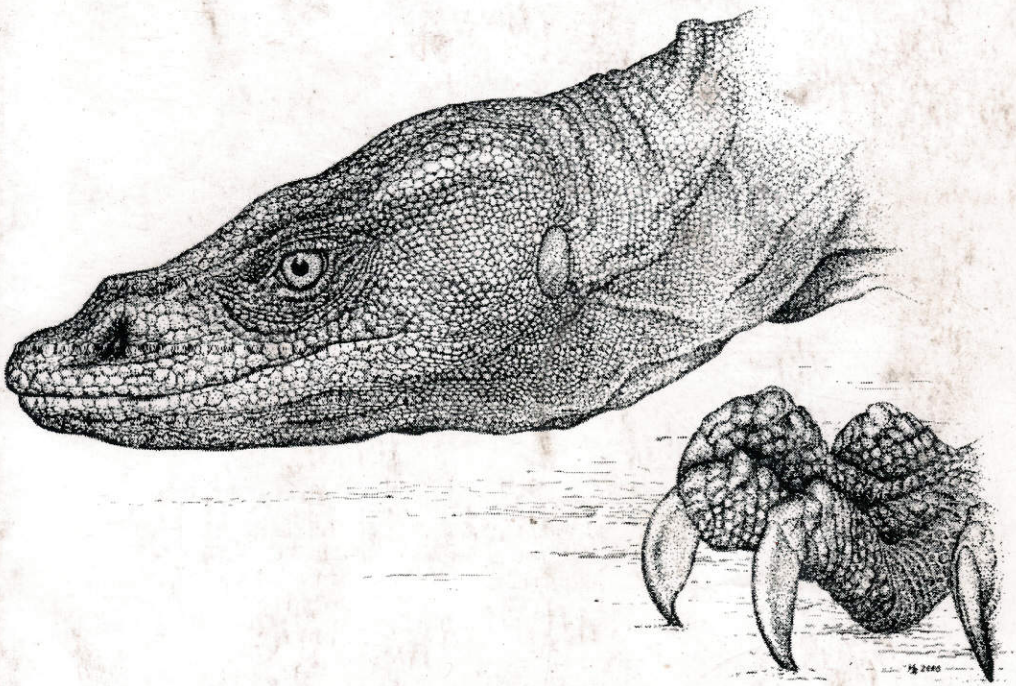
SILLIMAN JOURNAL

Special Visayas Conservation Issue



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Notice to Authors

The Silliman Journal welcomes contributions in all fields from both Philippine and foreign scholars, but papers should preferably have some relevance to the Philippines, Asia, or the Pacific. All submissions are refereed.

Articles should be products of research, taken in its broadest sense; a scientific paper should make an original contribution to its field. Authors are advised to keep in mind that Silliman Journal has a general and international readership, and to structure their papers accordingly.

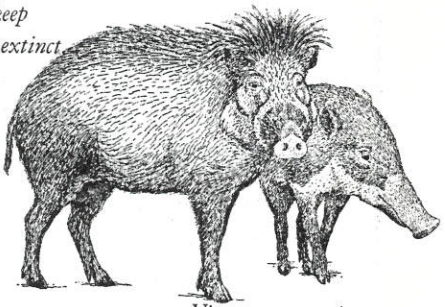
Silliman Journal also welcomes the submission of "Notes," which generally are briefer and more tentative than full-length articles. Reports on work in progress, queries, updates, reports of impressions rather than research, responses to the works of others, even reminiscences are appropriate here. Book reviews and review articles will also be considered for publication.

Manuscripts should conform to the conventions of format and style exemplified in this issue. Whenever possible, citations should appear in the body of the paper, holding footnotes to a minimum. Documentation of sources should be discipline-based. Pictures or illustrations will be accepted only when absolutely necessary. All articles must be accompanied by an abstract and must use gender fair language. All authors must submit their manuscripts in duplicate, word-processed double-space on good quality paper. A diskette copy of the paper, formatted in MSWord 6.0 should accompany the submitted hard copy.

The Editorial Board will endeavor to acknowledge all submissions, consider them promptly, and notify authors of its decision as soon as possible. Each author of a full-length article is entitled to 20 off-print copies of his/her submitted paper. Additional copies are available by arrangement with the Editor or Circulation Manager before the issue goes to press.

EDITOR'S NOTES

Man has been endowed with reason, with the power to create, so that he can add to what he's been given. But up to now he hasn't been a creator, only a destroyer. Forests keep disappearing, rivers dry up, wild life's become extinct, and the climate's ruined and the land grows poorer and uglier everyday.
— Anton Pavlovich Chekhov



Visayan warty pig

Until he extends the circle of his compassion to all living things, man will not himself find peace.
— Albert Schweitzer

Our moral and ethical responsibility is to protect other species in the spirit of husbandry rather than in an attitude of conquest.
-- Charles Southwick

IN THIS ISSUE: It is said that after reading a 1633 report of Concord, Massachusetts, Henry David Thoreau sat down to consider the ways in which Concord had been altered by two centuries of European settlement and expansion. In *Walden Pond* he listed animals and trees that were no longer present in his beloved hometown in 1854 and concluding that the changes had been drastic, wrote:

> *I take infinite pains to know all the phenomena of spring, for instance thinking that I have here the entire poem, and then, to my chagrin, I hear that it is but an imperfect copy that I possess and have read, and that my ancestors have torn out many of the first leaves and grandest passages, and mutilated it in many places. I should not like to think that some demigod had come before me and picked out some of the best stars. I wish to know an entire heaven and an entire earth.*

Thoreau was of course not the first to comment on the changes in the environment he saw around him but what he said 1854 and what other individuals as different from each other as Chekhov, Schweitzer, and Southwick have expressed in their respective generations continues to resonate to the present with even greater urgency at the alarming rate and scale the world is losing a profusion

of plants, animals, and micro-organisms that make up the planet's rich biological diversity. According to Elizabeth Dowdeswell, Executive Director of the United Nations Environment Program (UNEP) in a speech delivered at the Convention on Biological Diversity, "there are indications that humanity is on the verge of the a new wave of massive extinctions".Thus, with the threat to all species never been greater, there is a need for society to establish a fine and finely negotiated partnership with the environment—the prospect for the failure of such partnership is annihilation.

Silliman Journal takes pride in being the forum for expressing and disseminating echoes of this continuing concern for the environment. Since its first publication, Silliman Journal has committed itself to support conservation by devoting special issues to topics about the environment. This present issue continues our work on the previous special issue which featured the conference proceedings of the Wildlife Conservation Society of the Philippines (vol. 42:2 2001). For this special edition we focus primarily on conservation work in the Visayas and draw much of the inspiration from Professor Eberhard Curio of the University of Ruhr and Chair of the EU Biodiversity project for ASEAN Regional Center for Biodiversity Conservation whose work with the Philippine Endemic Species Conservation Program (PESCP) in Panay Island has given us a model of commitment to emulate. For this purpose we have invited Prof. Curio to write the Preface for this issue to introduce the work of PESCP, as well as present for debate conservation issues in this country and the attendant problems confronting conservationists.

Although at the start we originally intended to publish in this issue only the works emanating from the PESCP, it soon it became apparent from the submissions we have received that other works on the Visayas raised equally urgent issues regarding biodiversity conservation in the region and clamored for space in our journal. In the end, we decided to widen our scope and included four contributions from the PESCP and five others from different conservation groups and individuals working on areas as diverse as birds, forest, frogs, mangroves, and marine reserves. This decision to present the Visayas as a geopolitical and biogeographic region providing the backdrop for conservation work highlighted in this

collection leads us rather serendipitously to the thematic focus of this issue.

Following this thematic focus, this issue opens with the first four articles from the Philippine Endemic Species Conservation Program (PESCP) in Panay Island. Founded by Professor Eberhard Curio of the University of Ruhr in Germany, the PESCP started its work on Panay in 1996. The PESCP research station is located in the Northwest Panay peninsula where significant stands of low-elevation rain forest harbor a variety of endangered endemic species of plants and animals. At this site research facilities have been established which conduct studies on the area's fauna and flora and undertake the overall conservation of the natural resource base on the peninsula. Among its notable accomplishments are the establishment of conservation and awareness programs for sustainable development, the conservation of the highly endangered Writhed-billed Hornbill (*Aceros Waldeni*), watershed management, rehabilitation and release of wildlife, livelihood and agricultural improvement, and the BIOPAT Mabitang Project for which its project herpetologist, Maren Gaulke, takes the credit for providing science the first descriptions of this rare lizard in 2001.

Graphically introducing our thematic focus is the fine artwork in the cover of this issue by the artist, Helga Schulze, of the Department of Neuroanatomy at the University of Ruhr in Bochum. Chosen to introduce our lead article, this exquisite drawing has been made especially for the PESCP and is the first representation of the rare Mabitang in this genre. This illustration and that of a few samples of other endangered species in the area featured in this issue, are Helga Schulze's contribution to conservation. Her art works poses the challenge that the serious business of conservation is not the sole responsibility of field biologists and other specialists but is also the concern of every individual in this planet whose survival is at stake by the rapidly depleting resources.

Leading this collection is the article *Varanus mabitang, a rare monitor lizard from Panay Island and a new conservation target* by Maren Gaulke, Eberhard Curio, Arnold Demegillo, and Narciso Paulino. This article is among the few that has come out describing the rare *varanus* species, known locally as Mabitang. According to the authors, this blackish, arboreal

lizard is confined to forested areas of NW and W Panay. It has a vegetarian diet, consisting of fruits and leaves of different forest plants. The authors contend that due to the restricted range and its specialized habits, the Mabitang is a threatened species and thus its protection must be directly correlated to the protection of its habitat.

The next article by Stefan Luft, Benjamin Tacud, Henry Urbina, and Felimon Geronimo on the *Visual Fruit Preferences of Visayan Tarictic Hornbills, Penelopides panini panini (Bucerotiformes: Bucerotidae), and Musky Fruit Bats, Ptenochirus jagori (Megachiroptera: Pteropodidae), in Cafeteria Experiments* reveals how Visayan Tarictic Hornbills (*Penelopides panini panini*) and Musky Fruit Bats (*Ptenochirus jagori)* choose their fruits. Findings from these cafeteria experiments using test fruits with different wavelength reflection characteristics indicate that while hornbills preferred red and blue test fruits, fruit bats showed a preference for yellow and red test fruits. The authors argue that although fruit bats are color blind, reflection properties of fruits might support visual guidance for foraging bats under dim light conditions.

Notes on fruit consumption of the Philippine Bulbul (Hypsipetes philippinus) and its quality as a seed disperser by Jens Schabacker & Eberhard Curio follows. This paper compiles data on 49 tree species used for their fleshy fruits by the Philippine Bulbul and describes their mode of consuming the fruits and dispersing the seeds that eventually benefits the environment. The authors contend that because it is a generalist frugivore and occurs in abundance, the Philippine Bulbul may be among the most important seed dispersers in the Visayas region.

The next article by Andreas Hamann on *The North Negros Forest Reserve: a biodiversity hotspot at risk* outlines the results of surveys, research, and conservation efforts that have been carried out between 1995 and 2000 by a team of scientists and environmental workers who conducted habitat surveys, species inventories, ecological research, and interviews with local people in the North Negros Forest Reserve (NNFR), Negros Occidental. The habitat survey revealed that 50 years after its establishment the reserve still holds 4,700 ha of mid-elevation old growth forest 5,200 ha of

high-elevation mossy forest, and 6,600 secondary forest. The author claims that despite its small size, the NNFR contains a stunning diversity of habitats, mainly due to its elevational gradient. The paper includes results of interviews and site inspections at 20 villages in the reserve which pointed towards some of the immediate threats to the reserve and its wildlife: small scale logging, forest extraction, and hunting. The article concludes by proposing a number of important first steps to constructively manage and protect the reserve.

The following article entitled *The advertisement calls of two endangered species of endemic Philippine frogs: Platymantis spelaeus and P. insulatus (Anura; Ranidae)* by Rafe M. Brown, Cynthia N. Dolino, Ely Alcala, Arvin C. Diesmos, and Angel C. Alcala provides the first published accounts of the acoustic mate-recognition signals of the Negros cave frog, *Platymantis spelaeus*, and the Gigante Island frog, *P. insulatus*. According to the authors, both species are endemic to the Visayan Pleistocene Aggregate Island Complex (and are from Negros and Gigante islands, respectively) and are considered to be at some level of vulnerability of extinction due to the activities of humans in their very restricted geographical ranges. The article compares the mating calls of each species to other taxa in the previously-defined species group to which each belongs and notes call characteristics that uniquely diagnose each species. According to the authors, call bioacoustics are powerful techniques for studying species-specific behavioral and neurophysiological attributes of Philippine frogs. The authors expect that several more endemic Visayan species may be discovered in the near future through on-going application of these techniques to problems in Philippine frog taxonomy and behavioral ecology.

The next article is by a group of young and dynamic field biologists, namely Lisa Marie J. Paguntalan, Juan Carlos T. Gonzales, Andres Tomas L. Dans, Mery Jean C. Gadiana, Marisol dG. Pedregosa, Apolinario Cariño, and Cynthia N. Dolino. *Birds of Banban, Central Negros, Philippines: Threats and Conservation Status* compiles data of existing bird species in the area based on surveys conducted from March to April 1999. Their survey reported massive reduction of forest from some 4,956 ha of extensive mature

secondary forest in 1991 to mere 1,559 ha in 1999, which in turn has severely affected the populations of bird species in the area. Their findings revealed that mining, quarrying activities, and the local development of the area have been largely responsible for the increasing devastation and fragmentation of the forest. For this reason, the writers contend that no less than an immediate conservation action is needed for the preservation of the forest and its wildlife inhabitants.

A related study on *The Status of threatened and Endemic Birds of Siquijor Island, Philippines* also by the group of Philip Godfrey C. Jakosalem, Lisa Marie J. Paguntalan, Marisol dG. Pedregosa, Mery Jean C. Gadiana, and Reginaldo G. Bueno is based on surveys conducted on three remaining forest patches of Siquijor Island, Central Visayas, Philippines from September 11 to 25, 2001.Using mist netting and line transects with ethnobiological survey, the team observed a total of 53 species of birds and four of the five endemic subspecies (Yellow-bellied Whistler *Pachycephala philippensis siquijorenses,* Orange-bellied Flowerpecker *Dicaeum trigonostigma besti, Everett's* White-eye *Zosterops everetti siquijorensis,* and Streak-breasted Bulbul *Ixos siquijorensis siquijorensis*). As in their other article, this paper points to habitat destruction, along with hunting, as the most serious threat to wildlife on the island.

