have it clear what quantities we demand from the other stars if they are accepted as parts of the same flock.

(1) Their proper motions must diverge from D —or converge on C .

(2) Any known facts about their distance, radial motion, and amount of proper motion must fit in with the assumption that the velocity of the flock is $11\frac{1}{2}$ miles per second. It is extremely unfortunate that for these stars the radial velocities are difficult to ascertain because they appear to be variable. Dr. Ludendorff establishes β as a spectroscopic binary, and satisfies himself that ϵ is so too, while ζ has long been so recognized. He obtains for ϵ and ζ the radial velocities — 13 and 12.6 kilometers (8.08 and 7.83 miles). If they belong to the flock those quantities should be — 13.2 and — 12.2 (8.20 and 7.58), so this is a fairly strong corroboration, but the main strength of the argument in favor of these five forming a flock is the convergence of their *directions* of proper motion, and their general similarity of magnitude and spectrum and possible duplicity.

We now come to a very pleasing development of this research. Dr. Hertzsprung has sought for other possible members of this flock, not confining his scrutiny to the immediate neighborhood of Ursæ Major. The two criteria above mentioned were his guides, the former of the two being naturally first applied. He found six stars whose motion fairly well converged on the point C , R. A. 303 deg. Dec. —37 deg., and one would naturally expect

that some such result would emerge in reviewing any extensive list of stars. We must not then give much weight to the possible connection unless the second criterion is also satisfied.

Now the only star among the six for which we have the necessary information as to radial velocity and distance is Sirius, and the fact that the evidence is entirely satisfactory will be an exceptionally popular addition to stellar astronomy.

In the first place, the arrow of Sirius's proper motion is directed nearly precisely to the point C , and since the length of that arrow is ten times as great as any of Proctor's five stars it affords to that extent a more delicate test. Then the parallax of Sirius is well determined; the Nautical Almanac only recognizes officially three parallaxes—those of Sirius and Centauri, and 61 Cygni, giving that of Sirius the value of 0.37 second. The radial velocity of Sirius has known many vicissitudes, and is at present accepted as —7.4 kilometers; that is to say, the *Sirian system* is approaching us at 4.6 miles per second.

On the September evenings, when C and D are so conveniently placed on our horizon, Sirius is not far from the Nadir; but without troubling to give the steps of computation it will suffice to state that the second criterion would demand from Sirius the following qualifications:

Parallax should be.....0.387"; it is 0.37"

Radial velocity should be —8.5; it is —7.4

This accord justifies us in stating with confidence that Sirius belongs to the same flock as Proctor's five stars, and Mr. Eddington has remarked: "It would have been an interesting theme for the classical mythologists to explain how so important a part of the Great Bear has come to be situated between the teeth of the Great Dog."

There are two further striking inferences to be made from the distances which this discussion discloses. The actual stars of the Great Bear must be from 30 to 130 times as luminous as our sun—which places them, according to Kapteyn's estimates, among the larger of the heavenly bodies, for he only admits about 12 per cent. of the stars to be intrinsically more luminous than the sun. And, secondly, this stream, the existence of which is now accepted, comprises within its limits stars separated from each other by distances up to 30 light-years, say 600 billions of miles.

We pointed out at the beginning of this article that the doctrine of the Fixity of the Stars, immeasurable though its value has been, must now be abandoned, but we may begin to see that its place will be filled by another conception no less stimulating. In the place of the incorruptible crystalline sphere with its fixed stars we have opening gradually before us the appalling picture of the immensity of the universe. The utilitarian who points to navigation and to frontier-staking as the uses of astronomy merely convicts himself of being a shallow philosopher.

Making Money Out of Bees—III*

Keeping Bees for Pleasure and Profit

By E. F. Phillips, Ph.D., in charge of Bee Culture, Bureau of Entomology

Concluded from Supplement No. 1834, page 126

PREPARATION FOR THE HARVEST.

AN essential in honey production is to have the hive overflowing with bees at the beginning of the honey flow, so that the field force will be large enough to gather more honey than the bees need for their own use. To accomplish this, the bee keeper must see to it that brood rearing is heavy some time before the harvest, and he must know accurately when the honey flows come, so that he may time his manipulations properly. Brood rearing during the honey flow usually produces bees which consume stores, while brood reared before the flow furnishes the surplus gatherers. The best methods of procedure may be illustrated by giving as an example the conditions in the white-clover region.

In the spring the bees gather pollen and nectar from various early flowers, and often a considerable quantity from fruit bloom and dandelions. During this time brood rearing is stimulated by the new honey, but afterwards there is usually a period of drought when brood rearing is normally diminished or not still more increased as it should be. This condition continues until the white-clover flow comes on, usually with a rush, when brood rearing is again augmented. If such a condition exists, the bee keeper should keep brood rearing at a maximum by stimulative feeding during the drought. When white clover comes in bloom he may even find it desirable to

Fig. 18.—Knives for Uncapping Honey

prevent brood rearing to turn the attention of his bees to gathering.

