Supplementary material 3

To:

Bernardo, U. [1], E. J. van Nieukerken, R. Sasso, M. Gebiola, L. Gualtieri, S. Vicidomini & G. Viggiani, 2014. Characterization, distribution, biology and impact on Italian walnut orchards of the invasive North-American leafminer *Coptodisca lucifluella* (Lepidoptera: Heliozelidae). - Bulletin of Entomological research xx: . Doi:

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Taxonomic Information

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1. Checklist of genus *Coptodisca* and hostplants, with Type localities (TL)

Coptodisca Walsingham, 1895: 41 [replacement name of *Aspidisca*]

= *Aspidisca* Clemens, 1859: 87, type species *Aspidisca splendoriferella* Clemens, 1859: 87 [junior homonym]

arbutiella Busck, 1904: 769

Ericaceae: *Arbutus menziesii*, *Arctostaphylos andersonii*

TL: USA, Washington: Seattle

cercocarpella Braun, 1925: 218

Rosaceae: *Cercocarpus ledifolius, C. montanus*

TL: USA, Utah: Logan

condaliae Busck, 1900: 242

Rhamnaceae: *Krugiodendron ferreum*

TL: USA, Florida: Palm Beach

diospyriella (Chambers, 1874b): 217 (*Aspidisca*)

Ebenaceae: *Diospyros virginiana*, *texana*

TL: USA, Kentucky: Edmondson County, "Bee Spring Camp"

juglandiella (Chambers, 1874a): 151 (*Aspidisca*)

Juglandaceae: *Juglans nigra*

TL: USA, Kentucky: Covington

kalmiella Dietz, 1921: 44

Ericaceae: *Kalmia angustifolia*

TL: USA, New Jersey: Browns Mills

lucifluella (Clemens, 1860): 209 (*Aspidisca*)

Juglandaceae: *Carya, Juglans*

TL: USA, Pennsylvania: Easton

= *ella* (Chambers, 1871): 224 (*Aspidisca*)

TL: USA, Kentucky: Covington

magnella Braun, 1916: 138

Ericaceae: *Gaylussacia baccata*

TL: USA, Ohio: Lancaster

matheri Lafontaine, 1974: 126
Ericaceae: *Vaccinium arboreum*
TL: USA, Mississippi: Jackson
negligens Braun, 1920: 79
Ericaceae: *Vaccinium macrocarpon*
TL: USA, Ohio: Cranberry Island, Buckeye Lake.
ostryaefoliella (Clemens, 1861): 82 (*Aspidisca*)
Betulaceae: *Ostrya virginiana*
TL: USA, Pennsylvania: Easton
powellella Opler, 1971 : 194
Fagaceae: *Quercus agrifolia*, *suber*, *wislizeni*
TL: USA, California: San Diego County, Descanso Ranger Station
quercicolella Braun, 1927: 192
Fagaceae: *Quercus*
TL: USA, Arizona: Cornville
rhizophorae Walsingham, 1897: 143
Rhizophoraceae: *Rhizophora mangle*
TL: Virgin Islands: St. Thomas
ribesella Braun, 1925: 217
Grossulariaceae: *Ribes cereum*
TL: USA, Utah: Logan Canyon
saliciella (Clemens, 1861): 82 (*Aspidisca*)
Salicaceae: *Salix lasiolepis*
TL: USA, Pennsylvania: Easton
splendoriferella (Clemens, 1859): 87 (*Aspidisca*)
Rosaceae: *Prunus*, *Crataegus*, *Malus*, *Pyrus*
TL: USA, Pennsylvania: Easton
= *pruniella* (Clemens, 1861): 82 (*Aspidisca*)
TL: USA, Pennsylvania: Easton
= *saccatella* (Packard, 1889): 355, pl. 8:18 (*Lyonetia*)
TL: USA, Pennsylvania: Easton
sp. *Amelanchier* [sp. 1]
Rosaceae: *Amelanchier utahensis*
[possibly = *cercocarpella*]
sp *Carya* Georgia [sp. 2]
Juglandaceae: *Carya*
sp *Juglans* California
Juglandaceae: *Juglans californica*
sp *Juglans* Texas
Juglandaceae: *Juglans microcarpa*
sp *Populus* [sp. 3]
Salicaceae: *Populus fremonti*, *tremuloides*

Lectotype selection of *Coptodisca lucifluella*

Coptodisca lucifluella was described (as *Aspidisca lucifluella*, Clemens 1860) from an unspecified number of specimens, reared from larvae in leafmines found on hickory (*Carya* sp.).

