IFUGAO: A BRIEF OVERVIEW

Rice Terraces of Ifugao (N-Luzon, Philippines) - Ecological History and Developments

by
Josef SETTELE & Konrad MARTIN

1 Introduction

For tourists the rice terraces of Ifugao Province (N-Luzon/Philippines; see Fig. 1, p. 9 and Fig. 2, p. 10) are well known as an attractive place to visit. That the beauty of the landscape is dependant on a highly complex "Agri-Culture" only becomes obvious if one looks more closely. Throughout the centuries the people of Ifugao have shaped this landscape and thus created a permanent basis for living. The village structure, with small groups of houses usually scattered across the terraced landscape, allows production and consumption of food in the same landscape units. Therefore nutrient cycles are oftentimes regarded as more or less closed (MARGRAF & VOGGESBERGER, 1986, 1988). This guarantees sustainability. One important component of this balanced system is a - compared to other agricultural landscapes - high biodiversity.

However, population growth, improved education and hope for better living conditions in other regions, among other factors, are responsible for the inevitable change of this subsistence system. Depending on mainly political circumstances, this ongoing change can be managed more or less in a sustainable way, but may on the other hand also result in the destruction of agricultural and - interrelated with these - primary forest areas.

2 History

Ethnic groups from Malaya reached the Philippine archipelago throughout the last millenia. This made people, who formerly inhabited the lowlands, to withdraw into mountainous areas. As irrigated rice production in the lowlands has been such an essential part of daily life, people maintained this type of cultivation in their new and at first extremely unfavourable steep environment. To achieve flooded fields, terraces had been built. Thus local conditions have been adjusted to cultural requirements. The formerly completely forested mountains have been cut - at least at lower elevations - severeal hundred (up to 2000) years ago and have been transformed into aquatic systems by terracing and irrigation. Permanent water supply was a precondition for a functioning terrace culture and was guaranteed by vegetation (watersheds covered by mossy forests) and climate (see CONKLIN 1980, DUMIA 1983, FRY 1983, VOGGESBERGER 1988).

3 Ifugao landuse system

Rice growing determines social, religious and economic life of the Ifugao people. It is regarded as the expression of partnership between man and his gods. Many rituals serve to satisfy the gods and to keep the "rice's soul" healthy. Many of these rituals are practiced depending on the time of the year. Thus the Ifugao landuse system and calendar is determined by rice growth and the accompanying rituals (CONKLIN, 1980; VOGGESBERGER, 1988; SCHRETZMANN & BARTHELMES, 1996).

A new year starts with a fallow season after rice harvest. During that time (rainy season; see Figure 3) remnants of the growing period (e.g. straw of rice plants and aquatic weeds) are mixed with mud and put together to small compost mounds on which vegetables are planted (locally called 'pinkol' - more commonly to be seen in the Kiangan area). From October to December terrace walls and dikes are reconstructed, seedbeds and later all terrace areas, on which rice will be transplanted, are prepared. For germination of the rice plant, complete panicles are put on the mud while the water level is kept extremely low. Grown seedlings are transplanted in February/March. Normally 2-4 seedlings are used for one hill. Rice then grows up to July/August. Human interference in this growth stage is restricted to weeding (2-3 times), cleaning of dikes to control rats, and preventing birds to get the grains at the ripening stage (e.g. by use of scarecrows). Harvest finally is the central event of the year. Only the panicles (approx. at the hight of the flag leaf) are cut and bound into bundles (see Pict. 12, p. 20). These are transferred to granaries and houses for drying. The rests of the rice plants remain in the fields and are put into the mud some time later, mostly at the end of the fallow period. The annual rice cycle now is completed.

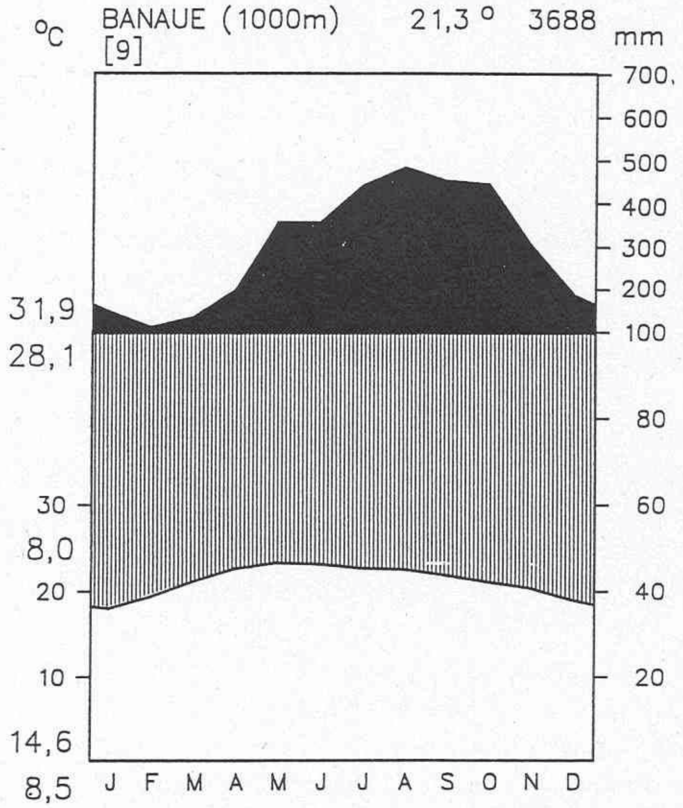


Figure 3: Climate diagram of Banaue/Ifugao (taken from SETTELE, 1992)

All activities within one growth cycle are performed more or less synchronously in the whole area (see Pict. 4-8, pp. 16-17). Timing of the growing period is oriented to a maximum use of climate (e.g. solar radiation). In difficult periods, like the main typhoon season, the fields are fallow.

