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Source: Florida Entomologist, 87(2) : 237-240

Published By: Florida Entomological Society

URL: https://doi.org/10.1653/0015-4040(2004)087[0237:EAPCSA]2.0.CO;2

EUMICROTA AND *PHANEROTA* (COLEOPTERA: STAPHYLINIDAE: ALEOCHARINAE) ATTACKING CULTIVATED MUSHROOMS IN FLORIDA

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Most Staphylinidae, as adults and larvae, are predators or facultative predators. However, minorities feed only on plant materials including fungi. Among these minorities is the subtribe Gyrophaenina, which contains only fungivores. It belongs to the tribe Homalotini and subfamily Aleocharinae. Six genera of Gyrophaenina (Ashe 2001) occur in America north of Mexico, of which three (*Eumicrota* Casey, *Gyrophaena* Mannerheim, and *Phanerota* Casey) occur in Florida. Four species of *Eumicrota*, two of *Gyrophaena*, and five of *Phanerota* (Frank 1986) are known in Florida, although it is possible that some species are yet unreported.

Seevers (1951), despite using an out-of-date classification, gives the only recent keys to North American *Eumicrota* and *Gyrophaena* adults, including the species known in Florida. A checklist of Florida Staphylinidae (Frank 1986) includes mention of a new species description in *Phanerota* and key to adults of Florida species of that genus by Ashe (1986a).

There are thus 11 known species of Gyrophaenina in 3 genera in Florida. Adults of all species are small, ranging from 0.6 mm up to about 2 mm in length. Adults and larvae feed by grazing on spores, basidia, cystidea, and hyphae from the hymenium layer of fruiting-bodies (mushrooms). Their food range is limited to the Polyporaceae and several families of gilled mushrooms. Among the various species groups of *Gyrophaena*, Ashe (1984) detected some level of specialization to fungal hosts. However, earlier fungal identification is in doubt because most beetle collectors do not have such skills. The mushrooms of North America are described and illustrated by McKnight & McKnight (1987), but even expert mycologists encounter mushrooms in Florida that they find difficult to identify to the species level, in part because some are yet undescribed (K. H. McKnight, pers. comm.). No comparative study about the habits of species of Gyrophaenina occurring in Florida has been written. The subject would make a good research project for a graduate student interested in these beetles and in mycology.

Gyrophaenine staphylinids are not the only staphylinid beetles, and far from the only beetles, that feed on mushrooms. Some Staphylinidae attracted to mushrooms prey on other small insects. An entire book was published on beetles and mushrooms observed in the vicinity of Vienna, Austria (Scheerpeltz & Höfler 1948). A book with adequate worldwide treatment of beetles and mushrooms is still far in the future because so much is unknown.

Fruiting-bodies of gilled mushrooms provide an ephemeral habitat in nature, and are unpredictable in time and space. Fruiting-bodies of polypore mushrooms are less ephemeral. The physical and chemical characteristics of mushrooms are diverse. Gyrophaenines eat only fresh mushrooms, not those in decomposition. Constraints on the adult beetles are that they must be able to detect ephemeral fresh mushrooms efficiently, despite the varied physical form and chemical characteristics of the mushrooms. The eggs and larvae must develop rapidly before decomposition of the mushrooms occurs. Pupation occurs in a silken cocoon in the soil. The adults are potentially much longer-lived, and they are winged and can fly. It is the larvae that must eat intensively and rapidly in order to complete development quickly (Ashe 1984).

In March 2003, an organic grower of mushrooms in Lee County, Florida, noted an infestation of small insects on oyster mushrooms (*Pleurotus ostreatus* [Jacq.] Quélet, Tricholomataceae) grown indoors. Collected specimens were placed in alcohol for subsequent identification. Based on keys by Ashe (1986a) and Seevers (1951), these were identified as two *Eumicrota socia* (Erichson), four *Phanerota cubensis* Casey, one *P. fasciata* (Say), and an unidentified larva. More specimens were collected on 29 April, and these included four *E. socia*, ten *P. cubensis*, 36 *P. fasciata*, and six unidentified larvae.

Eumicrota socia was described from the Carolinas in 1840. In 1906 it was described under four new names in various states of the USA, and in 1920 it was described from northern Florida under yet another new name (Seevers 1951). We assume that this is a Florida native species in which minor intraspecific variability and lack of an adequate series of specimens confused early writers of descriptions, who failed to examine long series of specimens for intraspecific variability, and failed to dissect specimens and examine the microscopic sexual characters. Adults of *Eumicrota* exhibit a subsocial behavior in guarding eggs in an egg chamber (Ashe 1987), and the larva of one North American species was described by Ashe (1986b).

