



Fig. 8.

and the pistil as the female. The flower of the oat also magnified four diameters, which is shown detached from its sheath in Fig. 8, closely resembles that of the wheat, but here the stamens and pistil are more distinctly seen.

In nature, fertilization takes place within the tightly closed chaffy case, where, as the anthers mature, they burst open and the pollen they contain is shed on the delicate feathery pistil. Portions of this pollen remain attached to the surface of the pistil and from one or more of these minute microscopic bodies a small thread-like growth proceeds which gradually lengthens and piercing the soft tissues of the pistil soon extends to its base where it enters the ovary which is shown below the base of the pistil in Fig. 8. and fertilization takes place, resulting in the growth of a kernel. Where it is desired to effect a cross the outer glume or coating of chaff is torn off by the use of a pair of finely pointed forceps and the inner coating pulled back by seizing it at the upper end and bending it downwards thus exposing the flower. The anthers are now carefully examined usually with a magnifying lens and if their condition is sufficiently advanced to offer the possibility of any of the pollen having been shed, the spikelet is rejected and torn off and others examined until flowers are found where the stamens are green but almost mature. These are removed with great care as the slightest injury to the soft and delicate pistil will cause it to wither, and after the removal of the stamens from a sufficient number of selected flowers, all other portions of the head are torn off and rejected. Having previously collected heads of another variety which it is desired should serve as male, flowers are sought for which contain anthers mature and covered with pollen when the individual flowers to be fertilized are again opened in succession by bending down the glume, when the soft pistil is gently touched with one or more of the pollen bearing anthers from the other variety until a perceptible quantity of the fertilizing powder has been applied. The flower case is again carefully closed and when all the flowers prepared in the head have thus been operated on, the mutilated head is wrapped in thin manilla paper and so secured by tying as to prevent the possibility of access of other pollen either by wind or insects. To prevent accidents the covered head is now tied to a piece of stick or bamboo cane and remains untouched until harvest time when any kernels which have formed will be mature, and each one of these when sown the following season will form the starting point of a new variety.

The single plant grown the first year will produce heads all alike and may take after the female plant which has supplied the pistil and on which the kernel has grown, or they may resemble those on the plant from which the pollen has been gathered. In any case if the cross has been accomplished the grain from the plant of the first year, when sown the next season, will usually produce several different forms, some resembling one parent and some the other, while others again may be more or less intermediate in character. After selecting the most desirable type or types from a cross, all other forms are discarded and only those retained from year to year which are true to the types selected. After several seasons of careful selection the type usually becomes established and is then fairly permanent. Variations will however in many cases still occur occasionally, even after the variety is supposed to have become fixed; these variations are known as sports and must be separated whenever they appear or the new grain will not be preserved pure.

To accomplish such work as cross-breeding requires much care, and with all the skill which trained hands can bring to bear on it the ripened kernels are always few compared with the number of flowers operated on. A partial record of the crossing done on wheat at the experimental farms shows that from 1,650 flowers carefully crossed but 220 kernels were obtained which is about 1 in 8, nevertheless during the past six years more than 700 cross-bred and hybrid varieties of grain have been produced at the farms.