A worker bee emerges from its cell twenty-one days after the egg is laid, and it usually begins field work in from fourteen to seventeen days later. It is evident, therefore, that an egg must be laid five weeks before the honey flow to produce a gatherer. Since the flow continues for some time and since bees often go to the field earlier than fourteen days, egg laying should be pushed up to within two or three weeks of the opening of the honey flow. In addition to stimulative feeding, the care of the colony described under the heading of "Spring management" will increase brood production.

THE PRODUCTION OF HONEY.

The obtaining of honey from bees is generally the primary object of their culture. Bees gather nectar to make into honey for their own use as food, but generally store more than they need, and this surplus the bee keeper takes away. By managing colonies early in the spring as previously described, the surplus may be considerably increased. The secret of maximum crops is to "Keep all colonies strong."

Honey is gathered in the form of nectar secreted by various flowers, transformed by the bees, and stored in the comb. Bees also often gather a sweet liquid called "honeydew," produced by various scale insects and plant-lice, but the honeydew honey made from it is quite unlike floral honey and should not be sold for honey. It is usually unpalatable and should never be used as winter food for bees. When nectar or honeydew has been thick-

ened by evaporation and otherwise changed, the honey is sealed in the cells with cappings of beeswax.

It is not profitable to cultivate any plant solely for the nectar which it will produce, but various plants, such as clovers, alfalfa, and buckwheat are excellent honey plants

Fig. 19.—Honey Extractor

as well as valuable for other purposes; their cultivation is therefore a benefit to the bee keeper. It is often profitable to sow some plant on waste land; sweet clovers are often used in this way. The majority of honey-producing plants are wild, and the bee keeper must largely accept the locality as he finds it and manage his apiary

Fig. 20.—Perforated Zinc Queen Excluder

so as to get the largest possible amount of the available nectar. Since bees often fly as far as two or three miles to obtain nectar, it is obvious that the bee keeper can rarely influence the nectar supply appreciably.

EXTRACTED HONEY.

Extracted honey is honey which has been removed by means of centrifugal force from the combs in which the

bees stored it. In providing combs for the storage of honey to be extracted, the usual practice is to add to the top of the brood chamber one or more hive bodies just like the one in which brood is reared and fill these with frames. If preferred, shallower frames with bodies of proper size may be used, but most honey extractors are made for full-size frames. The surplus bodies should be put on in plenty of time to prevent the crowding of the brood chamber, and also to act as a preventive of swarming.

Honey for extracting should not be removed until it is well ripened and a large percentage of it capped. It is best, however, to remove the crop from each honey flow before another heavy producing plant comes into bloom, so that the different grades of honey may be kept separate.

The frames containing honey to be extracted are removed from the hive, the cappings cut off with a sharp, warm knife (Fig. 18) made specially for this purpose, and the frames are then put into the baskets of the honey extractor (Fig. 19). By revolving these rapidly the honey is thrown out of one side. The basket is then reversed

Fig. 21.—Shipping Cases for Comb Honey

and the honey from the other side is removed. The combs can then be returned to the bees to be refilled, or if the honey flow is over, they can be returned to the bees to be cleaned and then removed and stored until needed again. This method is much to be preferred to mashing the comb and straining out the honey, as was formerly done.

The extracted honey is then strained and run into vessels. It is advisable not to put it in bottles at once, but to let it settle in open vessels for a time, so that it can be skimmed. Most honeys will granulate and become quite hard if exposed to changes of temperature, and to liquefy granulated extracted honey it should be heated in a water bath. Never heat honey directly over a stove or flame, as the flavor is thereby injured. The honey should never be heated higher than 160 deg. F., unless it is necessary to sterilize it because of contamination of disease.

Extracted honey is put up in bottles or small tin cans for the retail trade, and in 5-gallon square tin cans or barrels for the wholesale market. Great care must be exercised if barrels are used, as honey will absorb moisture from the wood, if any is present, and cause leakage. The tin package is much to be preferred in most cases. In bottling honey for retail trade, it will well repay the bee keeper or bottler to go to considerable expense and trouble to make an attractive package, as the increased price obtained will more than make it up. Honey should be heated to 160 deg. F., and kept there for a time before

*Farmers' Bulletin No. 397, U. S. Department of Agriculture.

bottling, and the bottle should be packed as full as possible and sealed hermetically.*

COMB HONEY.

