Pasquale'). In both crops of figs the flowers are exclusively female, though always malformed in the *brebas*, according to Gasparrini and Solms-Laubach, and sometimes in the second generation, according to Dr. Eisen. The flowers in the *brebas* are never pollinated, and indeed no pollen is to be had at the season when they develop. The ordinary figs may be fecundated by pollen from the caprifig, and the sorts which produce the dried figs of commerce are regularly so pollinated by the fig insect (*Blastophaga*), and in consequence yield fertile seeds in abundance. These figs of the so-called Smyrna type often absolutely require pollination in order to set a crop while the ordinary sorts esteemed for eating in the fresh condition develop without the inclosed flowers having been pollinated, but lack the peculiar nutty flavor communicated to the dried fig by the presence of the fertile seeds, a fact to which attention was first called by Dr. Eisen.

THE CAPRIFIG.

The caprifig is even more complicated in its fruiting than is the ordinary fig. There are three generations of fruits, usually known by their Neapolitan names. I. The *mamme*, or caprifigs of the winter generation, which set about October and ripen from March to May, usually in April. II. The spring generation, called *profichi*, setting when the *mamme* fall, and ripening in June or July. This is the generation for caprification. III. The summer generation, *mammoni*, which set shortly after the *profichi* fall and ripen when the *mamme* set. All three generations harbor the fig insect, *Blastophaga psenes*,* which lives inside the ovaries, converting the seed into a gall. When the female insects enter the young caprifigs after leaving the ripe caprifigs of the previous generation, they lay one egg in each of the gall flowers, which are then very like female flowers but not identical, having imperfect stigmas. The *profichi* or spring generation caprifigs bear abundant male flowers in a zone occupying the upper part of the fig, just below the mouth. It is this generation, abounding in pollen, which is used in caprification. It is worthy of note that male flowers mature *nearly two months* after the gall flowers are ready to receive the eggs of the insect, and only just before the figs ripen; *e. g.*, *mammoni* female flowers, which occur though rarely, are pollinated by *profichi* pollen, the rare *mammoni* male flowers not developing until two months later. The *mammoni* or summer generation produce a few male flowers in the same position, and the *mamme* or winter generation none, or only a few imperfect flowers. The *mamme* and *profichi* never produce seeds; the *mammoni* a very few only.

There are two or three exceptions to the normal noted above. As in most dicœcious species, monœcious forms of figs occur, though rarely. There are, for example, male flowers occasionally produced in cultivated figs, and on the other hand, there are nearly always a very few female flowers

**Blastophaga psenes* of Cavolini, perhaps not of Linnaeus whose *Cynips psenes* was based on the account of Hasselquist, edited by Linnaeus, and published in 1757, and included Hasselquist's two species, *Cynips ficus* and *Cynips caricæ*. Both these species were described as '*Corpŭs totum rufum*,' and, as Mayer points out in opposition to Loew, can scarcely app'y to *Blastophaga*. Hasselquist's names having been published before 1758, the earliest available descriptions of indubitable application to the fig insect and its common messmate are, respectively, *Ichneumon psenes* and *Ichneumon ficarius* of Cavolini, published in 1782, the latter of which should be known as *Philotrypesis ficaria* (Cavolini).

in the summer generation of caprifigs (*mammoni*), although Count Solms-Laubach found only twenty seeds in forty *mammoni*. Perhaps one flower in 2,000 is female, the others being gall flowers.

Then, too, there is a fig, called Erinosyche, which according to Pontedera bears *profichi* like a caprifig, and then a summer generation of ordinary edible figs; also the Croisic fig of Brittany and the Cordelia fig of California, which have a zone of male flowers above the ordinary edible part. This upper portion of the fig, bearing the male flowers, remains tough and inedible. Such abnormalities have, however, many analogies in other groups of plants, and do not obscure the fact that the edible fig is, as Hegardt contended in 1744, the female form, and the caprifig the male form of a dicœcious species. The remarkable feature of the fig is that its male receptacles bear gall flowers which are only slightly modified female flowers, and that these gall flowers harbor insects which pollinate the female fig flowers, and lay eggs in succeeding generations of caprifigs. The symbiosis is doubtless one of the oldest known, all of the hundreds of species of figs being inhabited by insects of a special family, Agaonidæ, which are all remarkably adapted to their peculiar habitat, while the figs appear as if specially constructed to nourish and protect the insects on which they are completely dependent for pollination. Both the insects and the plants are much more profoundly modified than are, for example, the Yucca and its moth, Pronuba.