The next article by Richard King, Craig Turner, Terence Dacles, Jean-Luc Solandt,and Peter Raines on *The Mangrove Communities of Danjugan Island, Philippines* represents the first detailed inventory of the mangrove resources of Danjugan Island, completed recently as part of the Danjugan Island Biodiversity Survey conducted by Coral Cay Conservation in partnership with the Philippines Reef and Rainforest Conservation Foundation (Inc). The results of the completed inventory of all mangroves of the island suggest that the island supports very diverse (14 true species identified) and abundant communities that vary with location on the island. These are discussed in this paper in terms of their geographic location and potential conservation value.

The final article in this collection deals with a study conducted on a location that geographically no longer belongs to the Visayas region. Yet this issue takes exception to include

this paper in recognition of the significance of its findings not only for the Visayas area but for many coastal regions in which marine life is constantly under threat by overfishing and other destructive practices. Needless to mention, still one more reason that qualifies this paper for inclusion in this collection is that its authors are at the forefront of marine life conservation studies at the Marine Laboratory and the Angelo King Center for Research and Environmental Management at Silliman University, itself situated centrally in the Visayas.

In this article, *Preliminary notes on Mantigue Island capture fisheries: implications of a marine reserve,* Aileen P. Maypa, Angel C. Alcala, and Gary R. Russ report the first part of the Before-After-Control-Impact Pair (BACIP) results for Mantigue Island fishery yield designed to evaluate the effectiveness of established marine reserves and detect their impacts on fishery. Their findings showed that the reef/seagrass fisheries of Mantigue Island may have reached growth overfishing as indicated by the low reef/seagrass fish yield and the data on fish lengths of some species caught. The authors argue that if unsustainable fishing practices are continued, further degradation of fishery resources may move up to the higher levels of overfishing and this in turn will have adverse impact on the economy of island and coastal communities largely dependent on fishing. According to the authors, an immediate management action has been proposed and a marine reserve in the area is now being established through community based management.

Despite the diversity of their perspectives and the variety of their disciplinary backgrounds, the authors in this collection are one in pointing out the potentially catastrophic effect of reduced biological diversity. In the face of this impending catastrophe, they press unanimously for the enhancement of scientific knowledge through improved biological surveys and research designed to identify factors limiting population viability, while calling for the identification of habitats and species of special concern, and methods to protect them. On the one hand, they stress the importance of introducing effective restoration methods for ecosystems or species of concern; at the same time, they underline the need to improve management techniques based on scientific

knowledge of the conservation of biological diversity. A shared concern of the writers in this collection is the broad-based education efforts regarding the importance of biological diversity and the need for conservation, and the use of cooperative program among government agencies, public and private ventures, and the communities involved. Finally, as the articles in this issue imply, unless a set of clear objectives, well-defined mechanisms for action, and a strong commitment from all stakeholders are in place, future efforts for conservation and management of natural resources are bound to fail.

Clearly, the question faced by society today is how to balance our need to grow with our responsibility to protect our array of ecosystems and species. If we are to find our way to sustainability, conservation must become a reality not just in our daily lives, but must be entrenched in the basic institutions and practices of our culture. As Gandhi has reminded us, "what we are doing to the forests of the world is but a mirror reflection of what we are doing to ourselves and to one another." As the articles in this collection have highlighted, the challenge of conservation is critical. Silliman Journal congratulates the contributors in this issue for taking the lead in conservation and widening our understanding and appreciation of the problems faced in the world, and the importance of biodiversity in that context. In closing, I wish to leave thoughtful readers of this issue with a special invitation and hope that they take up the challenge:

I have come to terms with the future.
From this day onward I will walk easy on the earth.
Plant trees.
Kill no living things.
Live in harmony with all creatures.
I will restore the earth where I am.
Use no more of its resources than I need
And listen, listen to what it is telling me.
— M. J. Slim Hooey

Acknowledgments

This particular issue is unique in a number of ways and mainly that it is an experiment in distance editing. Unlike the past issues which I have had the privilege of editing, this present issue is a true product of cybertechnology. Although the internet has long been part of our publication work, allowing us with incredible speed to receive and transmit submissions, get in touch with authors and reviewers and establish vital network connections, including virtual friendships with them, this is the first time we are embarking on distance editing. Distance in the sense that while half of the production work I finished while I was still at Silliman, much of the remaining editorial work and editorial notes have been completed after I have moved to Germany.

My profoundest thanks go to the Vice President for Academic Affairs, Dr. Everett Mendoza for suggesting that I take Silliman Journal with me and work on it online—he could not have guessed how much this project helped to carry me through the isolation and biting cold of German winter; to President Agustin A. Pulido for so much of the confidence and support needed to carry out this work, and especially for his kind understanding in allowing me to go on leave at a difficult time when I was most needed at Silliman; to my colleagues in the Editorial Board for trusting in my ability to deliver the finished product even from halfway across the globe; and to the Department of English and Literature for remaining generous with the use of our office equipment, especially to my colleagues whose unfailing support at times when I was most frantic I missed immensely during the final stages of work on this issue—I think of them with the same fondness I usually reserve for exquisite sunrise peeking out of the calm blue waters of the Boulevard.

Particularly patient through the long wait for the journal to get to press have been our authors—to them my profound thanks for having been incredibly forbearing. Receptive to critical comments and prompt in returning their revisions, they made working on this issue a truly gratifying undertaking.

Hopefully, they will find our efforts well-placed.

The generosity of our reviewers to share their time with our manuscripts is matched only by the keenness of their insights and the thoroughness of their reading. Much appreciation goes especially to some of them who provided not only critical comments but also preliminary editing, sparing me many hours of editorial work

Special thanks go to Helga Schulze of the Department of Neuroanatomy, Ruhr University-Bochum, Germany for the exquisite artwork that graces the cover of this issue as well as this editorial. In order to give justice to her beautiful drawing of the rare Mabitang, we have decided to take exception from our official cover color of burgundy and opted for white in this issue to bring out the fine details of this work of art. Our gratitude to her for generously sharing with Silliman Journal these beautiful illustrations.

It is also my special pleasure to thank Prof. Eberhard Curio for demonstrating to me another view of conservation and that is its relevance to a humane and politically engaged view of contemporary life. In recognition of his conservation initiatives in this country, we invited him to write the preface for this special issue. Silliman Journal is truly privileged that he has kindly accepted this invitation in the midst of his other urgent duties.

Finally, my greatest thanks are reserved for two people, literally worlds apart from each other—Dr. Christian K. Schales in Germany and Prof. Philip van Peel at Silliman.

Dr. Schales provided the infrastructure that made online editing more than a virtual reality. Besides setting up my work place and creating just the right environment for this endeavor, he furnished all the furniture, equipment, and materials—needless to mention, donating virtually everything from the PC, the network connection, the permanent access to the internet, the laser printer, the paper, to the last staple—thus providing Silliman Journal a major contribution.

For working on the final formatting of this issue for camera ready without me breathing down his back, and for shepherding this issue to press in my absence, Philip van Peel

must take the credit for any enjoyment the reader might gain over this finished product. I am certain that this experiment in distance editing would not have succeeded without someone as competent and as creative as him on the other end to put things together.

Without the invaluable contributions of Dr. Schales and Prof. Van Peel, our experiment in distance editing would not have succeeded with such ease and this issue would not have seen the light. Many thanks beyond words!

Ceres E. Pioquinto
Munich, Germany

PREFACE

Among the hotspots of Philippine biodiversity, the Visayas feature prominently on a global scale. At the same time, this region is sadly ranking high in regard to habitat, i.e. forest and reef destruction, with Cebu, Masbate, and Ticao being virtually denuded. Given this two-tier impasse, it is laudable that an impressive collection of nine papers on research on and conservation of selected Visayan islands, i.e. Negros, Panay, Gigante included, and Siquijor, could be assembled for publication. The prominence thus given to the Visayas region aptly reflects their conservation importance. This is so because, different from customary but ill-informed and hard-die thinking, the Visayas should be assigned top priority among Philippine island biotas when it comes to implementing conservation activities.

Prioritization for conservation so far has relied on a static, rather narrow view that emerged from a number of costly, nationwide symposia. This view is based on counting numbers of species, landscapes, socio-economic factors, and other quantities. What has been left out is a dynamic approach which considers the imminent threat to the island biotas at stake. This threat is projecting the dieback of fauna and flora into the future that is to be expected from habitat destruction. Habitat loss varies immensely across islands, and taking it into account *in addition* to the orthodox counting of species, endemics, and the like, yields a new and broadly-informed view on priorities. Accordingly, the West Visayas rank equal to the larger and, hence, more species-rich islands of Luzon and Mindanao. They make up for their smaller species numbers by their larger expected dieback ('faunal relaxation') due to their vastly larger habitat loss. Unfortunately, this dynamic and, thus, more realistic view had been largely unheeded by the conveners of the prioritization workshops mentioned earlier. In its most grotesque spin-off, the static prioritization approach ranked little-threatened Palawan neck-to-neck with the less threatened faunas of Luzon and Mindanao.

This in turn led most recently to the equally ill-informed allocation of a major funding by the Critical Environmental Partnership Fund to these three large islands, leaving in particular the West Visayas virtually out. It is hoped that the present special Visayas issue of Silliman Journal would bring about a realignment of the funding decisions.

However, funding is not a panacea for the country's environmental misery. 'Conservation' has become a buzzword. The field comprises a gamut of activities designed to preserve pieces of nature. 'Conservation' begins with collecting information during surveys on species, their mutual interrelationships, their habitats, and the endangerment thereof. For many people surveys have become tantamount to 'conservation' and thereby an end by themselves, which they are not. First, they are only a start, optimally leading to consummate conservation activities. Second, they are usually restricted to recording which species occur where. With few exceptions (see below), surveys thus leave out the fundamentally important relationships among species in a community. When properly analyzed, these relationships add weight to conservation-driven postulates. For example, shooting out the fruit-eating birds and fruit bats deprives the forest of its most important pollinators and seed dispersers. This in turn prevents the trees from reproducing and the forest from regenerating. In this connection it is important to note that the Philippine Endemic Species Conservation Project (PESCP) has voiced alarm that such extermination would adversely affect around 60 % of seed dispersal-dependent forest trees in North Negros (NNFR) and, similarly, elsewhere (see also the article by Schabacker & Curio). Yet, this red alert signal has gone unheeded by the political decision-makers. In conclusion, conservation will fail if it is not planned out and based on a broad understanding of biological communities. Conservation needs a clear, yet complex agenda that comprises more than conducting surveys.

A holistic view of conservation requires yet another pillar to rest upon. Any hands-on *in situ* conservation work will have

to take on board the local people. Idealistic approaches ignoring the socio-economy of local stakeholders remain fragmentary at best, and will totally fail at worst. It is gratifying to see that *in situ* work seeks the cooperation with the communities at stake. This takes the form of education as, e.g., in the fisheries project of Maypa et al. (this issue), the Danjugan Island Project of the Philippines Reef and Rainforest Conservation Foundation, Inc., the Polillo Ecology Stewardship Project, the EU-ARCBC funded projects conducted on Negros by SUAKCREM (see Brown et al., this issue) and on Panay by both BioCon and PESCP, to name only a few. Yet education is only a first step. Livelihood support programs have to follow to make conservation a success story. In exceptionally lucky cases sheer transfer of knowledge can lead to income generation, yet generally the latter requires extra funds usually exceeding those needed for education. It therefore is no surprise that conservation projects implementing this last, and usually crucial step, are few. In the Visayas, the PESCP is one of them though it painfully feels the shortage of funds when striving at an extension of its coverage from the NW Panay Peninsula into the Panay Mountains.

There are many foreign-funded development and human-aid projects, and conservationists devoid of funding are well advised to include those projects encompassing the maintenance of biodiversity eventually as well. Only when thus are operating more comprehensively, these charity-driven projects will serve their goals effectively and in the long-term. At a subtler level, many of these charity-centered projects use the buzzword 'conservation' to capitalize on a trend gaining momentum since the Rio Summit, thus deceptively misusing the buzzword in yet another, though more harmful way than mentioned above. Accordingly conservationists are well advised to divulge to donors this dishonest use of conservation, unless those projects take on board biodiversity conservation as well.

Given the competitive nature of fund-raising for conservation, concerned donors are increasingly asking project

proponents for indicators of success. This is because, for quite some time, it has been becoming clear that literally thousands of conservation projects worldwide report on their results in often eye-catching ways; popularization ranges from expensive glossy paper brochures to even more expensive TV documentaries. However, success is rarely documented in a rational and quantitative way in that, for example, a pre- and a post-education assessment is being conducted. One of the laudable exceptions to this is the study by Maypa et al. (this issue) pointing the way of how success can be measured by BACIP. Likewise, the PESCP is about to report on the success of a Wildlife Conservation Education Project utilizing quantitative indicators of success proposed by Margoluis & Salafsky (Measures of success: Designing, managing and monitoring conservation and development projects. Washington D.C., 1998). Only by a stroke of good luck, success may be so easily visible requiring no sophisticated measures to gauge its magnitude. This happened, for instance, when in 2002 the President of the Philippines declared the NW Panay Peninsula as a Protected Area, thanks to the year-long lobbying by conservationists spear-headed by PESCP. Another less spectacular way of popularizing and attaining success is publishing in a peer-reviewed journal. This should be the most obvious thing to do, given the ever increasing, vast amount of dubious 'grey literature'. Clearly, donors of all ranks should look more and more at rational, objective indicators of success which would quickly separate the wheat from the chaff.