Comb honey is honey as stored in the comb by the bees, the size and shape being determined by the small wooden sections provided by the bee keeper. Instead of having comb in large frames in which to store surplus honey, the bees are compelled to build comb in the sections and to store honey there (Fig. 2). A full sec-

tion of the need of supers is the whitening of the brood combs at the top. If the bees are in two-hive bodies they should generally be reduced to one, and the frames should be filled with brood and honey so that as the new crop comes in the bees will carry it immediately to the sections. If large hives are used for the brood chamber it is often advisable to remove some of the frames and use a division board to crowd the bees above. To prevent the queen from going into the sections to lay, a sheet

tions fit exactly, are manufactured by dealers in supplies. In shipping these cases, several of them should be put in a box or crate packed in straw and paper and handles provided to reduce the chances of breakage. When loaded in a freight car the combs should be parallel with the length of the car.

In preparing comb honey for market it should be carefully graded, so that the sections in each shipping case are as uniform as possible. Nothing will more likely cause

A PENNSYLVANIA APIARY.

REMOVING A BEE THAT HAS STUNG THE BEE-KEEPER.

tion weighs about 1 pound; larger ones are rarely used. By the use of modern sections and foundation the comb honey now produced is a truly beautiful, very uniform product—so uniform in fact that it is often charged that it must be artificially manufactured. The purchaser of a section of comb honey may be absolutely certain, however, that he is obtaining a product of the bees, for never has anyone been able to imitate their work successfully. To show their confidence in the purity of comb honey, the National Bee Keepers' Association offers \$1,000 for a single pound of artificial comb filled with an artificially prepared sirup.

There are several different styles of sections now in use, the usual sizes being $4\frac{1}{4}$ inches square and 4 inches by 5 inches. There are also two methods of spacing, so that there will be room for the passage of bees from the brood chamber into the sections and from one super of sections to another. This is done either by cutting "bee ways" in the sides of the sections and using plain flat separators or by using "no bee-way" or plain sections and using "fences"—separators with cleats fastened on each side, to provide the bee space. To describe all the different "supers" or bodies for holding sections would be impossible in a bulletin of this size, and the reader must be referred to catalogues of dealers in bee-keeping supplies. Instead of using regular comb-honey supers, some bee keepers use wide frames to hold two tiers of sections. It is better, however, to have the supers smaller, so that the bees may be crowded more to produce full sections. To overcome this difficulty, shallow wide frames holding one tier of sections may be used. The majority of bee

of perforated zinc (Fig. 20) may be put between the brood chamber and the super (Fig. 2).

It is often difficult to get bees to begin work in the small sections, but this should be brought about as soon as possible to prevent loss of honey. If there are at hand some sections which have been partly drawn the previous year, these may be put in the super with the new sections as "bait." Another good plan is to put a shallow extracting frame on either side of the sections. If a few colonies in the apiary that are strong enough to go above still refuse, lift supers from some colonies that have started to work above and give them to the slow colonies. The super should generally be shaded somewhat to keep it from getting too hot. Artificial swarming will quickly force bees into the supers.

To produce the finest quality of comb honey full sheets of foundation should be used in the sections. Some bee keepers use nearly a full sheet hung from the top of the section and a narrow bottom starter. The use of foundation of worker-cell size is much preferred.

When one super becomes half full or more and there are indications that there will be honey enough to fill others, the first one should be raised and an empty one put on the hive under it. This tiering up can be continued as long as necessary, but it is advisable to remove filled sections as soon as possible after they are nicely capped, for they soon become discolored and less attractive. Honey removed immediately after capping finds a better market, but if left on the hive even until the end of the summer the quality of the honey is improved. A careful watch must be kept on the honey flow, so as

wholesale purchasers to cut the price than to find the first row of sections in a case fancy and those behind of inferior grade. Grading rules have been adopted by various bee keepers' associations or drawn up by honey dealers. The following set of rules are in general use:

Eastern Grading Rules for Comb Honey.

Fancy.—All sections well filled; combs straight; firmly attached to all four sides; the combs unsoiled by travel, stain, or otherwise; all the cells sealed except an occasional one; the outside surface of the wood well scraped of propolis.

No. 1.—All sections well filled except the row of cells next to the wood; combs straight; one-eighth part of comb surface soiled, or the entire surface slightly soiled; the outside surface of the wood well scraped of propolis.

No. 2.—All sections well filled except the row of cells next to the wood; combs comparatively even; one-eighth part of comb surface soiled, or the entire surface slightly soiled.

No. 3.—Three-fourths of the total surface must be filled and sealed.

No. 4.—Must weigh at least half as much as a full-weight section.

In addition to this the honey is to be classified according to color, using the terms white, amber, and dark; that is, there will be "Fancy White," "No. 1 Dark," etc. New Comb-Honey Grading Rules Adopted by the Colorado State Bee Keepers' Association.

No. 1 White.—Sections to be well filled and evenly capped, except the outside row, next to the wood; honey

A BEE COLONY ON THE ROOF OF A HOUSE.

