

GUIDE TO SHIPPING HONEY BEE QUEEN CELLS



Oregon State
University

Project Apis m.



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ACKNOWLEDGEMENTS & INTRODUCTION

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INTRODUCTION

Queen failure is consistently identified as one of the top contributors to colony loss (Kulhanek et al. 2017). Beekeepers can replace failing queens and divide healthy colonies in the early spring to offset winter colony losses if they can readily source queens from producers. Reports on management practices suggest that the rate of queen replacement by U.S. beekeepers has drastically increased in recent years (Pettis et al. 2016). This heavy increase in demand for new queens often exceeds domestic supply.

Using honey bee queen cells is an economical alternative to buying mated queens. While the beekeeper assumes risks associated with queen mating and introduction processes when purchasing queen cells, the savings can be substantial. Queen cells cost, on average, about 75% less than the cost of a mated queen. It is customary for beekeepers to only offer queen cells within a reasonable driving radius of their operation, but some queen producers transport mated queens by air freight to customers that extend beyond the vicinity of their operation.

Greater access to queen cells could promote a more profitable and sustainable beekeeping industry by increasing accessibility to queen cells and bolstering queen producers' income streams. This could also give beekeepers an economical solution to reduce colony losses and improve their ability to satisfy the demand for pollination services by increasing their number of rentable colonies.



Air transportation of queen cells presents several advantages to the industry. Shipping queen cells facilitates stock exchange protocols for queen breeding cooperatives. Queen producers may extend their production season into the hot summer months when maintaining mating nuc colonies and queen banks for mated queens is difficult. Shipping queen cells also offers an opportunity for queen production in genetically compromised areas, such as those with historic detection of Africanized honey bees. Additionally, introducing queen cells provides an extended interruption of the colony's brood cycle, and thus a longer opportunity for *Varroa* treatment.

Shipping queen cells successfully requires technical skill and attention. Queen cells are sensitive to temperature and agitation. Success and survival depends on proper timing, preparation, and handling. Shipping materials require special modifications. This guide seeks to address several of the technical challenges of shipping cells, providing recommendations for air shipping queen cells based on input from several queen producers that successfully ship queen cells and results from research performed by Oregon State University.



PROCEDURES FOR CELL PRODUCERS: PRIOR TO SHIPPING DAY

Requirements for queen cell producers before shipping day:

- A. Select 15-day queen cells
- B. Amend queen shipping box and assemble JZs BZs equipment
- C. Construct custom shipping bar inserts (optional)

A. SELECT 15-DAY QUEEN CELLS

Pay careful attention to queen cell age. Younger queen cells (aged 12–14 days) are fragile compared to more mature 15-day queen cells. Some virgin queens will likely emerge from 15-day queen cells during shipment. However, the downside of a few emerged virgins when shipping 15-day queen cells outweighs a higher risk of death and wing damage that is associated with shipping 14- and 13-day queen cells (see Solutions section, pgs. 15-16). Isolating the breeder queen and grafting age-appropriate larvae will help with selecting queen cells of uniform age for shipment.

BREEDER QUEEN MANAGEMENT

Isolate the breeder queen five days before grafting to obtain frames with many larvae of similar age. This will reduce the time spent grafting thus narrowing the age gap of grafted larvae.

Ways to isolate breeder queens:

- Transfer breeder queen to a small nucleus (nuc) colony.
- Restrict breeder queen on 1–2 frames of emerging worker brood with an excluder cage made from a queen excluder and/or physical barrier.
- Isolate breeder queen under a push-in cage (#8 hardware cloth) that covers about half of a frame.

GRAFTING

- Select larvae that are 12–24 hours old from eclosion (see Figure 1, Day 4). At this age, larvae are very small and do not have visible segments.
- Graft 50% more larvae than what is required of the anticipated queen cell order.
- Insert grafted larvae into two starter colonies to mitigate risks e.g., rogue virgin queen.