This preface may be the proper place for making a remark on fund-raising for conservation within the country. Regrettably, there is a deplorable reluctance in donating funds, even among extremely rich individuals in the upper echelons of the society. By making the public aware of what is at stake in this unique country and thus makethe pendulum swing back, Filipino scientists and conservationists may yet succeed in changing this attitude. Furthermore, since the growing trend among foreign donors is to ask their potential local counterparts to step up their own

contribution, local project holders often have to work hard to raise funds in order to maintain the foreign backbone funding of their projects. This happened recently with the Frankfurt Zoological Society, the main donor of PESCP. To facilitate this request, PESCP has recently gone online (www.pescp.org) which might enhance chances of raising the necessary funds for meeting the demands of its highly complex agenda with five interrelated goals. The changing attitude of foreign donors, requesting counterparting from the recipient country, is exacerbating the problem of within-country fund-raising, and is hopefully sending an alerting signal to Filipino staff of conservation projects. It is they who can convince best the Filipino elite of the pervasive worth of conservation for human well-being.

Yet funding is only one stepping-stone on the road to success. Of equal importance is the human dimension of project implementation. It is widely acknowledged that the success of any project is deeply rooted in the dedication of both researchers and practitioners, Filipinos and foreign nationals alike. That the job of doing field work is tough is revealed by the number of volunteers who drop out of a project mainly because of the physical challenge involved in this type of undertaking. For this reason, project leaders also need to strive to keep happy the few who persevere. This again is often intertwined with the problem of finances and it is here that the attention and capacities of project leaders are becoming distracted from their genuine tasks. In order to be efficient managers and fund-raisers at the same time, project leaders ofen find themselves severely constrained in carrying out the tasks they have originally set out to accomplish. Here we come full circle: It is only with happy co-workers that we make the maximum of our slim resources. In this sense there is a positive feedback from funding on success, and from success on funding.

Looking at in situ work with a sober mind, we perceive yet another equally human hurdle on the road to success, and that is the personal risk to the fieldworker. Field researchers and conservation workers who keep an eye on violations of the

(wildlife) law often find themselves in a tangle with different interest groups. For instance, Filipino field researchers in South Negros became entangled in the conflict between the military, the NPA, the RPA, armed loggers, and the farmers. Similarly another project had to be folded down for half a year because of serious insurgent problems involving the local military. Consequently, much valuable time and creativity (Brown et al., this issue) which should have gone into research are being squandered in adopting safety measures to mitigate this personal risk. Rather than belittling the true risks involved in these projects, decision-makers should greet any tangible result of *in situ* work obtained under these most demanding conditions with greater respect.

In the current race among conservationists against time, it has become evident that research should be conservation-oriented (e.g. Hamann; King et al., this issue). Sometimes it has to be 'quick and dirty'. Aside from the surveys mentioned, there is a dearth of information on many conservation-related issues. For example, a proper census of population density or degree of inbreeding is not even available for a handful of critically endangered species. Hence, although assessments of minimum viable population sizes, for instance, remain currently utopian, they are badly needed for species-based agenda and must be vigorously pursued. A debate on field research by its practitioners often ends with the despairing sigh about the lack of funds. However, funds are not a panacea for many research topics asthe study of Luft et al. (this issue) on the role of color in fruit selection by hornbills and fruit bats demonstrates. Requiring no more than ripe bananas and food colors, this research provides an example that such a project need not be costly and, as the perceptive referee of this article has aptly pointed out, "Fílipino students and researchers alike would do well to heed this underlying message". Indeed, for much of conservation research one needs no more than

a clear hypothesis, pencil, and paper.

I congratulate the editors of Silliman Journal for highlighting both the research on and the plight of Philippine biodiversity by topically focusing attention on the biological treasures of the Visayan islands.

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Varanus mabitang, A RARE MONITOR LIZARD FROM PANAY ISLAND AND A NEW CONSERVATION TARGET[1]

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ABSTRACT

Despite its huge size (minimal total length of 175 cm), the Varanus mabitang became known to science only in 2001. According to present knowledge, this blackish, arboreal lizard is confined to forested areas of NW and W Panay. It has a vegetarian diet, consisting of fruits and leaves of different forest plants. Due to the restricted range and its specialized habits, the Mabitang is a threatened species. Its protection is directly correlated to the protection of its habitat.

Introduction

Shortly after PESCP (Philippine Endemic Species Conservation Project) started its work in a previously little known lowland rainforest area on the NW Panay peninsula in 1996, initial rumors on the sighting of a huge, black, arboreal monitor lizard reached the project. So far, only the West Visayan subspecies of the water monitor, *Varanus salvator nuchalis*, was recorded for Panay (Gaulke 1991a, 1992). Because this latter varanid is relatively large (with a total length of about 150 cm), has an almost uniformly black form among its different color morphs, and is well adapted to climbing, a debate started as to whether this undescribed species really is a different species or just the black form of *V. s. nuchalis*. From the beginning, the head of project believed the claim of local hunters that two completely different varanid species, the common water monitor known as Halo, and

the rare black one known as Mabitang, exist in the area. When finally, at the end of October 2000, the first live Mabitang was brought to the project, even the skeptics among us had to admit that this was an undescribed species of varanid. Initial investigations revealed its close relation to the Philippine monitor lizard, *Varanus olivaceus*, until then believed to be unique among all other varanids, especially in its tropic ecology (e.g. Auffenberg 1988).

V. olivaceus, a large and at least partially arboreal monitor lizard, is well known for its frugivorous-molluscivorous feeding habits, an exception among varanids, as all other known species are carnivorous. It is only known from parts of the Luzon faunal region (southern Luzon, Polillo, Catanduanes Islands; Auffenberg 1988, Bennett 1999). Within its range, it is restricted to primary and secondary lowland rainforests, a highly endangered habitat throughout the Philippines. Due to its small range and its dwindling habitat, it is one of the few varanids considered threatened with extinction, and therefore listed in Appendix I of CITES (Convention on International Trade in Endangered Species), while most varanids are listed in Appendix II (Eidenmueller 1997).

As earlier mentioned, initial investigations of the external morphology (for example, form and position of the nares, dentition, morphometry) of the Mabitang revealed its close relation to this rare and endangered Philippine monitor. But a number of differences, such as shape of head and tail, finer scalation, and coloration required the description of a new species, yet forming part of a *V. olivaceus*-group. After a collection permit was acquired, a second specimen of the Mabitang was caught (the first one was released back to nature after a non-invasive investigation), and the species described as *Varanus mabitang* by Gaulke & Curio in 2001. The name "Mabitang" was chosen to acknowledge the fact that although this species was new to science, it has long been known as Mabitang to the people of the region who raised our awareness about the existence of this species.

The description was just the first step in order to anchor this remarkable varanid officially within the scientific world. But the questions which are of most concern to us as conservationists, such as its exact distribution range, population status, and ecological requirements are just beginning to be answered. Thus, the purpose of this paper is to introduce this species to a wider public, present the results of our initial surveys, and provide information about the survey and conservation programs that have been started.

Methods

From the first time that the Mabitang was mentioned to PESCP project members, all information regarding this animal was recorded, and later on, when its existence was confirmed, analyzed. Two specimens of *Varanus mabitang* have been investigated so far. While one was released unharmed after some measurements and photos were taken, the other was kept in a large enclosure for more than a week to enable the project staff to conduct observations. This specimen was designated as holotype,[2] and data on its anatomy, dentition, and gut contents became available.

One of the most urgent tasks to be tackled was a distributional survey. The population status of this almost unknown varanid can be evaluated only if the geographic range has been established. Consequently, a short-term distributional survey previous to the scientific description was conducted from February 13 to April 12, 2001.[3] More than 20 localities on Panay (spread across all four provinces), three on the Semirara Islands, and three localities on Cebu were visited. In all visited areas, local inhabitants (especially hunters or former hunters and farmers with land close to forested regions) were interviewed using a standard questionnaire. The interview was structured to enable verification of the different responses. Thus, to ascertain the reliability of information provided by respondents, a photograph of a species that does not even occur within the Philippines was purposely

included among the photos of different Philippine varanid species that were presented to interview partners at the start of the interview. Hence, information from people who claimed that all varanids in photographs were present in the area was regarded as unreliable. On the other hand, information from people who provided accurate identification and named the Mabitang correctly was considered highly valuable. The interview included questions regarding habitus, relative abundance, reproductive biology, food and feeding habits, general behavior, and habitat.

The team visited the capture site of the investigated *V. mabitang* specimens to gain first hand information on their habitat and ecology. A preliminary survey to assess the possibilities of tracking the Mabitang based on traces was conducted around Sibaliw on the NW Panay peninsula.

Results

Characteristics. *V. mabitang* is a very large varanid. The first captured specimen had a total length of 175 cm (snout-vent length 64 cm, tail length 111 cm) and weighed 5750 g. The holotype (PNM 7272), a female, is smaller, measuring 126.8 cm (snout-vent length 52.7 cm, tail length 74.1 cm) in total length and weighing 1850 g. Local inhabitants considered the first caught specimen as medium-size, suggesting that the species can grow significantly longer. As recently as February 2002, a Mabitang with an estimated girth width of 21 cm and a total length of over 200 cm was sighted by a member of the project.

V. mabitang has a relatively slender habitus. Limbs and toes are long and slender, with very long and strongly curved claws. The slender tail is triangular in cross section while the upper crest forms a prominent, longitudinal, double-keeled scale row. The head profile shows a pointed and slightly upward turned snout, a swollen nasal region, and a bulging temporal region. The narial openings are slit-like and positioned much closer to the tip of the snout than to the eye. The teeth are blunt to conical; the dentary

teeth do not extend beyond the gum but are visible only as translucent, flat ovals within the gum.

With its exceptionally fine scalation, the *V. mabitang* has consequently very high standard scale counts (e.g. 70 scales from rictus to rictus across head, 124 transverse rows of ventral scales, 138 transverse rows of dorsal scales; for more details see Gaulke & Curio 2001). Most body scales, including the ventrals, are strongly keeled while the head scales are flat and polygonal to roundish, with several distinctive pustules on each.

V. mabitang is an almost uniformly black varanid. Slight indications of yellow on neck, anterior part of dorsum, and dorsal sides of extremities are visible only from a short distance. The ventral side is anthrazite. The eyes are reddish brown, the tongue is pink, and the claws are dark grey.

An unusual anatomical feature of varanids, shared by *V. mabitang* and *V. olivaceus*, is the possession of a large caecum.

Food and feeding habits. Information on the diet of the Mabitang is scarce and somewhat confusing. Some people told us that it has exactly the same feeding habits as the Halo (a carnivorous varanid, e.g. Gaulke 1991b), while others told us that it feeds on fruits and leaves exclusively. An omnivorous diet, as is known for *V. olivaceus*, was not reported. Observations on its herbivorous diet mainly came from hunters or former hunters who have extensive knowledge of the forest and its inhabitants, and who therefore seemed more reliable. The feces of the first caught Mabitang contained *Pandanus* seeds, but other food items were not discernible. Feeding trials with the second Mabitang showed that it feeds on the ripe seeds of different *Pandanus* species and the small ripe fruits of the fig tree *Ficus minahassae*. However, it refused molluscs (various species were offered), which form an important part of the diet of *V. olivaceus*. Additional data on its tropical ecology come from isotope analyses of claw and soft tissue material of the holotype, and of known food plants. They confirm a completely, or at least almost completely, vegetarian diet for this specimen (Struck, Altenbach, Gaulke, and Glaw, unpublished data).

Distribution and population density. From the beginning it was evident that the Mabitang is sighted in forested areas or, rarely, on clearings close to the forest edge, but never, unlike the water monitor, in completely cultivated areas. The forest cover on Panay is restricted to an isolated patch on the NW Panay peninsula, and the N-S oriented expanse parallel to the West coast, covering parts of the west Panay mountain range. Only inhabitants of villages close to forested areas were able to give information about the Mabitang. Many people interviewed in the barrios on the NW Panay peninsula, especially around Luhod Bayang, easily identified the Mabitang; some even considered it as relatively common, with last sightings having occurred not too long ago. On the other hand, it was obvious from their response that people from the eastern part of Panay have never seen a Mabitang or even heard about it

the since neither the pictures nor the name meant anything to them. Even along the western side of the region its distribution seems to be rather patchy.

Results from barrios along the West Panay mountain range, however, were quite different. In most barrios visited, some of the interview partners were able to identify the Mabitang, and a larger number of people were familiar with the name "Mabitang". However, in regard to last sightings, nobody had seen or caught a Mabitang for the past years or even decades. Only close to Tibiao, in the middle of the west coast area, one person reported a Mabitang catch just a few weeks prior to our visit.

The Semirara Islands, lying offshore of the NW Panay peninsula, were visited to verify reports on the occurrence of a very large and dark monitor lizard which looks different from the water monitor found on Panay. This proved true, but in a different way than hoped for. The varanid species occurring on the Semirara Islands is *V. salvator marmoratus*, the water monitor subspecies distributed on the western and northern islands of the Philippines. This subspecies is larger and generally darker than the West Visayan form. Its previously unknown distribution on this island group confirms that even though the Semirara Islands politically belong to the Antique Province in Panay, zoogeographically they belong to Mindoro. Situated on a submarine ridge ending at Mindoro (Ferner et al. 2001), they were connected to Mindoro during the Pleistocene glaciations.

Even though it was not considered as a likely distribution area for the Mabitang from the beginning, Cebu was visited because deforestation there is extremely advanced. Every new discovery, especially one as spectacular as a large vertebrate, could significantly boost efforts to protect the few remaining forest patches. However, neither the pictures, the name, nor additional descriptions yielded any positive information.

During our surveys, we met a number of people who could not identify the Mabitang from photos, but during the discussion remembered the name "Mabitang" and the descriptions of a large,

black monitor lizard from tales of their late parents and other old folks. People who had some knowledge of the Mabitang agreed that this species has become much rarer at the present time than it used to be some decades ago. They attributed the disappearance of the Mabitang to hunting. Like *V. s. nuchalis*, *V. mabitang* is hunted for its meat. If the Mabitang is tracked down on a tree, it is either shot by the hunter or forced to come down with the use of fire. Although habitat destruction was not mentioned as a reason for its population decline, it is obviously common knowledge that the Mabitang is a forest inhabitant.