Citation from Clemens (1860):

"The larva may be found in September and October mining the leaves of hickories. …… Early October the larva cuts out an oval disk an enters the pupal state, to appear as an imago early in June."

Clemens did not provide locality data, but he collected around his hometown Easton (Pennsylvania), which is therefore the type locality.

Authors in the 19th's century rarely selected types, but Clemens donated his collection with his "types" to the Academy of Natural Sciences in Philadelphia. Historical details can be read in Busck (1903). Busck also reported on page 204 that there are two types of *Aspidisca lucifluella*, one perfect, but not spread, the other damaged. The specimens were labelled with Clemens' number 114. At the moment one specimen in the Clemens collection is labelled "Holotype", probably the first mentioned specimen. On the minuten pin there is small label with the number "114", most likely Clemens' original label. The other labels have been added later by successive curators (see Fig. 1). Since the original description did not contain a holotype selection, and did not specify the number of types, all types have to be regarded as Syntypes (ICZN art. 72), even though labelled "Holotype". We select here the female specimen labelled Holotype as lectotype (following ICZN art. 74.6).

The external features of the lectotype agree with most other North American specimens reared from *Carya* (except the specimen here named sp *Carya* Georgia). On the basis of this diagnostic character and the hostplant we consider the type conspecific with these other North American specimens and thus with the invading Italian species.

We decided not to dissect the genitalia. Reasons for this are:

1. The identity is sufficiently established on the basis of externals and hostplant;
2. The unmounted state of the very small specimen, making breaking off the abdomen a risky procedure;
3. The fact that as yet no diagnostic features of female genitalia for the genus *Coptodisca* are known and the difficult procedure preparing these fragile genitalia;
4. By keeping the specimen intact, in a future taxonomic revision hopefully new techniques can be used to study genitalia and to analyse the DNA from this old specimen.

Fig. 1 Lectotype *Aspidisca lucifluella* Clemens, 1860

Remarks on other Juglandaceae feeding *Coptodisca* species

See also additional photographs of adults and leafmines at end of this document and the detailed specimen data in Supplementary Material 1.

Coptodisca juglandiella

Diagnosis
Coptodisca juglandiella can easily be distinguished from *C. lucifluella* by the complete absence of the dark suffusion of the forewing basally of the triangular spot: this is a narrow yellow band, from costa to dorsum. Posteriorly of the spot there is usually a small area with darker suffusion.

Biology
Host: *Juglans nigra*. Leafmine: similar to that of *C. lucifluella*, but always starting at a lateral vein or midrib (see Photos below).

Distribution:
Eastern North America: North Carolina, Kentucky, Ohio, Illinois, Pennsylvania, New York. Records from California refer to the next species.

Coptodisca sp *Juglans* California

Diagnosis
This unnamed species is externally very similar to *Coptodisca juglandiella*. It is considered to be an undescribed species on the basis of the isolation of *Juglans* in California, that harbours quite a different fauna from the *Juglans* in the Eastern States. This still needs to be corroborated by detailed morphological study and DNA barcoding.

Biology
Host: *Juglans californica*. Leafmine: no description available.

Distribution:
California only [material from collections Essig Museum and D.L. Wagner].

Coptodisca sp *Juglans* Texas

Diagnosis
This unnamed species is very small and also lacks the dark suffusion before the dorsal spot. The species occurs in isolated stands of *Juglans* and most likely represents an undescribed species, that needs to be studied in more detail.

Biology
Host: *Juglans microcarpa*. Leafmine: no description available.

Distribution:
Texas, Guadelupe Mountains [material from collection D.L. Wagner].

Coptodisca sp *Carya* Georgia

Diagnosis
Externally the adult resembles *C. lucifluella*, although the dark suffusion seems less before the dorsal spot. However, the DNA barcode and different mines suggest it is a different species. More material is needed for a final judgement on its status.