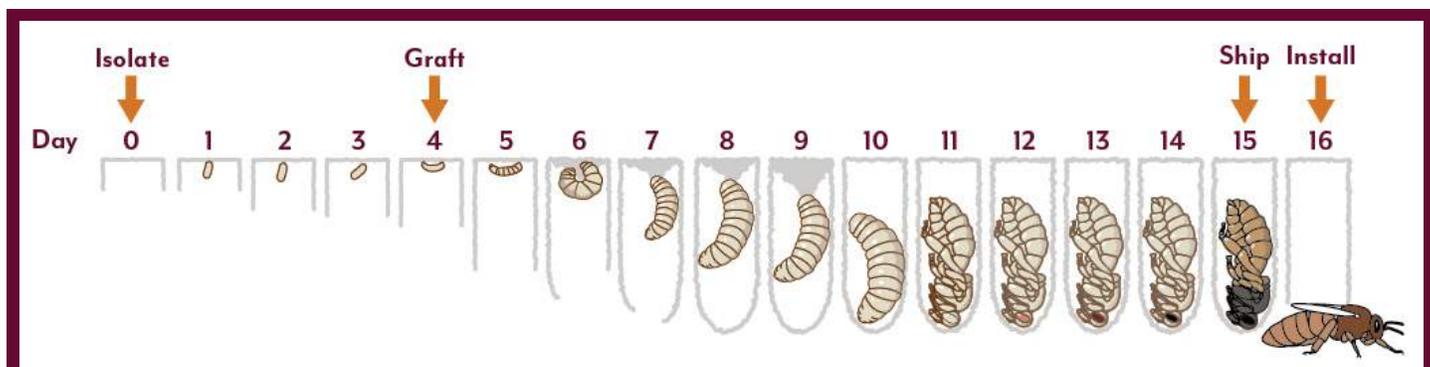


Figure 1. The 16-day queen development cycle. Image adapted from Wang et al. 2015.

OPTIMUM QUEEN CELL AGE

- Ship queen cells 12 days after grafting (see Figure 1, Day 15).
- Queen cells that are 9–11 days after grafting (Day 12–14) are at higher risk of wing damage and death.
- Keep cells below 96°F to avoid premature emergence.

All queen cells must be uniform in age

Isolating the breeder queen and grafting age-appropriate larvae will increase the likelihood that all queen cells will be the same age and emerge on Day 16. However, other factors, such as varying incubator temperatures, can influence queen development before shipment. First-time queen cell producers should conduct a test run of queen cells to observe emergence timing and confirm that their process yields similar aged queen cells before shipping to customers.

B. QUEEN SHIPPING BOX AMENDMENTS AND EQUIPMENT ASSEMBLY

Queen producers must make amendments to large and medium sized cardboard queen shipping boxes (see Figure 2) and assemble JZs BZs equipment inside the shipping box prior to shipping queen cells.

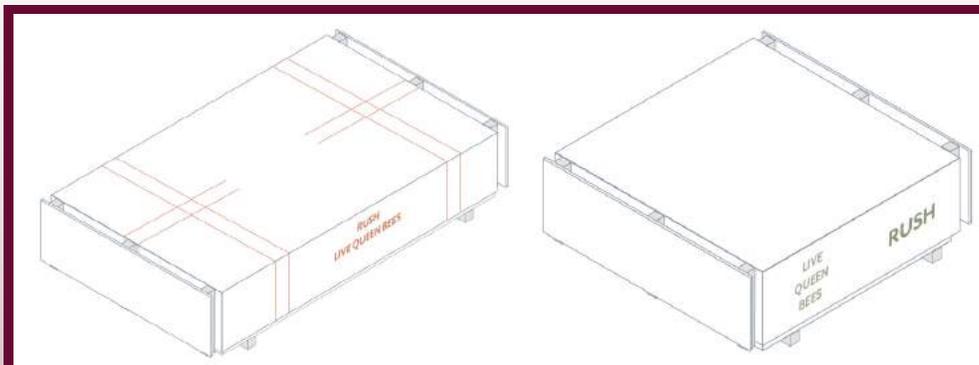


Figure 2. Cardboard queen shipping boxes are the gold standard for shipping queen cells. Large cardboard queen shipping boxes (left) can carry a maximum of 230 cells and medium cardboard queen shipping boxes (right) can carry a maximum of 120 queen cells.

