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REAL TIME INTERNET INVASIVE PEST IDENTIFICATION TRAINING: A CASE STUDY WITH *RHYNCHOPHORUS* WEEVILS[§]

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ABSTRACT

Early detection of potentially invasive pests is critical to avert significant economic and environmental damage that may result from their successful introduction and establishment in the U.S. Recent advances in affordable USB (universal serial bus) compliant digital microscope cameras and internet platforms for disseminating information in real time have created the potential for enhanced training for insect pest identification. Using the palm weevil genus *Rhynchophorus* as a test group, we conducted real time training demonstrations which suggested that remote identification training is possible with the U.S. government internet-based portal “FoodShield” which employs Adobe Connect software, along with an open conference call line to reduce audio feedback. A training module was developed employing easy to use keys with photographs of diagnostic characters for species of *Rhynchophorus* that were distributed with an observation kit (containing image capture software, a digital microscope, a stand, and a specimen holder) to remote participants along with numbered but unidentified voucher specimens of *R. cruentatus*, *R. palmarum* and *R. ferrugineus* prior to the training evaluations. The screen-sharing features of the portal allowed each test participant to project back images of diagnostic features of their unknowns for confirmation that they were correctly identifying their voucher specimens.

Key Words: insect identification, invasion prevention, palm weevils

RESUMEN

La detección temprana de plagas potencialmente invasoras es fundamental para evitar daños económicos y ambientales significativos que puedan resultar de su exitosa introducción y establecimiento en los EE.UU. Los recientes avances en las cámaras digitales para microscopios y las plataformas de Internet para la difusión de información en tiempo real que son compatibles con las unidades de USB han creado el potencial para mejorar en entrenamiento en la identificación de plagas de insectos. Utilizando el picudo del género *Rhynchophorus* como un grupo de prueba, realizamos demostraciones de entrenamiento en tiempo real lo que sugiere que el entrenamiento de identificación a distancia es posible basado en un portal de la Internet del gobierno de EE.UU “FoodShield”, que utiliza el software de Adobe Connect, junto con una línea de llamada de conferencia abierta a reducir el “feedback” (retroalimentación) del audio. Un módulo de capacitación fue desarrollado utilizando claves fáciles de usar con fotografías de los caracteres diagnósticos de las especies de *Rhynchophorus* que fueron distribuidos con un equipo de observación (con el software de captura de imágenes, un microscopio digital, un soporte y un soporte de la muestra) a los participantes a distancia junto con especímenes con números codificados, pero no identificados de *R. cruentatus*, *R. palmarum* y *R. ferrugineus* antes de las evaluaciones de la capacitación. Las características de la pantalla compartida del portal permiten a cada participante de la prueba a proyectar y

enviar los imágenes de nuevo de las características diagnósticas de sus especímenes desconocidas para confirmación de que estaban identificando correctamente.

Palabras Clave: identificación de los insectos, prevención de la invasión, gorgojos de palma

Invasive pest management begins with the recognition that a non-native organism has arrived in a previously unoccupied area. It usually requires a certain level of taxonomic expertise and is then followed up with confirmation by an expert. Unfortunately, this approach is often time inefficient and not executed until major host symptoms or crop damage is noted. By this time, an invasive pest may have become established or spread significantly, increasing the cost to eradicate, suppress, or manage it. Ultimately, this lag time in pest detection and identification can cost millions of dollars in management efforts, as well as crop losses and damage to the ecosystem.

The proximity of the Caribbean Island nations to the U.S. puts it at risk to the entry of pests of regulatory significance that have gained a foothold in this region. The limited taxonomic expertise available within the safeguarding system in the Caribbean countries allows invasive pests to go undetected until they are causing significant damage and threaten to spread to U.S. shores. This suggests the need for increased expertise and capacity to identify a greater variety of plant pests.

Recent advances in affordable USB (Universal Serial Bus) compliant digital microscope cameras for standard computer connectivity and internet platforms for disseminating information in real time have created the potential for enhanced training for insect pest identification. We evaluated a system to help train personnel to rapidly detect pests of regulatory significance before they become established and begin to spread and cause damage in other areas. Several front line surveyors and identifiers in the U.S. and in the Greater Caribbean Basin were trained on how to recognize invasive pests and thereby improve early pest detection programs. The project focused on identification of palm weevils (*Rhynchophorus* spp.) that are economically important palm pests established in the Caribbean (*R. ferrugineus* [Olivier] in Curacao and Antigua [Fiaboe et al. 2011; Roda et al. 2011]) and were recently collected in Southern California, Arizona or Texas (Giblin-Davis et al. 2013). Palm weevils pose an imminent threat to the continental U.S. and may be introduced either inadvertently with imported products, through tourism, or by natural movement.

