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INSECT PESTS IN WOOD PACKAGING MATERIALS

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Abstract In Europe softwood is usually used for packaging materials. Wood is an ideal material for boxes whose size is adapted to large machine parts that are to be shipped by sea. But it can be infested by wood destroying quarantine species. To exclude infestation by green wood feeding insects, the wood must be treated with heat (HT) according to ISPM 15 after trimming and before use as a wood packaging material. Evidence of infestation killed by HT treatment are tolerated in the ISPM 15 regulations. Nonetheless container freights without live infestation in the feeding tunnels or with dead larvae which are dehydrated due to the HT treatment are frequently sent back with the comment of evidence of live infestation. In various studies of containers that were returned due to evidence of infestation by wood wasp larvae, ambrosia beetles or various longhorn beetles the history of the infestation was assessed. Feeding tunnels of the larvae were dissected, and exuviae and dehydrated larvae were examined if present,. Advice is given to the quality of the wood that should be used as wood packaging material.

Key words Wood packaging material, green wood feeders, Siricidae, Ambrosia beetles, Cerambycidae

INTRODUCTION

Wood has been the most important building material for humans since ancient times and, due to its excellent physical properties, sustainability, and easy processing it plays a leading role among building materials (Grosser, 1985). Wood is also suited as packaging material for machine parts and other goods the size of which exceeds the standardized container dimensions and as a sled under goods in containers. However, as a biological raw material, wood is subject to a constant food cycle by breaking down dead trees and benefiting living plants from the nutrients they contain. Insects that are able to utilize this wood substance play an important role in nature as beneficial organisms (Grosser, 1985; Hickin, 1975). By introduction into other continents, these species can cause damage in the new environment. Wood-destroying species are classified as quarantine pests and packaging wood materials must be free from infestation. Packaging and dunnage timber is certified in accordance with ISPM 15, and timber intended for overseas transport must be marked with an appropriate stamp (USDA U.S. Customs and Border Protection 2016, IPPC, 2017).

MATERIAL AND METHODS

Nine shipments that were returned due to evidence of infestation in the wood packaging materials were examined between January 2018 and December 2019, six of them directly after arrival in the home port (Table1: No1; 3; 6-8). Samples with evidence of infestation of three rejected shipments were sent to the author for assessment (Table1: No 2; 5; 9). An expert opinion was prepared based on images of a shipment that was rejected in the United States and Panama and was in the Grand Bahama Island, (Bahamas) (Table1: No 4). In 2 cases, crate bottoms and sleds for transport of containers were inspected and released before being transported to the USA (Table1: No 10-11). Samples sent in by timber suppliers that had previously undergone HT treatment were also checked (Table1: No 12).

RESULTS AND DISCUSSION

Softwoods are generally used in Europe for construction of wooden boxes, sleds and as dunnage to stabilize the freight. In order to ensure that these woods are free from insect infestation, a heat treatment is required according to ISPM 15 in which the inside of the woods is demonstrably heated to at least 55°C over half an hour. Fumigation with methyl bromide which can also be carried out according to ISPM 15, is not allowed in Germany since 2006. Treated timbers must be marked with an appropriate stamp which includes the IPPC logo, country code, facility number and treatment type (USDA U.S. Customs and Border Protection 2016, IPPC 2017).

The operator of a sawmill sent two bars (diameter: 11.5 x 8 cm) to the author that had been infested by wood wasp larvae before the heat treatment to check the condition of the larvae. (Table: No 12). The tunnels of the wood wasp larvae (Siricidae) only reached a depth of 2.5 cm below the surface in the sapwood. The heartwood was not infested. No evidence for living infestation was found in the sapwood. Two dead larvae were found 1 to 1.5 cm below the surface of the wood in tunnels which had no connection to the wood surface. The larvae were dehydrated and had a dark gray color. The aisle walls at the sites where the larvae were found were also colored gray. The same phenomenon was also found in the sections of the tunnels where molting had taken place. The exuviae were also colored light gray. The dehydrated gray larvae are a typical indicator of a correct heat treatment.

Table 1. Inspections for infestation of wood packaging materials by green wood insects

No.	Date	Inspected goods	Evidence of pest infestation	Live specimens
1	January, 2018	2 wooden boxes on 2 flatracks	Siricidae, Scolytidae, Cerambycidae	1 wood wasp larva
2	March, 2018	Small wood samples	No infestation	-
3	July, 2018	2 wooden boxes	Siricidae, Tetropium sp.	-
4	October, 2018	(images of infestation)	Siricidae,	-
5	November, 2018	stripes of a wooden box	Cerambycidae, Siricidae	-
6	February, 2019	2 wooden boxes on 2 flatracks + 2 containers	Cerambycidae, Siricidae	-
7	March, 2019	2 wooden boxes on flatrack	Cerambycidae. Siricidae,	*Tetropium castaneum* 1 larva, 11 adults
8	March, 2019	48 sleds (16 containers)	Siricidae, Cerambycidae	-
9	October, 2019	wooden box on a flatrack	Siricidae	-
10	March, 2019	New constructions of wooden boxes	-	-
11	December, 2019	Sleds for goods in containers	Siricidae, Scolytidae (empty boreholes)	-
12	March, 2018	Assessment of wood samples after heat-treatment according ISPM 15	Siricidae	-