Phanerota cubensis, as the name implies, was originally described from specimens collected in Cuba, published in 1906. Ashe (1986a) reported it in localities from Dade and Monroe counties in

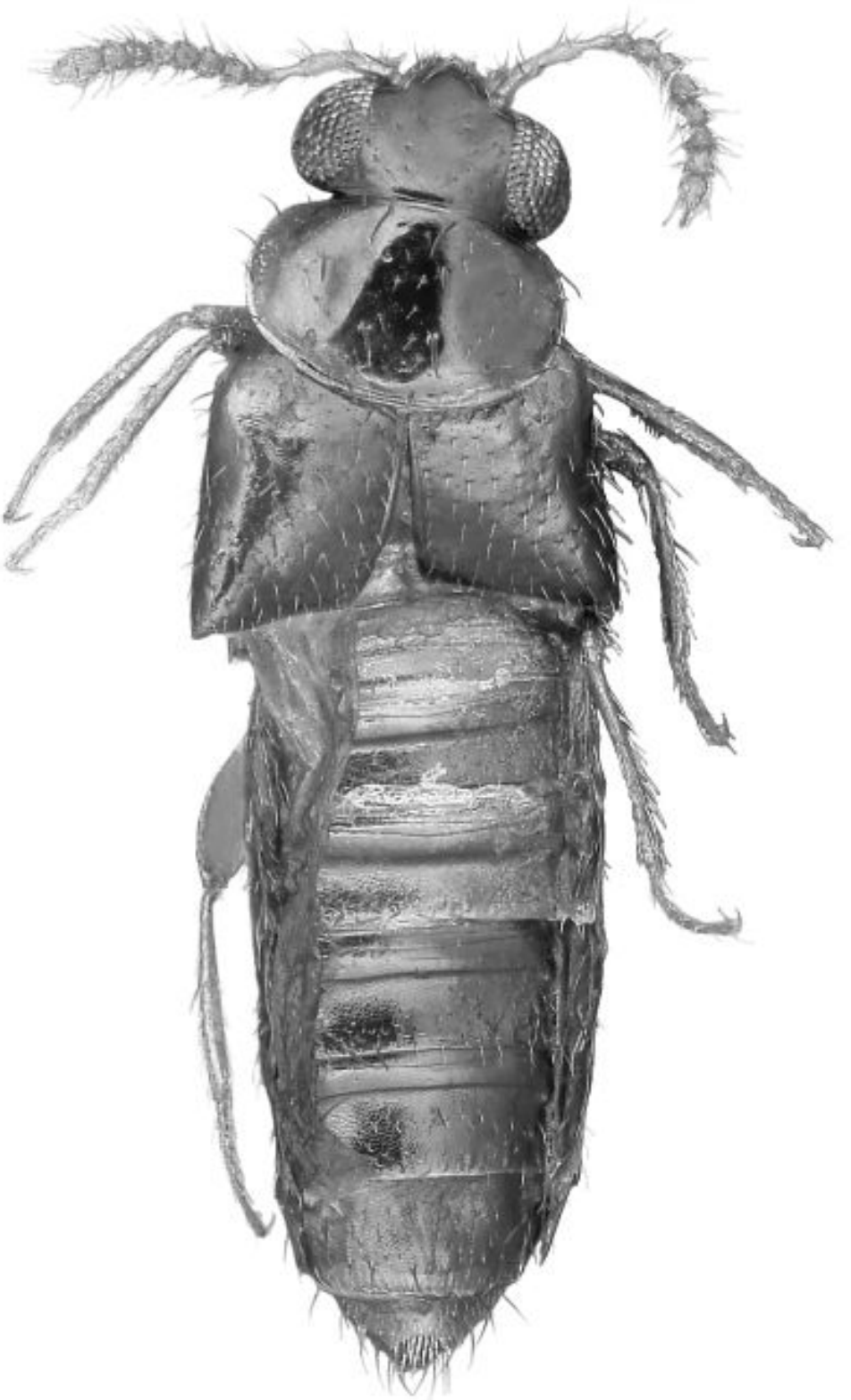

Fig. 1. Habitus photograph of adult *Phanerota fasciata*. The mark on the pronotum is a shadow, not an indentation.

