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**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**

JAMES L. TRACY & THOMAS O. ROBBINS



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# 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*, видов-двойников (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 SYNONYMY. Иллюстрированный определитель использует гениталии, включая мужской эндофаллус, женские вагинальные пальпы и внутренний стернит VIII. Рассмотрено распространение, сравнительная биogeография, биология и возможности использования для биологического контроля *Tamarix* в Северной Америке. *Diorhabda elongata* является циркум-средиземноморским видом, предпочитающим 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 и 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