The second important cultivated plant of the subsistence system is sweet potato, which is mainly grown in steep, dry areas, e.g. on the dikes or at steep mountain slopes, which are not suited for terraces (see Pict. 10, p. 18). Directly around houses and villages small forested areas (woodlots in the sense of CONKLIN, 1980) are maintained, where fruit trees are cultivated and firewood is harvested.

The whole cycle, however, is dominated by the rice crop. Work in sweet potato fields (swiddens in the sense of CONKLIN 1980) and woodlots only is performed if there is less work in the paddies (see CONKLIN 1980, MARGRAF 1988, VOGGESBERGER 1988). The annual distribution of working activities for the three types of compartments - rice/pond fields, swiddens, and woodlots - are summarized in Figure 4. The interlocking agricultural cycles are presented in Figure 5.

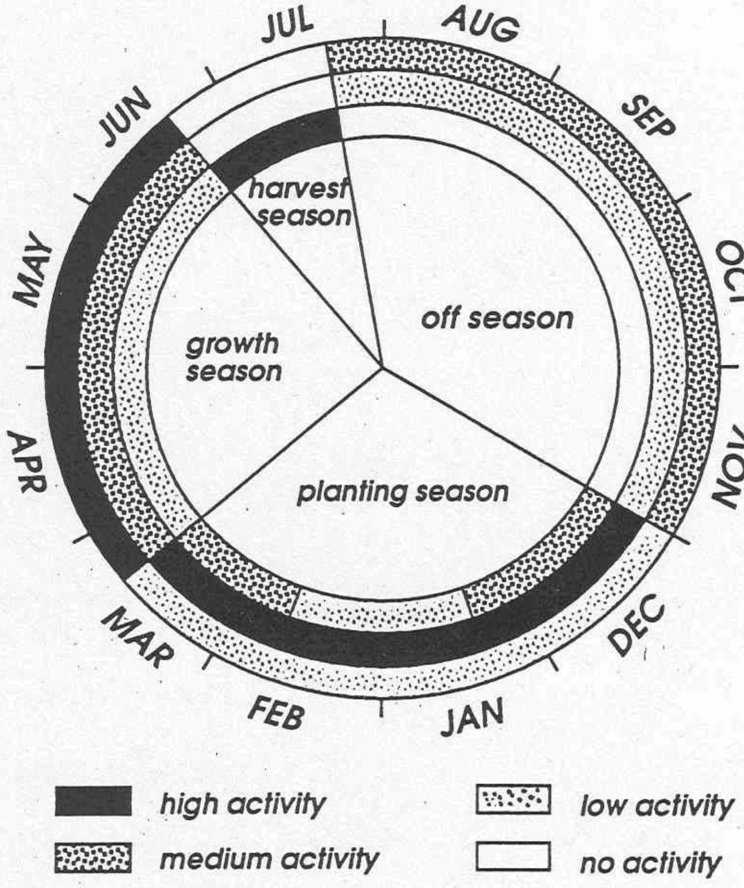
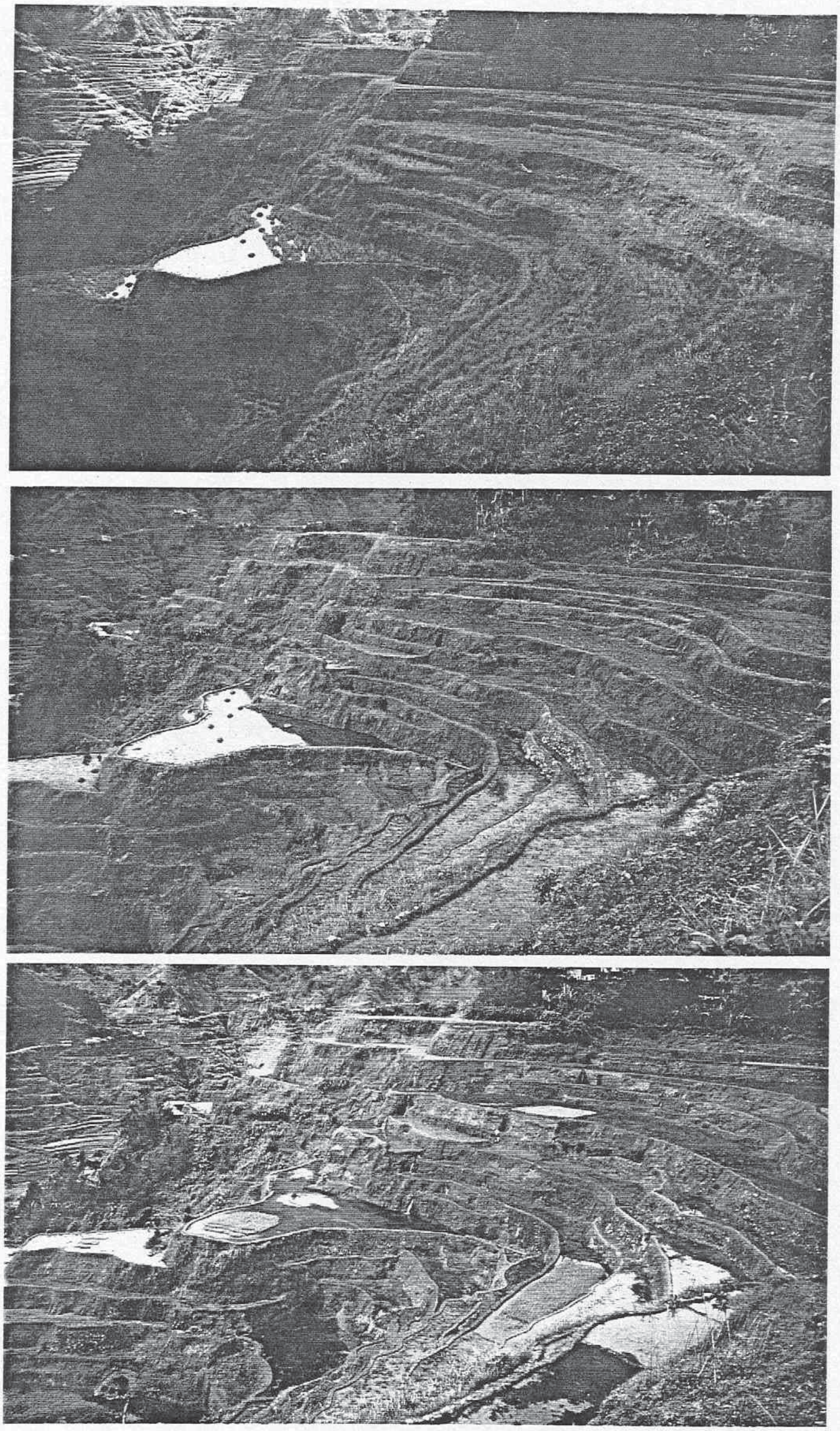