Living infestation in rejected shipments was identified twice. A piece of wood was found on a flatrack with evidence of infestation by wood wasps (Siricidae), which could be assigned to a longitudinal beam of the box and was apparently abetted by the US authorities during the inspection of the boxes (Table1: No. 7). Further signs of infestation were ambrosia beetles and a longhorn beetle, but no evidence of living individuals. During close examination of the wood sample 2 exuviae and a living wood wasp larva were found in the tunnels. The longitudinal beams of another box (Table: No. 7) had typical signs of the longhorn beetle *Tetropium castaneum* , such as oval tunnels, large wood chips and hook-like pupal chambers. Wood samples taken for further investigation contained living adult beetles, one living larva and several dehydrated and light gray colored larvae. A dehydrated larva of the ambrosia beetle *Hylecoetus dermestoides* (Linnaeus 1761) (Lymexylonidae) was found in this wood sample. Since the boxes in both cases were stamped according to ISPM 15, it could be assumed that the heat treatment had not been carried out properly.

In 6 further investigations, tunnels with bore dust from wood wasp larvae were found (Table: No 3; 5; 6; 8; 9). However, no live infestation was detected. In some cases, u-shaped tunnels led into the beam and came out again at another point nearby. This indicates that the larvae had already left the wood before the heat treatment. Crate bottoms and sleds were inspected before loading onto flatracks or in containers (Table: No. 10; 11). The crate bottoms were free of bore holes and other signs of infestation. Some of the boards and beams of the sleds had to be replaced due to slight damage from wood wasps or ambrosia beetles. After the release both shipments passed customs in the port.

The wood moisture of felled and processed woods has a great influence on the infestation by green wood insects (physiological pests). Wood wasps, Ambrosia beetles (Scolytidae, Platypodidae and Lymexylidae) and some species of Cerambycidae, such as *Tetropium* spp., belong to the green wood insects and occur as physiological pests on weakened trees and as technical pests of stored green logs (Grosser, 1985, Hickin ,1975; Scheiding et al., 2015), The oviposition takes place both on standing trunks and on felled trunks, which lay for a longer time in the forest. Green logs with bark which are stored can likewise be attacked if they still have a high water content in their cell lumen.

Freshly felled (green) logs have a moisture content above the fiber saturation range, which is between 50 and 180%, depending on the type of wood and the sapwood and heartwood content. The cell lumen and intercellular spaces are at least partially filled with water and the cell walls are maximally saturated with water. During the drying phase, the water content in the cell lumen first decreases until a fiber saturation range of 22 to 35% is reached. With the subsequent removal of water in the cell walls, the wood moisture is reduced to 15 to 7% depending on the storage conditions. Larvae of wood wasps and some Cerambycid species are able to finalize their development in dry wood while extending their life (Grosser, 1985,; Binker et al., 2014; Kempe, 2009). A new infestation of seasoned wood by these insects does not occur. The infestation by these "green wood" insects takes place before drying, debarking and trimming the woods and a re-infestation by these species after heat treatment is unlikely (Binker et al., 2014; Grosser, 1985). Longitudinal cut feeding tunnels at the surface of trimmed wood specimens indicated that the oviposition took place before the processing of the timber and thus before the heat treatment. The physiological condition of the wood after trimming in the sawmill followed by heat treatment are also contradicting to attack by these green wood pests after processing.

CONCLUSION

The identification of wood wasp larvae by morphological signs is hardly possible and DNA barcodes are only available for a few species (Eichhorn, 1982; Schmidt et al., 2017). The development stages of the common longhorn beetles and ambrosia beetles can be identified by barcoding. However, the list of 8 most important pests of concern which are associated with wood packaging materials from the USDA contains the insect families Buprestidae, Cerambycidae, Cossidae, Curculionidae, Platypodidae, Scolytinae, Sesiidae and Siricidae without further limitations. Infestation of heat-treated wood can be excluded at least by the green wood feeders of the mentioned insects families (USDA U.S. Customs and Border Protection 2016, IPPC, 2017). Removing the bark is another important step to meet the quarantine regulations. Debarking is an industrial process in which most of the bark of the harvested tree is removed from the wood. But it does not necessarily result in wood which is bark free. The standard allows less than 3 cm bark in width regardless of the length or individual pieces of bark which do not exceed 50 square centimeters and do therefore not allow green wood feeders to lay eggs or develop below the bark.

Heat-treatment of debarked and trimmed timbers is a suitable method to get wood that is free from living infestation. However, the traces of a previous but killed infestation, that occurred during the storage of the barked trunks in the forest or on the wood storage area, remain visible and can easily lead to the return of the whole shipment, as shown in some examples. It is therefore advisable to use only wood as packaging material for international shipping that, in addition to the heat treatment, has no signs of old infestation by wood boring insects. According to the strict quarantine regulations in different arrival ports, instructions of the ISPM 15 regulations have to be followed and wood packaging materials, dunnage and have to be marked with appropriate stamps.

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