Biology
Host: *Carya* sp. Leafmine: In contrast to *C. lucifluella*, the mine always starts at the midrib, all in the edge with a lateral vein (see photos).

Distribution:
Georgia, only collected in the Chattahoochee National Forest [material in collection Naturalis].

References

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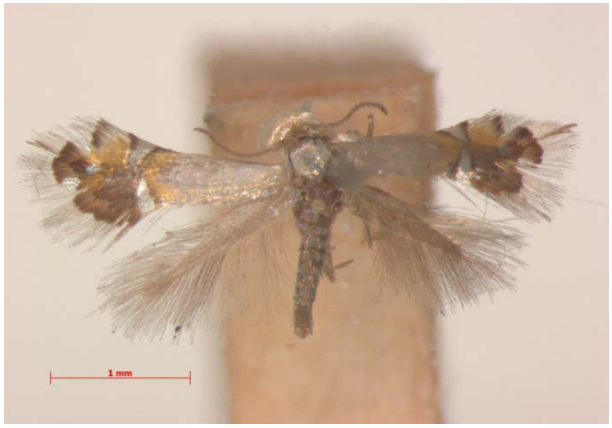
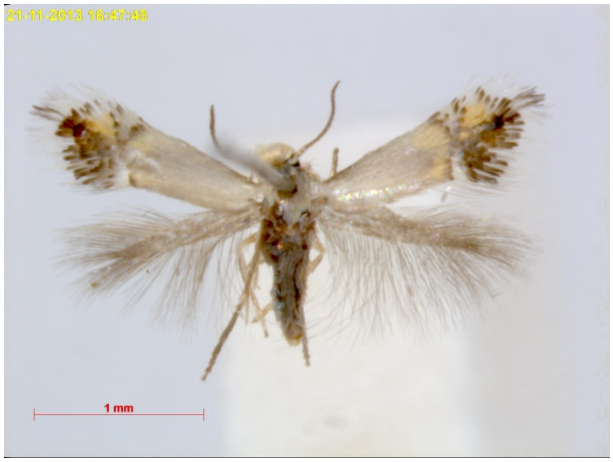
Photos of *Coptodisca* adults.

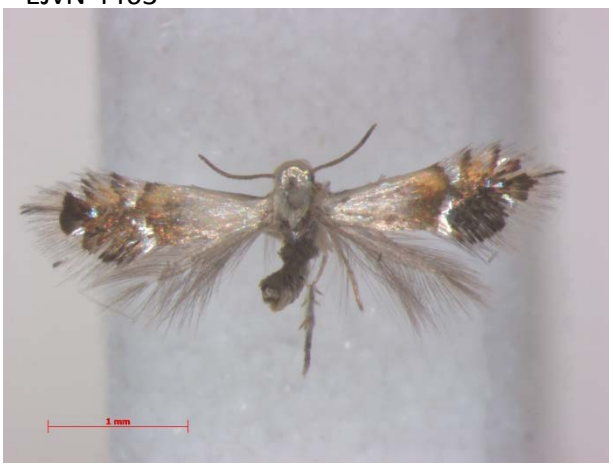


Coptodisca juglandiella male OH, Cincinnati, Coll. Braun

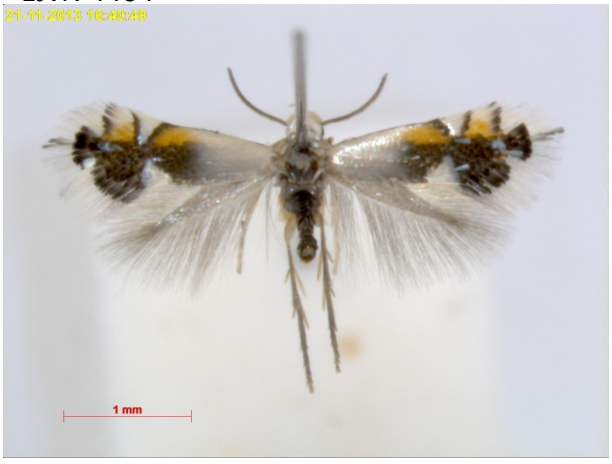
Coptodisca sp. *Juglans californica* male, CA, Costa Co. Coll. Wagner. Genitalia slide EJvN 4463