Figure 4: Distribution of working activities
(after CONKLIN, 1980, modified; graphics: K. GEYLER)



Picture 4-6: Seasonal variation and rice growing synchronicity in Ifugao 1988/89 (Itidung village above Banaue poblacion; 4: Feb.; 5: Feb./March; 6: March)

Picture 7-8: Seasonal variation and rice growing synchronicity in Ifugao 1988/89
(Itidung village above Banaue poblacion; 7: July; 8: Aug.)

Picture 9: Rice fields in Ifugao remain very constant for long time;
here: same view as in Pict. 4-8, picture taken nearly 10 years later (March 1997)

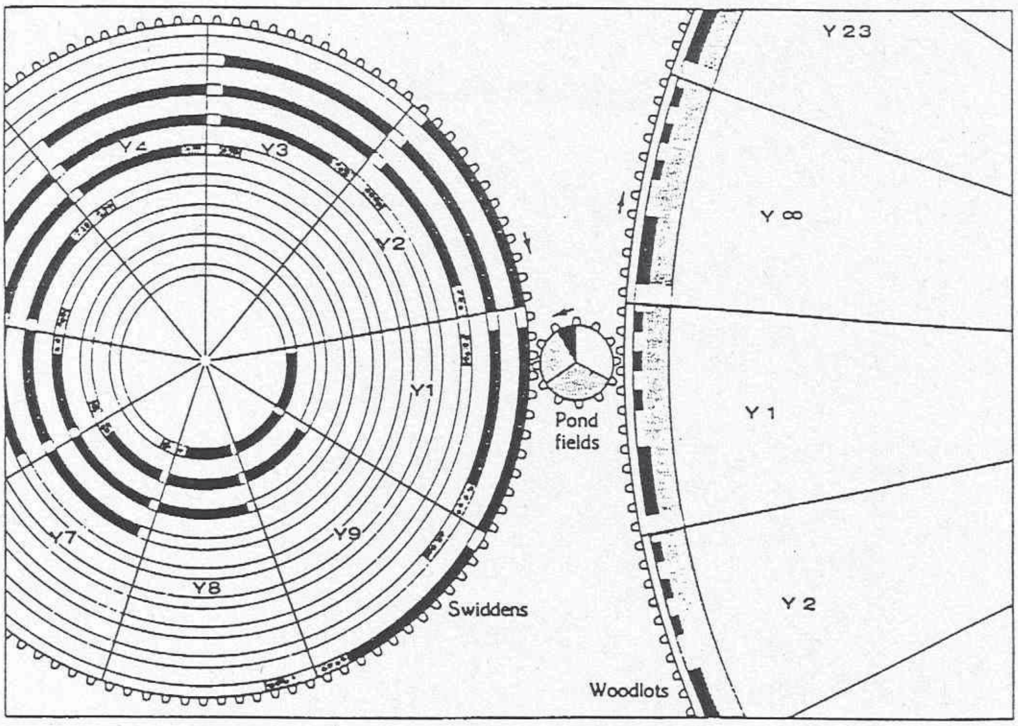


Figure 5: Interlocking agricultural cycles (after CONKLIN, 1980, slightly modified); compare also Figure 4

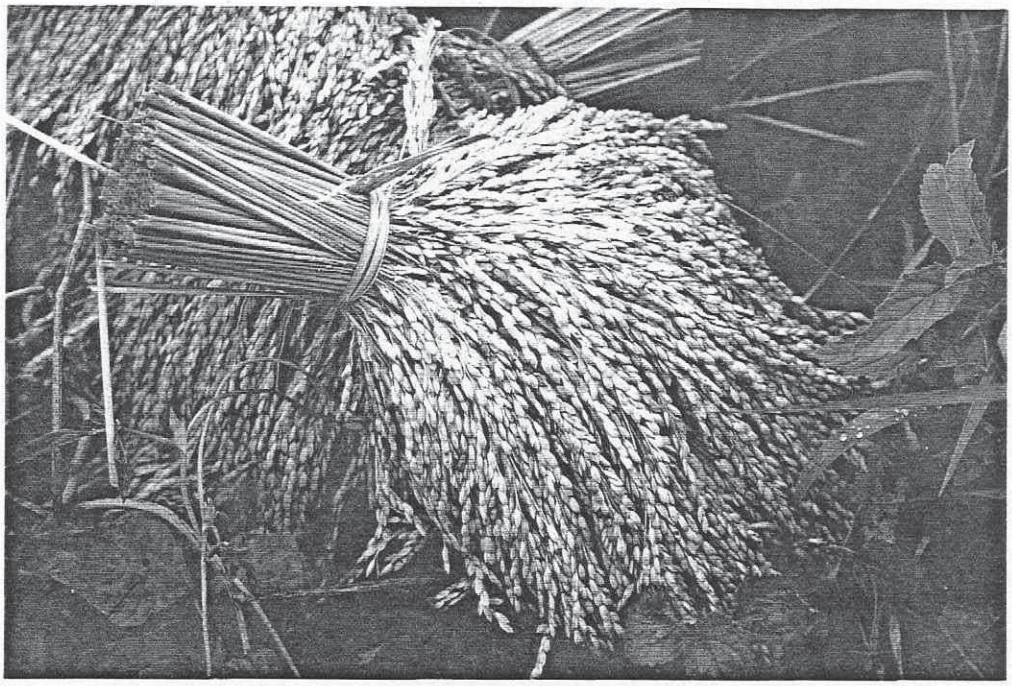
Picture 10: Swidden cultivation is physically hard work (near Batad, March 1997)

