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Involving local communities in amphibian conservation: Taipei frog *Rana taipehensis* as an example

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Farmland is an important habitat for many amphibians. However, the widespread and prolonged use of agrochemicals creates predictable difficulties and limitations for the conservation of agrobiodiversity. Farmland is an ecosystem in which human forces are greatly involved; therefore, conservation of natural resources in agricultural ecosystems must also relate to the existence of humans in order to achieve its goal. The Taipei frog *Rana taipehensis* has become a seriously threatened species in Taiwan because of wetland destruction and extensive use of agrochemicals on farmland. Nowadays, the species can only be found in Taipei, Taoyuan, Tainan and Pingtung Counties. Since 1999, Taipei Zoo has been surveying the distribution of Taipei frogs in Sanzhi, a small town in northern Taiwan. Taipei Zoo has adopted a two-pronged approach to its conservation project. Aside from collecting ecological data on Taipei frog populations, we also cooperated with a local school and the Tse-Xing Organic Agriculture Foundation (TXOAF) to carry out habitat-improvement work and community-education programmes about wetland conservation. We persuaded and assisted a farmer to halt his use of pesticides and eventually adopt organic-farming practices because his farm was located right in the centre of the Taipei frog's breeding habitat and our sampling area. We also helped the farmer to sell his organically grown water lilies to TXOAF in order to provide a long-term and stable income. From October 2002, the farmer stopped using agrochemicals on his fields. Beginning in 2003, when the population of Taipei frogs was apparently increasing, the farmer also became a follower of an organic lifestyle and is proud of the Taipei frogs on his land.

Key-words: agrobiodiversity; agrochemicals; amphibians; conservation; education; farmlands; local community; organic farming; pesticides; Taipei frog; Taiwan; wetlands.

INTRODUCTION

Almost half of the vegetation-covered land on the earth is devoted to agriculture (Polasky, 2007). Many invertebrates, fishes, amphibians, reptiles, birds and small mammals

inhabit farmlands, and so agrobiodiversity is an important part of global biological diversity. Owing to its climate and its rice-consuming culture, Taiwan's farmland consists mainly of paddy fields. These fields, along with the irrigating canals and farm pools of this agricultural system, have much to do with the area's amphibian biodiversity.

However, farmland is traditionally focused on producing agricultural products, a goal that can conflict with the conservation of biodiversity. For example, the use of pesticides, herbicides and fertilizers can threaten amphibians (Beebe, 1997). Also, farmland-use change may impact amphibian populations and distribution. Because biodiversity conservation in agricultural ecosystems involves considerations of both the natural resources and the interests of local people (e.g. farmers), it often requires careful deliberation and a practical approach. How to take both the farmer's profit and the preservation of natural resources into account is an important task for conservationists.

In Taiwan, the local community used to be excluded from natural-resource management. Community resident benefits were usually considered in conflict with resource conservation goals. Nevertheless, international natural-resource management practices are placing more emphasis on the rights of local communities, even considering the local community as an important partner of resource management (Lu, 2001).

In 1999, Taipei Zoo started the 'Taipei Frog (*Rana taipehensis*) Conservation

Project'. Aside from investigating the status and ecology of the Taipei frog, the more important goals of this project were to implement a more effective conservation strategy and improve the natural habitat of the species. This article will present an example of striking a balance between agricultural production and natural-resource conservation, by describing the cooperation between a conservation institute, a local school, a non-governmental organization (NGO) and a farmer.

THE STATUS OF *R. TAIPEHENSIS* IN TAIWAN

The Taipei frog is a member of the Ranidae family. An adult ♂ is about 4 cm in length while a ♀ is about 3 cm in length. The body is slim, with a green or green-brown back and an obvious golden line running along each side of its spine (Plate 1). *Rana taipehensis* is distributed in areas of southern China, such as Yunnan, Guangdong and Hong Kong, Cambodia, Lao People's Democratic Republic, Myanmar, Taiwan, Thailand and Viet Nam, while the South Asian species, now synonymized under *Rana tyleri*, are found in India, Bangladesh and Pakistan (Ohler & Mallick, 2002; Yang, 2005). However, the holotype of this species was collected in Taipei and so it was named accordingly.