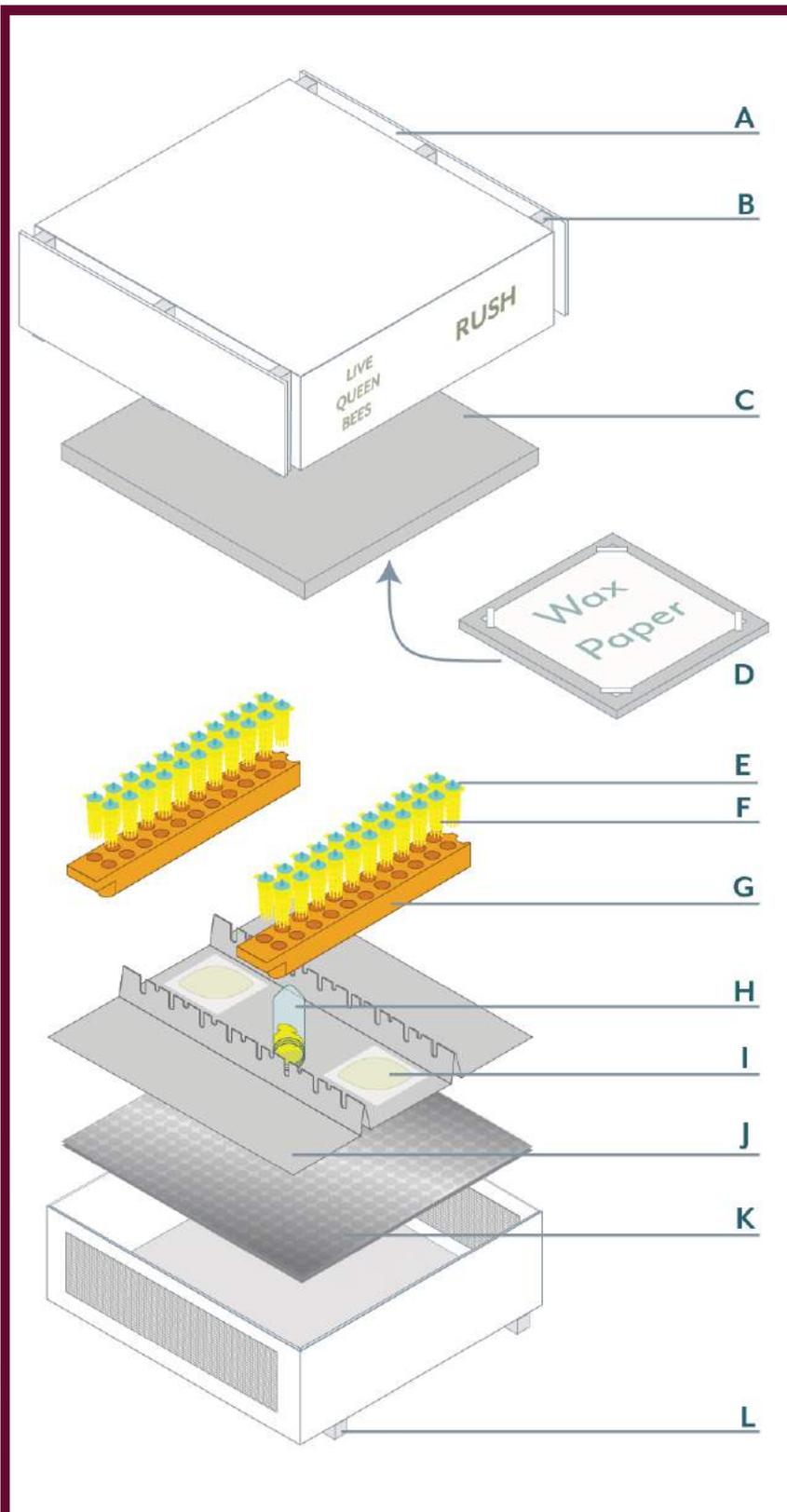


Figure 3. Exploded view of a medium cardboard queen shipping box with necessary amendments and assembled equipment.

ITEM DESCRIPTIONS

A) Ventilation guards: Use plasticore, particle board, or cardboard for ventilation guards for better temperature control inside the shipping box.

B) Wood spacers: Allow 5/8" space between the ventilation guards (A) and ventilation screen with wood spacers.

C) Insulation board: Cut insulation board of 1/2" thickness to fit above the queen cells.

D) Wax paper: Tape a sheet of wax paper around the underside of the 1/2" insulation board (C) to keep cell cups from sticking to the insulation board during removal.

E) JZs BZs cell cups: Graft into base mount JZs BZs cell cups.

F) JZs BZs cell protectors: Use yellow cell protectors. Do not use orange cell protectors (see *Yellow vs. orange JZs BZs cell protectors* section on pg. 6).

G) JZs BZs shipping bars: Secure yellow JZs BZs cell protectors (F) tightly into all plugs of 4-5 JZs BZs shipping bars.

H) Water feeder: Use a 1.7 fl oz. (50 ml) plastic centrifuge tube full of water and a 1.5"x2" sponge. Secure to the bottom of shipping box with a Velcro® strip (10-15 lb. strength). See *Resources* for product details (pg. 18).

I) Candy: Food for attendants (see *Candy recipes*, pg. 8)

J) JZs BZs cell bar insert: This insert accommodates 4-5 JZs BZs shipping bars (G). Cut additional grooves into the insert if a fifth JZs BZs shipping bar is desired.

K) Reflective insulation: Place 1/8" reflective insulation beneath the JZs BZs cell bar insert.

L) Bottom rails: Allow airflow underneath shipping box with 5/8" wood spacers.