CAPRIFICATION.

Herodotus (484–408 B. C.) seems to have known caprification, and Aristotle about 340 B. C., gave a perfectly clear account of it as follows:* "The figs of the caprifig contain small animals which are called *psenes*. These are at first small grubs, and when their envelopes are broken, *psenes* which fly come out; they then enter the fruits of the fig tree; and the punctures which they make there prevent these fruits from falling before they are ripe. So the countrymen take the trouble to put branches of the caprifig in the ordinary fig trees, and also plant caprifigs near the common fig trees." Theophrastus, his pupil, gave a more extended account, and for the first time noted that not all sorts of figs needed caprification.

This operation as now practiced consists in suspending in the fig trees strings of ripe caprifigs of the spring generation, containing the fig insects ready to emerge. The spring generation caprifigs, or *profichi*, are ripe in June or July, just when the young edible figs are large enough to allow the insect to enter the mouth, and when the female flowers are receptive. These spring generation caprifigs contain abundant male flowers, so that when the insects leave them and enter the young figs they carry pollen to the receptive female flowers. It should be noted that the insect is unable to lay her eggs in the normal female flower of the edible fig, and frequently dies within it. The female fig tree is therefore a death trap for the individual insect, although providing indirectly for a future supply of caprifigs. It thus appears that with these insects the less discriminating individual is the benefactor of the species. Only a few insects enter a single fig.

Caprification has been known for at least 2,300 years in the Eastern Mediterranean, and is still universally practiced in the fig regions about Aidin (near Smyrna) in Asiatic Turkey, at Kalamata in Western Greece, and in Kabylia, Northern Africa, the three greatest centers of production of dried figs. It is also frequent in Sicily, South Italy and Spain, but is not possible in cold countries near the northern limit of fig culture, because the insect could not

* History of Animals, Book 5, ch. 26, p. 4.

pass the winter where the *mamme* or winter caprifigs are liable to freeze.

Caprification is sometimes practiced on the caprifig itself in spring when the tree happens to bear no winter generation fruits. In such cases *mamme* from other trees are suspended in the branches, and the insects coming from them enter and lay eggs in the young spring generation caprifigs (*profichi*). Except for such caprification the *profichi* on such trees would not contain fig insects, and would be valueless for caprifying the edible fig in summer.

CAPRIFICATION IN AMERICA.

In 1880 and 1882, Mr. J. P. Rixford, of the San Francisco *Bulletin*, imported into California, by the aid of Consul E. F. Smithers, some fourteen thousand cuttings of the best sorts of Smyrna fig trees, it having been found impossible to prepare from any of the figs then cultivated in California a dried article able to compare with the best Smyrna product. These *Bulletin* cuttings were widely distributed, and hopes ran high until it was found that the trees refused to hold their fruit. The failure was absolute—not a single fruit has ever ripened during these nineteen years of culture, except some few hundred, pollinated by hand, as will be explained below. Believing that the Smyrniots, fearful of competition, had not sent the right sorts, many growers became disgusted and dug up their trees.

In 1890, Mr. George C. Roeding, of Fresno, produced the first Smyrna figs ever ripened in California, by artificially transferring the pollen from the caprifigs to the young Smyrna figs. In 1891, Dr. Eisen repeated this experiment at Niles. It was necessary to shake the pollen out of the caprifigs and introduce it with a quill into the young fig. From this time it became evident that it would be necessary to import the *Blastophaga*, since the artificial fertilizing of the figs was too slow and too expensive an operation to be applied in practice in the culture of Smyrna figs.

In 1890 also, the Division of Pomology of the Department of Agriculture had imported and distributed cuttings of these male or caprifig trees, together with the insects, but the latter were, of course, unable to survive in the absence of trees producing the necessary succession of caprifigs. Mr. James Shinn, of Niles, secured the insect in the summer of 1891, and Mr. Anthony C. Denotovitch in 1895, but in both cases with no result. Dr. Riley, then Entomologist of the Department, had devoted much thought to the matter, and in 1891 and 1895 he published papers calling attention to the importance of introducing the insect.