4 Genetic resources

The numerous traditional rice varieties (mainly of the "javanica" type) are characterised by tall growth, low grain/straw ratio, long panicles, large grains (often with long awns) and low photosensitivity (see Pict. 11). The farmers of Ifugao distinguish between sticky and non-sticky varieties. The sticky ones ('dayakot' or 'dayaot'), which have a high content of dextrin and amylopectin are nearly exclusively for rice wine brewing (mainly for celebrations). Approximately one third of the rice area in the traditional system is planted with such varieties. Each family grows several varieties - oftentimes even on one field. In total far more than 100 varieties are known in the province. The local varieties are adapted to climatical and pedological peculiarities of the region and determine the communities of plants and animals in the paddies (information based on VOGGESBERGER, 1988; WACKERNAGEL, 1985).

To use this potential, for example for rice breeding, an intensive inventory and description of the different varieties as well as measures for their preservation would be necessary. It seems however of limited use, if only the varieties are preserved as such, without the knowledge of ecological and socioeconomic frame conditions of their growth. For the development and introduction of new varieties for example, such aspects might be of crucial importance for the acceptance by local farmers.

Picture 11: Traditional rice variety (Kiangan, 1988)



Picture 12: Rice bundles of traditional rice harvest (Kiangan, 1985)

5 Species in the terrace system

First results show, that there are hundreds of species still to be discovered, not only in the natural forests (see chapter 6) but also in many terraced areas and other water bodies, as can be shown by the description of quite a number of new caddis flies discovered within the direct vicinity of Banaue (MEY 1990, 1995).

Besides that and besides the 'normal' terrestrial rice field invertebrate fauna (compare HEONG et al., 1991; ROGER et al., 1991; SETTELE, 1992; SETTELE et al., 1995; SCHOENLY et al., 1996) there is for example a quite high diversity of aquatic invertebrates - compared to other areas of irrigated rice production. Some important numbers have been mentioned by MARTIN (1994) and are shown in Table 1.

Figure 6 summarizes some of the major interactions within the food web of Ifugao rice fields. There, some of the species mentioned in Table 1 are shown as well as the more important groups of terrestrial arthropods.

Table 1: Species numbers of aquatic invertebrates in traditionally used rice fields of Banaue (Ifugao/Philippines), compared to inventories of other regions (from MARTIN, 1994)

Aquatic invertebrate group	A Philipp. (Banaue)	B Thai-land	C Laos	D Cali-fornia	E Egypt	F Hungary
Chironomidae	>20	5	1	>9	1	22
Culicidae	ca. 2	4	2	1	>2	2
Stratiomyidae	+	1	-	-	1	-
Ephemeroptera	ca. 2	1	-	1	1	2
Trichoptera	+	-	-	1?	-	-
Nymphulinae	ca. 3	1?	-	-	-	2
Notonectidae	ca. 3	3	4	2	1	1
Ceratopogonidae	+	1	1	1	-	-
Pleidae	2	2	-	-	-	-
Belostomatidae	1	2	-	1	3	-
Naucoridae	1	-	1	-	-	1
Ranatridae and Nepidae	2	2	3	-	1	2
Zygoptera	+	9	1	2	1	1
Anisoptera	+	12	3	1	1	3
Corixidae	1	1	2	1	2	2
Haliplidae	1	-	-	?	-	1
Dytiscidae	12	ca. 8	13	>9	6	4
Gyrinidae	1	1	1	-	-	-
Hydrophilidae	9	10	3	>4	5	2
Gastropoda	15	12	3	>2	*	6
Bivalvia	4	-	-	-	*	2

+: present, species number unknown; -: not present; *: no data available
sources: A: MARTIN (1994); B: HECKMAN (1979); C: HECKMAN (1974);
D: MIURA et al. (1981); E: EL-SHERIF et al. (1976); F: BERCZIK (1973).

6 The mossy forests, their watershed function and biodiversity

Although possibly being the largest remaining patches of the whole of the Philippines, the mossy forests of Northern Luzon have declined throughout the last decades. In some areas they are completely lost, like for example in the Baguio area. In regions where they still exist - as in higher elevated parts of Ifugao - they guarantee a constant water supply throughout the year. Precipitation is soaked like in a sponge, thus immediate surface runoff is rather limited even after strong downpours. Most of it is retained in vegetation and soils. At certain spots it appears again with quite some delay (springs) and thus guarantees satisfying water levels in the mountain creeks in times of less rain as well. The water of the creeks and rivers in Ifugao is diverted into the rice paddies through complex, community based irrigation systems. It passes many rice fields and finally - hundreds of meters downhill - flows back to the original river bed.