Yellow vs. orange JZs BZs cell protectors

Always use yellow JZs BZs cell protectors when shipping queen cells. Unlike orange JZs BZs cell protectors, yellow cell protectors are designed to fit tightly into JZs BZs shipping bars. Yellow cell protectors also have an ideal base for pushing into comb during installation. Place an order for yellow cell protectors directly with JZs BZs Honey Co. (see Resources, pg. 18).



C. CUSTOM SHIPPING BAR INSERTS (OPTIONAL)

Queen producers can construct shipping bar inserts (see Figure 4) that serve as a durable and reusable alternative to the JZs BZs cell bar insert (see Figure 3, item J).

Steps to construct custom shipping bar inserts:

1. Cut two 10"(L) x 1"(W) x 1.5"(H) pieces of insulation board.
2. Hot glue insulation board inserts to the cardboard floor of queen shipping box.
3. Place Velcro® strips (10-15 lb. strength) on top of each insulation board piece.
4. Firmly attach shipping bars to insulation board with Velcro® strips of 10–15 lb. strength (see Figure



Figure 4. Custom shipping bar inserts.



Figure 5. Velcro® strip (10 lb. strength) on the underside of JZs BZs shipping bars to attach to custom shipping bar inserts.

Test your equipment setup

Invert the shipping box without the lid or upper insulation board to confirm that all cell protectors, shipping bars, and insert parts are secured. Hot glue Velcro® strips if they fail to stick to equipment pieces.



PROCEDURES FOR CELL PRODUCERS: SHIPPING DAY

Requirements for queen cell producers on shipping day:

- A. Prepare perishable items: queen cells, candy, water, and attendants
- B. Process shipment with courier services

A. PREPARE PERISHABLE ITEMS: QUEEN CELLS, CANDY, WATER, AND ATTENDANTS

Queen cells, candy, water, and attendants should be added to the shipping box on the day of shipping.

QUEEN CELL PLACEMENT

- Place queen cells in the centermost yellow JZs BZs cell protectors in each JZs BZ shipping bar.
- Partial orders: fill all empty JZs BZs cell protectors with empty waxed JZs BZs cell cups (see Figure 6).

	Large cardboard queen shipping box	Medium cardboard queen shipping box
Queen Cells	230 max 50 min	120 max 50 min
Candy	6 oz.	4 oz.
Water	1.2 fl oz.	1.2 fl oz.
Attendants	24 oz. OR 6.5 cups	15 oz. OR 4 cups

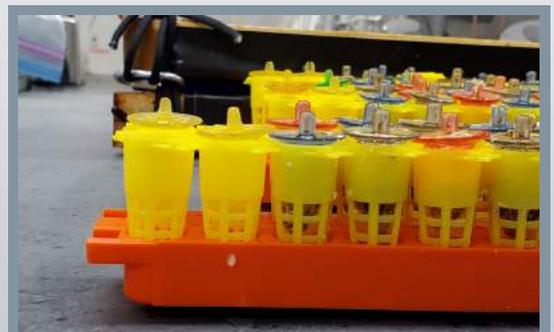


Figure 6. Dummy cells placed in empty JZs BZs cell protectors of the last two plugs (far left).

CANDY RECIPES:

Recipe 1 Higher quality and expense	Recipe 2 Lower quality and expense
12 cups dry invert sugar (Drivert®) 1 cup liquid invert sugar (Nulomoline®)	7.5 cups powdered sugar 1 cup corn syrup

Steps for both recipes:

1. Hand knead or mechanically mix dry and liquid sugar to form candy with a firm but malleable consistency.
2. If mechanically mixing candy, microwave liquid sugar for 30 seconds. Add dry sugar to a stand mixer, e.g. KitchenAid, then slowly pour warmed liquid sugar while mixing.
3. Optional: cover candy with thin coating of dry sugar and rest over night. Add more dry or liquid sugar to achieve desired consistency.
4. Optional: freeze candy for later use.



Figure 7. Two 2 oz. scoops of candy and a water feeder.

Do not make candy with honey

Do not substitute honey in the candy recipes listed above. Honey may contaminate candy with American Foulbrood spores.

CANDY PLACEMENT:

For a medium queen shipping box, place 2 oz. of candy at two outer edges of shipment to help keep the cluster evenly spaced throughout the shipment (see Figure 7). Place another 2 oz. of candy in the center of a large queen shipping box (candy in 3 places: the center and two outer edges of the box).

WATER FEEDER:

Steps for making a water feeder:

1. Add 1.2 fl oz. (35 ml) of water to a 1.7 fl oz. (50 ml) plastic centrifuge tube.
2. Push 1.5"x2" sponge into the tube opening to the point where the sponge is completely enclosed in tube. Water will wick out of the tube if parts of the sponge touch the cardboard surface of the shipping box.
3. Test for leakage by inverting tube filled with water.
4. Place water feeder in the center of shipping box with Velcro® strip of 10–15 lb. strength (see Figure 7). Hot glue the sticky side of Velcro® strips to secure them to the bottom of the shipping box.