A QUICK DOWNWARD JERK PRECIPITATES THE BEES ON THE ROOF.

keepers find it advisable to use special comb-honey supers.

In producing comb honey it is even more necessary to know the plants which produce surplus honey and just when they come in bloom than it is in extracted honey production. The colony should be so manipulated that the maximum field force is ready for the beginning of the flow. This requires care in spring management, and above all the prevention of swarming. Supers should be put on just before the heavy flow begins. A good indica-

*For further discussion of the production and care of extracted honey, see Bulletin 75, Part 1, Bureau of Entomology. It may be obtained from the Superintendent of Documents, Washington, D. C. Price 5c.

to give the bees only enough sections to store the crop. If this is not done a lot of unfinished sections will be left at the end of the flow. Honeys from different sources should never be mixed in the sections, as it gives the comb a bad appearance.

To remove bees from sections, the super may be put over a bee escape so that the bees can pass down but can not return, or the supers may be removed and covered with a wire-cloth-cone bee escape.

After sections are removed the wood should be scraped free of propolis (bee glue) and then packed in shipping cases (Fig. 21) for the market. Shipping cases to hold 12, 24 or 48 sections, in which the various styles of sec-

white or slightly amber, comb and cappings white, and not projecting beyond the wood; wood to be well cleaned; cases of separated honey to average 21 pounds net per case of 24 sections; no section in this grade to weigh less than $13\frac{1}{2}$ ounces. Cases of half-separated honey to average not less than 22 pounds net per case of 24 sections. Cases of unseparated honey to average not less than 23 pounds net per case of 24 sections.

No. 2 Light Amber.—Sections to be well filled and evenly capped, except the outside row, next to the wood; honey white or light amber; comb and cappings from white to off color, but not dark; comb not projecting beyond the wood; wood to be well cleaned. Cases of

separated honey to average 21 pounds net per case of 24 sections; no section in this grade to weigh less than 13½ ounces. Cases of half-separated honey to average not less than 22 pounds net per case of 24 sections. Cases of unseparated honey to average not less than 23 pounds net per case of 24 sections.

No. 3.—This includes all white honey, and amber honey not included in the above grades; sections to be fairly well filled and capped, no more than 25 uncapped cells, exclusive of outside row, permitted in this grade; wood to be well cleaned; no section in this grade to weigh less than 12 ounces. Cases of separated honey to average not less than 19 pounds net. Cases of half-separated honey to average not less than 20 pounds net per case of 24 sections. Cases of unseparated honey to average not less than 21 pounds net per case of 24 sections.

THE PRODUCTION OF WAX.

Beeswax, which is secreted by the bees and used by them for building their combs, is an important commercial product. There are times in almost every apiary when there are combs to be melted up, and it pays to take care of even scraps of comb and the cappings taken off in extracting. A common method of taking out the wax is to melt the combs in a solar wax extractor. This is perhaps the most feasible method where little wax is produced, but considerable wax still remains in old brood combs after such heating. Various wax presses are on the market, or one can be made at home. If much wax is produced, the bee keeper should make a careful study of the methods of wax extraction, as there is usually much wax wasted even after pressing.

PREPARATIONS FOR WINTERING.

After the main honey flow is over the management must depend on what may be expected later in the season from minor honey flows. If no crop is to be expected, the colony may well be kept only moderately strong, so that there will not be so many consumers in the hive.

In localities where winters are severe and breeding is suspended for several months great care should be taken that brood-rearing is rather active during the late summer, so that the colony may go into winter with plenty of young bees. In case any queens show lack of vitality they should be replaced early, so that the bees will not become queenless during the winter.

The important considerations in wintering are plenty of young bees, a good queen, plenty of stores of good quality, sound hives, and proper protection from cold and dampness.

If, as cold weather approaches, the bees do not have stores enough, they must be fed. Every colony should have from 25 to 50 pounds, depending on the length of winter and the methods of wintering. It is better to have too much honey than not enough, for what is left is good next season. If feeding is practiced, honey may be used, but sirup made of granulated sugar is just as good and is perfectly safe. If honey is purchased for feeding, great care should be taken that it comes from a healthy apiary, otherwise the apiary may be ruined by disease. *Never feed honey bought on the open market.* The bees should be provided with stores early enough so that it will not be necessary to feed or to open the colonies after cold weather comes on. Honeydew honey should not be left in the hives, as it produces "dysentery." Some honeys are also not ideal for winter stores. Those which show a high percentage of gums (most tree honeys) are not so desirable, but will usually cause no trouble.