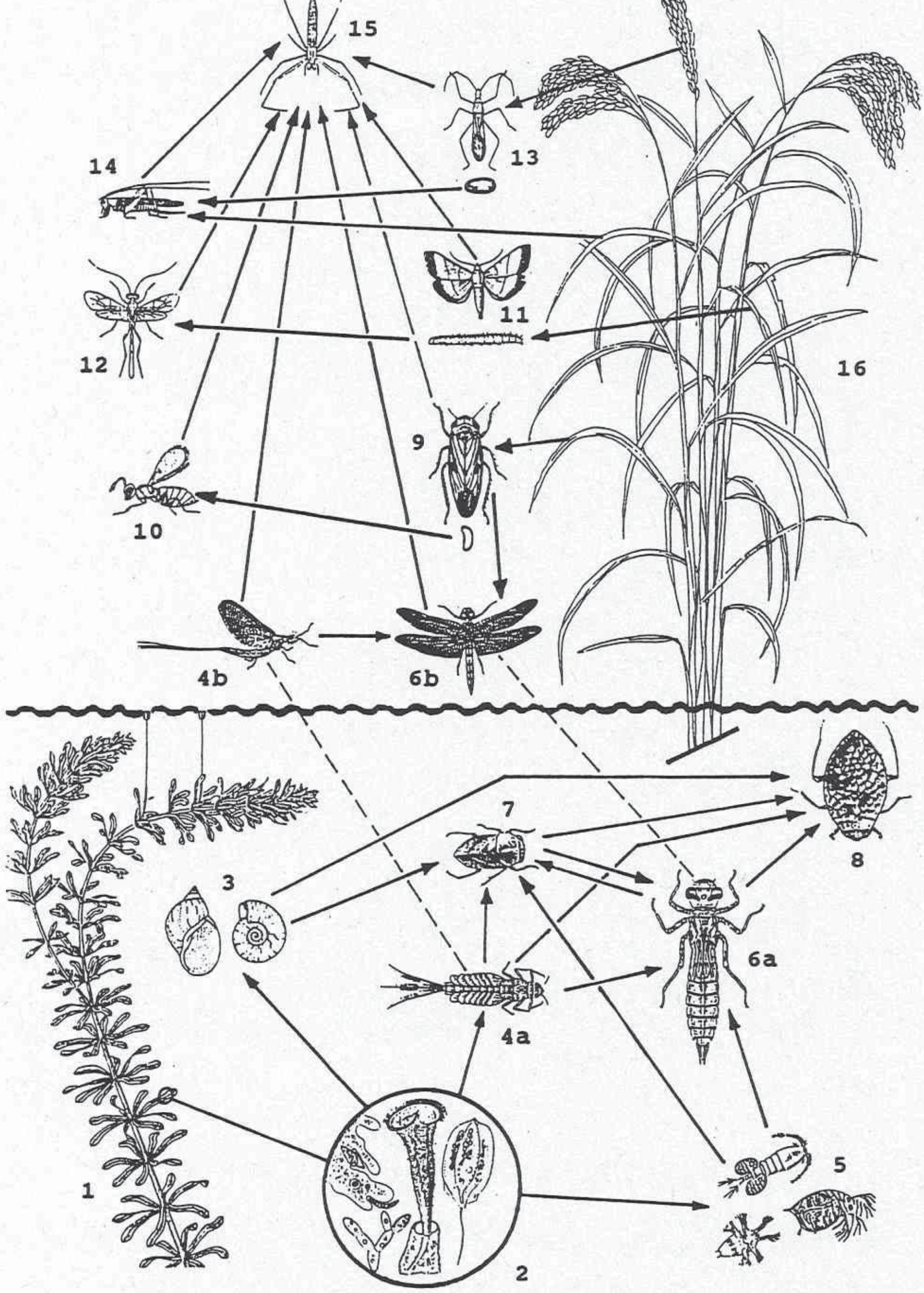
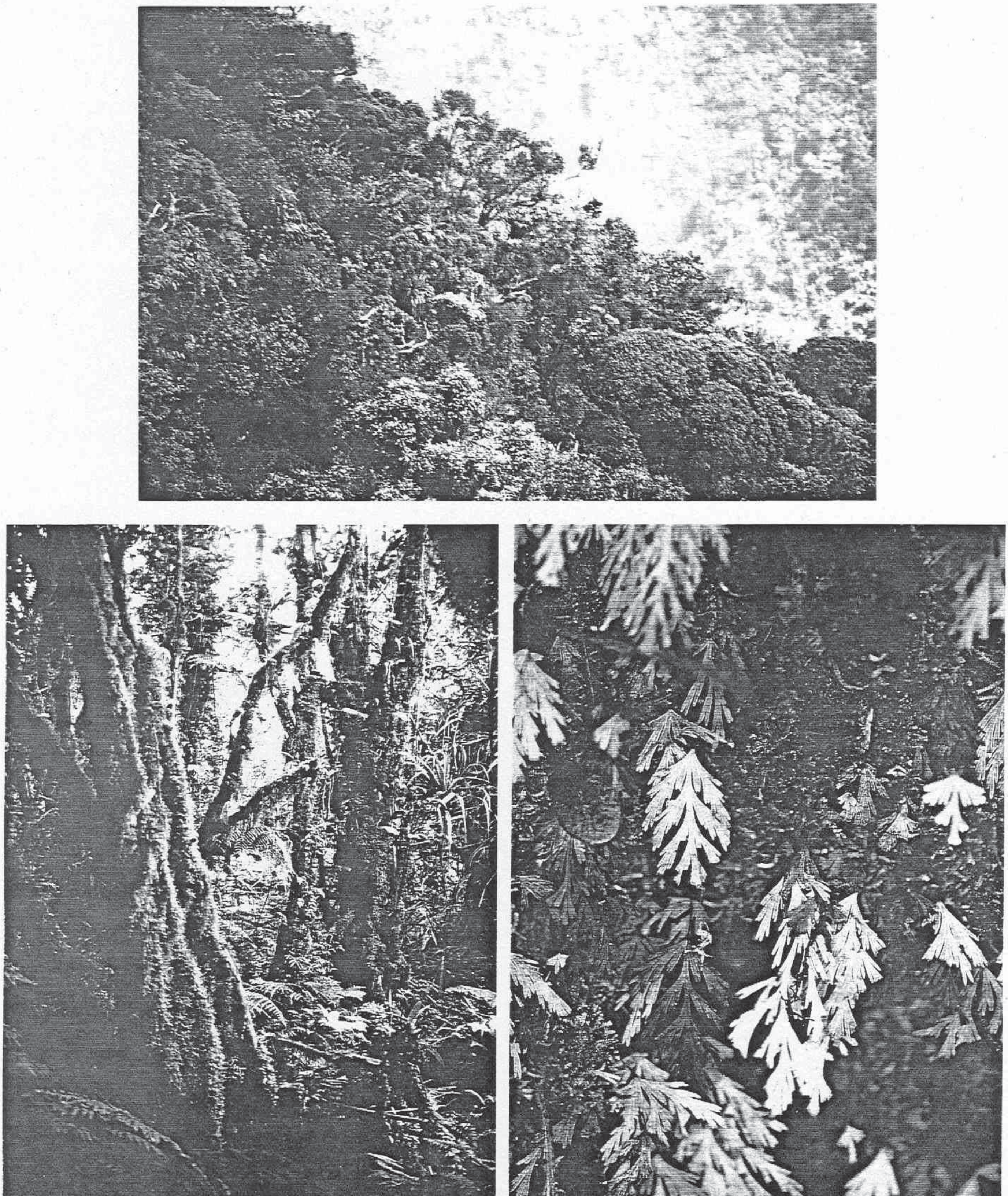