Habitat. Both animals that were investigated originate from the same area within the South Pandan forest. It is a very hilly area with primary lowland rainforest (around 250 m a.s.l.). Water is abundant in the area and the larger rivers are perennial. The forest is relatively dense with huge dipterocarps covering the upper level. Especially along the riverbanks, trees are heavily overgrown with epiphytes. Another confirmed distribution area of the Mabitang is the forest around Sibaliw (approximately 450 m a.s.l.), on the NW Panay peninsula. In 2001 a Mabitang was sighted there by project members in an area where tracks document the regular occurrence of this species. Consisting of a patchwork of primary and secondary growth interrupted by clearings, the forest around Sibaliw is more disturbed than the South Pandan forest.

Almost all interview partners agreed that the Mabitang is a mainly arboreal lizard and only seldom seen on the ground. It spends the night either on big branches in treetops, or in tree holes. At Sibaliw one specimen was sighted inside a tree hole of a dipterocarp, at a height of about 10 m. That the Mabitang can climb the dipterocarps which grow very straight and have a smooth and hard bark illustrates its well developed climbing abilities. During dry and warm weather, especially following extended rainy periods, the Mabitang is sometimes seen basking in sunny patches on the ground.

Breeding biology. Very few observations on the breeding biology of the Mabitang are available. Three different hunters remembered numbers of 6, 10, and 12 eggs, respectively, in previously dissected females. According to hunters, oviposition takes place once a year and eggs are usually deposited in tree holes.

Behavioral observations. Based on information provided by interview partners and on our own observations, *V. mabitang* shows some rather unusual behavioral characteristics. Once the animal is caught, it very quickly stops any attempts at defending itself and instead remains in a state of stupor for extended periods of time. This death-feigning behavior is very convincing. When the first large specimen was brought to the research station, both local and foreign members of the project who saw it in a state of stupor regarded the animal as dead even though it showed no indications of injuries. Although it was neither enclosed nor tethered in any way, the lizard lay completely motionless for several hours, even when measurements were taken. Only when it was brought to the forest edge and felt unobserved for some time, did it become mobile again. When 'hooked' onto a tree it rushed upward, jumped to another tree, and disappeared from sight. The other specimen, which was held in a large enclosure for some days, did not move for almost two days. When it became active again, it showed astoundingly little shyness towards people. Once while being photographed inside the cage by a member of the team, the lizard appeared undisturbed and continued to climb on a tree stem and the wire meshing of the cage. Only when the camera was very close to its face did it show slight indications of threatening behavior by coiling its tail tip a bit. Otherwise, it showed none of the typical varanid threatening and defense behaviors, such as gular extension, hissing, or tail lashing. Each time the lizard was picked up, it became motionless again, its head, extremities, and tail hanging down. Yet, anyone who has experienced handling large varanids knows that this can easily end in nasty bites and cuts from tail lashings and scratches if the handling is done incorrectly:

head, limbs, and tail have to be fixed at the same time. But this never was necessary with *V. mabitang*. Local members of the project, regard this docile behavior as typical for this species.

Traces. *V. mabitang* leaves characteristic traces on its food trees. During surveys around Sibaliw station and in the South Pandan forest, we detected several long scratches on screw palms. Though civet cats (*Paradoxurus hermaphrodites*, *Viverra tangalunga*) might visit the same food trees, their scratches are distinguishable by their size. Possessing long fingers and claws, the Mabitang's scratches are predictably and significantly longer.

Discussion

Our description regarding the external habitus of the Mabitang, based on two individuals only, was confirmed throughout the interviews. According to available information, this species is always black regardless of size, can grow significantly larger than *V. s. nuchalis*, has conspicuous reddish eyes, and extremely large front and hind feet. The large feet, with their extremely long and slender fingers and long, curved claws are obviously adaptations for the highly arboreal habits of the Mabitang. They enable a good grip around smaller limbs and safe footing on bigger stems. The second captured specimen was observed gripping around a small twig with its fifth finger opposed to the others while climbing.

The well developed caecum of the Mabitang is an indication of its herbivorous diet. In carnivores, such as most varanids, it is usually absent, but it occurs frequently in herbivores. The caecum has an important function in the microbial fermentation and degradation of cellulose (e.g. McBee & McBee 1982, Troyer 1984). Another informative feature with regard to its diet is the dentition of *V. mabitang*. Most varanids have sharp and pointed teeth, sometimes curved backwards, with a serrated hind edge (see e.g. Auffenberg 1981, Mertens 1942). These teeth are well adapted for holding mobile prey species and for tearing bits of

flesh from carrion. Blunt teeth are only reported in few varanid species, such as *V. niloticus*, *V. albigularis*, *V. olivaceus* (see e.g. Auffenberg 1988, Mertens 1942), and now the Mabitang. This type of dentition is usually considered as an adaptation for crushing molluscs or other hard-shelled animals by exerting vertical pressure. Although there is no difference in number and general shape as compared with *V. olivaceus*, the dentary teeth of both investigated *V. mabitang* are very unusual in so far that they are almost completely embedded in the gum. At first glance, this type of dentition gives the impression that the Mabitang does not possess dentary teeth at all. This would mean that the Mabitang could not possibly crush molluscs or other hard-shelled prey species without causing serious gum injuries to itself. In fact, so far we have no indications of a partly molluscivorous diet as in *V. olivaceus*.

The Mabitang is the only known varanid feeding not only on fruits but also on leaves. The leaves of screw palms and a shrub species were detected in the gastrointestinal tract of a dissected Mabitang. However, data are still very scarce. Observations on the feeding habits of juveniles would be extremely interesting. The juveniles of *V. olivaceus* have sharper and more pointed teeth than the adults (Auffenberg 1988). If this is also the case in the Mabitang, it can be assumed that at least the juveniles prey on small animals.

The present distribution range of *V. mabitang* is comparatively well established as a result of our distributional survey. However, two important questions are in urgent need of further investigation. One is the altitudinal distribution of the Mabitang. If further surveys confirm that *V. mabitang*, like *V. olivaceus* (Auffenberg 1988), is restricted to lowland rainforests, it must be considered as critically endangered. This is so because only few patches of lowland rain forests are left on Panay, and even these are not sufficiently protected from further deforestation. So far the highest altitudinal record for the Mabitang is at about 450 m a.s.l., based on a sighting close to our research station in Sibaliw. Data from high elevation areas are difficult to obtain. There

are no settlements within high altitudinal forests of the west Panay mountain range, and this varanid is too rare as to make direct sightings likely during short trips. The best method will be an investigation of the altitudinal distribution of its known food plants, and a search for its traces on and around these trees. In addition to altitudinal distribution survey, surveys on other neighboring islands of the West Visayan region which still have rainforests are needed. So far we have no strong evidence indicating the occurrence of the Mabitang outside of Panay. However, there still remains a possibility that it might be detected on one of the neighboring islands. Both surveys will be started this year.[4]

A real progress in our knowledge of the reproductive mode (sensu Wake 1999) of *V. mabitang* can only be expected in the long term. Observations on mating, egg-laying, sightings of egg clutches, and the like are extremely rare in all varanids. Dissections of specimens to determine their reproductive status, as for example in *V. olivaceus* (Auffenberg 1988), are of course out of the question for a rare animal such as the Mabitang. But in respect to the close relationship between both species, we can certainly expect similarities in their reproductive biology. Clutches with 4 to 11 eggs have been reported for *V. olivaceus*; clutch size and female size are highly correlated. Most females lay one clutch per year, but some instances of females laying two clutches in one year are known (Auffenberg 1988). Clutch size of *V. olivaceus* is small compared to other large varanids. For example, the average clutch size for *V. s. salvator*, a similar sized tropical varanid, is 13, with a range between 5 and 40 (Shine et al. 1996, Erdelen 1989), and multiple annual oviposition is the norm at least in parts of its range (Shine et al. 1996). Ovulation, mating, and oviposition in *V. olivaceus* is concentrated from the end of June to the beginning of October (Auffenberg 1988). However, as the western Panay mountain range has different climatic conditions than the distribution range of *V. olivaceus*, therefore, a different breeding season is likely.

The most remarkable behavioral trait observed is the Mabitang's tendency to become completely immobile for a

prolonged period of time if frightened. The only other varanid in which letisimulation is described is *V. exanthematicus* (Barbour 1926), but it is not reported for *V. olivaceus*. The death-feigning behavior in juvenile Mabitang might be explained as passive defense strategy especially against birds of prey which detect their victims through movements. This behavior is certainly supported by the overall dark coloration of the Mabitang which blends well with the shady environment of its arboreal habitat in rainforests. However, the reason for this behavior in adults is hard to understand. Because of their large size, they probably do not have many natural enemies. The largest predator in the Philippines is the water monitor, but as adults hunt on the ground or in water, and not on trees, it is unlikely that they will prey on the Mabitang. Besides, their main prey consists of relatively small arthropods and small vertebrates such as frogs or rodents (e.g. Gaulke 1991b, Traeholt 1994, Shine et al. 1996), and their preferred habitats are swampy coastal regions, not the rainforest (e.g. Gaulke & Reiter 2001).

Another noteworthy characteristic of *V. mabitang* is its dark, blackish underside, i.e. its virtual lack of countershading (Cott 1957). If this is an adaptive characteristic, it might suggest that the animal is less often positioned horizontally than vertically. In the latter situation light would hit the body from all sides and not particularly on the back. Only field observations could give a clue as to the possible adaptation of this characteristic pattern.

Conclusions and Prospects

All available information suggests that *V. mabitang* is threatened with extinction since it is a forest dweller and most of its distribution area is deforested. Its known distribution range is very small even if the entire western Panay mountain range is included because only a very small part of this range can be inhabited. If, like the *V. olivaceus,* it is confined to the lowland rain forest, then its distribution area is even smaller still.

Unfortunately, deforestation continues and highly specialized animals such as this varanid (with regard to its feeding biology as well as its arboreal habits) cannot adapt to cultivated areas in the same way as, for example, the generalistic water monitor. Population density in the available habitat seems to be very low as evidenced by the extremely rare sightings reported by local inhabitants. An intervening period of almost three years from the first time that this lizard was mentioned to project members to the time the first individual was actually presented to the team confirms this assumption. Although hunting success is obviously very small nowadays, hunting activities continue to exert pressure on the remaining population. Consequently, the most urgent question is which conservation measures should be taken to stabilize the *V. mabitang* population.

At present, *ex situ* breeding, in other cases a very helpful measure, cannot be seriously considered because as long as data on reproductive mode and environmental needs of the Mabitang remain unavailable, the risk is high that mortality rate in captivity will exceed breeding success. Besides, the population density is so low that it seems almost impossible to collect a potential breeding group within a reasonable time. Therefore, the extraction of single individuals over a longer time period, with the hope that partners will be found in the future, is inappropriate. Another problem is that the non-invasive sex determination in varanids is extremely unreliable (see e.g. Auliya & Erdelen 1999). Even if a breeding group can be assembled, present experience shows that continued breeding of large varanids is successful only in very few species, such as some subspecies of the water monitor (e.g. Andrews & Gaulke 1990, Wicker et al. 1999). Most of the time reproduction occurs as "accidental" success and cannot be systematically repeated. Up to now there exists no report on the successful breeding of *V. olivaceus*, the closest relative of the Mabitang, despite the fact that groups of this species have been kept in captivity since many years (e.g. Auffenberg 1988). This is due to various factors, one of them being the extremely long

incubation time of large varanids. Auffenberg (1988) concludes from sightings of *V. olivaceus* hatchlings and from the number of *times of observed egg-depositions that incubation in this species* takes from six months to one year! Obviously, the risk of fungal infections and the loss of embryos are much larger in eggs which have to be incubated for such a long time than, for example, in crocodile eggs with their significantly shorter incubation periods.

The only promising conservation measure at the moment is habitat protection supported by an anti-hunting program. One of the main distribution areas of the Mabitang lies within the action radius of PESCP whose main objective is the protection of the remaining forest patches in this area. Cooperation with the local inhabitants is immensely important, while their acceptance of and understanding regarding conservation projects continue to deepen. As a result, many former hunters have, in the meantime, become project members—a move which benefits both sides.

The "flagship" of the project is the Writhed-billed Hornbill or Dulungan (*Aceros waldeni*), a highly endangered hornbill, which only occurs on Panay and Negros. *In situ* measures such as anti-hunting campaigns and nest-incentive schemes conducted since 1995 have led to a better understanding of the uniqueness of this beautiful bird (e.g. Curio 2002, in press). As a consequence, hunting and poaching in the area have significantly decreased since then while knowledge of its natural history has increased (Curio in press).

Now the project hopes to get the same attention for the Mabitang. Included in our educational programs is raising the awareness among local inhabitants of the uniqueness of this remarkable lizard, and instilling in them a sense of responsibility for its survival. With the help of local project members, the Wildlife Conservation and Education Program and the PESCP are undertaking a project to collect more data on the natural history of the Mabitang. We hope that publicity of the lizard's plight will lead to concerted efforts and stronger commitments to provide total protection to the remaining forest areas on Panay.

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[4] Funded by the Frankfurt Zoological Society (continuation of FZS-Project No. 1267/01).

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VISUAL FRUIT PREFERENCES OF VISAYAN TARICTIC HORNBILLS, *Penelopides panini panini* (BUCEROTIFORMES: BUCEROTIDAE), AND MUSKY FRUIT BATS, *Ptenochirus jagori* (MEGACHIROPTERA: PTEROPODIDAE), IN CAFETERIA EXPERIMENTS

Stefan Luft, Benjamin Tacud, Henry Urbina, and Felimon Geronimo

ABSTRACT

Cafeteria-choice experiments revealed preferences of Visayan Tarictic Hornbills (Penelopides panini panini) *and Musky Fruit Bats* (Ptenochirus jagori) *for test fruits with different wavelength reflection characteristics. Preferences for certain colors were assessed by offering artificially colored fresh fruit cubes of banana pulp ('test fruits'). Findings indicate that while hornbills preferred red and blue test fruits, fruit bats showed a preference for yellow and red test fruits. Although fruit bats are color blind, reflection properties of fruits might support visual guidance for foraging bats under dim light conditions. Samples of reflectance measurements of 'typical' bat and bird fruits in the wild are given.*

Introduction

Hornbills and fruit bats are known to be important seed dispersal agents and therefore essential for the maintenance of tropical rainforests (e.g. Marshall 1985, Kemp 1995, Corlett 1998, Whitney & Smith 1998, Hamann & Curio 1999). Many studies have reported distinct fruit preferences by frugivores that may effect seed dispersal. Plant characteristics, such as fruit color, fruit, and seed size, as well as plant life forms are often assumed to be adapted for certain seed dispersal agents (e.g. Marshall 1983, Howe & Westley 1986, Fleming & Estrada 1993): factors such as fruit display, crop size, and the spatial distribution of food plants influence food choice of bats and birds (e.g. Moermond & Denslow 1983, Heithaus et al. 1975, Utzurrum 1995).