Test Your Equipment Setup

Invert shipping box without the lid or upper insulation board to confirm that all JZs BZs equipment, candy, and water feeder parts do not move out of place. Hot glue Velcro® strips if they fail to stick to equipment pieces.



Save time on shipping day

Prepare everything except adding attendants to the shipping box before shipping day.

Items to prepare before shipping day:

- Attendants should be added to the shipping box on the shipping day but can be collected from donor colonies 1–2 days prior to shipment.
- Add queen cells, candy, and water feeder to the shipping box.
- Place assembled shipping box or JZs BZs shipping bars with queen cells inside an incubator set to 88 - 93°F to await attendants on shipping day.

ATTENDANTS:

Collect attendants from brood frames of well-fed colonies.

Steps to add attendants to shipping box:

1. Mist bees with small amount of water to reduce flight and enable easier maneuvering when weighing and transferring attendants.
2. Measure attendants by weight or volume (see Figure 8).
3. Add attendants to shipping box. Optional: measuring attendants into a tall container before adding to shipping box for easier handling.

Check queen cell coverage by attendants

The amounts listed in “Attendant quantities for shipping boxes” will allow attendants to properly cover all queen cells in the shipping box. Queen cell producers should always check attendant coverage before sealing the shipment. Add more attendants if there is partial coverage.

Attendant quantities for shipping boxes:

Large Cardboard Shipping Box	Medium Cardboard Shipping Box
24 oz. OR 6.5 cups	15 oz. OR 4 cups



Figure 8. Adding attendants directly to shipping box using a measuring cup.



Large cardboard queen shipping box with 146 cells and 24 oz. of attendants.



Medium cardboard queen shipping box with 88 cells and 15 oz. of attendants.

Do not ship queen cells to Canada

Queen shipments from the U.S. to Canada must have attendants inside queen cages instead of loose attendants inside shipping boxes for inspection at customs. Loose attendants are required for queen cell shipments thus cannot cross the Canadian border.

B. PROCESS SHIPMENT WITH COURIER SERVICES

Once the shipping box is properly prepared, queen producers must follow procedures to minimize handling and time spent with courier services.

COMMUNICATION WITH LOCAL COURIER:

Select a local courier service to ship queen cells (see table below). Choosing the courier service will depend on availability near the producer and recipient. A company pick up point may be the only option for some places. Contact the recipient-end courier service before shipping day to alert them of the incoming shipment.

Courier service facility	Overnight shipping service	Tips
FedEx Office® FedEx Ship Center®	FedEx First Overnight® FedEx Priority Overnight®	Preferred service for Hawaiian shipments. See Special shipping requirements for Hawaii (pg. 11).
UPS Customer Center® The UPS Store®	UPS Next Day Air®	Call recipient facility in advance to confirm that they allow a hold for pickup option.
USPS Post Office™	Priority Mail Express®.	May not offer overnight air shipping to desired destination. Only courier service that offers in-house insurance for animals and perishables.

SHIPPING SERVICE SELECTION:

- Select overnight air shipping service with guaranteed delivery time by 10:30 am at the latest.
- Plan the shipping day according to specific delivery location. Courier service facilities may have limited hours on weekends, and some services do not accommodate Saturday deliveries in rural areas. USPS Priority Mail Express® may not offer overnight air shipping to the desired location.
- If possible, do not deliver to a private/residential address. Request to hold the parcel at a courier service facility for the recipient. If requesting to hold at The UPS Store or company pick up point, call in advance to confirm that they allow this option.

Recipient shipping label example:

HOLD FOR PICKUP: FIRST NAME, LAST NAME
(XXX) XXX-XXXX
UPS STORE #5088
5060 SW PHILOMATH BLVD
CORVALLIS, OR 97333

COMMUNICATION WITH RECIPIENT:

Contact the recipient:

- **One week** before shipment to confirm order details and pickup location.
- **On shipping day** to provide the shipment's tracking number.
- **A few days after delivery** for feedback on shipment quality.

SHIPMENT TRANSPORT TO COURIER FACILITY:

Reducing the shipment's time on delivery vehicles will minimize risk of mishandling.