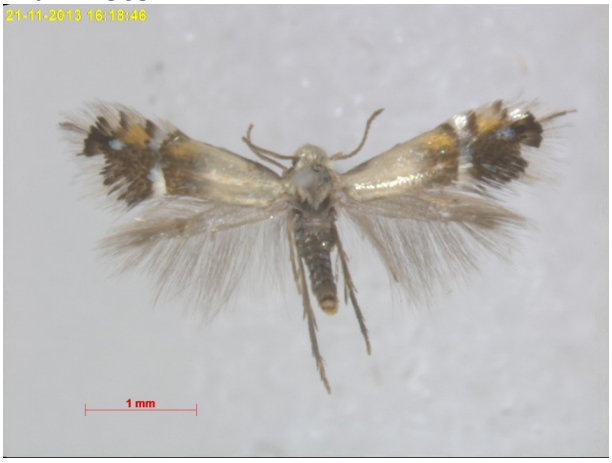
Coptodisca sp. *Juglans* Texas male. TX, Culberson Co. Coll. Wagner. Genitalia Slide EJvN 4464



Coptodisca sp. *Carya* Georgia male. GA: Murray Co. Coll. RMNH. Genitalia Slide EJvN 4369



Coptodisca lucifluella male. Italy, Negrar Coll. RMNH. Genitalia Slide EJvN 4462

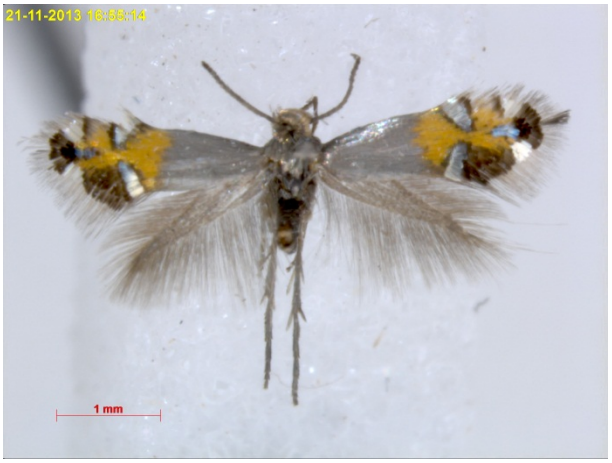


Coptodisca lucifluella male. MD, Montgomery Co. Coll. USNM Genitalia Slide EJvN 4458

Coptodisca lucifluella male. TX, Harris Co. Coll. Wagner. Genitalia Slide EJvN 4459

Coptodisca lucifluella male. GA, Tift Co. Coll. USNM. Genitalia Slide EJvN 4460

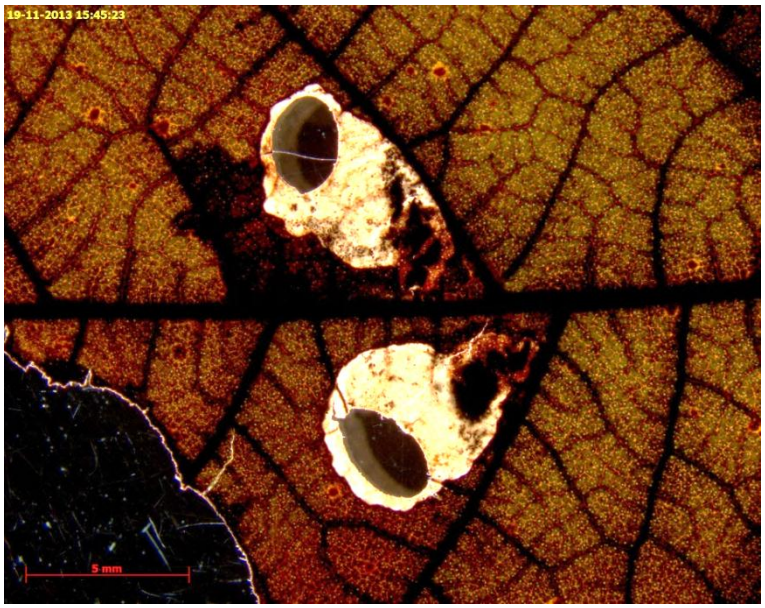
Coptodisca lucifluella female. NY, St. Lawrence Co. Coll. Wagner. Genitalia Slide EJvN 4461