Figure 6: Simplified food web of an Ifugao rice field (from KOCH et al. 1990, modified); arrows indicate the trophic relationships (according to energy flow in the food chain)

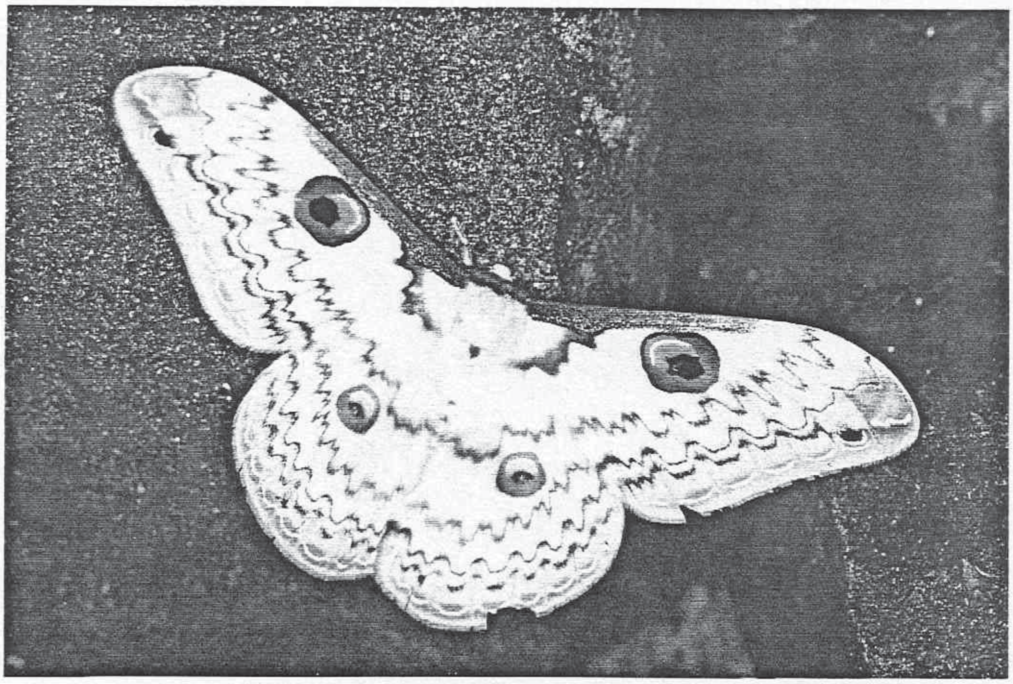
1: aquatic vegetation, in this case *Hydrilla* spp. (*Najas* spp. are also very common); *2:* microbiocoenosis of the leaf surface, consisting of e.g. algae, bacteria, protozoans and detritus; *3:* snails living on submerse vegetation (*Lymnaea*, Planorbidae); *4:* Ephemeroptera (a. larva, b: adult); *5:* zooplancton (small Crustacea); *6:* Odonata (a: larva, b: adult); *7:* aquatic bug (Pleidae); *8:* aquatic bug (*Sphaerodema* spp., Belastomatidae); *9:* leafhopper, egg and adult (*Nephotettix* spp., Cicadellidae), sucking on rice leaves, virus transmitter; *10:* egg parasitoid of leafhoppers (Trichogrammatidae); *11:* leaffolder larva and adult (*Cnaphalocrocis medinalis*, Pyralidae); *12:* larval parasitoid of leaffolders (Ichneumonidae, Braconidae); *13:* rice bug (*Leptocorisa* spp., Alydidae), sucking on seeds in milky stage; *14:* grasshopper (*Conocephalus longipennis*, Tettigoniidae), feeding on rice as well as on eggs of bugs and hoppers; *15:* spider (Tetragnathidae); *16:* rice (*Oryza sativa*)