In wintering out of doors the amount of protection depends on the severity of the winter. In the South no packing is necessary, and even in very cold climates good colonies with plenty of stores can often pass the winter with little protection, but packing and protection make it necessary for the bees to generate less heat, and consequently they consume less stores and their vitality is not reduced. Dampness is probably harder for bees to withstand than cold, and when it is considered that bees give off considerable moisture, precautions should be taken that as it condenses it does not get on the cluster. An opening at the top would allow the moisture to pass out, but it would also waste heat, so it is better to put a mat of burlap or other absorbent material on top of the frames. The hive may also be packed in chaff, leaves, or other similar dry material to keep out the cold. Some hives are made with double walls, the space being filled with chaff; these are good for outdoor wintering. The hive entrance should be lower than any other part of the hive, so that any condensed moisture may run out. The hives should be sound and the covers tight and waterproof.

Entrances should be contracted in cold weather not only to keep out cold wind, but to prevent mice from entering. There should always be enough room, however, for bees to pass in and out if warmer weather permits a flight.

In the hands of experienced bee keepers cellar wintering is very successful, but this method requires careful study. The cellar must be dry and so protected that the temperature never varies more than from 40 to 45 deg. F.; 43 deg. F. seems to be the optimum temperature. The ventilation must be good or the bees become fretful. Light should not be admitted to the cellar, and consequently some means of indirect ventilation is necessary.

Cellar wintering requires the consumption of less honey to maintain the proper temperature in the cluster and is therefore economical. Bees so wintered do not have an opportunity for a cleansing flight, often for several months, but the low consumption makes this less necessary. Some bee keepers advocate carrying the colonies out a few times on warm days, but it is not fully established whether this is entirely beneficial and is usually not practiced.

The time for putting colonies in the cellar is a point

of dispute, and practice in this regard varies considerably. They should certainly be put in before the weather becomes severe and as soon as they have ceased brood rearing. The time chosen may be at night when they are all in the hive, or on some chilly day.

The hives may be piled one on top of the other, the lower tier raised a little from the floor. The entrances should not be contracted unless the colony is comparatively weak. It is usually not considered good policy to close the entrances with wire cloth, as the dead bees which accumulate more or less on the bottom board may cut off ventilation, and the entrance should be free so that these may be cleaned out.

The time of removing bees from the cellar is less easily determined than that of putting them in. The colonies may be removed early and wrapped in black tar paper or left until the weather is settled. If the weather is very warm and the bees become fretful, the cellar must either be cooled or the bees removed. Some bee keepers prefer to remove bees at night, so that they can recover from the excitement and fly from the hive normally in the morning. One of the chief difficulties is to prevent the bees from getting into the wrong hives after their first flights. They often "drift" badly with the wind, and sometimes an outside row will become abnormally strong, leaving other colonies weak.

DISEASES AND ENEMIES.

There are two infectious diseases of the brood of bees which cause great losses to the bee-keeping industry of the United States. These are known as American foul brood and European foul brood. Both of these diseases destroy colonies by killing the brood, so that there are not enough young bees emerging to take the place of the old adult bees as these die from natural causes. The adult bees are not attacked by either disease. In the hands of careful bee keepers both diseases may be controlled, and this requires careful study and constant watching. In view of the fact that these diseases are now widely distributed throughout the United States, every bee keeper should read the available literature on the subject, so that if disease enters his apiary he may be able to recognize it before it gets a start. The symptoms and the treatment recommended by this Department are given in another publication which will be sent free on request.*

It is difficult for a bee keeper to keep his apiary free from disease if others about him have diseased colonies which are not properly treated. The only way to keep disease under control is for the bee keepers in the neighborhood to cooperate in doing everything possible to stamp out disease as soon as it appears in a single colony. The progressive bee keeper who learns of disease in his neighborhood should see to it that the other bee keepers around him are supplied with literature describing symptoms and treatment, and should also try to induce them to unite in eradicating the malady. Since it is so often impossible to get all the bee keepers in a community to treat infected colonies properly and promptly, it is desirable that the States pass laws providing for the inspection of apiaries and granting to the inspector the power to compel negligent bee keepers to treat diseased colonies so that the property of others may not be endangered and destroyed. This has been done in a number of States, but there are still some where the need is great and in which no such provision has been made. When no inspection is provided, bee keepers should unite in asking for such protection, so that the danger to the industry may be lessened.

In case there is an inspector for the State or county, he should be notified as soon as disease is suspected in the neighborhood. Some bee keepers hesitate to report disease through fear that the inspector will destroy their bees or because they feel that it is a disgrace to have disease in the apiary. There is no disgrace in having colonies become diseased; the discredit is in not treating them promptly. The inspectors are usually, if not universally, good practical bee keepers who from a wide experience are able to tell what should be done in individual cases to give the best results with the least cost in material and labor. They do not destroy colonies needlessly, and, in fact, they all advocate and teach treatment.