In Taiwan, Taipei frogs typically inhabit inland wetlands, such as swamps, pools, paddy fields and canals (Lue *et al.*, 1999). There is a lack of long-term observational



Plate 1. Taipei frog *Rana taipehensis* is a threatened species of frog in Taiwan. Chin-Fong Lin.

statistics but limited records (Chou, 1993; Lin, 2000; Yang, 2005) and our own investigation indicate that at least 30 years ago, Taipei frogs would have been widely distributed in the low-altitude areas of western Taiwan. Although the species is listed as Least Concern by IUCN (2007), Taipei frogs are seriously threatened in Taiwan, with only small populations remaining in Taipei, Taoyuan, Tainan and Pingtung Counties (Lue *et al.*, 1999; Yang, 2005) (Fig. 1a).

Research undertaken since 1999 shows that Taipei frog distribution and population are decreasing, and those that remain may have difficulty interacting because they are fragmented by long distances of a mostly urban environment. Moreover, they are mainly distributed on private land, and so their most critical threat is habitat destruction by human development and farmland-use changes, such as paddy fields becoming fallow or no longer

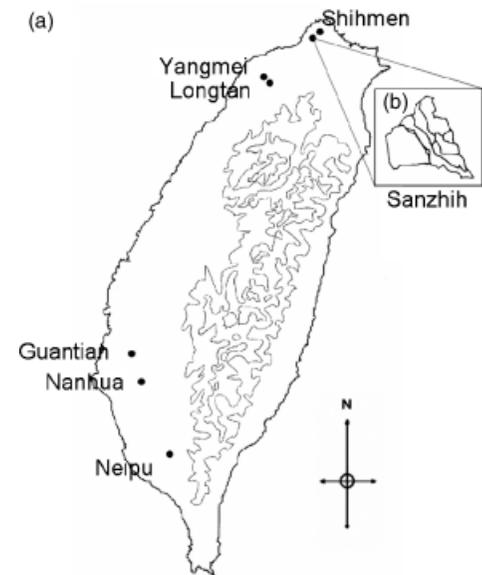


Fig. 1. (a) Taipei frog *Rana taipehensis* is threatened in Taiwan because only small populations remain. The dots show Taipei frogs distributed at Shihmen (Taipei County), Sanzhih (Taipei County), Yangmei (Taoyuan County), Longtan (Taoyuan County), Guantian (Tainan County), Nanhua (Tainan County) and Neipu (Pingtung County); (b) Taipei frog studying the area at Sanzhih.

irrigated. Another important threat is the use of pesticides. Although there is no specific research on the effect of agricultural chemicals on Taipei frogs, the species is not found on farmlands where pesticides are used frequently.

GOAL AND STUDY AREA

Although Taipei frogs are seriously threatened in Taiwan, ecological studies and information about the species are quite limited (Chou, 1993; Chou *et al.*, 1993; Chuang, 2006). Therefore, in our project, we first wanted to understand the life history and ecology of the Taipei frog clearly.

In July 1999, we found farmland in Hengshan village, Sanzhi town, Taipei County, inhabited by Taipei frogs (N25°15'41.4", E121°31'21.8") (Fig. 1b). Ninety per cent of this farmland was stepped paddy field; the rest was grass field (Plate 2). The total area was around 9000 m². In a preliminary survey, we found 15 frog species (including the Taipei frog) (Table 1), which were close to a half of all native species in Taiwan. There were also two water snakes, *Enhydria chinensis* and *Sinonatrix annularis*, and other rare aquatic insects and plants. We therefore decided to designate this important wetland as a study area, and since February 2000 we have spent two nights of every month at the site for fieldwork purposes.

The owner of the farmland is an 85 year-old farmer Yang Wenshih, who has planted



Plate 2. Sample area includes stepped paddy fields and grass fields. This is a typical habitat for Taipei frogs *Rana taipehensis*. Hwa-Ching Lin.