Equipment, Kit and System Parameters

We procured and evaluated digital microscope camera equipment including the Dino-Lite

AM413T, AM413, AM4113TL-M40, and AM-7023 and AM-4023 Dino-Eye digital eyepiece cameras (<http://www.dino-lite.com/> and http://www.mohawkmedicalmall.com/dinolite-handheld-digital-microscope/?gclid=CKy_4cPPr7cCFQ317AodpisAajg) (the last 2 of which required the use of a dissecting scope and external light source). We preliminarily concluded that the most versatile, inexpensive and easy to use system was the AM4113TL-M40 because of the long working distance and relatively uniform lighting provided by the in-line LED light bank. Because our first training efforts focused on a hand held model, we procured and evaluated several table-top vertical microscope stands to steady the viewing and decided upon the Dino-lite model MS-35B easy-to-assemble microscope stand (<http://www.dino-lite.com/>). We also procured and evaluated several options for ease of specimen manipulations and decided upon the Dino-lite model MS16C versatile multi-positioning specimen holder (<http://www.dino-lite.com/>). After receiving evaluations from our first few internet test sessions, we also ordered and tested a Bio-Quip cork specimen holder (<http://www.bioquip.com/>) and a Dino-lite MS-34B microscope stand (<http://www.dino-lite.com/>). The limited focal distance of the MS-34B relegated it to close-up work only.

We developed a pictorially-aided adult key of the 5 most important and potentially-invasive species of *Rhynchophorus* in the world based upon previous work (Wattanpongsiri 1966; Thomas 2006; Giblin-Davis et al. 2013) that was delivered along with each digital microscope and specimen positioning holder for reference material during training exercises. Each kit was also provisioned with a box of 6 numbered and randomly arrayed adult *Rhynchophorus* specimens in a small transport box (one of each sex of each of 3 species; *R. ferrugineus*, *R. palmarum* [L.], and *R. cruentatus* [Fabricius]) that were labeled with unique voucher numbers, but otherwise not identified. We also developed simple instructions for each kit for installation of the computer software, digital microscope, and assembly of the microscope stand and specimen manipulator to aid in the internet-based training modules for palm weevils. Following early user evaluations, we also developed a pictorial compendium of key characters to further aid identification of the unidentified weevils that were provided in each kit (Figs. 1 and 2, which are also shown in color as Suppl. Figs. 1 and 2 in the supplementary document online at <http://purl.fcla.edu/fcla/entomologist/browse>).