The brood diseases are frequently introduced into a locality by the shipping in of diseased colonies; or, more often, the bees get honey from infected colonies which is fed to them, or which they rob, from discarded honey cans. It is decidedly dangerous to purchase honey on the market, with no knowledge of its source, to be used in feeding bees. Many outbreaks of disease can be traced to this practice. It is difficult to prevent bees from getting contaminated honey accidentally. If colonies are purchased, great care should be taken that there is no disease present. Whenever possible, colonies should be purchased near at home, unless disease is already present in the neighborhood.

There are other diseased conditions of the brood, known to bee keepers as pickled brood, but these can usually be distinguished from the two diseases previously mentioned. The so-called "pickled brood" is not contagious and no treatment is necessary. Bees also suffer from "dysentery," which is discussed in the earlier part of this bulletin, and from the so-called "paralysis," a disease of adult bees. No treatment for the latter disease can as yet be recommended as reliable. The sprinkling of powdered sulphur on the top bars of frames or at the entrance is sometimes claimed to be effective, but under what circumstances it is beneficial is unknown.

A number of insects, birds, and mammals must be classed as enemies of bees, but of these the two wax moths, and ants, are the only ones of importance. There are two species of moth, the larger wax moth (*Galleria*

*Circular 79, Bureau of Entomology, U. S. Department of Agriculture. The Brood Diseases of Bees.

mellonella L.) and the lesser wax moth (*Achroia grisella* Fab.), the larvae of which destroy combs by burrowing through them.* Reports are frequently received in the Department that the larvae of these moths (usually the larger species) are destroying colonies of bees. It may be stated positively that moths do not destroy strong healthy colonies in good hives, and if it is supposed that they are causing damage the bee keeper should carefully study his colonies to see what other trouble has weakened them enough for the moths to enter. Queenlessness, lack of stores, or some such trouble may be the condition favorable to the entrance of the pest, but a careful examination should be made of the brood to see whether there is any evidence of disease. This is the most frequent cause of the cases of moth depredation reported to this Department. Black bees are less capable of driving moth larvae out, but, even with these bees, strong colonies rarely allow them to remain. The observance of the golden rule of bee keeping, "Keep all colonies strong," will solve the moth question unless disease appears.

Moth larvae often destroy combs stored outside the hive. To prevent this the combs may be fumigated with sulphur fumes or bisulphid of carbon in tiers of hives or in tight rooms. If bisulphid of carbon is used, great care should be taken not to bring it near a flame, as it is highly inflammable. Combs should be stored in a dry, well-ventilated, light room.

In the warmer parts of the country ants are often a serious pest. They may enter the hive for protection against changes of temperature, or to prey on the honey stores or the brood. The usual method of keeping them out is to put the hive on a stand, the legs of which rest in vessels containing water or creosote. Another method is to wrap a tape soaked in corrosive sublimate around the bottom board.

GENERAL INFORMATION.

For the purpose of answering numerous questions which are asked of this Department the following brief topics are included.

BREEDERS OF QUEENS.

There are a large number of bee keepers who make a business of rearing queens of good stock for sale. The queens are usually sent by mail. If poor stock is all that can be obtained locally, it is recommended that such colonies be purchased and the queens removed and replaced with those obtained from a good breeder. This Department can supply names of breeders, nearest the applicant, of any race raised in this country.

INTRODUCING QUEENS.

When queens are shipped by mail they usually come in cages which can be used for introducing. If the colony to receive the new queen has one, she must be removed and the cage inserted between the frames. The small hole leading into the candy compartment is uncovered, and the bees gradually eat through and release the queen. If queens are reared at home, a similar cage may be used for introducing.

In view of the fact that disease may be transmitted in mailing cages, it is always a wise precaution to remove the new queen and destroy the accompanying workers and the cage and its contents. The queen may then be put into a clean cage without worker bees with candy known to be free from contamination (made from honey from healthy hives) and introduced in the regular way. Queens sold by breeders are always mated unless otherwise specified, and consequently the colony in which they are introduced has no effect on the offspring. During the active season the bees in the colony are all the offspring of the new queen in about nine weeks. Three weeks is required for the previous brood to emerge (if the colony has not been queenless), and in six weeks after all the old brood emerges most of the workers from it will have died.

DEALERS IN BEE KEEPERS' SUPPLIES.

There are several manufacturers of supplies in this country who can furnish almost anything desired by the bee keeper. Some of them have agents in various parts of the country from whom supplies may be purchased, thus saving considerable in freight.

BEE KEEPERS' ASSOCIATIONS.

There are a large number of associations of bee keepers in all parts of the country, formed for the betterment of the industry and a few associations which are organized to aid the members in purchasing supplies and in selling the crops. Of these the National Beekeepers' Association is the largest. It helps its members in obtaining their legal rights, and aids in securing legislation for the furtherance of the industry. The annual conventions are held in different parts of the country, and copies of the proceedings are sent to the members. There are also numerous state, county, and town associations, some of which publish proceedings. The names of officers of the nearest associations or of the National Beekeepers' Association will be sent on request from this Department.