Following the early concepts of fruit syndromes (Ridley 1930, van der Pijl 1969), it is possible to define fruit characteristics in relation to the main dispersers of certain plant species (Howe & Westley 1986). Bat-dispersed fruits are often described as having dull green colors (Kalko et al. 1996, Korine et al. 1998), emit musky, strong odors (van der Pijl 1969, Howe & Westley 1986, Luft 2002), and contain a high proportion of carbohydrates, while being poor in lipids and proteins (Korine et al. 1998, Ruby et al. 2000, Wendeln et al. 2000). By contrast, typical bird fruits are thought to be black, violet, red, or blue (Knight & Siegfried 1983, Howe & Westley 1986), nearly odorless, and offer a pulp rich in sugars and, occasionally, lipids (Howe & Westley 986, Corlett 1998, Schabacker & Curio 2000). Furthermore, ultraviolet reflection of certain fruits seems to be strongly associated with dispersal by birds and rodents both of which could perceive UV radiation (Altschuler 2001).

In cafeteria-choice experiments, we tested one hornbill and one fruit bat for fruit color preferences. Fruit bats are thought to possess no color vision (Suthers 1970, Neuweiler 1993, Nowack 1999). In spite of this, we included a fruit bat in the cafeteria experiment since fruit bats are likely to perceive colors as various shades of grey. Kalko et al. (1996) hypothesized that ripening fruits of red, orange, or yellow coloration should be attractive to pteropodids as they stand out against the surrounding vegetation and are presumably easier to detect visually in dim light than cryptic greenish fruits (see Burns and Dalen 2002). Unlike fruit bats, most birds have a highly developed color vision (e.g. Martin & Lett 1985, Kreithen & Eisner 1978, Jane & Bowmaker 1988) including UV-vision in several species (e.g. Goldsmith 1980, Emmerton & Delius 1980, Burkhardt 1983). For example, at least one species (*Buceros bicornis*) displays a sexual dimorphism in the UV reflection of certain head structures (Burkhardt 1989). Unfortunately, the color vision of hornbills has not been studied in detail. Nevertheless, there are several ecological and

behavioral observations demonstrating the importance of fruit colors for foraging hornbills (e.g. Whitney & Smith 1998, Poulsen et al. 2002).

Although much is already known about the importance of frugivore-plant relationships in the tropics, aspects of fruit characteristics and how they relate to physiology, sensory capabilities, morphology, and behavior of the animals eating the fruits and dispersing the seeds are still generally understudied. This paper addresses the fruit color preferences of two Philippine fruit-eaters, the Visayan Tarictic Hornbill (*Penelopides panini panini*) and the Musky Fruit Bat (*Ptenochirus jagori*), in an experimental setup and discusses the ecological backgrounds of the findings.

Materials and Methods

The study was conducted in and around the research station of the Philippine Endemic Species Conservation Project (PESCP) in the NW Panay peninsula, Philippines (11°49,2' N, 121°58,1'E). The station lies at 450 m a.s.l. and is surrounded by a mosaic of primary and secondary forest. Three adult Tarictic Hornbills, *Penelopides panini panini*, and ten adult Musky Fruit Bats, *Ptenochirus jagori*, with both species coming from NW Panay, were kept in the PESCP-Rehabilitation-Center.[1] While bats were kept isolated from each other in cages (1.2 x 1.0 x 1.5 m), hornbills were housed as a pair and a single male in large aviaries (5.0 x 2.5 x 3.0 m).

The purpose of the cafeteria experiments was to reveal the animals' potential color preferences while feeding on fruits. In order to standardize fruits, we used cubes of ripe banana pulp (2 cm^3), which were treated with food colors (National Foods Inc., Manila) in red, green, blue, and yellow in watery solution. Uncolored banana cubes of the same size, which were dipped in water prior to each trial, served as controls. Fruits were offered simultaneously in white (birds, bats) or green dishes (bats) (flat plastic plates of 20 cm diameter) in equal numbers (bats: 4 fruit cubes of

each color; birds: 10 fruit cubes of each color). The colors were mixed randomly in the dish. The feeding bowls for *P. jagori* were suspended under the roof at one narrow end of the cage while those for the *P. p. panini* were placed on a feeding stand 1.6 m from the ground. This setup ensured equal access to both bats and birds. After placing the dishes in the cages, we noted the number of fruit pieces removed and eaten every 15 min (0-75 min) for bats and every minute (0-10 min) for birds. This difference in timing was necessary because of the varying feeding modes of birds (swallowing whole fruits in a short time) as compared to fruit bats (processing each fruit over minutes). Each bat was tested on three evenings ($n_{trials} = 30$) and hornbills on four days ($n_{trials} = 12$). These data were analyzed following Rodger's (1984) suggestion of an appropriate measure of preference by calculating the area under each cumulative consumption curve standardized to a maximum of 1.0. The areas under curves were estimated using the following formula (Sachs 1999):

$$Area = \frac{1}{2}\sum_{i=0}^{n-1}(t_{i+1} - t_i)(y_i + y_{i+1})$$

where n + 1 are numbers of observations y_i at times t_i with i = 0,1,..., n (birds) or i = 0, 15, 30, ..., n (bats). These preference scores were then standardized to the range 0-1.0 by the formula (Krebs 1989):

$$R_i = \frac{A_i}{\max(A_i)}$$

where Rodgers' index of preference for species i (R_i) is calculated by dividing the area representing the cumulative proportion eaten by this species (A_i) by the largest value of the A_i ($\max(A_i)$) of hornbills or fruit bats, respectively.

The results of R_i of fruit bats for each color were tested with the Friedman test and pairwise comparisons were made using Wilcoxon-Wilcox tests (Sachs 1999) because values of R_i are not independent. Prior to the analysis, R_i values were transformed ($\arcsin \sqrt{R_i}$).

[1] As per MOA with the DENR

To quantify the color data of the tested banana cubes and some wild fruits eaten by fruit bats, we used a miniature fiber optic spectrometer (Ocean Optics, Inc., model S2000) attached to a Tungsten Halogen Lightsource (HL2000) with a wavelength range of 360-1100 nm. As fiber optic probes, R200 Reflection probes which consist of 7 optical fibers (6 illuminating fibers, 1 read fiber; each 200 µm diameter) in combination with a Reflection Probe Holder with 45° aperture were used. Spectrawin 4.0-Software was used to analyze the reflection data of fruits.

Results

The cafeteria experiments revealed that hornbills preferred red, blue, and uncolored banana cubes more than yellow and green cubes (Fig. 1). The differences in preference indices of the three favorites are small (R_i = 0.82-1.0), but there is a clear difference between green and yellow fruits (R_i = 0.07-0.15). This is also obvious when the proportion of eaten fruits over time is considered (Fig. 2), although the magnitude of variation among trials is high (e.g. first time interval (1 min): red 28.3 ± 23.7 %, yellow 0 %, control 14.2 ± 21.1 %, blue 18.3 ± 25.2 %, green 0 %; all mean ± SD, n = 12 trials).

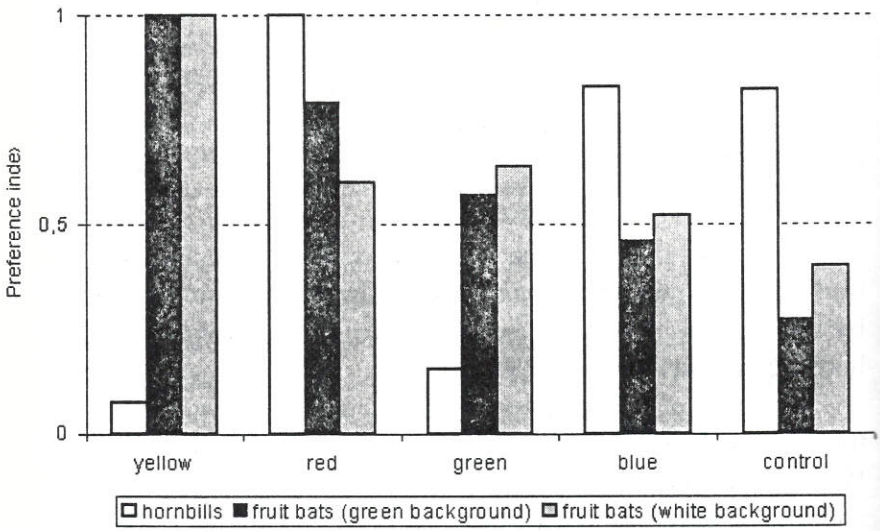

Fig. 1: Preference indices for fruit-bats (*P. jagori*) and hornbills (*P. p. penelopides*) of color choice in cafeteria experiments.

When presented with the colored fruit cubes set against a green background, fruit bats exhibited the strongest preference for yellow fruits ($R_i = 1$), followed by red ($R_i = 0.79$), and green ($R_i = 0.57$) cubes. Blue ($R_i = 0.46$) and uncolored ($R_i = 0.27$) banana cubes were least attractive choice to bats (Fig. 1). Similar to the results of hornbills, the proportion of eaten fruits over time (see Fig. 3) varies much among trials (e.g. first time interval (15 min): red 16.7 ± 12.9 %, yellow 20.8 ± 24.5 %, control 0 %, blue 12.5 ± 20.9, green 4.1 ± 10.2; all mean ± SD, n = 30 trials).

A Friedman test revealed a significant difference in visual preferences ($\div^2 = 15.83$, d.f. = 4, $p = 0.00325$). Pairwise comparisons showed that fruit bats preferred yellow test fruits over blue and uncolored fruits (Wilcoxon-Wilcox test, $D_{\text{yellow vs blue}} = 20.0$, $p < 0.05$; $D_{\text{yellow vs control}} = 23.0$, $p < 0.01$). All other pairwise comparisons did not reveal any significant results. When colored test fruits were set against a white background, yellow fruit cubes were preferred by fruit bats over other colored cubes. However, differences between red, green, and blue fruits almost vanished ($R_i = 0.52$-0.64) and uncolored banana cubes still yielded the lowest R_i (0.40) of all (Fig. 1).

Fig. 4 demonstrates the reflectance measurement from one typical bat-dispersed fruit (*Ficus variegata*, Moraceae) and one typical bird dispersed fruit (*Pygeum vulgare*, Rosaceae). While ripe *F. variegata* var. *elangoides* figs appear greenish-yellow (high percentage of reflectance between 540 and 600 nm), *P. vulgare* fruits are purplish-black (reflectance mainly > 750 nm wavelength). Table 1 shows the results of reflectance measurements of seven *Ficus* species and three fruits of other genera regularly eaten by bats. Most fruits eaten by bats seem to have yellowish green colors, but red and purple colors likewise occur. The latter fruit species are preferentially taken by birds (pers. obs.).

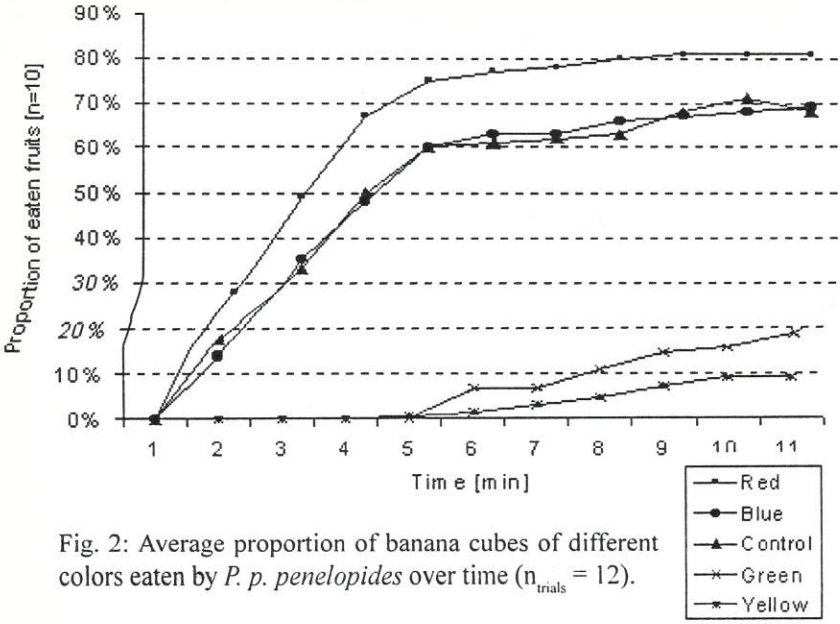

Fig. 2: Average proportion of banana cubes of different colors eaten by *P. p. penelopides* over time (n_{trials} = 12).

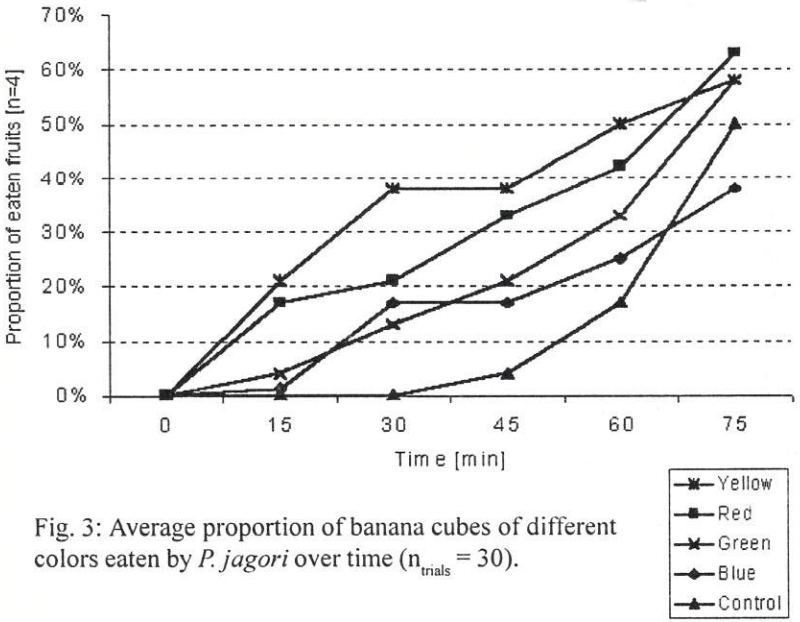

Fig. 3: Average proportion of banana cubes of different colors eaten by *P. jagori* over time (n_{trials} = 30).