SPECIES	IUCN
<i>Bufo bankorensis</i> *	LC
Spectacled toad	
<i>Bufo melanostictus</i>	LC
Guenther's frog	
<i>Rana guentheri</i>	LC
Kuhl's fanged frog	
<i>Rana (Limnonectes) kuhlii</i>	LC
Indian rice frog	
<i>Rana (Fejervarya) limnocharis</i>	LC
Latouche's frog	
<i>Rana latouchii</i>	LC
Long-legged frog	
<i>Rana longicrus</i>	VU
Indian bullfrog	
<i>Rana rugulosa</i>	
Taipei frog	
<i>Rana taipehensis</i>	LC
Ornate narrow-mouthed toad	
<i>Microhyla ornata</i>	LC
Meintin tree frog	
<i>Chirixalus (Kurixalus) idiootocus</i> *	LC
White lipped tree frog	
<i>Polypedates megacephalus</i>	LC
Brown tree frog	
<i>Buergeria robusta</i> *	LC
Taipei green tree frog	
<i>Rhacophorus taipeianus</i> *	NT
Chinese tree frog	
<i>Hyla chinensis</i>	LC

Table 1. Frog species discovered in a survey of the study area at Hengshan's farmland, Taiwan: *endemic species of Taiwan; LC, Least Concern, NT, Near Threatened, VU, Vulnerable (IUCN, 2007).

water lilies in the paddy field by himself for more than 20 years. He prepares the soil and plants the water-lily spears in late April and commences harvesting in June to send produce to the market. Water-lily florescence lasts until the end of November, at which point the plants wither. To control the water lily's main pest, *Eoophyla* sp, a small moth with larvae that eat water-lily leaves, Mr Yang would sometimes spread pesticide on his plants (Plate 3). In order to keep the field tidy, he also used herbicides.

Our survey showed that Taipei frogs in the field would become active in April to May, reproduce in June to July and enter hibernation in October to November (Fig. 2). Their active season almost completely overlaps with the water-lily cultivation season. Therefore, in addition to the ecological study, eliminating

the threat from pesticides and effectively improving the habitat became additional important goals for our project. Renting or buying this farmland was not considered to be appropriate because maintaining its present pattern of use was the highest consideration for the habitat-improvement programme.

HABITAT IMPROVEMENT

Our first habitat-improvement initiative for Mr Yang was that Taipei Zoo would compensate him for any financial losses incurred when he stopped using agro-chemicals.



Plate 3. Mr Yang spreads pesticides on his plants.
Hwa-Ching Lin.

However, Taiwan has a long history of farmers using pesticides, which are considered to be necessary for improving the quantity and quality of agricultural products (Li & Lin, 1989; see also Pesticide Information Website at <http://pesticide.baphiq.gov.tw/>). In addition, owing to an ageing population and the lack of labour power in the countryside, old farmers such as Mr Yang work alone and depend heavily on pesticides and herbicides. Hence, it was a great challenge to persuade Mr Yang to stop using these chemicals.

In addition, although the Taipei frog is protected by law in Taiwan, landowners may not welcome this species for fear of disadvantageous limitations on land use and development. Mr Yang allowed us to study the frogs on his land but never showed any interest or attention towards them himself. Therefore, we decided not to approach him about halting pesticide use directly for fear that it might discourage his cooperation, end our access to his land for research and perhaps even jeopardize the study into *R. taipehensis*.

Taiwanese villagers maintain a traditional communication network that strengthens relationships between neighbours and within the

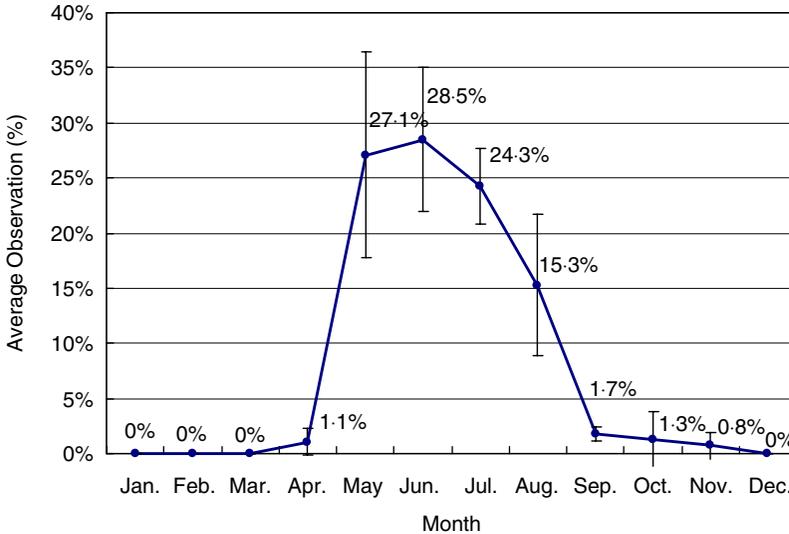


Fig. 2. Occurrence of Taipei frog *Rana taipehensis* in each month during 2002–2006; total observations for 2002–2006; *n* = 931.

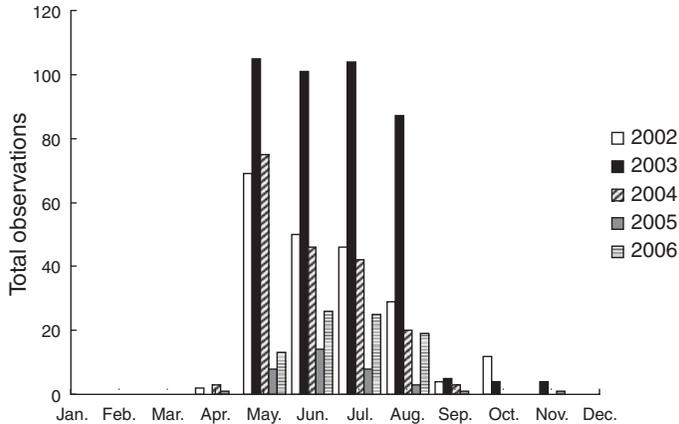


Fig. 3. Occurrence of Taipei frogs *Rana taipehensis* in each month during 2002–2006; total observation for 2002–2006: $n = 931$.

clan. We hoped to work with Mr Yang by contacting his friends and acquaintances through this system. We first visited the Sanzhi Township Office and the Farmers' Association, hoping that the local government and farmers' organization could support our project. In addition, because teachers are influential in the Taiwanese countryside, we visited Hengshan elementary school near our study area. This tiny school of < 100 students is where we met Wu Jinchung, a teacher who loved nature and knew Mr Yang well. In this way, we contacted Mr Yang through his acquaintances and asked them to determine the farmer's opinion about stopping the use of agro-chemicals.

Nevertheless, Mr Yang did not give us a specific response to our project. We invited Mr Wu and relevant members of the Sanzhi Township Office, Farmers' Association and Taipei County Government Bureau of Agriculture to make a formal visit to Mr Yang and promote our project. Mr Yang immediately rejected our proposal because he believed there would be no harvest without using pesticides and the loss in profit was inestimable.

Although our initial approach failed, we worked more closely with Mr Wu, who understood the importance of this land and sometimes joined us in our fieldwork. He also encouraged students to experience this valuable wetland. In November 2001, in the name of Hengshan elementary school, Mr Wu

officially joined our team, participating in the Taipei frog habitat-improvement and wetland-education programme. He also proposed the idea of organizing students to cut weeds for Mr Yang, which would enable him to stop using herbicides. This suggestion was accepted and was our first breakthrough, inspiring us to think about how to persuade Mr Yang to stop using pesticides.

At the beginning of 2002, a new partner joined the programme: Tse-Xing Organic Agriculture Foundation (TXOAF), an NGO Buddhist group organized in 1997. One of the principal missions of this Foundation is to popularize organic farming and guide farmers to abandon agro-chemicals and take up organic-farming methods. TXOAF's purpose for popularizing organic farming is for the love of the earth and life, and so when we explained our project to the Foundation, we quickly received their support.

Taipei Zoo and TXOAF outlines a new habitat improvement programme under which TXOAF, Mr Wu and Taipei Zoo continued to persuade Mr Yang to alter his practices to organic farming, while the Zoo paid for any necessary expenses. If Mr Yang stopped using pesticides, TXOAF pledged that its organic stores would sell at least 120 bunches of the farmer's water lilies per day, thus providing him with a steady income to allow him to continue organic farming.

TIME (HOURS)	8 JUL	9 JUL	10 JUL	11 JUL	12 JUL
1000–1230	The Importance of Wetland Conservation and Education Introduction of Wetland Ecosystem Environmental Ethics Close to Nature	The Crisis and Conservation of Wetlands	Research of Freshwater Fishes in Wetlands	The Freshwater Spiral Shells in Wetlands	Wetland Yard Tour at the Taipei Zoo
1330–1530		Potentiality of the Eco-community: Management and Planning of Tao-mi Village	A Case Study of Community Conservation: Using Farmland tree frog (<i>Rhacophorus arvalis</i>) as an Example	The Plan of Eco-Campus	Workshop
1530–1730	How to Classify “Animals”	The Hydrophyte of Wetlands	The Education of Wetland Conservation	The Aquatic Insects in Wetlands	Final Presentation
1815–2015	Practice of the Fieldwork	Practice of the Fieldwork	The Amphibian and Reptiles in Wetlands	Practice of the Fieldwork	

Table 2. The Course of Wetland Conservation Camp for Community Residents in Sanzhin.



Plate 4. Staff of Taipei Zoo and Tse-Xing Organic Agriculture Foundation at the side of the paddy field persuading Mr Yang to stop using pesticides on his crops. Hwa-Ching Lin.

Beginning in February 2002, counsellor Li Fungchi of TXOAF was entrusted with the task of persuading Mr Yang to accept the new habitat-improvement programme. At that time, Mr Li already had 5 years of experience of persuading farmers to join the organic movement. He initially talked to Mr Yang beside the paddy field as the farmer worked (Plate 4) but found this difficult because Mr Yang seemed dispirited about the counsellor’s visits. Perhaps lacking faith in us, Mr Yang did not seem interested in the new programme.

At the same time, we continued to try to gain more support from community residents and inform them of the presence of this precious wetland. In July 2002, with the cooperation of Mr Wu, we held a 5 day wetland conservation study camp in Hengshan elementary school. The course included an introduction to wetland animals and plants, wetland–human relationships and the crisis facing the wetland. It also contained night walks in the study area (Table 2). More than 80 members from the Sanzhi, Danshui and Shimen communities joined the camp. Most of them were elementary- or high-school teachers and local social workers. After the camp, we received considerable positive feedback. For example, three members said they were willing to provide their farmland for wetland restoration and Taipei frog relocation.

In October 2002, to demonstrate its practicability, the programme’s head within TXOAF,



Plate 5. Taipei Zoo designed an ecological brand for Mr Yang's water lilies and displayed posters in the Tse-Xing Organic Agriculture Foundation's organic shop. *Li-Yi Chen.*

Chung Chanhwa, suggested selling Mr Yang's water lilies in the TXOAF stores as an ornamental rather than an edible product, although they were not organic at that time. Although this thought did not fit within the Foundation's regulations, the proposal received complete support. Thus, in mid-October Mr Yang's water lilies were first displayed in TXOAF's biggest shop in Taipei City, Li Ruhn organic shop. Taipei Zoo designed a promotional poster and gave his flowers an ecological brand. The slogan was, 'Buying Water Lily Flowers, Protecting Taipei Frogs' (Plate 5). Every day, the water lilies that Mr Yang delivered to the shop at 0500 hours were sold out within an hour. Those who knew the story behind the water lilies were willing to buy them. Mr Yang was amazed at the success of the sales. When he entered the shop in person 2 weeks later and saw customers enthusiastically buying his water lilies, he decided to accept our conservation programme and has stopped using pesticides on his farmland since 2003.

In April 2003, Mr Yang was hospitalized as a result of an injured leg, and so the planting of water lily spears was postponed until May. Every team member visited the farmer in the hospital. In June, the water-lily pest *Eoophyla* sp started to reproduce. We hoped that after stopping pesticide use, *Eoophyla* sp's natural predators, the insectivorous aquatic insects, such as *Cybister sugillatus*



Plate 6. Mr Yang displays his newly designed name card, on which is printed a picture of a Taipei frog *Rana taipehensis*. *Li-Yi Chen.*

and *Laccotrephes japonensis*, would increase and control the pest. *Bacillus thuringiensis*, a pathogenic bacterium that infects *Eoophyla* sp larvae and kill them, was used twice. We originally feared that Mr Yang would give up in this period but his attitude was unexpectedly resolute. At the beginning of August, the presence of *Eoophyla* sp was reduced to an acceptable level. Nature provided the best feedback – the Taipei frog population in the field doubled and the number and quantity of aquatic insect species increased significantly (Fig. 3). Unfortunately, some river construction work on the stream bank beside the farmland occurred during the spring and summer of 2004. The irrigating water was polluted by a considerable amount of mud and concrete. As a result, the population of Taipei frog declined drastically in late 2004 and 2005. However, by 2006, the population seemed to be recovering well (Fig. 3) (Lin & Cheng, 2007).

However, one of the greatest achievements is that Mr Yang turned himself into a

practitioner of an organic lifestyle and also a guardian of Taipei frogs. In 2004, Mr Yang showed his newly designed name card, on which was printed a picture of a Taipei frog, to a TV reporter. He proudly described the frog species and ecology of his water-lily field (Plate 6). He also presented the reporter with fruit and bamboo shoots from the farmland and emphasized that these were all organic.

TXOAF has held at least five life-education summer camps for college students since 2003 and more than 6000 students have attended lectures by our team members (H.-C. Lin, L.-Y. Cheng and F.-C. Li), at which we present our conservation philosophy and describe all the efforts involved in saving Taipei frogs. Mr Yang's story has also been shared with the students, describing his change of attitude from incautious individual to willing collaborator to protect the frogs. In 2006, Taipei Zoo held a 'Wetland Conservation Festival' at which Mr Yang was invited to show his pesticide-free water lilies to visitors and describe his journey to becoming a guardian of Taipei frogs.

This story of the zoo and NGO that cooperated to persuade a farmer to stop using pesticides and secure a species from threat brought about more than 15 reports in newspapers and magazines. In addition, there were three special programmes shown on television to introduce this story, including a film called '*Uncle Stone's Lotus Field*' (Stone is Mr Yang's middle name) (Wang & Chu, 2005), issued by the Taiwan Public Television Service. This film was also shown at *Earth Vision*, the 15th Tokyo Global Environmental Film Festival, and was nominated for an Earth Vision Award, appearing in the final top ten of the total 131 films shown (see also <http://www.earth-vision.jp/top-e.htm>).

Although we cannot estimate accurately how many people have heard the story of Mr Yang and the Taipei frogs, the public responses we have had to the educational activities and media reports over the past few years suggest that many people have discovered in amazement that humans and nature can coexist harmoniously, as long as an appropriate path to initiating change can be found.

CONCLUSION

When we decided to persuade Mr Yang to stop using pesticides in order to improve the habitat of the Taipei frogs, the Taipei County Government Bureau of Agriculture and the Sanzhi farmers' association suggested that we buy or rent the land to prevent it from being destroyed. However, this was never in our interest because we did not want to eliminate its original use solely to conserve the Taipei frog (see also Chang *et al.*, in press). In the past 20 years, there were several cases where conservation activity blocked land development, resulting in the misunderstanding that conservation and human development are conflicting approaches. In fact, seeking the balance between conservation and local-community benefit has become a new focus of resource conservation and management (IUCN, 1993; Western & Wright, 1994; Pimbert & Jules, 1997; Holdgate & Phillips, 1999). Paddy fields are important frog habitats but they are also man-made wetland ecosystems. Therefore, it is not reasonable to exclude the original land usage in favour of conservation. Furthermore, the sudden change or cessation of human-evolving factors would result in an unpredictable environmental impact on the man-made ecosystems, such as farmland, and would likely cause habitat degradation. Thus, our aim was to maintain Mr Yang's original farming patterns while conserving the Taipei frog by stopping the use of herbicides and pesticides. Throughout this project, we have shown that agricultural development and resource conservation can co-exist.

Mr Yang did not accept our suggestion to stop using agro-chemicals until 2002. For an old farmer who has used agro-chemicals for more than 20 years, maintaining the *status quo* may have appeared to be the best strategy to ensure his harvest. Later, he accepted our programme because of the guarantee of basic profit, although he indicated that he was also moved by our ceaseless spirit. Mr Yang's actions after 2004 demonstrate that, although he initially accepted our programme for profit, as time went by the philosophy of

'rejecting the use of herbicides and pesticides' had become incorporated into his own life style. Therefore, he turned all his crops over to organic-farming techniques.

Local-community profit should be included in all resource-conservation and management strategies, or should even become the core thought (Lucas, 1992; Lu, 2001). When planning conservation actions, it is necessary to take into consideration not only natural-resource availability but also the needs of the local community. If the human element is ignored, conservation will become an unreachable goal.

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REFERENCES

- BEEBEE, T. J. C. (1997): *Ecology and conservation of amphibians*: 214. London: Chapman Hall.
- CHANG, J. C. W., TANG, H.-C., CHEN, S.-L. & CHEN, P.-C. (In press): How to lose a habitat in 5 years: trial and error in the conservation of the Farmland green tree frog *Rhacophorus arvalis* in Taiwan. *International Zoo Yearbook* **42**. DOI: 10.1111/j.1748-1090.2008.00045.x.
- CHOU, W. H. (1993): Tadpole and call of *Rana taipehensis* in Taiwan. *Bulletin of National Museum of Natural Science* **4**: 77–86.
- CHOU, W. H., CHANG, H. W. & LUE, K. Y. (1993): Notes on distribution of the frog *Rana taipehensis* in Taiwan. *Bulletin of National Museum of Natural Science* **4**: 183–186.
- CHUANG, M. S. (2006): The discussion on the agrobiodiversity of the distribution of Taipei grass frog in Tainan county. In *The conference of symposium on the scheme vision of village features, Taipei, November 11, 2006* C3: 1–12. Nantou, Taiwan: Soil and Water Conservation Bureau. <http://en.swcb.gov.tw>
- HOLDGATE, M. & PHILLIPS, A. (1999): Protected areas in context. In *Integrated protected area management*: 1–24. Walkey, M., Swingland, I. R. & Russell, S. (Eds). London: Kluwer Academic Publishers.
- IUCN (1993): *Parks and progress*: 240. Gland, Switzerland: IUCN.
- IUCN (2007): *2007 IUCN red list of threatened species*. Gland: IUCN. <http://www.iucnredlist.org>
- LI, G. C. & LIN, H. T. (1989): Pesticides and soil. *Journal of Taiwan Agricultural Chemicals and Toxic Substances Research* **13**: 1–8. [In Chinese.]
- LIN, C. F. (2000): *Amphibians and reptiles in Tainan*: 163. Chichi: Endemic Species Research Institute, Council of Agriculture, Executive Yuan, R.O.C. [In Chinese.]
- LIN, H. C. & CHENG, L. Y. (2007): Conservation of the endangered Taipei frog, *Rana taipehensis*. In *The conference of understanding agriculture's effects on amphibians and reptiles in a changing world, February 6–8, 2007*: 34. St Louis, MO: US Geological Survey (USGS).
- LU, D. J. (2001): Collaborative and participatory management of natural resources. In *The symposium on biodiversity conservation strategies of Taiwan National Park, Taipei, December, 1999*: 127–139. Lin, Y. S. (Ed.). Taipei, Taiwan: Construction and Planning Agency. [In Chinese.] <http://www.cpami.gov.tw/english/enindex.php>
- LUCAS, P. H. C. (1992): *Protected landscapes: a guide for policy-makers and planners*: 297. London: Chapman Hall.
- LUE, K. Y., DU, M. J. & SIANG, G. S. (1999): *An illustrated handbook for Taiwan amphibians and reptiles*. Taipei: Nature Magazine, The Society for Wildlife and Nature. [In Chinese.]
- OHLER, A. & MALLICK, P. K. (2002): *Rana (Hylarana) sensu Dubois (1992) in India and the identity of Hylarana tytleri* Theobald, 1868. *Hamadryad* **27**(1): 62–70.
- PIMBERT, M. P. & JULES, N. P. (1997): Parks, people and professionals: putting 'participation' into protected-area management. In *Social change and conservation; environmental politics and impacts of national parks and protected areas*: 297–330. Ghimire, K. B. & Pimbert, M. P. (Eds). London: Earthscan.
- POLASKY, S. (2007): Economics and agriculture: past, present and future. In *The conference of understanding agriculture's effects on amphibians and reptiles in a changing world, February 6–8, 2007*: 41. St Louis, MO: US Geological Survey (USGS).
- WANG, C. L. & CHU, S. C. (2005): *Uncle Stone's lotus field* (DVD) (24 mins). Taipei: Taiwan Public Television Service.
- WESTERN, D. & WRIGHT, R. M. (1994): The background to community-based conservation. In *Natural connections: perspectives in community-based conservation*: 1–12. Western, D. & Wright, R. M. (Eds). Washington, DC: Island Press.
- YANG, Y. R. (2005): *Field research handbook for Taiwan amphibians*: 127. Taipei: The Forestry Bureau, Council of Agriculture, Executive Yuan, R.O.C. [In Chinese.] <http://www.forest.gov.tw>

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