LAW AFFECTING BEE KEEPING.

Disease inspection.—Various States have passed laws providing for the state or county inspection of apiaries for bee-disease control, and every bee keeper should get in touch with an inspector when disease is suspected, if one is provided. The inspectors are practical bee keepers who fully understand how to control the diseases, and are of great help in giving directions in this matter. The name of the inspector of any locality can usually be furnished, and this department is glad to aid bee keepers in reaching the proper officers.

Laws against spraying fruit trees while in bloom.—The spraying of fruit trees while in bloom is not now advised by economic entomologists, and to prevent the practice

*Bee keepers refer to these insects as "moths," "wax moths," "bee moths," "millers," "wax worms," "honey moths," "moth worms," "moth millers" and "grubs." The last six terms are not correct.

some States have passed laws making it a misdemeanor. Such spraying not only kills off honeybees, causing a loss to the bee keeper, but interferes with the proper pollination of the blossoms and is thus a detriment to the fruit grower. Bee keepers should do everything in their power to prevent the practice.

Laws against the adulteration of honey.—The National Food and Drugs Act of 1906, and various state pure food laws, are a great aid to the bee keeper in preventing the sale of adulterated extracted honey as pure honey. Bee keepers can often aid in this work by reporting to the proper officials infringements of these laws which come to their notice.

When bees are a nuisance.—Some cities have passed ordinances prohibiting the keeping of bees in certain areas, but so far none have been able to enforce them. If bees are a nuisance in individual cases, the owner may be compelled to remove them. The National Beekeepers' Association will help any of its members in such cases, if they are in the right, as well as in cases where bees sting horses. Bee keepers should be careful not to locate bees where they can cause any trouble of this kind.

SUPPOSED INJURY OF CROPS BY BEES.

Bee keepers are often compelled to combat the idea that bees cause damage to fruit or other crops by suck-

ing the nectar from the flower. This is not only untrue, but in many cases the bees are a great benefit in pollinating the flowers, making a good crop possible. A more frequent complaint is that bees puncture fruit and suck the juices. Bees never puncture sound fruit, but if the skin is broken by some other means bees will often suck the fruit dry. In doing it, however, they are sucking fruit which is already damaged. These and similar charges against the honeybee are prompted by a lack of information concerning their activities. Bees may, of course, become a nuisance to others through their stinging propensities, but bee keepers should not be criticised for things which bees do not do.

Some Mental Illusions of Vision

Explanations of Various Optical Phenomena

By R. T. Lewis, F.R.M.S.

NOTWITHSTANDING the popular saying that "seeing is believing," neither of our faculties is subject to such complete illusions as our sense of sight, some being optical, others ocular, while again others are purely mental.

To the first kind belong those due to refraction—such for instance as the mirage, or the apparent displacement of an object from its true position; to the second kind may be referred the phenomena of irradiation, and of subjective images and colors; while the third includes the impression which most persons have of the apparent increase of the size of the Sun and Moon when rising or setting, and the similar increase in the apparent size of constellations, or the distance apart of stars when seen near the horizon, as compared with our estimate of such at their meridian altitude.

That this last-named illusion is neither optical nor ocular is shown at once by the fact that when seen through a telescope no such apparent increase is found to exist; indeed, when accurately measured, after making all necessary corrections for height of barometer, temperature, and refraction in altitude, it is found that the apparent diameter of either body is really greatest when on the meridian, inasmuch as they are then some 4,000 miles nearer to us than when near the horizon, though the difference is too small to be appreciated by the naked eye.

It should be noted, however, that the amount of the apparent augmentation varies considerably with individuals; artists, for instance, depict the rising moon of a variety of exaggerated sizes up to about 15 deg. diameter, or about thirty times greater than it should be drawn, and one not infrequently hears it described as looking "as large as a dinner plate," whereas a three-penny bit held at arm's length is rather larger than is necessary to hide it completely.

That this almost universal illusion is entirely mental, is not easy to demonstrate, although it will be readily admitted that if a false impression of the distance of an object can be created, the mental estimate of its actual size will be proportionately altered; in other words, if an object we believe to be near to us appears of a certain size, and one of the same kind believed to be at a distance appears also of the same size, we at once from experience correctly judge that the latter must be the larger of the two. Hence though the Moon, whether high or low in the sky, practically subtends the same angle, and therefore its image on the retina of the eye is in both positions the same, we naturally from experience imagine it must be a larger body in the latter case, because though so much farther off it appears to be of the same size as the Moon we see when apparently nearer.