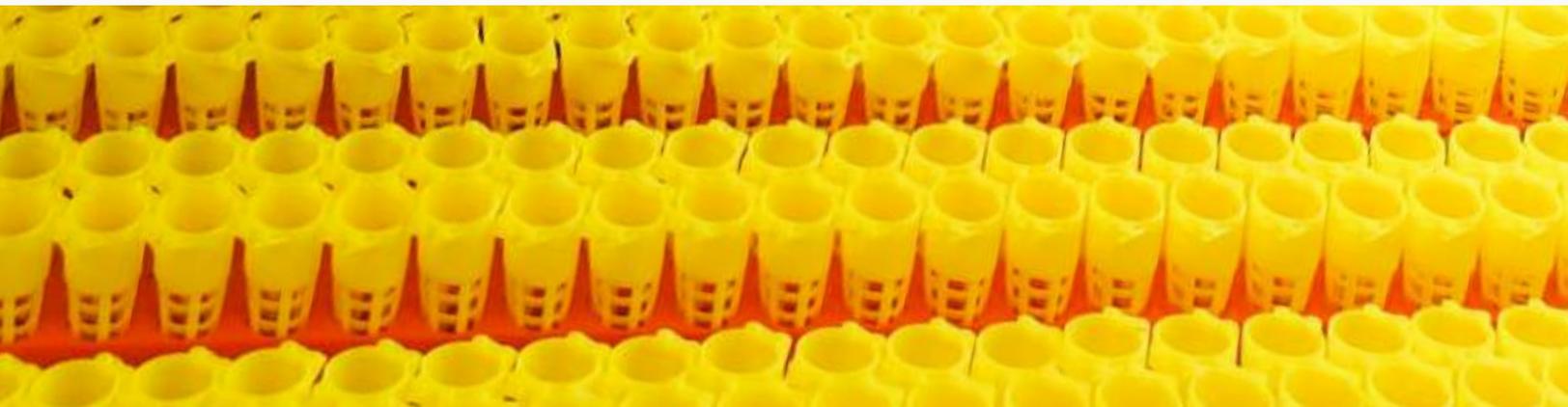
*****DO NOT DROP THE SHIPPING BOX***** (See solutions section, pgs. 15 & 16)

Ways to minimize contact with delivery vehicles:

- Hand deliver shipment to the courier service facility.
- Deliver shipment to the nearest UPS Customer Center® or FedEx Ship Center® with an airport.
- Time the shipment delivery 30 minutes prior to parcel departure from airport.
- Avoid rough, uneven roadways when traveling to the courier service facility.

Special shipping requirements for Hawaii

Queen shipments from Hawaii to the U.S. mainland can only be shipped via FedEx® overnight air shipping service to recipients on the West Coast. All other courier services and U.S. regions must use two-day shipping services when shipping from Hawaii. This extra time spent in shipment will not support the optimum queen cell age (Day 15, pg. 4). Consider shipping virgin queens to regions other than the West Coast.



HANDLING MULTIPLE SHIPPING BOXES FOR THE SAME DELIVERY:

If sending two shipping boxes for the same order, send them as one shipment to reduce shipping expenses. This can be done by stacking the shipping boxes on top of each other and taping them together with strapping tape (see Figure 9). When using shipping boxes of multiple sizes, secure the smallest box on top.



Figure 9. Two large cardboard queen shipping boxes taped together with strapping tape. The bottom rails allow airflow between the boxes (see Item L, pg. 5).



GUIDELINES FOR QUEEN CELL RECIPIENTS

Beekeepers that receive queen cell shipments must be ready to install cells into colonies immediately after delivery. They must also carefully handle queen cells during transportation and colony installation.

These instructions provide key details on:

- A. Shipment transportation**
- B. Queen cell installation**
- C. Troubleshooting**

A. SHIPMENT TRANSPORTATION

RECEIVING SHIPMENT FROM COURIER:

- Monitor the shipment for unexpected delays or abrupt changes in delivery using the assigned tracking number.
- Bring a government-issued ID and the shipment's tracking number when accepting shipment in person at the courier service facility or company pick up point.

QUEEN CELL TRANSPORTATION AFTER SHIPMENT DELIVERY:

*****DO NOT DROP THE SHIPPING BOX***** (See solutions section, pgs. 15 & 16)

- Keep cells at 91°–96°F. This is best achieved by keeping cells enclosed in the shipping box with attendants.
- If possible, keep all queen cells inside the shipping box. If transferring some queen cells from the shipping box, store transferred queen cells in a warmed insulated cooler. Always handle queen cells by the shipping bar when transferring. Keep cells upright, inside their cell protectors, and tightly packed into shipping bar.
- Avoid exposing queen cells to hot and cold temperatures. Keep them out of direct sunlight and hot surfaces (e.g., truck's dashboard). Keep queen cells inside truck cab near driver or passengers. Do not place shipment underneath truck seats.

B. QUEEN CELL INSTALLATION

COLONY PREPARATION:

Colonies should be well-fed, queenless, and large enough to adequately cluster around the brood nest and newly introduced queen cell. However, queen acceptance is higher with a smaller colony unit, such as a nuc or single-story colony.