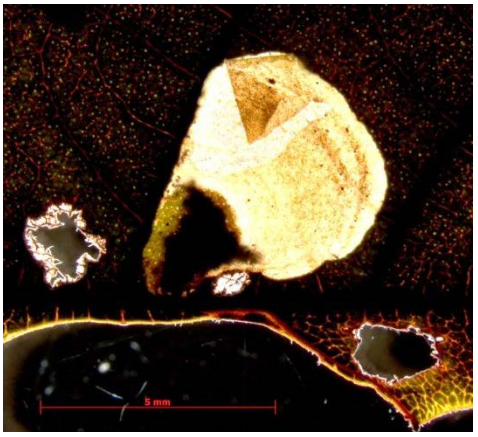


Coptodisca arbutiella male. Canada, BC, West Vancouver. Coll. RMNH. Genitalia Slide EJvN 4466

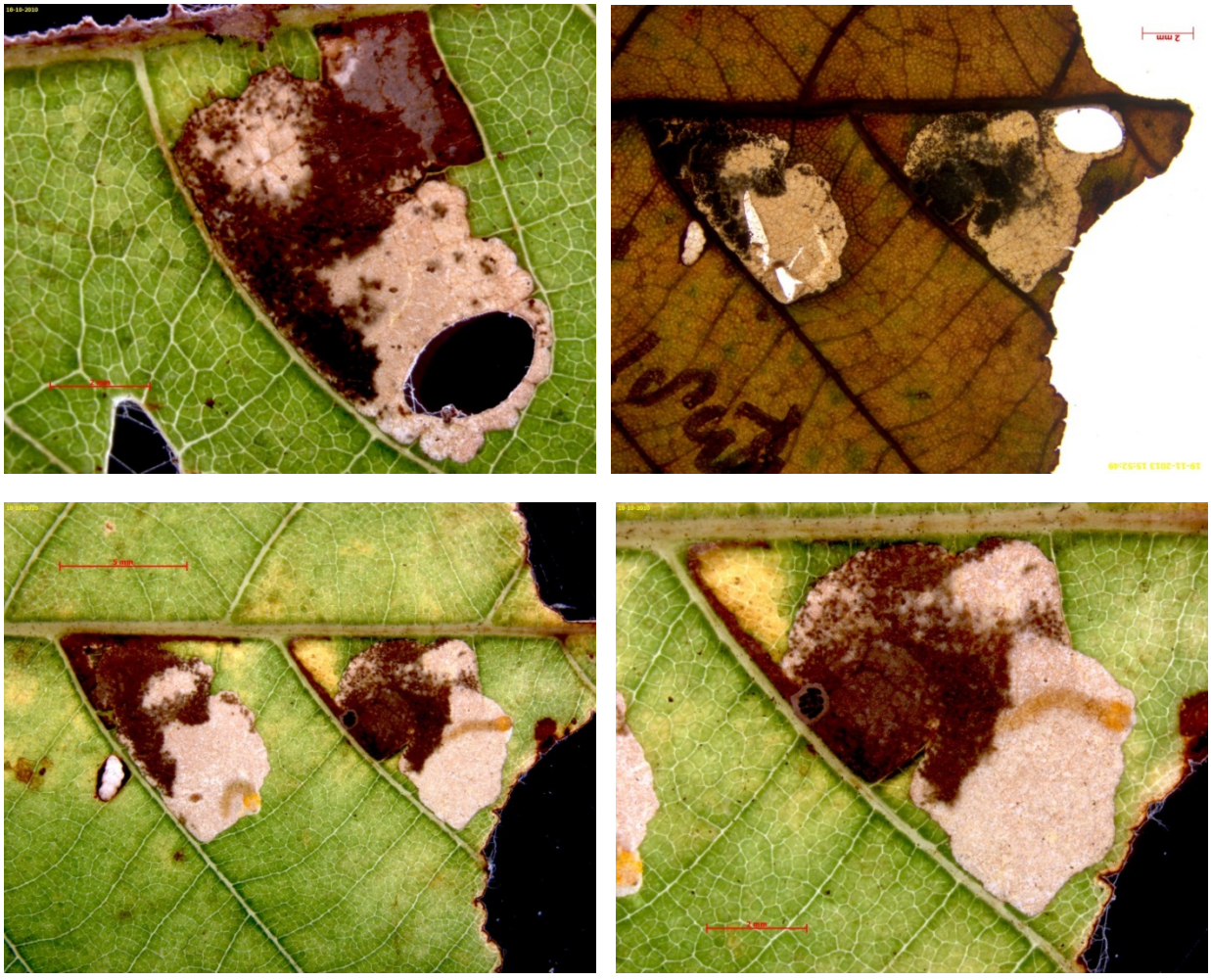
Coptodisca kalmiella males. VT, Franklin Co. Coll. RMNH. Genitalia Slide EJvN 4467