The experiment referred to in the accompanying diagram affords a convincing illustration of the curious mental effect produced by the creation of a false impression of distance, and is one which may be performed by any persons who possess sufficient control of the eyes to dissociate the focusing and the convergence, which though quite separate and independent actions, are from constant habit usually performed automatically together. A-B represents a stereoscopic slide, which we will suppose to be of the full Moon, placed at the normal distance of ten inches from the eyes, when the two pictures are seen clearly in focus. If while retaining the local distance we alter the convergence so that the axis of the right eye (R) passes centrally through the picture B, and that of the left eye (L) through the center of A, as shown by the two firm lines L-C and R-C, these axes will meet at the point C, which will be more or less distant from the plane of A-B according to the width apart of the eyes of the observer. The result of this will be that three images of the pictures A and B will be seen, of which the central one, consisting of A and B superposed, will be seen apparently at C, and

of course perfectly stereoscopic. If then without altering the distance between the eyes and the slide we look so "cross eyed" that the axis of R passes centrally through A, and that of L through B, as indicated by the two dotted lines, we shall again see three images, the center one apparently at D, but in this case pseudoscopic. It is clear that in both cases the images of the pictures on the sympathetic portions of the retina will be approximately the same, but in the former case where the Moon is seen apparently at C, or much farther off than it really is, the effect is that of a considerably magnified image, whereas in the latter case where the picture is seen apparently at D, or much nearer than it really is, the mental impression produced (after making due allowance for the difference between R-A and R-B) is that of a considerably smaller Moon than either of those seen at A-B, the mental illusion in each case being due to the fact that a false idea has been created, as to the distances of the objects observed.

Diagram Illustrating False Impressions of Distance

A further experiment may be suggested by means of the subjective image of any object which is gazed upon long enough to produce a continued impression upon the eyes. If, for instance, the filament of an incandescent electric lamp is steadily looked at for a few seconds, the impression produced by it upon the sympathetic portions of the eyes will persist until the vibrations so excited have run down, and a spectral image of the filament will meanwhile be seen so long as the convergence of the eyes is maintained at the same angle as when the lamp was originally looked at. If this image is projected upon the distant wall of the room it will appear of magnified proportions, whereas if thrown upon some surface nearer to the eye than the exciting cause, it will apparently be seen of very reduced dimensions, although in both cases the actual picture formed must be precisely the same.

As yet another, though somewhat different class of mental illusion in the case of vision, I may mention that I have before me a photograph of the "Challenger" medal, taken under a strong oblique light, falling upon it from the top. Knowing from experience that if the light falls in that direction upon a raised surface, the shadows would fall as depicted, the mental impression produced when the top of the photograph is held toward a source of light is that of a design in strong relief, although the sense of touch assures me it is flat; but if

the picture is turned round so that the light falls upon it from the bottom, experience immediately suggests that shadows, as they then appear, can only be thrown by an intaglio, and the mental suggestion is that of a sunk pattern, an illusion which would be complete but for the fact that the inscription still reads the right way about.

A false estimate of distance, and therefore of size, is very common to persons in the clear air of high mountainous regions, who under ordinary circumstances are accustomed to see landscapes through our own more murky atmosphere, and the common illusion of meeting suddenly with gigantic figures in the street on a foggy night, because they are much closer than imagined, will occur to most people.

It seems also quite within the limits of possibility that some of the errors of interpretation as to the meaning of what is seen under the microscope may be due to mental suggestion.

It will be understood that the extent of such illusions as have been referred to varies somewhat according to the "personal equation" of the observer, and that what has been described is simply the experience of the writer, who it may be of some interest to mention, has since he thought out the matter, almost entirely lost the impression that the Sun and the Moon appear larger when rising or setting than at other times, though he has been quite unable to divest himself from the illusion in the case of constellations or stars.—Knowledge.

Moving Picture Camera, as a Hand Camera, by Using a Gyroscope

At a recent meeting of the Societe de Physique, of Paris, an interesting method of taking moving picture views was presented by M. De Proszynski. Heretofore such a camera had to be mounted on a tripod to keep it quite steady and it was generally turned by a hand crank. The inventor succeeds in making a hand camera for use in taking such views. He keeps it steady by using the principle of the gyroscope in an ingenious way, so that holding it in the hand causes no trembling. But the problem was how to drive the gyroscope and also the film machine, as an electric motor with a battery is not practical, neither is a spring motor. He uses a small compressed air motor devised for the purpose, and it is very compact. It gives no shocks when running, which is, of course, an essential point. A unique feature is that an ordinary bicycle pump is used to fill the air cylinder of the motor, so that the whole can be made in the form of a hand camera about the size of a large kodak, and it is thus self-contained. The inventor showed what the camera would do by projecting some street views on a screen. These were taken when moving the camera about in the hand quite rapidly, and the images were remarkably sharp. We expect to illustrate this apparatus in the near future.

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