

A geometric morphometric study on populations of the Rice Stem Borer, *Chilo suppressalis* Walker (Lepidoptera: Crambidae) in northern Iran

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Abstract. Multivariate analysis of the morphological variation in six populations of the Rice Stem Borer, *Chilo suppressalis*, was performed using 15 and 10 landmarks selected from the fore- and hindwings respectively. The raw planar coordinate data were aligned using geometric and mathematical calculations in Kendall's shape space. Multivariate analysis was performed following transfer of the data to a linear Euclidean space, i.e. tangent space. 311 and 319 images of fore- and hindwings respectively were made using their geometric morphometric characters (26 in the forewings and 16 characters in the hindwings). The analysis showed a significant difference between the sexes and between the populations of Guilan and Mazandran provinces. A direct correlation was observed between morphological and geographic distance.

Kurzfassung. Die morphologische Variation innerhalb von sechs Populationen des Reisstengelbohrers, *Chilo suppressalis*, wurde mit Hilfe der multivarianten statistischen Analyse untersucht. Dazu wurden 15 Landmark-Punkte vom Vorder- und 10 Punkte vom Hinterflügel ausgewählt. Die Rohkoordinaten wurden mit Hilfe von geometrischen und mathematischen Berechnungen aufeinander angepasst. Die Daten wurden vor der multivarianten Analyse in einen linearen euklidischen Raum (Tangentenraum) überführt. Für die Analyse standen 311 Bilder von Vorder- und 319 Bilder von Hinterflügeln mit ihren geometrisch-morphologischen Parametern zur Verfügung (26 Parameter am Vorder- und 16 am Hinterflügel). Die Analyse brachte signifikante Unterschiede zwischen den Geschlechtern und zwischen den Populationen in Guilan und Mazandran zu Tage. Die morphologische Distanz ist direkt mit der geographischen Entfernung zwischen den einzelnen Populationen korreliert.

Key words. Geometric morphometrics, thin plate-spline, *Chilo suppressalis*, populations.

Introduction

The Rice Stem Borer (RSB), *Chilo suppressalis* Walker, is a key pest on rice that was first reported in Iran in the main rice-growing area of northern Iran (Tonekabon) (EBERT 1972). This pest is primarily controlled by the use chemicals that indirectly cause water pollution in the rivers that terminate in the Caspian Sea, causing environmental damage in the region. Observations on the pest behaviour show intraspecific variation in the damage to rice in different geographic locations. It is expected that the recognition of intraspecific variation, its nature and scope, may aid our understanding of the pest and allow us to predict the spatial and temporal occurrence of its problems, to devise effective management strategies, and to characterise RSB population responses to control measures. The purpose of this study is to estimate the relative importance of genetic and environmental (host plant) effects on the morphological characters of RSB in Iran.

Recent developments in landmark analysis of shape change using thin plate-spline (TPS)