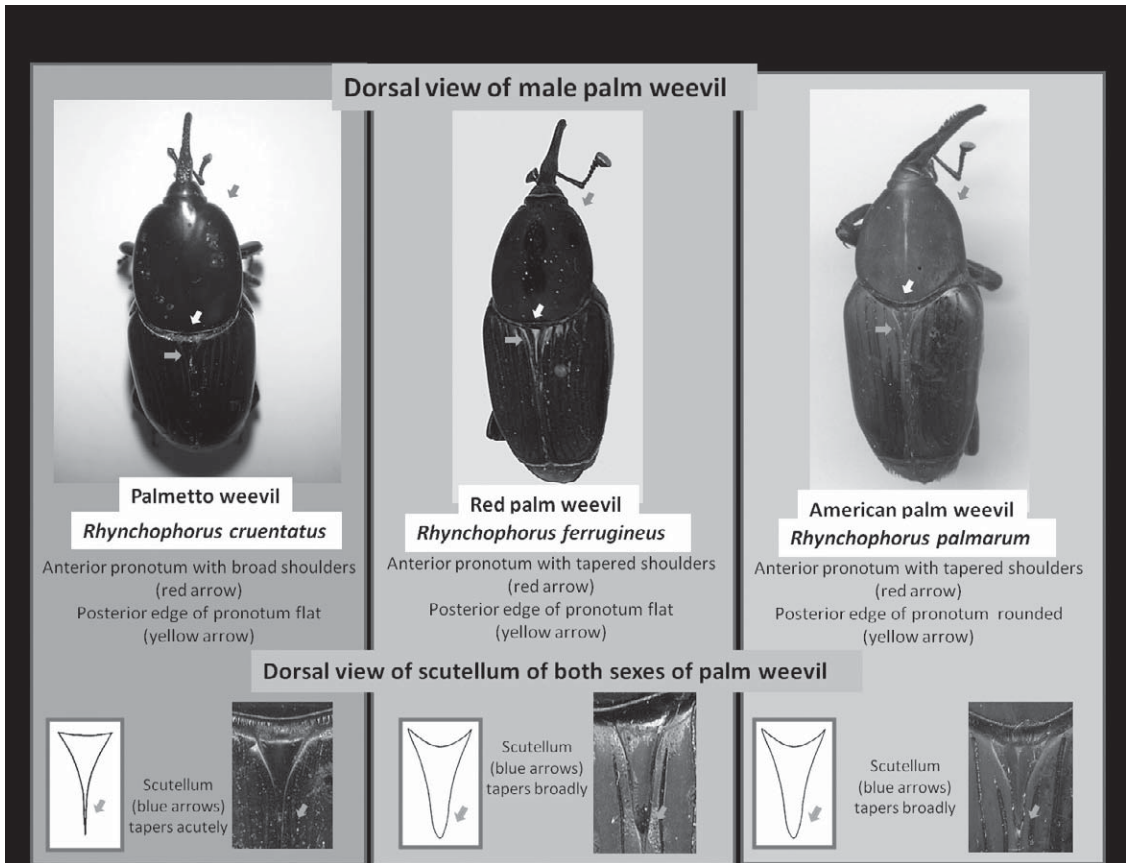


Fig. 1. Compendium diagram for identifying 3 species of *Rhynchophorus* that could be found in the Caribbean and were included as unknowns in the demonstration kit showing the dorsum of the male and scutellum of both sexes. This figure is shown in color as Suppl. Fig. 1 in the supplementary document in Florida Entomologist 96(3) (2013) online at <http://purl.fcla.edu/fcla/entomologist/browse>

We conducted 3 major pilot tests of the FoodShield (Adobe Acrobat Connect Pro) internet interface coupled with a conference call line for improved audio (reduction of feedback when a participant microphone is left open) both locally and remotely over different distances (see details below). Because of the initial success with this system, we continued to use it for all but 2 of the trainings, where we used the UF-IT Adobe connect URL when Dr. Roda was not available. We continued our training trials with training package improvements based upon written and verbal evaluations received from most of the trainees (an evaluation form was included in each kit for each training).

Case Study: Correctly Identifying Three *Rhynchophorus* Species in Real Time on the Internet

The final training session was performed on 19 September 2012 from 10 AM-1 PM through FoodShield and a USDA-APHIS conference call

with Dr. Roda USDA-APHIS @ Chapman Field, Miami, FL as the lead Adobe Connect facilitator and Dr. Robin Giblin-Davis at UF-FLREC as the trainer. Trainees were: 1) Paula Morales, Agricultural Scientist, USDA-APHIS-IS, U.S. Embassy, Santo Domingo, Dominican Republic; 2) Patricia Abad, CA Area Director (for Marco Gonzalez Vargas, Agricultural Scientist), USDA-APHIS-IS, U.S. Embassy, San Jose, Costa Rica; 3) Lionel Wayne De Chi, Agricultural Scientist, USDA-APHIS-IS, U.S. Embassy, Port of Spain, Trinidad; and 4) Dr. Cesar Sandoval, DVM, Ph.D., Agricultural Scientist, USDA-APHIS-IS, U.S. Embassy, Panama City, Panama. Improved kits were sent out to all participants via FedEx at least 2 weeks before the scheduled session. There were a few minor problems with computer privileges on LAN (local area network) systems for loading the Dino-Lite 2.0 software (<http://www.dino-lite.com/>) which were overcome with local IT support/permissions. The training lasted over 3 hours, but all reports were very positive for eventual mas-