Having become interested in the subject of caprification through acquaintance with Dr. Paul Meyer while studying at the Naples Zoological Station in 1896, and having had placed at my disposal, through the liberality of Director Dohrn, the unequaled facilities of that institution, I entered upon a second and more detailed study in 1898. In this I was most kindly assisted by material and suggestions from Dr. Meyer and Count Sohms-Laubach. While engaged in this investigation, the results of which are soon to be published, a test was made, on private responsibility, of a method of mailing the winter caprifigs wrapped in tinfoil after the cut end had been sealed. This simple expedient proved effective, and the contained insects reached California in good condition. Meanwhile Dr. L. O. Howard, Entomologist of the Department of Agriculture, had determined to attempt the introduction of the *Blastophaga* and was in California in the interest of such an undertaking. The shipment accordingly received his personal attention. Although the insects failed to establish themselves, the experiment showed the advantage of sending the small, firm, winter caprifigs rather than the larger and softer spring generation, which had been

used in previous attempted introductions. In the spring of 1899, while traveling for the Section of Seed and Plant Introduction, I again sent winter caprifigs from Naples, and also, in considerable numbers, from the fig-producing regions of the mountains of Algeria. These also endured the journey well, and on arrival at Washington they were turned over to Dr. Howard, under whose direction they were liberated by Mr. Roeding in his extensive orchards at Fresno. This time the introduction was successful, and *Blastophaga* is now breeding in California, and, it is hoped, may pass the winter and become permanently established.

The principal fig growing regions of North Africa, Italy, Greece, and Asia Minor were also visited in order to learn the methods of culture there pursued, and the conditions necessary to the life of the insect. In the spring of 1898, when the fig orchards about Smyrna were severely frozen, the extraordinary price of from one to three dollars a pound was paid for caprifigs from islands of the Archipelago and from Western Greece, to be used in restocking the orchards with the *Blastophaga*. From one to two cents a pound is the ordinary price of caprifigs. Some lucky owners of large caprifig trees realized fabulous sums for their crop, much more than would ever be obtained from a tree producing edible figs.

Caprifigs are by no means all wild, as commonly supposed, but are extensively propagated and exist in several named and well-known varieties in Greece and Asia Minor. It is further worthy of note that the *profichi* which are produced by certain trees often have a value greatly superior, and there is reason to suppose that some sorts produce not only more *profichi*, but more insects to the fig, and furthermore do not harbor the mess-mate, *Philotrypesis ficaria*, which is considered injurious by growers. I was shown a fig tree in Algeria to secure the fruits of which natives often journeyed twenty or thirty miles. Another yielded *profichi* which sold in 1897, for seven dollars; and in Patras, Greece, I saw a third tree which had brought in as much. These facts give some idea of the views of the natives as to the importance of the process of caprification, which, indeed, all testimony agrees in proving to be *absolutely necessary* for securing a crop in all figs of prime commercial value in the dried condition.

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SCIENTIFIC BOOKS.

Praxis und Theorie der Zellen- und Befruchtungslehre. By Professor Valentin Häcker. Jena, G. Fischer. 1899. 260 pp. 137 Figs.

The last decade has witnessed the appearance in a large number of biological laboratories of a new course of study, now becoming generally known as cellular biology or cytology, which has created new demands in the way of text-books and laboratory methods. In its morphological aspect this study is nearly related to, and strictly speaking forms a part of, the older histology; though a practical ground of distinction lies in the fact that cytology is principally concerned with the anatomy of the cell considered as an individual, while histology includes also the comparative anatomy of the tissues. Cytology covers, however, a much wider field than that of cell-anatomy, for a very important part of the study relates to the processes of cell-reproduction and cell-physiology, including the phenomena of cell-division, the maturation and fertilization of the germ-cells, the physiological relations of nucleus, cytoplasm, and other cell-organs, and many cognate problems relating to growth and development. The subject thus becomes one of very wide scope, and indeed joins hands with every branch of biology that can be studied from the cell-standpoint. As practically taught, however, cytology is still largely occupied with cell-morphology and reproduction, and the historical development of the subject has been such as to concentrate the attention of cytologists to a considerable degree on the structure of the reproductive organs and on growth, division and