QUEEN CELL INSTALLATION:

- Install queen cells in colonies as soon as possible.
- Do not hang queen cells on the top bars of frames. In cooler temperatures, press cell protector into wax comb near the upper edge of the cluster or brood nest (see Figure 10).
- In warm temperatures, do not place queen cells near the lid to prevent overheating.
- Check the bottom of cell protector to make sure the opening is not obstructed by comb.
- Do not revisit colony for at least 3 days.



Figure 10. Queen cell pushed into wax comb near upper portion of brood nest.

INSTALLING QUEEN CELLS IN LARGE AND/OR QUEENRIGHT COLONIES:

Queen cells can be installed in double brood chamber colonies to replace a mated queen. The success rate will be lower in these large queenright colony units than in smaller and/or queenless colony units. Previous research has shown that ~13% of colonies will be successfully requeened using this method, whereas 53% will retain their current queen, 24% will rear a new daughter queen, and a small proportion will have two queens or become queenless (Szabo 1982). Follow the instructions listed in Queen Cell Installation (above), but use these additional tips for large or queenright colonies below.

Tips to increase queen introduction success rate:

- There will be a higher success rate during a strong nectar flow rather than a dearth period.
- Consider introducing the queen cell to a nuc. Merge the nuc into a larger colony after the queen is mated and laying.
- Queen cells near brood are more likely to be accepted. Consider adding a frame of healthy, young open brood when you introduce the cell.
- If the colony is queenright, do not place the queen cell in the brood nest area. Put the cell in a honey super that is active with bees but as far from the brood nest as feasible.
- Install cells when nighttime temperatures are warm. There must be a constant presence of bees in the super with the installed queen cell. This will keep the cell warm until emergence.
- Do not use a queen excluder beneath the super with the installed queen cell.

VIRGIN QUEEN INSTALLATION

Expect a few emerged virgins upon shipment delivery. Always handle queen cells by the shipping bar. Keep cells upright, inside their cell protectors, and tightly packed into shipping bar. This will keep any virgin queens confined to their individual cell protector prior to colony installation.

Ways to prepare virgin queens for colony introduction:

- Transfer virgin queen to a queen cage with a candy plug.
- Insert a candy plug or dollop of candy into the bottom opening of cell protector.



Figure 11. An emerging queen



C. TROUBLESHOOTING

Queen cell recipients should inspect colonies 4–5 days and 14 days after cell installation. Identifying problems with queen cells will provide cell producers and recipients with useful feedback for quality control.

PROBLEMS:

Check colonies 4-5 days after cell installation

Observe remnants of queen cells inside cell protectors. Queen cells from which a queen has emerged will have a round hole in the tip (Figure 11). Dissect cells from which queen cells do not emerge to observe the appearance of dead pupae. Note the color of their eyes if they are present.

- What was the stage of pupal development of the dead queen cells? (See Figure 1, pg. 4)
- Did queens in all affected queen cells die around the same age?

Observation	Problem
Queen cell did not emerge after installation. Dissected queen pupa appears fully developed and is recognizable as a pupa.	Queen cell was agitated in shipment OR Queen cell experienced extreme temperatures during shipment.
Queen cell did not emerge after installation. Dissected queen pupa has no structural resemblance to a pupa.	Queen likely died before shipment.

Check colonies 14 days after cell installation

If eggs and young larvae are present, the new queen has successfully emerged, mated, and begun to lay.



Figure 12a and 12b. Virgin queens with wing damage that were shipped as pupae in cells. Queens can emerge with no wings (top) or malformed wings (bottom).

Observation	Problem
Older worker larvae (fourth and fifth instar) are present in colony.	The queen is not from the shipped queen cell. There may be a resident queen in colony that was not removed before queen cell installation.
No eggs or larvae are present in colony but installed queen cell has emergence opening.	The queen emerged but died after colony installation.
Virgin queen has wing damage (see Figures 12a and 12b).	Queen cell was agitated in shipment e.g., the shipment dropped from 4 ft. or collided with another package on courier's conveyor belt. OR Queen cell was younger than 15 days old on shipping day (see Figure 1, pg. 4) OR Queen cell experienced long term exposure (beyond duration of shipment) to extreme temperatures.

SOLUTIONS:

Efforts to reduce cell agitation and regulate the temperature inside the shipping box are the main solutions to the problems listed above.

Highlights

- Maximize uniform selection of 15-day queen cells.
- Increase awareness of shipment's fragility.
- Add the proper number of attendants to the shipment.
- Place temperature data loggers inside shipping boxes.
- Time shipments with mild forecasted temperatures.

