Selection of Indicator Organisms for Functional Agrobiodiversity in Paddy Ecosystems in Japan

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Environment-friendly farming systems have been developed and propagated

Agricultural productivity is attempted to be compatible with conservation of biodiversity

Effect of these farming systems on biodiversity in agro-ecosystems – A little is known

A research project was started in 2008

“Selection of Functional Biodiversity Indicators and Development of Assessment Methods”
VIII. Developing an indicator of biodiversity in agriculture, forestry, and fisheries

Preservation of biodiversity, which provides the footing for agriculture, forestry and fisheries is essential to ensure stable provision of safe agricultural, forestry, and fishery products of high quality to our citizens.

(Snip)

However, there has been no development of an indicator which can be used to quantitatively grasp the effects although measures related to agriculture, forestry and fisheries including environment-friendly agriculture are taken with consideration of biodiversity, and it is necessary that an indicator be developed in effectively promoting these agricultural, forestry and fishery measures.

We shall, therefore, promote examination of development of an indicator to grasp the positive and negative effects of agriculture, forestry, and fisheries on biodiversity based on science and a biodiversity indicator to effectively promote the related measures, elucidate the roles of agriculture, forestry and fisheries in biodiversity and deepen domestic and international understanding by studying what organisms live in rice paddies, forests, seaweed beds, tidal flats, and so forth and utilizing the basic data obtained in the past including properties of biota characteristic in ecosystems formed by agriculture, forestry and fisheries and study methods.
Objectives of Project

• To develop indicators
• The indicators can be used to evaluate the effect
• Of environment-friendly farming systems
• On conservation and enhancement of biodiversity in agro-ecosystems or farmlands
Organisms beneficial to agriculture

e.g. arthropod predators and prasitoids of crop pests

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<td>• These functional groups include a great number of species.</td>
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<td>• They form intermediate trophic levels in a food web.</td>
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<td>• Supported by diverse prey organisms at a lower trophic level</td>
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<td>• Supporting populations of a higher trophic level.</td>
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<td>• Their biodiv. reflect biodiv. of lower and higher trophic levels</td>
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<td>• They are useful for practicing env.-friendly farming.</td>
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Composition of arthropods in paddies

Settle et al. (1996)

No. of species by functional group

Predators + Parasitoids = 64%

Indonesia (Java)

Settle et al. (1996)
Period of Project

2008 – 2009
• To select candidates for indicator organisms

2010 -- 2012
• To develop simple techniques to survey indicators
• To develop standard methods to evaluate the accomplishment of environment-friendly farming
• To establish the indicator organisms
• Selection of indicator organisms
  • At a crop field level
  • At a landscape level
• Development of simple assessment and prediction methods
  • Simple assessment methods
  • Analyzing and predicting functional biodiversity at a national scale
Methods for selecting indicator organisms

(1) Selecting fields/areas with environment-friendly and conventional farming
(2) Surveying organisms (mainly insects and spiders) in the selected fields/areas
(3) Comparing species and abundance of the organisms between the two
(4) Selecting more abundant organisms in environment-friendly farming as candidates for indicator organisms
1) Hokkaido-Tohoku (northern Japan)
   - plain paddy, sub-mountainous paddy, vegetable fields
2) Kanto (eastern Japan)
   - plain paddy, sub-mountainous paddy, rice-wheat double cropping
3) Chubu (central Japan)
   - plain paddy, sub-mountainous paddy
4) Kinki (western Japan)
   - plain paddy, large-area environment-friendly
5) Chugoku-Shikoku (western Japan)
   - sub-mountainous paddy
6) Kyushu-Okinawa (southwestern Japan)
   - rice/vege. paddy, early-planted paddy, traditional citrus fields
7) Various agricultural areas
   - suburban, vegetation-managed, grassland
Study sites: Selection of indicators at a landscape level

- Representative landscapes (almost paddy fields) covering whole Japan
- Various areas: Suburban area, Vegetation-managed area, Grassland

![Map of Japan with study sites indicated]
Procedure for selecting indicator organisms

Creating a list of organisms in all study areas

More than 2 million individuals were captured in all the study areas.

1st screening: Selecting organisms significantly more abundant in environment-friendly fields/areas than in conventional fields/areas using statistical tests

423 organisms were listed as potential indicators at several taxonomic levels (e.g. species, genus, family).

2nd screening: Considering the suitability of each organism as an indicator (e.g., benefit for agriculture and representative and prevalence (not so rare) in each habitat)

Nationwide- and regional-common organisms were selected as candidates for indicator organisms.
Case study: Paddy fields in Kanto

Location of four study sites in Tochigi Prefecture

24 field plots in 4 study sites
Species richness (No. of species): Spiders

No. of species of insects and spiders collected > 400 spp.

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<th>Site</th>
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<th>B</th>
<th>C</th>
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<td>NP:</td>
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<td>CV:</td>
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- Site A: NP, Site B: No pesticides, Site C: Conventional

Mean number of species

NP: No pesticides
CV: Conventional

Fig. 2 Species richness of spiders.
(by all sampling methods)

(Tanaka et al. unpublished data)
Abundance of web-building spiders

Number of *Tetragnatha* spiders by sweeping rice plants with a sweep net. Mean for 3 field plots (Tanaka et al. unpublished data)
Paddy areas

(1) Web-building spiders inhabiting the upper parts of rice plants
   *Tetragnatha* spp.
   Araneids

   All study areas (13 areas)

(2) Wandering spiders dwelling on the lower parts of rice plants and water or ground surfaces
   *Lycosids* (Wolf spiders)

   9 of 13 study areas
Regional-common indicators

Applicable to specific regions

Chubu
- **Paddy**: parasitoid wasps
- **Others**: parasitoid wasps, ants, predatory mites

Northern Japan
- **Paddy**: aquatic bugs
- **Others**: parasitoid wasps, predatory lady beetles, predatory stinkbugs, hoverflies

Chugoku/Shikoku
- **Paddy**: frogs, aquatic beetles, aquatic bugs
- **Others**: parasitoid wasps, ants

Kanto
- **Paddy**: odonates, frogs, predatory lady beetles, aquatic beetles
- **Others**: parasitoid wasps, predatory lady beetles, staphylinid beetles, hoverflies

Kyushu
- **Paddy**: odonates
- **Others**: predatory stinkbugs

Kinki
- **Paddy**: odonates, frogs, hoverflies
- **Others**: parasitoid wasps, predatory stinkbugs, staphylinid beetles, hoverflies
Examples of regional-common indicators in paddy areas

- **Hoverfly** (ヒラタアブ)
- **Odonate (Dragonfly)** (トンボ(赤とんぼ))
- **Odonate (Damselfly)** (トンボ(イトトンボ))
- **Aquatic beetle** (水生コウチュウ)
- **Frog** (カエル)
- **Aquatic bug** (水生カメムシ)
Further work (from this year)

1. Confirming whether the selected candidate organisms are suitable indicators

2. Developing simple, efficient techniques to survey indicator organisms

3. Developing standard methods to evaluate accomplishment of environment-friendly agriculture

Establishing the indicator organisms
Compiling a manual to survey the indicators and to evaluate environment-friendly agriculture
Utilization of indicators

1. To assess effects of agricultural programs and activities that attempt to preserve environments by surveying the indicators in the area where such programs/activities are practiced.

2. To efficiently use functional biodiversity for practicing environment-friendly farming by surveying the indicators (including natural enemies) in farms and adjusting farming to conserve/enhance them.

Environment-friendly agriculture will be popular. Its technologies will be advanced.
Side Event (Lectures)

• Reason for using our indicators
• Outline of the research project

Interactive Fair (Outdoor Exhibition)