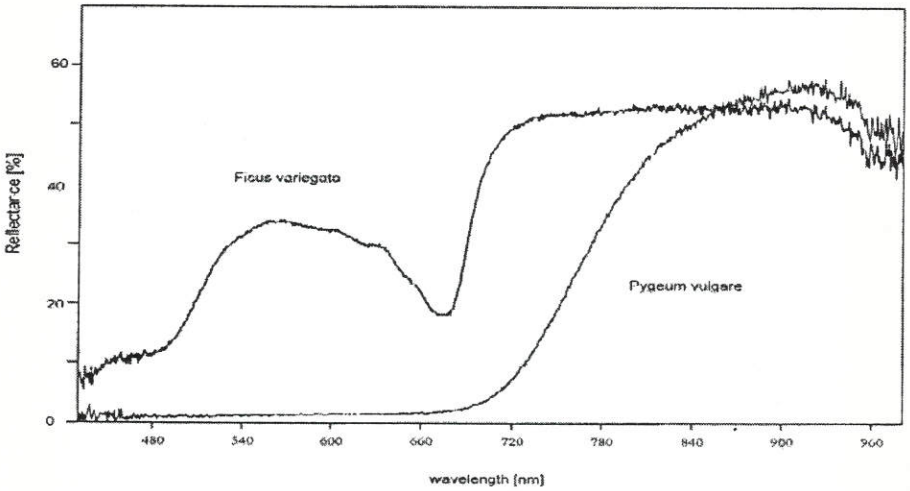

Fig. 4: Reflectance measurements of *Ficus variegata* (bat fruit) and *Pygeum vulgare* (bird fruit).

Table 1: Color impressions and reflectance maxima of ten fruit species eaten by bats in the study area. Only ripe fruits were considered.

Fig species	*Reflectance maxima*	*Color impression*
Ficus congesta	***540-640 nm***	***yellowish green***
F. septica	***510-630 nm***	***yellowish green***
F. *sp., P351*	***570-630 nm***	***orange yellow***
F. variegata *var.* elangoides	***540-640 nm***	***yellowish green***
F. variegata *var.* variegata	***590-630 nm***	***red with a tinge of green***
F. pseudopalma	***630-650 nm***	***dark red to purple***
F. *sp., P350*	***540-650 nm***	***yellowish green***
Columella corniculata	***690-900 nm***	***purplish red***
Gnetum indicum	***660-900 nm***	***red***
Saurauia latibractea	***550-660 nm***	***green with red parts***

Discussion

The results obtained for Visayan Tarictic Hornbills confirm the seemingly universal preference of birds for red and/or purple-black fruits. A recent study in Africa supporting the separation of

primate and hornbill diets reveal that fruits eaten by hornbills differ in color from those eaten by primates. Primates prefer green and brownish fruits whereas the majority of hornbill fruits are red and purple (Poulsen et al. 2002). Other birds similarly prefer diets of red, purple, and black fruits (e.g. Gautier-Hion et al. 1985, Wheelwright & Janson 1985). Knight & Siegfried (1983) found that birds favor black, orange, and red whereas mammals favor species with yellow, orange, and green fruits. In this study the relatively high preference index among hornbills for uncolored banana might be a consequence of their diet of bananas in the rehabilitation facility. Bats were also fed bananas but they were only kept for a few days before being released.

While the color vision of frugivorous birds is generally well developed, fruit bats are expected to be color blind (Suthers 1970, Neuweiler 1993, Nowack 1999). Nevertheless, the sensory systems for vision and olfaction of frugivorous bats are well developed (Schneider 1957, Kolb 1971, Bhatnagar & Kallen 1975, Baron et al. 1996), and represent an adaptation to their feeding habits (Phillips 2000). Based on this premise, one would expect that plants relying on pteropodids for their dispersal should have relatively exposed fruits to facilitate visually guided access. Kalko et al. (1996) hypothesized that fruits turning red, orange, or yellow when ripening should be attractive to Megachiroptera as they stand out from the mostly greenish background even under dim light conditions. On the other hand, grey shades of different colors can be confusingly similar to a colorblind animal, such that it will not be able to find a colored object that has been mixed with identical objects of several shades of grey (Von Frisch 1988). Fruit bats exhibited a higher preference index for yellow fruits presented against a green background over all other colors tested. This result is not surprising because many figs, a main component of the natural diet of *P. jagori,* turn from green to yellow, or yellowish green when ripening. Similarly, red fruits are represented by some species in the diet of the Musky Fruit Bat (e.g. *Veitchia merrillii*), while blue fruits are very rare. Green banana cubes

might resemble unripe fruits and thus are less attractive to bats. Although Utzurrum (1995) found that smaller bats like *P. jagori* select fruits based on color while larger bats choose their food based on crop size, her work does not explain how fruit color might effect the food choice of colorblind (!) pteropodids.

How can fruit color influence the choice of colorblind fruit bats? In general, each surface has a characteristic reflection function which describes the proportion of incident light that is reflected by the surface at each wavelength (Stroppe 1990). Brightness or lightness of a color is an attribute of a visual sensation according to which an area appears to exhibit more or less light (Purves et al. 2002). It follows that colors differing substantially in their reflection show a high brightness contrast (e.g. black with c. 3 % reflection of light and white with c. 97 % reflection of light show the greatest brightness contrast). Furthermore, the lightness of the background influences the way in which colors or shades of grey are perceived (Burns & Dalen 2002). This effect is called simultaneous brightness contrast (Purves et al. 2000). Megachiropterans are able to detect brightness differences accurately even under dim light conditions (Suthers 1970, Neuweiler 1993). Thus fruit reflection properties and brightness contrasts between fruits and background vegetation are likely to influence the visual detection of fruits.

In addition to visual cues, flying foxes use their well-developed sense of smell to find and assess the quality of fruit resources (e.g. Acharya & Krishna 1998, Luft 2000, 2002). Moreover, many plant species used by Megachiroptera offer their fruits openly, probably to allow better visual detection. For example, *Alpinia haenkii* (Zingiberaceae) produces fruits at the outer tips of branches away from leaves. In many cases, figs (Moraceae), as well as genera like *Saurauia* sp. (Altinidiaceae) or *Syzygium* sp. (Myrtaceae) show cauliflory, and fruits often grow in clusters. At least one fig species in the study area (*Ficus* sp., P351) loses its leaves when fruits are ripe, which is likely to be adapted to fruit

bats as the main seed dispersers of this species. The results of the choice experiments suggest that certain colors like yellow and red may facilitate visual detection of fruits by bats. How visual fruit properties may affect the detection by fruit bats is still largely unstudied. Experiments with free ranging fruit bats might provide further insights to this aspect of fruit bat ecology. It might be promising to study fruits in the natural environment of megachiropterans, for instance, by manipulating their color and/or odor. This is likely to yield useful information about the relationship between fruit characteristics and the choice behavior of foraging pteropodids under natural conditions.

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APPENDIX A

Definitions:

Reflectance: The ratio of reflected power(4 to incident power generally expressed in dB or percent.

Reflection: The abrupt change in direction of a wave front at an interface between two dissimilar media so that the wave front returns into the medium from which it originated. *Note 1:* Reflection may be specular (*i.e.*, mirror-like) or diffuse (*i.e.*, not retaining the image only the energy) according to the nature of the interface. *Note 2:* Depending on the nature of the interface *i.e.*, dielectric-conductor or dielectric-dielectric the phase of the reflected wave may or may not be inverted.

Brightness is a subjective attribute of light to which humans assign a label between very dim and very bright (brilliant). Brightness is perceived not measured. Brightness is what is perceived when lumens fall on the rods and cones of the eye's retina. The response is non-linear and complex. The sensitivity of the eye decreases as the magnitude of the light increases and the rods and cones are sensitive to the luminous energy per unit of time (power) impinging on them.

Simultaneous brightness contrast is defined as the same surface looking differently bright in different surrounds. Here the same gray target—the circular patch—looks brighter in a darker surround than in a lighter one *(left)*.

Luminance is the luminous intensity per unit area projected in a given direction.

Light is radiant energy that is capable of exciting the retina and producing a visual sensation. This definition is the one most meaningful for display professionals although it differs from the definition frequently used by physicists. Our definition excludes ultraviolet (UV) and infrared (IR) wavelengths. UV is shorter in wavelength than light as we have defined it and IR is longer. The visible wavelengths of the electromagnetic spectrum extend from about 380 to 770 nm. The unit of light energy is the lumen second.

Luminous intensity is the luminous flux per solid angle emitted or reflected from a point. The unit of measure is the lumen per steradian or candela (cd). (The steradian is the unit of measurement of a solid angle.) The Intensity control on an oscilloscope adjusts the magnitude of the luminous intensity and consequently the luminance and the brightness of the light output. Luminance and brightness are defined below.

Luminance is the luminous intensity per unit area projected in a given direction. The SI unit is the candela per square meter which is still sometimes called a nit. The footlambert (fL) is also in common use (1 fL = 3.426 cd/ m^2). The concept of luminance is challenging and deserves detailed discussion. First let us look at what is meant by "projected area." Think of a slide projector containing a slide that is opaque except for a small clear spot at the center. When d1 and d2 are correctly related to the focal length of the lens light passing from the lamp through the clear spot in the slide is focused by the lens onto the receiving surface. This in-focus image of the spot is the projected area. The size of the projected area can be adjusted by changing the focal length of the lens d1 and d2 and/or the size of the spot - the aperture - on the slide. Replacing the projection lamp with a photodetector and the projected area with a source of light - either self-luminous or reflected provides the basic elements of a luminance photometer. Most luminance photometers' have special optics that allow the user to view the source and bring the projected area into focus. Any luminous flux that leaves the source - as defined by the projected area - and passes through the lens will also pass through the Aperture. That luminous flux will enter the photodetector and permit a luminance measurement. What is being measured is power - the rate at which energy is being transferred from source to detector - but there can be no power without energy.

To see how luminous intensity contributes to luminance review the definition of luminous intensity. Each of the points - such as P1 and P2 - on the projected area emits luminous flux over a solid angle of 2 PI steradians. However only that portion of the flux that falls within the cone defined by the effective area of the lens and the distance d from the lens to the point on the source succeeds in arriving at the detector.

There is a little cone for every point on the projected area. Two cones of angles 1 and 2 are shown. For each point on the projected area there will be a corresponding solid angle. The greater the projected area the greater will be the luminous flux collected by the lens. The larger the lens diameter the greater will be the luminous flux from each point collected by the lens and directed through the Aperture to the photodetector. P1 and P2 are two of the many points on the object source plane. The optics form the images PI' and P2' of these points at the aperture plane. A point on the source is focused by the lens onto the aperture plane. There is no need to focus on the photodetector because all of the light that passes through the aperture must fall on the photodetector. If the projected area were to be reduced to one-half the number of little cones would be reduced to one-half and the luminous flux collected by the lens and arriving at the photodetector would

be reduced by one-half. This assumes that the projected area is uniformly luminous. If the projected area is not uniformly luminous the photodetector will average the luminous flux over the projected area.

The luminous flux collected by the photometer lens (and directed to the photodetector) is proportional to the projected area. This is important in for example measuring the luminance of a display. The placement of the projected area on the luminous source of a display - such as a symbol stroke - is important when making a luminance measurement.

Luminance is the measurable quantity which most closely corresponds to brightness. The luminance photometer and the human eye both have a lens and both receive light from specific directions. The photometer has a single photodetector - maybe three for color - while the eye has a very large number of sensors (rods and cones). One may think (loosely) of each cone in the fovea - the area near the center of the retina - as being part of a human light meter using a common lens.

Illuminance is the luminous flux incident on a surface e per unit area. The SI unit is the lux or lumen per square meter. The foot-candle (fc) or lumen per square foot. is also used (1 fc = 10.764 lux). An illuminance photometer measures the luminous flux per unit area at the surface being illuminated without regard to the direction from which the light approaches the sensor. Using cosine correction to correct for changes in the illuminated area of a surface as a function of angle of incidence guarantees that the measured value of illuminance is independent of the direction from which the light approaches the sensor.

Let us try to say that again in a more intuitive way. If a flashlight is aimed perpendicular to a nearby surface it produces a circle of light on the surface. Tilt the flashlight and the illuminated spot increases in area and becomes elliptical in shape. The same luminous flux is now spread over a larger area as the angle between the axis of the flashlight and the normal to the surface increases. For a given luminous flux the illuminance decreases as the illuminated area increases.

If you have an illuminance photometer handy make an illuminance measurement with the light directly over the sensor. Now make a measurement with the light off axis by a given number of degrees from the normal. The off-axis reading should be equal to the on-axis reading times the cosine of the angle. If it is the meter is cosine corrected. This experiment requires the meter sensor to be smaller than the projected area.

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NOTES ON FRUIT CONSUMPTION OF THE PHILIPPINE BULBUL(*Hypsipetes philippinus*) AND ITS QUALITY AS A SEED DISPERSER

Jens Schabacker & Eberhard Curio

ABSTRACT

The Philippine Bulbul (Hypsipetes philippinus, Pycnonotidae) *is, by virtue of its relative abundance, the most common frugivorous bird in primary and secondary forests in the West Visayas, Philippines. This paper compiles data on 49 tree species used for their fleshy fruits by the Philippine Bulbul. Additional more detailed observations were made on one tree each of four fig* (Ficus sp.) *species as well as a number of other fruit-eating forest birds.*

Bulbuls feed in general on small fruits of up to 20 mm in diameter. Depending on tree species, they eat 66-82% of the fruits which they pluck from the source tree and drop only a minor proportion into the ground. Only less than 9-22% of fruits harvested are carried away from the source tree in the bird's beak. Since birds stay in the near vicinity of an exploited tree, the fraction of fruits carried over long distances seems to be small. However, of those many seeds ingested on and near a source tree, a substantial fraction may be dispersed over longer distances upon passing the gut. The bulbul benefits a fruiting tree through seed dispersal since it ingests all seeds by swallowing the fruits whole. Both this species and other frugivorous birds handle (eat, drop, carry) fruits in distinct ways irrespective of the tree species on which they feed. Thus, birds of up to eight species, including the bulbul, exploiting the same fig species differ significantly from each other in the manner of handling mentioned. This translates into quality differences among those birds as seed dispersal agents. Being a generalist frugivore, and because of its abundance, the Philippine Bulbul may be among the most important seed dispersers in this region. Other forest birds, though being in part more specialized on fruits, appear to rank lower as seed dispersers for a number of reasons.

Introduction

In tropical rainforest about 60–90% of the plants are adapted to disperse their seeds with the help of vertebrates (Fleming 1979, Howe & Smallwood 1982, Dirzo & Domínguez 1986, Hamann & Curio 1999, Hamann et al. 1999). Woody plants of the understory in particular depend on animal mediated seed dispersal (Howe & Smallwood 1982, Howe & Westley 1988). Along with various species of mammals (van der Pijl 1972, Fleming 1981, 1986, Cox et al. 1991, Bizerril & Raw 1997, Whitmore, T. C. 1991), birds are among the most important seed dispersal agents in tropical forests (van der Pijl 1972, Stiles 1980, Howe & Smallwood 1982, Corlett 1998a). This characteristic of birds affects plant species composition (Janzen 1970) and may be so important that a given species may qualify as a keystone species (Cox et al. 1991, Powers et al.1996). Hence, in tropical biology, seed dispersal by frugivorous animals takes center stage.

To gain further insight into the mutualistic interactions between fruiting plants and frugivorous animals in a given area, basic studies are still needed. This study focuses on the Philippine Bulbul (*Hypsipetes philippinus*, Pycnonotidae) in order to identify the fruiting trees it uses for food, and to establish both its quality and its efficiency as a seed dispersing agent in the West Visayas, Philippines.

The endemic Philippine Bulbul is one of the most common frugivores in the Philippines. The bird is the size of a thrush and rather inconspicuous when skulking in foliage. The sexes are alike (Kennedy et al. 2000). Distributed from sea level up to about 2,000 m a.s.l., it can be found in primary and secondary forests, in mangrove and lowland rainforest, as well as mountain mossy forest (Dickinson et al. 1991, Kennedy et al. 2000). It lives regularly along the edges of clearings and cultivated areas close to original forests, as well as in patches of secondary growth (Rabor 1986). Being highly social, it roams the woods in groups or in mixed species flocks. Breeding occurs from March to July (Dickinson et al. 1991). The bird is known to feed on fruits as well as insects (Rabor 1986).

Material and Methods

Study areas and birds

Observations at fruiting trees were conducted at the research station of the Philippine Endemic Species Conservation Project (PESCP) on the island of Negros, Philippines. The study site is situated in the North Negros Forest Reserve (NNFR) within the jurisdiction of the province of Negros Occidental. This forest reserve lies between the volcanoes Mt. Silay (1,510m) and Mt. Mandalagan (1,885m), and is about 80,454 ha. Both secondary forest (1/3) and primary forest (2/3, Diestel 1996) cover about 20% (16,487ha) of the area. Observations were conducted near the village of Patag, Silay City district (10°41.7'N; 123°10.6'E; 650m a.s.l.) on the NW slope of Mt. Mandalagan between 23 August and 10 September 1996 (see also Heindl & Curio 2000, Hamann & Curio 1999).

Additional capture of Philippine Bulbuls and further observations on their fruit consumption were carried out at the PESCP research station at Sibaliw in the NW of Panay island (11°49.2'N, 121°58.1'E) during the summer and winter 1997/98. Situated about 450m a.s.l., the station is located within a former farmland (kaingin) surrounded by primary forest. Parts of the kaingin fields are now stocked by 25 year old secondary forest. Birds were netted in mist nets which were placed mainly in the former kaingin fields and at the edges of the nearby primary forest. The following morphological data were taken: body weight, body length, wing length, tail length, beak length, beak width at base.

Located less than 190 km from each other, both research areas belong to the West Visayan biogeographic region. Hence, for the most part they are comparable in forest composition and other biotic and abiotic factors such as the weather.

Observations at fruiting trees

Four fruiting fig trees (*Ficus* sp., Moraceae) were observed for 1–5 days near the village of Patag in the NNFR. Observations went on from early morning until rain started in the afternoon. The

visiting bird species and their behavior were recorded. Individuals were observed for as long as it was possible to do so until they disappeared in the foliage.

Fruit handling by birds is divided into three categories: 1. Fruits eaten; 2. Fruits dropped from the tree; 3. Handling of fruits with unknown outcome. This latter category includes an unknown proportion of fruits carried off in the bird's beak. No estimate can be made in terms of distance or quantity of the fruits dispersed by being carried off in the bird's bill. Because of the dense canopy, the data are biased in favor of the more abundant and the more active bird species. Hence, no estimate of the relative abundance of a bird species at a given fruiting tree could be made.

On Panay, only the visiting birds and the species of tree they visited were recorded. In order to establish the full range of fruits used by the Philippine Bulbul, all seasonally available fruiting trees were observed during mornings between 6 and 12 o'clock until at least several bulbuls had eaten fruits of a tree under scrutiny. The array of fruits consumed by the bulbul was further estimated by examining the faeces of caught birds. In some cases direct observation could not verify an particular fruit species that the birds readily took in the cage even though fruits known to be used by the bulbul in the wild were present as well. From this observation, it is possible to regard those fruits as being part of the food in the wild, too.

Statistics

Tests were run with the SPSS 10.0.7 package; p values are given two-tailed.

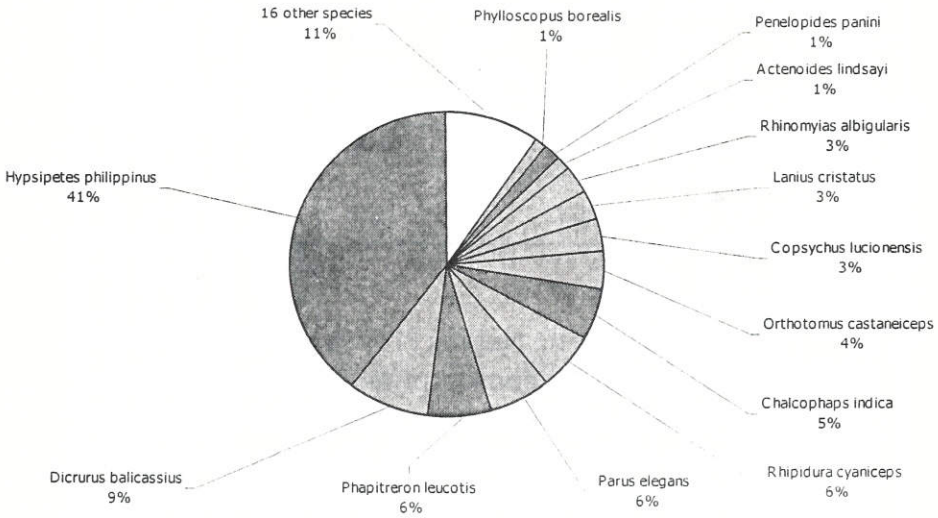
Results

Avifauna of West Visayan forests

Out of 271 bird species listed for Negros by Dickinson et al. (1991), 111 have been recorded by project members during the years of study within the NNFR. Out of the 111 observed, 85 occur in forest habitats. According to our observations as well as

information from locals, 36% of these species are known to feed on fruit. They include 8 doves, 4 parrots, 2 hornbills, 2 bulbuls, all belonging to families of mainly fruit-eating birds. Others like 2 *Rhabdornis*, 2 orioles, and 1 starling have also been observed feeding in many fruiting trees, and maybe considered potentially important for seed dispersal (see Hamann & Curio 1999, Heindl & Curio 2000 for species names).

Fig. 1: Forest birds netted on Panay, broken down to species. Total = 267. Frugivorous species in dark gray. The others are mixed-diet feeders or insectivorous.



By virtue of its relative abundance, the Philippine Bulbul is one of the most common frugivorous birds in primary and secondary forest in this area. About 41% of the caught birds were bulbuls (Fig. 1). Other fruit eating birds like the fruit doves *Phapitreron leucotis (*6%), or Hornbills *Penelopides panini* (1%), were much less abundant. The netting data reflect the abundance of frugivores in secondary forest and at the edges of primary forest. However, estimating the relative abundance from capture data might be biased because of two reasons. First, birds

differ in the probability of being caught in mist nets; second, the netting covers only the lower 15 m above ground. This includes all strata in the secondary forest but primary forest is usually much taller. Though the true relative abundance of species other than the bulbul might be higher, the bulbul is still the most abundant frugivorous bird in this area. Morphological data of *Hypsipetes philippinus* given in Table 1 show the size of the bird and its bill size (beak width at base=gape size).

Table 1: Morphological data of 107 *Hypsipetes philippinus (guimarasensis?)* on Panay Island.

	Body weight [g]	Body length [mm]	Wing length [mm]	Tail length [mm]	Beak length [mm]	Beak width at base [mm]
Arithmetic-mean	47.4	222.4	104.5	83.8	22.6	13.
± s.d.	3.8	36.4	5.2	14.3	2.6	1.

Fruit consumption

The fieldwork on Negros (1996) and Panay (1997 and 1998) revealed the consumption of fruits of 25 tree species by bulbuls as judged from direct observation and/ or from seeds in the faeces (Table 2). Two species are known through their seeds only. For four additional fruit species the direct evidence for consumption in the wild is missing although the birds took these fruits readily in the cage in the presence of established food-fruits. Data from Hamann & Curio (1999) reveal the use of 10 fruit species while Heindl & Curio (2000) reported 10 more additional fruit species. Taken together the data reveal the use of 49 fruiting tree species by the bulbul (Table 2). Among these, Euphorbiaceae (9 species) and figs (Moraceae) (up to 13 species) are the bulk of all species consumed.

Table 2: Fruits consumed by bulbuls as judged from direct observation (o) or from seeds in the feces (s); measurements viz. counts: arithmetic mean ± s.d. For four fruit species the observation of consumption in the wild is missing but the birds took these fruits readily in the cage in the presence of established food-fruits (c). Observation on p = Panay, n = Negros. Indet = unidentified tree species. Data from hm = Hamann & Curio 1999 and hdl = Heindl & Curio 2000, both on Negros, included.

	Scientific name	Family		Fruit height length?	Fruit width	Number of seeds	Seed height length?	Seed width
1	*indet. 1.*	-	o/p	-	-	-	-	
2	*indet. 2.*	-	s/p	-	-	-	16.2 (n = 1)	12.0 (n = 1)
3	*indet. 3.*	-	s/p	-	-	-	5.4 (n = 1)	2.5 (n = 1)
4	*Schefflera octophyllum*	Araliaceae	hdl		3-4 (estimate)	some		< 1 (estimate)
5	*Polyscias nodosa Wall.*	Araliaceae	o/p	5.8 ± 0.5 (n = 20)	7.2 ± 0.3 (n = 20)	5 (estimate)	3.4 ± 0.1 (n = 10)	2.5 ± 0.1 (n = 10)
6	*Canarium asperum*	Burseraceae	hdl		12.3 ± 0.9 (n = 25)	1 (estimate)		11.5 ± 0.9 (n = 4)
7	*Elaeocarpus sp.*	Elaeocarpaceae	hdl	-	7.9 ± 0.7 (n = 9)	1 (estimate)	-	5.5 ± 0 (n = 2
8	*Elaeocarpus cf. multiflorus (Poir.) Muell.-Arg.*	Elaeocarpaceae	o/p	10.2 ± 0.6	7.2 ± 0.3 (n = 20)	1 (estimate)	8.9 ± 1.1	5.3 ± 0.6 (n = 20)

Table 2 (continued)

	Scientific name	Family		Fruit height length?	Fruit width	Number of seeds	Seed height length?	Seed width
9	*Macaranga tanarius (L) M.A.*	Euphorbiaceae	hm	10	-	-	3	-
10	*Macaranga bicolor Muell.-Arg.*	Euphorbiaceae	o/p	-	-	1	-	-
11	*Bischhofia javanica Bl.*	Euphorbiaceae	hm	11	-	-	4	-
12	*Homalanthus alpinus Elm.*	Euphorbiaceae	hm	10	-	-	5	-
13	*Antidesma pleuricum Tul.*	Euphorbiaceae	o/p	4.4 ± 0.2	4.2 ± 0.2 (n = 20)	1 (estimate)	3.7 ± 0.2 (n = 19)	1.7 ± 0.1 (n = 19)
14	*Breynia cf. rhamnoides (Retz) Muell.-Arg.*	Euphorbiaceae	o/p	5	4 (estimate)	6 (estimate)	2 (estimate)	1 (estimate)
15	*Aporosa aurita (Tul.) Merr.*	Euphorbiaceae	o/p	9.4 ± 0.2 (n = 14)	8.6 ± 0.4 (n = 14)	2 (estimate)	8.1 ± 0.2	7.8 ± 0.4 (n = 8)
16	*Neoscortechinia philippinensis (Merr.) Welzen*	Euphorbiaceae	o/p	19.2 ± 1.0	11.3 ± 0.6	1	17.2 ± 1.2 (n = 20)	11.7 ± 1.7 (n = 20)
17	*Mallotus mollissima (Geisel) A. Shaw*	Euporbiaceae	hm	10	-	-	3	-