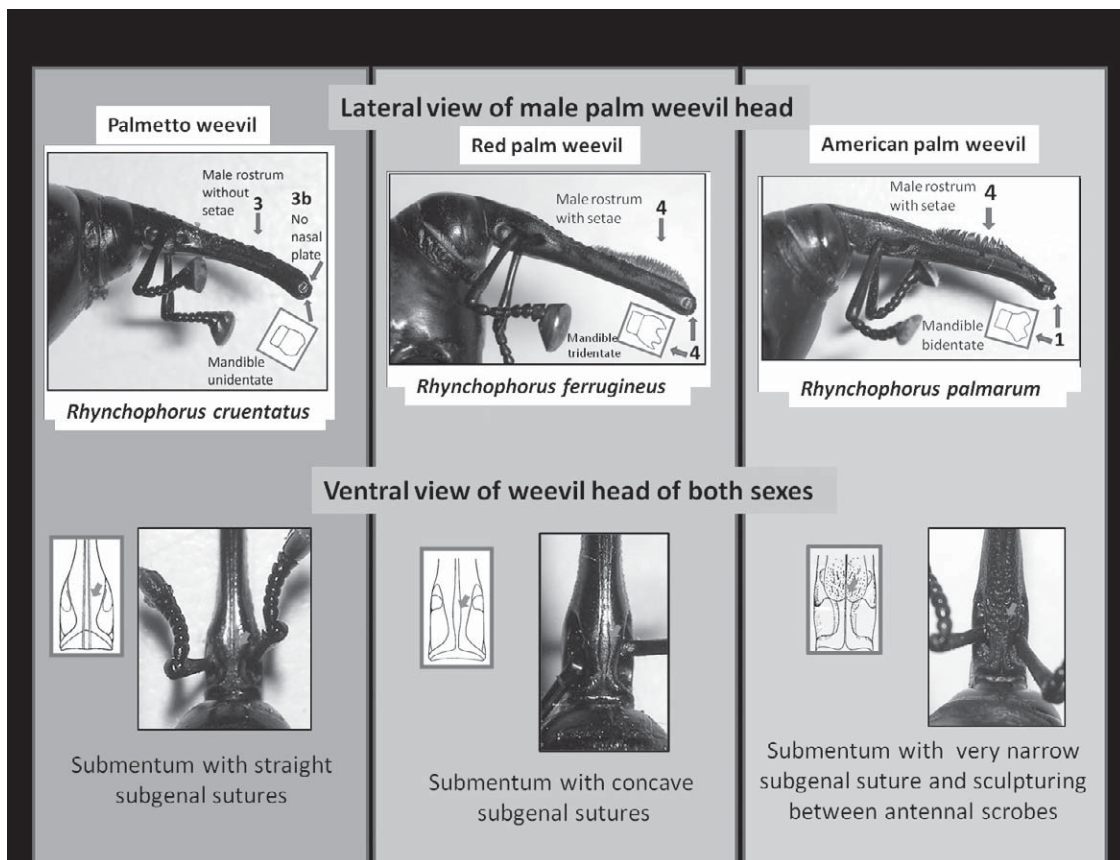


Fig. 2. Compendium diagram for identifying 3 species of *Rhynchophorus* that could be found in the Caribbean and were included as unknowns in the demonstration kit showing the lateral and ventral view of the head of both sexes. This figure is shown in color as Suppl. Fig. 2 in the supplementary document in Florida Entomologist 96(3) (2013) online at <http://purl.fcla.edu/fcla/entomologist/browse>

tery over the basics of identifying the unknown weevils and for being able to find and share key morphological features with all participants using the provided specimens and equipment over Adobe connect through the FoodShield interface in concert with the conference call. Half of the participants received the AD4013TL [US\$ 489] which goes up to 92X and the other half received the cheaper [US\$ 449] AM4013TL-M40 which goes up to 37X (with an additional LED lighting source). There were no complaints about the magnification limits of the cameras and all students were able to focus on key characters of their own specimens for rebroadcast when asked to do so, but there were a few complaints on the difficulty and time of refocusing after changing magnification with these "hand held digital microscopic" cameras. The general consensus was that it would be easiest and less expensive to use the cheaper eyepiece camera ([US\$ 289] 1.3 MP AM-4023), if each site had access to a reasonably good dissecting scope and good external lighting that could

be moved close to the computer for USB access to the camera installed through a trinocular head or through one of the eye-pieces. However, in situations where no dissecting scope was available, the AD4013TL with the focusing base was judged to be an acceptable option. Because this system will probably be used for insects and other organisms requiring greater magnification than the large *Rhynchophorus* weevils used in these training evaluations, the AD-4013-TL was chosen over the AM4013TL-M40, even though it was more expensive. Another suggestion involved making sure that everyone had taken the time to familiarize him or herself with the system and attempted to identify the unknown weevils in the kits before the session started to help expedite the sessions.

CONCLUSIONS AND RECOMMENDATIONS

The immediate goal of this project was to see if currently available digital microscopes and internet interfaces were sufficient for identifica-

tion training for a large pestiferous insect to address gaps in taxonomic expertise for rapid recognition and subsequent real time discussions. It appears that this goal was met. It is possible to connect relatively naïve first line responders with an expert through the internet using relatively inexpensive digital microscopes (there are currently many additional brands that may work as well or better than the equipment used here). The major challenge was to provide clear and simple kits with good instruction materials. A compendium appeared to be preferable over a dichotomous key and the students appreciated the time working through a sample group of unidentified insects with other students online with the encouraging support and help of an expert. The ultimate goal of this project was to help establish the technical framework that would efficiently and economically train surveyors and identifiers of other invasive pests that continuously enter the region. It appears that this goal can also be met, but will require the sustained support and orchestration of training sessions and development of training materials by taxonomic experts.

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