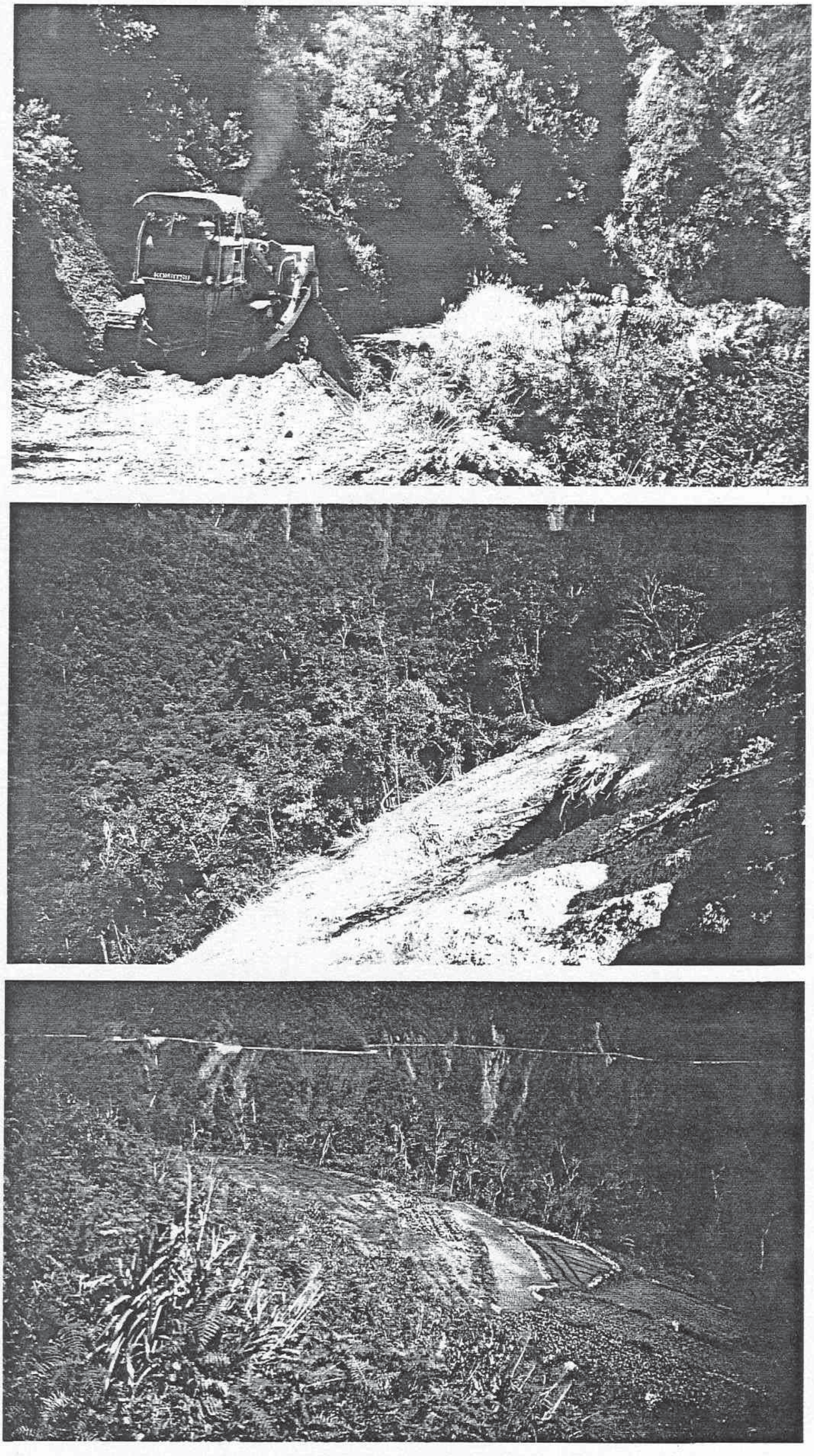
Picture 13-15: Impressions of the mossy forests of Mt. Pulis area (border of Ifugao and Mountain Province)

As the people of Ifugao in some areas already experienced the effects of cutting forests at mountainous sites (namely pronounced dry or wet periods, depending on the season; see e.g. EDER 1982), the remaining forests are valued by the people. Thus large scale impacts usually are prevented. However, the ongoing construction of roads (at present especially the Banaue-Bontoc road) is a major factor responsible for most of the decline of forest areas at certain locations. Construction directly is destructive, but erosion is enforced as well. In limited but increasing amount wood is also extracted from these forests, which among other sources, form the basis for local handicrafts (mainly for carving).

Besides their importance for the water regime of the region, the mossy forests also harbour a vast number of endemic and/or endangered plant and animal species (see Pict. 16). Inventory of species diversity has only started. First results however show, that there are hundreds of species still to be discovered (literature on species of butterflies and moths as an example: SETTELE et al., 1990; THOMAS, 1990; CERNY, 1993, 1995; SCHINTLMEISTER, 1993; NÄSSIG & TREADAWAY, 1988, 1997a, 1997b, 1998a, 1998b; TREADAWAY, 1995; HOGENES & TREADAWAY, 1998).



Picture 16: *Loepa nigropupillata* NÄSSIG & TREADAWAY 1988 - an endemic Saturniid moth of the Ifugao Rice Terrace area and the mossy forests of Ifugao and Mountain Province



Picture 17-19: Destruction of mossy forests of Mt. Pulis area (border of Ifugao and Mountain Province) by road construction and upland agriculture

7 Cultural change and ecological effects

Should the present development continue without alterations, drastic changes may be expected in the terraced landscape of Ifugao Province. Rice cultivation more and more fails to meet the requirements and expectations of people. Hard labour in the terraces, combined with low yields, as well as an increasing population, which can no longer live without imports, lead to the search of alternatives either in lowland areas or in the higher elevated mossy forests. Both in the long run leads to the destruction of irrigated agriculture. More extreme dry periods would make irrigation more difficult (including decreasing stability of terraces and thus increasing danger of erosion), leading to further emigration. This vicious circle can hardly be broken while maintaining the traditional system. A new adaptation and change of the system, combined with the adaptation of people to new frame conditions, as hundreds of years ago, might become necessary (compare SETTELE et al., 1993b).

8 Important prerequisites for future development

Projects aiming at improvements and adaptations of the system, as the EU funded CECAP (Central Cordillera Agricultural Programme), have no easy task. The more this holds true, as the space for optimisation in such a subtly balanced system might be rather small. Too enthusiastic improvements may accelerate the system's destruction. It's of major importance to enhance creativity and the openness to small scale experiments of the local people, instead of bringing in numerous solutions of vague applicability from outside.

Conservation of (mossy) forests is essential for the maintainance of irrigated terraces and in general nearly any kind of land use in the region. The different possibilities to achieve such a goal (as well as potential alternatives) are illustrated and discussed in the chapter „Scenarios" at the end of this booklet.

8.1 Characteristics of the system which should be maintained

A detailed knowledge of the traditional system (one of the central aspects of our research activities in the area), should form the basis for a search for modification possibilities. Major sources of information which are very useful for basic information are VAN BREEMEN et al. (1970), CONKLIN (1980), EDER (1982), DUMIA (1983), WACKERNAGEL (1985) and VOGGESBERGER (1988).