Reduce cell agitation during shipment

Queens can die if agitated, such as being dropped during shipment (Smith 1962). A recent study from Oregon State University found that 12–14-day queen cells are more susceptible than 15-day cells to wing damage and death when agitated (see table below). Perfecting the process of selecting 15-day queen cells for shipment will mitigate the risk of damage by agitation. Isolating the breeder queen before grafting can minimize the time spent grafting and lead to a more uniform age of grafted larvae intended for the shipment. Identifying the proper age of larvae when grafting will also benefit the age selection process (see Optimum Queen Cell Age section, pg. 4).

Oregon State University's 2021 study results:

Average survival and wing damage of queen cells dropped from 4 feet twice while inside shipping boxes.

Queen age	Survival (%)	Wing damage (%)
Day 15	74	7
Day 14	37	23
Day 13	18	54
Day 12	0	N/A

Increase awareness of the shipment's fragility by placing green LIVE ANIMALS stickers and FRAGILE stickers on all sides of the shipping box (see Figures 13a and 13b). Gluing foam corner protectors on all outer corners of the shipping box will help absorb the impact of any collision or drop (Figure 14).



Figure 13a and 13b. "Live Animals" sticker (left) and "Fragile" sticker (right).



Figure 14. Foam corner protectors that fit on outer corners of shipping boxes.

Regulate temperature inside shipping box

Pupating queens are sensitive to temperatures outside of the brood nest's core temperature of 91.4–95°F. Even a 5°F difference from the brood nest temperature can affect queen development timing (Spivak et al. 1992). Temperatures inside shipping boxes often exceed optimal brood nest temperature during air and ground transportation (Rhodes 2011, Pettis et al. 2016, McAfee et al. 2020, Rousseau et al. 2020). **The number of attendants added to the shipping box will affect their thermoregulation ability** (Rousseau et al. 2020). See the Attendants section (pg. 9) for tips on precise measurements. Always check queen cell coverage by attendants before sealing the shipping box and add more attendants with unsatisfactory coverage (see examples on pg. 9).

Placing data loggers inside shipping boxes will provide valuable insight on internal temperatures of shipping boxes.

Attach a data logger to the center of the shipment and record temperature readings in 10–15 minute intervals (Figure 15). A recent study (McAfee et al. 2020), found that safe temperatures inside shipping boxes for **mated queens** range from 59–100°F. Ongoing work at Oregon State University found that 12–15-day **queen cells** survive 6 hours at 68°F, 6 hours at 104°F, and 18 hours at 75°F. Interestingly, zero of the queen cells in OSU's temperature-based study emerged with wing damage. **Consider timing shipments with mild forecasted temperatures to reduce the likelihood of queen death from extreme internal shipment temperatures.**



Figure 15. An Onset HOBOT Pendant® MX2201 temperature data logger attached to a JZs BZs shipping bar.



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RESOURCES

QUEEN SHIPPING BOXES

Riteway shipping boxes

Mann Lake Ltd.

800-880-7694

<https://www.mannlakeltd.com/>

C. F. Koehnen shipping boxes

*Boxes require custom shipping bar inserts (pg. 6)

C. F. Koehnen & Sons Inc.

530-891-5216

<https://www.koehnen.com/products>

JZs BZs EQUIPMENT

JZs BZs Honey Co. accepts direct order requests:

Nick Irsfeld <jzsbzs@aol.com>

866-559-0525 Toll Free

831-469-9000 Direct/Int'l

TEMPERATURE LOGGER

Onset HOBO Pendant® MX2201:

<https://www.onsetcomp.com/products/data-loggers/mx2201/>

WATER FEEDER

Centrifuge Tubes—50mL, polypropylene or polystyrene material, non-sterile, flat screw cap

https://us.vwr.com/store/category/centrifuge-tubes/574937?facet_16707177=-

<https://www.globescientific.com/15ml-50ml-general-purpose-screwcap-centrifuge-tubes.html?psku=6287N&cid=0>

SPONGES

Armaly ProPlus Contractor Grade Sponge

QEP Extra Large Multipurpose Sponge

VELCRO® STRIPS

10–15 lb. strength

3M Scotch 1 in. x 10 ft. Black Extreme Fasteners

VELCRO® 15 ft. x 2 in. Industrial Strength Tape

SPECIAL DELIVERY LABELS

Fragile: https://www.uline.com/BL_1212/Fragile-Shipping-Labels?keywords=fragile+shipping+labels

Live Animals: https://www.uline.com/BL_1226/Shipping-Labels

CONTACT US

We would appreciate any questions or feedback on the content of this guide. Your responses will impact the guide's future revisions.

WAYS TO CONTACT US:

- Send an email to Ellen Topitzhofer: topitzhe@oregonstate.edu
- Complete this anonymous survey:

