## **ZOOTAXA**

**2101** 

Taxonomic revision and biogeography of the *Tamarix*-feeding *Diorhabda elongata* (Brullé, 1832) species group (Coleoptera: Chrysomelidae: Galerucinae: Galerucini) and analysis of their potential in biological control of Tamarisk

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(Zootaxa 2101)

152 pp.; 30 cm.

11 May 2009

ISBN 978-1-86977-359-5 (paperback)

ISBN 978-1-86977-360-1 (Online edition)

FIRST PUBLISHED IN 2009 BY

Magnolia Press

P.O. Box 41-383

Auckland 1346

New Zealand

e-mail: zootaxa@mapress.com

http://www.mapress.com/zootaxa/

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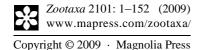
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ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)





# Taxonomic revision and biogeography of the *Tamarix*-feeding *Diorhabda elongata* (Brullé, 1832) species group (Coleoptera: Chrysomelidae: Galerucinae: Galerucini) and analysis of their potential in biological control of Tamarisk

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#### **Dedication**

This work is dedicated to Culver Jack DeLoach, Jr., our long time friend and mentor in weed biological control research who has inspired us with his dedication and energy for bringing the natural marvel of insect biological control of invasive plants into the process of native ecosystem restoration, especially in his last two decades of research and implementation in the use of *Diorhabda* as tamarisk biological control agents in North America.

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#### **Abstract**

The primarily Palearctic Diorhabda elongata species group is established for five Tamarix-feeding sibling species (tamarisk beetles): D. elongata (Brullé, 1832), D. carinata (Faldermann, 1837), D. sublineata (Lucas, 1849) REVISED STATUS, D. carinulata (Desbrochers, 1870), and D. meridionalis Berti & Rapilly, 1973 NEW STATUS. Diorhabda koltzei ab. basicornis Laboissière, 1935 and D. e. deserticola Chen, 1961 are synonymized under D. carinulata NEW SYNONYMY. Illustrated keys utilize genitalia, including male endophallic sclerites and female vaginal palpi and internal sternite VIII. Distribution, comparative biogeography, biology, and potential in biological control of *Tamarix* in North America are reviewed. Diorhabda elongata is circummediterranean, favoring Mediterranean and temperate forests of Italy to western Turkey. Diorhabda carinata resides in warm temperate grasslands, deserts, and forests of southern Ukraine south to Iraq and east to western China. Diorhabda sublineata occupies Mediterranean woodlands from France to North Africa and subtropical deserts east to Iraq. Diorhabda carinulata primarily inhabits cold temperate deserts of Mongolia and China west to Russia and south to montane grasslands and warm deserts in southern Iran. Diorhabda meridionalis primarily occupies maritime subtropical deserts of southern Pakistan and Iran to Syria. Northern climatypes of D. carinulata are effective in Tamarix biological control, especially in the Great Basin desert. Diorhabda elongata is probably best suited to Mediterranean woodlands of northern California. Northern climatypes of D. carinata may be best suited for central U.S. grasslands. Diorhabda sublineata, D. meridionalis, and southern climatypes of D. carinata and D. carinulata may each be uniquely suited to areas of the southwestern U.S.

**Key words:** *Diorhabda elongata* species group; Chrysomelidae; Taxonomy; Comparative Biogeography; Biology; Host Range; *Tamarix*; Tamarisk; Saltcedar; Weed Biological Control; Sibling Species; Hybrid Morphology; Morphometry; Genitalic Phenogram; Biomic Dendrogram; Habitat Suitability Index Models

#### Резюме

Видовая группа Diorhabda elongata основана для пяти палеарктических, питающихся на Tamarix, видовдвойников (тамарисковые жуки): D. elongata (Brulle, 1832), D. carinata (Faldermann, 1837), D. sublineata (Lucas, 1849) REVISED STATUS, D. carinulata (Desbrochers, 1836) и D. meridionalis Berti & Rapilly, 1973 NEW STATUS. Diorhabda koltzei ab. basicornis Laboissiere, 1935 и D. e. deserticola Chen, 1961 синонимизированы с D. carinulata NEW SYNOMYMY. Иллюстрированный определитель использует гениталии, включая мужской эндофалус, женские вагинальные пальпы и внутренний стернит VIII. Рассмотрено распространение, сравнительная биогеография, биология и возможности использования для биологического контроля *Tamarix* в Северной Америке. Diorhabda elongata является циркум-средиземноморским видом, предпочитаю щим средиземноморские и умеренные леса Италии до западной Турции. Diorhabda carinata обитает в теплых умеренных остепненных биотопах, пустынях и лесах южной Украины и далее на юг до Ирана и восток до Западного Китая. Diorhabda sublineata обитает в лесах Средиземноморья от Франции до Северной Африки и субтропических пустынях на восток до Ирака. Diorhabda carinulata в основном населяет холодные н умеренные пустыни Монголии и Китая и далее на запад до России и на юг до горных степей и теплых пустынь южного Ирана. Diorhabda meridionalis населяет приморские субтропические пустыни южного Пакистана и Ирана до Сирии. Северный климатип D. carinulata является эффективным агентом биологического контроля Tamarix, особенно в пустынях Большого Бассейна. Diorhabda elongata, вероятно, наиболее подходит для контроля Tamarix в средиземноморских лесах Северной Калифорнии. Северный климатип D. carinata может быть наиболее подходящим для травянистых биоценозов центральной части США. Diorhabda sublineata, D. meridionalis, южный климатип D. carinata и D. carinulata могут быть подходящими для различных мест юго-запада США.

#### Introduction

*Tamarix*-feeding leaf beetles in the genus *Diorhabda* Weise (1883), or tamarisk beetles, are probably the most damaging specialized defoliators of Old World tamarisks (Kulinich 1962; Sinadsky 1968; Tomov 1979; Samedov and Mirzoeva 1985; Tian *et al.* 1988; Bao 1989; Sha and Yibulayin 1993; Myartseva 1999; Mityaev and Jashenko 1999, 2007; DeLoach *et al.* 2003b). Consequently, tamarisk beetles are valued as current and