Dynastid white grubs as rainfed rice pests or agrosystem engineers in Madagascar

A. Ratnadass, R. Randriamanantsoa, M.Y. Rabearisoa, T.E. Rajaonera, E. Rafamatanantsoa, C. Isautier
URP/SCRiD, BP 230, Antsirabe 110, Madagascar
E-mail: ratnadass@cirad.fr

Introduction :

In Vakinankaratra (Central Highlands of Madagascar), white grubs and black beetles (Coleoptera: Scarabaeidae) are pests of rainfed rice. Direct seeding, Mulch-based, Cropping Systems (DMCSs)(Séguy et al., 2006) reduce erosion and loss of fertility of hill slope soils. In these Highlands, DMCS management reduced attacks by these pests, but in the medium-elevation region around Lake Alaotra, they heavily damaged rice cropped on mulch (Ratnadass et al., 2005).
These discrepant results can partly be ascribed to differences in the entomofauna spectrum (Ratnadass et al., 2006). More direct effects may involve soil quality, causing the phytophagous larvae to move from rhizophagy to saprophagy, as reported for Latin America (Brown and Oliveira, 2004).
The objective of the study was to determine the status of soil-dwelling Dynastid beetles, and its potential variation with agrosystem management.

Material and Methods :

Damage to rice by Dynastid larvae was observed in 30 cm X 25 cm X 2.5 cm parallelipeds made of sheets of glass, filled with ferrallitic soils from plots conducted under continuous tillage for seven years at the Andranomanelatra and Ibity TAFA research stations (resp. 15 km north, and 20 km south of Antsirabe) (Ratnadass et al., 2005). There were three treatments per soil type:
- 1.2 kg of plain soil
- 1 kg of soil added/thoroughly mixed with 100 g of ground rice stems
- 1 kg of soil added/ thoroughly mixed with 100 g of dried cow dung

Organic carbon and nitrogen contents of these soil mixtures, as measured at the FOFIFA Soil Laboratory (Antananarivo) are given in Fig. 1. All mixtures were oven sterilized for 72 h at 60°C before use.

Parallelipedic microcosms were divided in two compartments by a wall made of strong cardboard. Two rice plants (cv FOFIFA 161) were transplanted at one end of each compartment and watered daily. Studies were conducted on field-collected larvae (L3 instar) from several spots around Antsirabe :
- *Hexodon unicolor unicolor* in March 2006 (4 reps of 6 compartments)
- *Heteroconus paradoxus* in May-June 2006 (4 reps of 6 compartments)
- *Heteronychus* spp (*H. arator rugifrons*, *H. bituberculatus* and *H. plebejus*) in May-June 2006 (4 reps of 6 compartments)

One week after rice transplantation, one white grub was placed under the soil surface, at the end of each compartment opposite to rice plants, and damage to rice plants was recorded one week later.

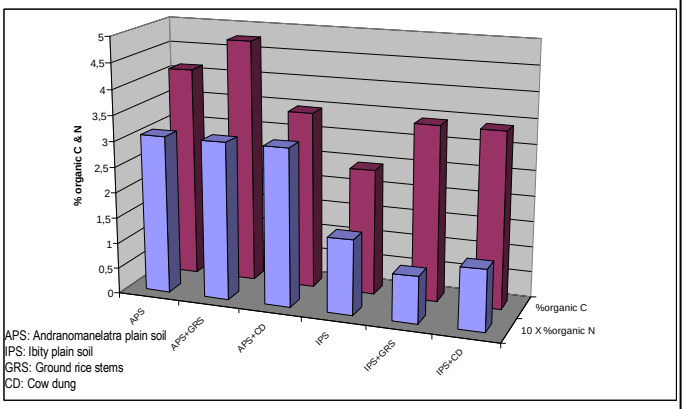

Fig.1. Organic matter characteristics of the various soil mixtures used

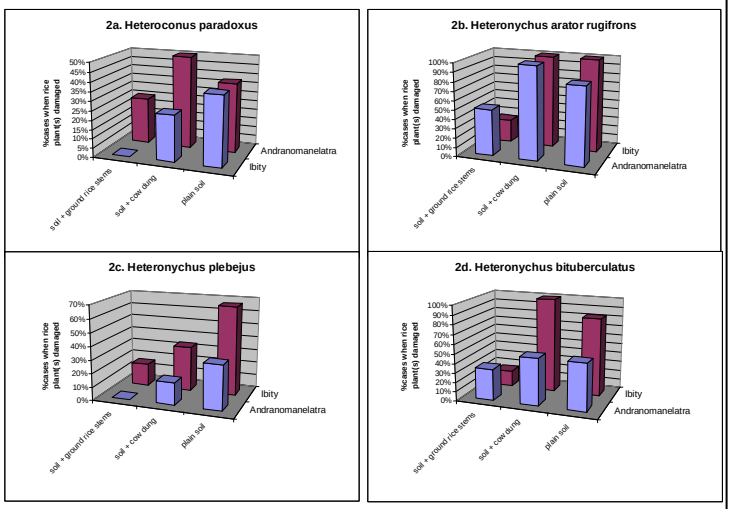

Fig.2. Damage to rice by 4 Dynastid species as a function of soil organic matter content

Results :

Hexodon unicolor unicolor was found to be obligatorily saprophagous at the larval stage, since rice plants were never damaged and larvae remained remote from rice roots.

All the other four Dynastid species studied, namely *Heteroconus paradoxus*, *Heteronychus* spp. (*H. plebejus*, *H. bituberculatus* and *H. arator rugifrons*) were mainly saprophagous, that is, they seldom attacked rice roots in soils rich in organic matter with a high C/N ratio, but they became rhizophagous in either poor soils or soils rich in organic matter with a low C/N ratio (Figs. 2a-2d).

Conclusion :

Our results confirm that *H. unicolor unicolor* is erroneously considered as a pest by farmers, while it should be considered as beneficial for its role as ecosystem engineer.

On the other hand, the change of status of white grubs depending on the organic status of the soil (namely their shift from that of pests to that of beneficials), provides new insights for the management of rainfed rice-based agrosystems.

References

Brown, G.G., Oliveira, L.J. 2004. 14th International Colloquium on Soil Zoology and Ecology, 30 Aug-3 Sep 2004, Rouen, France.

Ratnadass, A. et al. 2005. III World Congress on Conservation Agriculture, 3-6 Oct 2005, Nairobi, Kenya.

Ratnadass A. et al. 2006. in Biological Approaches for Sustainable Soil Systems (Uphoff N. et al. eds.). CRC Press, Boca Raton, FLA, USA: 589-602

Séguy, L. et al. 2006. in Biological Approaches for Sustainable Soil Systems (Uphoff N. et al. eds.). CRC Press, Boca Raton, FLA, USA: 323-342

Presented at the International Rice Congress : October 9-13, 2006. New Delhi, India.