Florida. We think it was not reported earlier from Florida simply because nobody looked extensively in mushrooms for tiny staphylinids in the extreme south of Florida until the 1970s, and nobody bothered to identify specimens of this species until the 1980s. We do not know how it got to Cuba from Florida or vice versa, but wind-assisted flight is the simplest explanation.

Phanerota fasciata (Fig. 1) was described in 1834 based upon specimens collected in Pennsylvania. The type specimens of other nominal species later declared to be synonyms of *P. fasciata* were collected in Florida, New York, and Texas; also, the species was found to be widespread in the eastern USA, as far west as Kansas and Texas (Seevers 1951). The larva of *P. fasciata* was described by Ashe (1986b).

None of these three species has previously been reported from Lee County, probably due to inadequate knowledge of these little beetles in Florida. The grower's question was about how to eliminate the insects from the mushroom culture. A search of the computerized literature (post-1970) revealed only one publication on an infestation of such beetles anywhere in the world. That publication (Shivaramu et al. 1993) revealed only an identification of *Gyrophaena nilambura* Cameron, which, along with non-staphylinid beetles, was found in mushroom cultures in India, but gave no indication about growing conditions, the extent of the problem, or control methods. It should be noted that *G. nilambura* does not occur in North America and is just one of well over 100 species of Gyrophaenina recorded from "British India including Ceylon and Burma" (Cameron 1939). This makes it highly improbable that *G. nilambura* is the only species that causes or may cause problems in the countries now called India, Bangladesh, Pakistan, Sri Lanka, and Myanmar.

Because the mushrooms in Lee County were grown indoors, it should have been fairly easy to control the infestation. The building is approximately 3.66 × 6.10 m (12 × 20 ft) and of concrete block construction, and its windows had USA-standard ("16 × 18 mesh") window screening, whose openings are ≈1.5 mm, thus larger than the maximal width (≤1 mm) of any of the tiny adult beetles; they could not fly in with wings extended, but they could alight on the screen and crawl in. Of course the little adult beetles would have been attracted to the cultures, which provided a permanent source of mushrooms (as contrasted with ephemeral and unpredictable sources in nature), and they would have entered the building by any means possible. We recommended (a) temporary elimination of all mushroom cultures from the building, (b) vacuum-cleaning of all deposits likely to house adult beetles, (c) a temporary trap in the building, to be constructed of mushrooms in a net bag suspended over a large pan of soapy water, to trap flying adults, (d) fitting of the windows with screen of very fine mesh, and fitting the entrance with double screen doors, (e) if employee time were sufficient, frequent inspection of the grounds for "wild" mushrooms and their hand-picking to eliminate local populations, and (f) compostion of rejected cultivated mushrooms as well as any hand-collected from the property, in plastic bags outdoors in the sun (because solar heat and the heat generated within the bags should kill any of these insects). We were later told that fitting of the windows with screen of finer mesh caused other kinds of problems; we presume this was a result of reduction of airflow. We recommend, that in future construction of such buildings, the window area should be greatly increased, and windows should be fitted with screen of very fine mesh in order to block entry of these beetles yet maintain an adequate airflow. The ideal design needs further study.

We acknowledge reviews of the manuscript of this note by Ronald D. Cave (Univ. Florida, Ft. Pierce, FL) and Michael C. Thomas (Florida State Collection of Arthropods, Gainesville, FL). Dr. Kent H. McKnight was, until his retirement, a mycologist at the USDA Beltsville Agricultural Research Center, Maryland. David Almquist (formerly a student in the Entomology & Nematology Dept., Univ. Florida, Gainesville, FL) kindly prepared the habitus photograph (Fig. 1). This is University of Florida, Agricultural Experiment Station, Journal Series No. R-09738.

Summary

We report what may be the first recorded infestation of cultivated mushrooms in North America by gyrophaenine Staphylinidae. The infested mushrooms were *Pleurotus ostreatus* (Jacq.) Quélet (Tricholomataceae), called "oyster mushrooms", and were grown organically indoors. The infesting beetles were *Eumicrota socia* (Erichson), *Phanerota cubensis* Casey, and *Phanerota fasciata* (Say); they are part of Florida's native "wildlife", and they normally eat uncultivated wild mushrooms and cause no problem.

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