Coptodisca splendoriferella female. CT, Tolland Co., DLW89G7. Coll. RMNH





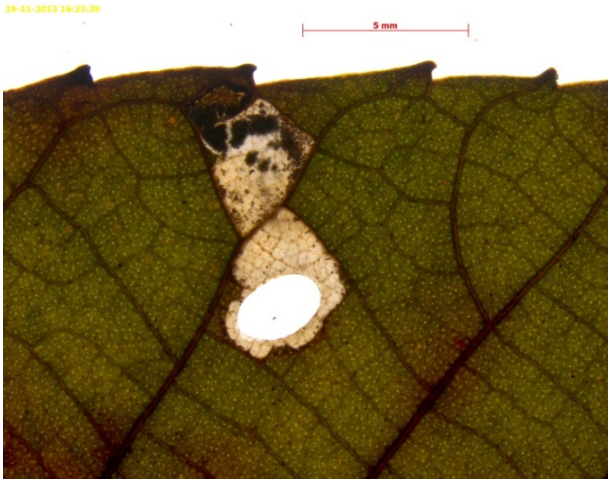
Coptodisca juglandiella
USA (NC), Swain Co., NP Great Smoky Mts, Smokemound Campground. 29.ix.2010, Evn2010094-1. *Juglans nigra* (top right: sequenced, no RMNH.INS.18240)

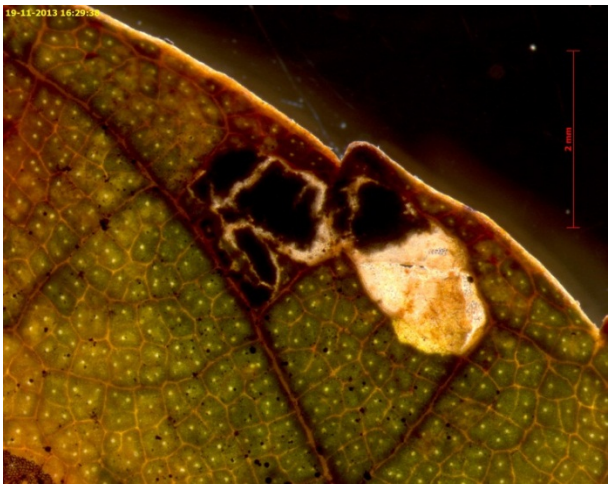


Coptodisca "Carya Georgia*"*
USA (GA), Murray Co., Chattahoochee Nat. Forest, Cohutta Overlook. 14.x.2010, EvN2010273-2 .

Below with live larvae, top right dried mines (left larva sequenced), same as photos below.

Coptodisca lucifluella
USA (TN), Blount Co., NP Great Smoky Mts, Cades Cove N.. 1.x.2010, *Carya alba*
EvN 2010102-4 RMNH.INS. 18264 (left and below)





Coptodisca lucifluella
USA (TN), Blount Co., NP Great Smoky Mts, Cades Cove N. 1.x.2010, *Carya glabra*
EvN 2010107-3 RMNH.INS. 18269 (left)

Coptodisca lucifluella
USA (CT), Tolland Co, Mansfield, Hunters Run 22, 21.ix.2011, *Carya glabra*
EvN 2010306