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# Italian rice agroecosystems: a threat to insect biodiversity?

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**Abstract:** Italy is the most important rice producer in Europe and rice agroecosystems occupy a large area in the Po river lowland. The relationship between insect biodiversity and rice cultivated land is evaluated on the basis of the pre-existing literature.

**Key words**: rice alien species; rice pests; associated biodiversity, water management

## Introduction

In the Mediterranean area, natural wetlands were highly modified over the past years, with a impoverishment of the biotic community (Fasola & Ruiz 1996). In the Po river basin (Northern Italy), rice agroecosystems are the consequence of agricultural transformation of alluvial areas, characterized by perennial or periodical flooding, and it can be considered the evolution of wetlands (Suhling et al. 2000, AA.VV. 2008). Almost all rice fields are concentrated in the Po valley, but small areas are also present in Tuscany, Calabria and at the island Sardinia. In Italy rice is normally water-seeded but in about 25% of the rice-growing area it is dry-seeded and subsequently flooded when seedlings are at the 3-4 leaf stage.

Irrigated rice crops can in part compensate the effect of wetlands reductions, as they are similar to temporary ponds in which a thin layer of water, present in rice fields in spring and summer, dries up in autumn and winter. Water creates a microclimate with aspects of tropical and subtropical areas, with small thermal excursions (Confalonieri et al. 2005). This condition could be favorable to arthropod communities. Italian rice agroecosystems are also characterized by a dense network of rivers and secondary channels that can play an important role in maintaining biodiversity.

The water management in rice fields is closely related to the cultural strategy selected (e.g. seeding technique or water removal to allow operations such as weed treatments and eventually insecticide treatments). In recent times the increasing water demand has led to the development of dry rice cultures, increasing the distance between the natural wetlands and rice fields (Litsinger et al. 2009, AA.VV. 2008).

According to an EU decision (COM2010 4/4) rice agroecosystem biodiversity needs to be safeguarded. In the last year regional measures have been formulated aimed at encouraging the use of farming practices which favour maintenance of water in rice fields, compatible with the increasing need to protect and improve the environment, and the biodiversity (BURL 2011)

The purpose of this work is to perform a review of existing literature on the relationship between biodiversity and water management in rice fields which depends on the adopted cultural strategy.

## Biodiversity in rice fields

The rice agroecosystem is characterized by species that rely at least for some part of their life cycle on the rice plant (mostly rice pests) and others that live in canals and in the rice fields when watered (associated biodiversity) (Supino 1916, Moretti 1932). The climate and the habitat heterogeneity can be favourable to the development of competitive species belonging to all ecological niches: phytophagous, predators, saprophagous and phytosaprophagous arthropods. Biodiversity is strictly related to the permanence of water in rice fields (Moretti 1934, Kiritani 2000, Bambaradeniya & Amarasinghe 2003). A too short period of permanence of water can cause the irreversible disappearance of many aquatic predators whose life cycle needs a longer time span (months); species like aphids or mosquitoes, able to develop in very short periods (days), are less affected. For example *Sympetrum depressiusculum* (Selys) (Odonata) was abundant in rice fields in Lombardy in the 70' and is now quite rare because of the changing in the water management (Ruffo & Stoch 2005).

### *Rice pests*

Until a few years ago, phytophagous pests caused little damage in Italian rice fields. Main pest species were *Sypha gliceriae* Kalt and *Rhopalosiphum padi* L. (Hemiptera: Aphididae) (AA.VV. 2008) *Hydrellia griseola* (Diptera: Ephydridae) (Corbetta 1973) and different species of chironomids (Cavazza 1914, Ferrarese 1992, Pasini & Ferrarese 1998, Lupi & Rossaro 2010). *Donacia dentata* Hoppe (Coleoptera: Chrysomelidae), *Mythimna unipuncta* Haworth (Lepidoptera: Noctuidae), and *Ostrinia nubilalis* Hübner (Lepidoptera: Crambidae) were detected more rarely (Giudici & Villa 2004, AA.VV. 2008).

Recently, two other arthropods were reported in Italian literature: the exotic *Lissorhoptrus oryzophilus* Kuschel (Coleoptera: Erirhinidae), which is one of the most important rice pests in the world (Caldara et al. 2004; Lupi et al. 2009, 2010), and the autochthonous *Trigonotylus caelestialium* Kirkaldy (Hemiptera: Miridae) newly related to pecky rice (Giudici & Villa 2006). The detection of the rice water weevil may oblige farmers to dry their rice fields in June to control this pest and this can have a secondary effect on associated biodiversity (Lupi et al. 2007).

### *Associated biodiversity*

Among saprophagous and decomposers Ephemeroptera, Diptera, Trichoptera and Lepidoptera can be mentioned. Some species have an important role in trophic chains (Ephemeroptera, several families of Diptera and Trichoptera) (Moretti 1934, Goidanich 1939). Some other taxa can be considered good bioindicators, e.g. chironomids, which are well known from lakes and rivers, but whose role in agricultural system is less known (Lupi & Rossaro 2010). Some others (Culicidae, Tabanidae and Simuliidae) can compromise human and animal health. Calzolari et al. (2009) identified the presence of several arbovirus in mosquitoes collected in two Northern Italian regions in 2007 and 2008.

Different species of mosquitoes are able to exploit Italian rice fields for larval development (Bellini et al. 2000, Süss et al. 2008). Cultivation techniques can influence their development: hatching of *Ochlerotatus caspius* eggs is stimulated by flooding and drying in June, while other species such as *Culex pipiens* (L.), *C. modestus* (Ficalbi) and *Anopheles maculipennis* Meigen are more favoured when the water level is constant.

The predator community is well represented by Odonata, Hemiptera and Coleoptera. Among them, the best known in Italian rice agroecosystems are Odonata, easily identified directly in the field (Riservato 2009). These predators, as biological endpoints, are good indicators of water quality, and reflect the ecological integrity of their environment (Samways & Steytler 1996, Suhling et al. 2000, Ott 2010).

The most representative in predacious Coleoptera are specimens belonging to Hydrophilidae and Dytiscidae (Moretti 1932, Bellini et al. 2000). The small species *Hydrogliphus geminus* (Fabricius) results to be the first to colonize watered rice paddies and for this reason is a good controller of mosquito larvae (Bellini et al. 2000).

## Final considerations

It is evident that the rice agroecosystem is deeply influenced by human activity. Water management strategy can play an important role in lowering or enhancing species richness. The importance of rice paddies with their contiguous lands is demonstrated by numerous contributions from other areas in the world (Bahaar & Bhat 2011). The channels surroundings paddies can offer a niche favourable to the development of species as the dragonflies *Ophiogomphus cecilia* (Fourcroy) and *Gomphus flavipes* (Charpentier), and the butterfly *Licaena dispar* (Haworth) inserted in the attachments of the habitat directives.

The present review emphasizes that studies on rice field biodiversity in Italy are few and not recent. Most recent literature is on the rice water weevil and on mosquitoes. Rice fields are mostly concentrated in part of the Po plain characterized by intensive agriculture. Therefore characteristic arthropods of these systems play an important role in maintaining the agro-ecosystem equilibrium. However further research is needed to update information on arthropod biodiversity following recent changes in agricultural practices, and to suggest the best management strategies to maintain arthropod diversity.

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