If change of production systems in Ifugao is intended, one always has to keep in mind the reasons for their constant yields throughout the centuries without input of mineral fertilizers and pesticides. Most of them derive from irrigated rice production with its

general characteristics (according to MARGRAF & VOGGESBERGER, 1986, 1988; ROGER et al., 1986):

- high sedimentation within fields, thus minimized erosion and nutrient loss,
- anaerobic conditions (no nitrification, thus favouring nitrogen conservation),
- blue-green algae growth (biological N-fixation), and
- animal production (snails, ducks, fish, etc.),

and

specific characteristics of the Ifugao production system (according to MARGRAF & VOGGESBERGER, 1986, 1988; SETTELE, 1992; SETTELE et al., 1993a, 1995):

- improved symbiosis of *Azolla* ferns and *Anabaena* algae due to high altitude (1000m), thus high efficiency of N-fixation,
- vegetable production on compost mounds during rice fallow, while fields are kept flooded,
- harvest only of upper portions of the rice plant (from panicles to flag leaves, which are bound together to bundles), thus most parts of the plants remain in the field and are decomposed after being worked into the mud of the paddy,
- experience in rice production and variety selection for generations of farmers, and
- highly structured landscape with generally small fields.
- Synchronous growing seasons on large areas with nearly rice free fallow periods, which have been generally propagated by LOEVINSOHN et al. (1988) and specifically for Ifugao by SETTELE et al. (1995). This, however, has to be questioned and needs further investigation (compare for example HEONG et al., 1992; WAY & HEONG, 1994; HEONG, 1996; see also chapter 8.2)

8.2 Possible changes of/within the system to improve production conditions

Due to the many advantages of the present aquatic system compared to upland farming, it may hardly be replaced within Ifugao. Only temporary growth of upland crops in small, terraced patches, as partly practiced with sweet potatoes and beans, could produce cash crops for the market. Large scale replacement of irrigated rice, e.g. by beans, is not advisable at all (ENGELHARD et al., 1991; MARGRAF & VOGGESBERGER, 1986).

Increasing yields by maintaining the irrigated system and thus maintaining the long-term sustainability will only be possible by introduction of a second growing period - as is practiced in the Philippine lowlands or in the neighbouring municipality of Bontoc (BOTENGAN, 1976). Failure of attempts to introduce a second crop in higher elevations so far have been due to climate, or to the non-availability of respective rice varieties, respectively. An introduction of new cold tolerant and fast growing varieties with low nutrient requirements would be necessary. This has been done successfully already in elevations of 700 m in the nearby Kiangan area (VOGGESBERGER, 1988; SETTELE, 1992). Pest problems within such modified systems are not to be expected. The efficiency of natural enemies might even increase due to larger asynchrony of the system (HEONG et al., 1992; WAY & HEONG 1994; HEONG, 1996). The rich landscape structure may have additional beneficial effects on the dynamics of pests and their natural enemies (SETTELE et al., 1993a). Thus, also in the future application of pesticides will most probably not be necessary. This would guarantee the survival of the aquatic biocoenoses and the production of animal protein also in the future.

However, we have to keep in mind, that for the success of new varieties not only physiological but also socioeconomic problems have to be solved (WACKERNAGEL, 1985; BARTHELEMES et al., this volume, pp. 29-42), which means that innovations should be initiated by the farmers themselves and only be assisted by outside expertise.

Another solution, besides the two rice crops per year, could be derived from the compost mound component of the traditional system (see CONKLIN, 1980). Enlarging these mounds (e.g. towards a linear arrangement as practiced in some neighbouring areas), would create possibilities for vegetable production while keeping the terraces flooded and thus physically stable. If water supply is irregular and the field areas dry up temporarily new flooding often might cause severe erosions of whole field complexes.

Appendix:

German research activities in Ifugao

Mainly masteral and PhD students conducted research in Ifugao Province. Most of them have been members of the Agroecology Section (headed by Prof. Dr. Werner KOCH) of the Institute of Plant Production in the Tropics and Subtropics, University of Hohenheim (Germany). The following list gives the names of the researches in a chronological sequence, together with their field of expertise and their respective published outputs (detailed references then may be depicted out of the references at the end of this booklet; contributions within the present volume are not repeated):

- Josef MARGRAF, 1992/1993; animal ecology, future of the Ifugao system (MARGRAF, 1988; VOGGESBERGER & MARGRAF, 1986, 1988; ROGER et al., 1986)
- Monika VOGGESBERGER, 1992/1993; plant ecology, future of the Ifugao system (VOGGESBERGER, 1988; VOGGESBERGER & MARGRAF, 1986, 1988; ROGER et al., 1986)
- Josef SETTELE, 1985, 1988/1989, 1991, 1996; applied entomology/pest dynamics, biodiversity studies, future of the Ifugao system (ACHILLES & SETTELE, 1990; ENGELHARD et al., 1991; SETTELE, 1992, 1994; SETTELE et al., 1990, 1993a, 1993b, 1995; NÄSSIG & SETTELE, 1993, 1995; NÄSSIG et al., 1998)
- Konrad MARTIN, 1988/1989/1990, 1996; ecology of aquatic animals in rice paddies, food web studies (SETTELE et al., 1993a, 1993b, 1995; MARTIN, 1994)
- Brigitte ENGELHARD & Joachim KECK 1988; agronomy: bean production (ENGELHARD et al., 1991)
- Thomas ACHILLES 1988/1989/1990/1991; entomology: especially stemborers and leaffolders (ACHILLES, 1993; ACHILLES & SETTELE, 1990; SETTELE et al., 1990, 1993a, 1993b, 1995)
- Beate SCHRETZMANN & Ralf BARTHELMES 1995, 1996; socioeconomic aspects

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Rice Terraces of Ifugao (Northern-Luzon, Philippines) Conflicts of Landuse and Environmental Conservation

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edited by

Josef SETTELE
Harald PLACHTER
Joachim SAUERBORN
Doris VETTERLEIN