18	*Cinnamomum sp.*	Lauraceae	o/p	16.1 ± 1.6 (n = 19)	12.0 ± 0.1 (n = 19)	1	14.5 ± 1.1 (n = 19)	10.7 ± 0.8 (n = 19)
19	*Leea aculeata Blume*	Leeaceae	o/p	9.8 ± 0.4	14.0 ± 0.8	5.1 ± 2	6.2 ± 0.3 (n = 20)	5.1 ± 0.3 (n = 20)
20	*indet. 4.*	Meliaceae	c/p	14.1 ± 0.6 (n = 30)	10.9 ± 0.5	1	11.7 ± 0.5 (n = 30)	8.1 ± 0.5 (n = 30)
21	*Ficus heteropleura*	Moraceae	hm	10	-	-	1	-
22	*Strebus glaba (Merr.) Corner*	Moraceae	hm	-	-	-	-	-
23	*Ficus irisana*	Moraceae	hdl	-	6.6 ± 0.5	many	-	< 1 (estimate)
24	*Ficus benjamina*	Moraceae	o/p	16.9 ± 3.2	12.6 ± 1.9	many	-	-
25	*Ficus chrysolepis*	Moraceae	o/n	23.6 ± 8.1 (n = 10	21.8 ± 1.1 (n = 10)	many	-	-
26	*Ficus sp. 1*	Moraceae	o/p	10.9 ± 2.6 (n =20)	9.8 ± 1.5 (n = 20)	many	-	-
27	*Ficus sp. 2*	Moraceae	o/n	13.3 ± 1.0 (n = 12)	14.8 ± 0.4	many	-	-
28	*Ficus sp. 3*	Moraceae	o/n	9.0 ± 0.8 (n = 20)	8.7 ± 0.8	many	-	-

Table 2 (continued)

	Scientific name	Family		Fruit height length?	Fruit width	Number of seeds	Seed height length?	Seed width
29	*Ficus sp. 4*	Moraceae	o/n	19.7 ± 1.2 (n = 17)	23.7 ± 1.3 (n = 17)	many	-	-
30	*Ficus sp. 5*	Moraceae	hdl	-	11.2 ± 0,7 (n = 10)	many	-	< 1 (estimate)
31	*Ficus sp. 6*	Moraceae	hdl	-	10.5 ± 0.7 (n = 18)	many	-	< 1 (estimate)
32	*Ficus sp. 7*	Moraceae	hdl	-	10.5 ± 1.1 (n = 23)	many	-	< 1 (estimate)
33	*Ficus sp. 8*	Moraceae	hdl	-	19.4 ± 2.7 (n = 17)	many	-	<1 (estimate)
34	*Ardisia sp.*	Myrsiniaceae	c/p	6.6 ± 0.4 (n = 20)	7.6 ± 0.5	1	5.39 ± 0.3	5.1 ± 0.3 (n = 20)
35	*Syzygium sp. 1*	Myrtaceae	hm	22	-	-	11	-
36	*Syzygium sp. 2*	Myrtaceae	hm	23	-	-	10	-
37	*Syzygium sp. 3*	Myrtaceae	o/p	10.9 ± 0.2 (n = 20)	13.0 ± 0.1 (n = 20)	1 (estimate)	8.9 ± 0.1	7.9 ± 0.5 (n = 20)
38	*Syzygium sp. 4*	Myrtaceae	hdl	-	6.6 ± 0.9	1 (estimate)		6.3 ± 1.1 (n = 2)

39	*Decaspermum cf. fruticosum Forst*	Myrtaceae	o/p	5.1 ± 0.4	6.6 ± 0.7 (n = 20)	20 (estimate)	2 (estimate)	1
40	*Pandanus sp.*	Pandanaceae	hdl	-	4-5 (estimate)	some	-	< 1 (estimate)
41	*Gynotroches axillaris Blume*	Rhizophoracea	o/p	5.1 ± 0.6 (n = 20)	5.1 ± 0.5 (n = 20)	18.0 ± 3 (n = 44)	1.5	1
42	*Lasianthus cf. morus Elm.*	Rubiaceae	c/p	13.2 ± 1.7	11.2 ± 1.0	4.2 ± 1	5.2 ± 0.5	2.3 ± 0.3 (n = 20)
43	*indet. 5. (Psychotria ?)*	Rubiaceae	c/p	10.7 ± 0.9	8.9 ± 0.8 (n = 20)	2 (estimate)	8.2 ± 0.4 (n = 20)	5.6 ± 0.3 (n = 20)
44	*Guioa pleuropteris*	Sapindaceae	hm	15	-	-	3	-
45	*Eurya sp.*	Theaceae	o/p	3.9 ± 0.6	5.1 ± 0.8 (n = 20)	16.0 ± 4 (n = 50)	1 (estimate)	1
46	*Wikstroemia cf. ovata C.A. Mey*	Thymelieaceae	o/p	9.2 ± 0.5 (n = 20)	9.3 ± 0.6 (n = 20)	1	6.4 ± 0.4 (n = 20)	6.8 ± 0.9 (n = 20)
47	*Grewia multiflora*	Tiliaceae	hm	17	-	-	4	-
48	*Lantana camara Lin.*	Verbenaceae	o/p	-	-	1 (estimate)	-	-
49	*Geunsia cumingiana Rolfe*	Verbenaceae	o/p	4.6 ± 0.4 (n = 20)	6.8 ± 0.7 (n = 20)	10 (estimate)	3.1 ± 0.3	1.9 ± 0.2 (n = 17)

In general *Hypsipetes philippinus* arrive at a fruiting tree in flocks of various sizes. Only from time to time could solitary individuals or pairs be observed. Larger flocks contained more than 15 individuals. Birds pluck part of the fruits while perched on a branch. In most cases, however, bulbuls feed on the wing, plucking a fruit while hovering or jumping, or during a short flight. Carrying the fruit in its beak, a bird flies to a nearby branch and perches there to feed on it. Often birds fly longer distances with the fruit in their beaks and disappear in the surrounding trees.

Observations during fieldwork indicate that bulbuls fed on small fruits of about 10 mm in diameter (Fig. 2). They were not seen on trees with very large fruits and they generally did not peck at fruits to eat only the pulp. The length of the fruits ranged from 3.9±0.6mm to 19.2±1.0mm, the width from 4.2±0.2mm to 14.8±0.4mm. However, soft figs were as large as 19.7±1.2mm in length and 23.7±1.3mm in width (Table 2). The bulbuls usually selected the smaller ones from the range of fruits offered on this trees. With fruits of this size, however, the birds had obvious difficulty swallowing them. Birds pecked at soft fruits that exceeded 20mm diameter in width and swallowed only bits of pulp (Table 3). However, this was only observed on fig trees on Negros. Exceptionally, the fruits of one tiliaceaous tree (*Microcos stylocarpus*), although within the size range of consumed fruits (Fig. 2), were not taken by the birds, neither during the 20h of tree observation, nor in captivity. Likewise this tree was not visited by any other bird species in the same time.

Seeds are in general not regurgitated by the bulbul but defecated, and remain intact even after a gut passage time of between 5 and 51 min, with a median of 14 min ($Q_{25\%}$=11min, $Q_{75\%}$=21 min, n=47) (Schabacker & Curio 2000). 57 fecal samples were found and examined in the bags used to transport the birds. Out of these fecal samples, 16% contained parts of insects like antennaes, wings, or legs.

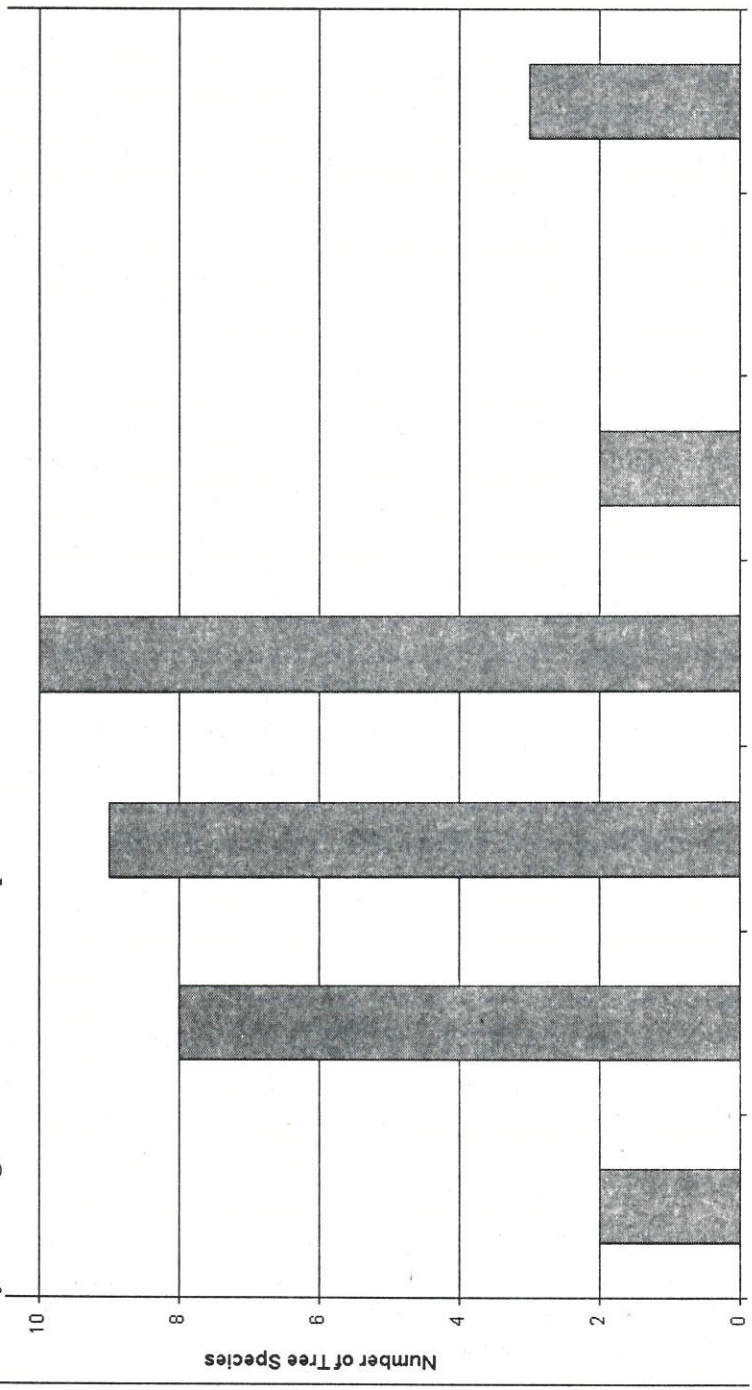


Fig. 2: Frequency distribution of the maximum width of the fruits consumed by the Philippine Bulbul on Panay and Negros. Total = 34 fruit species. See also Table 2.

A close look at four fig species revealed that the bulk (weighted mean 78%, n=323) of the fruits handled by birds of all species observed on the four trees were eaten (Table 3–6). Only about 13% (weighted mean) were dropped in the process, usually accidentally. Nine per cent (0–14%) of the fruits were handled while the bird was hidden from the observer. Because fruits 'handled unseen' could have been eaten further away from the parent tree, the proportion of fruits dispersed from the bird's bill and hence dropped without gut passage must be lower than 9%. This means also that the percentage eaten was certainly larger than 78%. Bulbuls do not differ from this overall picture. They ate at least 66–82% and dropped maximally 5–11% of the fruits they had plucked. Fruit doves and Hanging Parrots wasted more fruits of *Ficus chrysolepis* (Table 3). Bulbuls often plucked fruits on the wing and then flew some distance to a perch, as described above. Therefore, 9–22% of the fruits were handled while the bird was hidden from the observer. In general, the bulbuls tended to stay in the near vicinity of the parent tree and soon returned to it after finishing the fruit they had taken along. Flowerpeckers (*Dicaeum* spp.), Coletos (*Sarcops calvus*), and White-eared Brown-dove *Phapitreron leucotis* also carried away some fruits in their bill (Table 3–5). Because of their small size, flowerpeckers eat only parts of the pulp which may not contain large numbers of seeds.

Table 3 (on the right): Bird species feeding on *Ficus chrysolepis* Miq. (Moraceae). 25 Aug. – 1 Sep. 1996. Red fruits: height 23.6 ± 8.1 mm, range 22.3 – 31.0 mm; width 21.8 ± 1.1 mm, range 19.8 – 22.9 mm; weight 6.5 ± 1.1 g, range 4.5 – 7.6 g; n = 10.

Table 4 (right): Bird species feeding on *Ficus* sp. 2. (Moraceae). 1 – 9 Sep. 1996. Soft red fruits: height 13.3 ± 1.0 mm, range 12.3 – 15.3 mm; width 14.8 ± 0.4 mm, range 13.9 – 15.2 mm; weight 1.6 ± 0.2 g, range 1.4 – 2.0 g; n = 12.

Table 3.

Bird species	Feeding on	Fruits eaten where plucked (n)	Fruits dropped (n)	Fruits handled unseen (n)	n
Dicaeum bicolor	fruit parts	88% (15)	12% (2)	-	17
Ducula poliocephala	fruits, whole	64% (15)	36% (6)	-	21
Hypsipetes philippinus	fruits and fruit parts	82% (9)	9% (1)	9% (1)	11
Loriculus philippensis	fruit parts	73% (35)	27% (13)	-	48
Megalaima haemacephala	fruit parts	86% (6)	14% (1)	-	7
Ptilinopus occipitalis	fruits, whole	77% (14)	22% (4)	-	18
Sarcops calvus	fruit parts	50% (1)	-	50% (1)	2
Total		77% (95)	22% (27)	2% (2)	124

Table 4.

Bird species	Feeding on	Fruits eaten where plucked (n)	Fruits dropped (n)	Fruits handled unseen (n)	n
Dicaeum bicolor	fruit parts	63% (26)	20% (8)	17% (7)	41
Dicaeum trigonostigma	fruit parts	89% (8)	-	11% (1)	9
Hypsipetes philippinus	fruits and fruits parts	74% (56)	5% (4)	21% (16)	76
Megalaima haemacephala	fruit parts	100% (1)	-	-	1
Oriolus chinensis	fruit, whole	100% (1)	-	-	1
Phapitreron leucotis	fruit, whole	96% (25)	-	4% (1)	26
Ptilinopus occipitalis	fruit, whole	96% (24)	4% (1)	-	25
Sarcops calvus	fruit parts	100% (1)	-	-	1
Total		79% (142)	7% (13)	14% (25)	180

Table 5: Bird species feeding on *Ficus* sp. 3. (Moraceae). 7 – 9 Sep. 1996. Soft red fruits: height 9.0 ± 0.8 mm, range 8.0 – 11.1 mm; width 8.7 ± 0.8 mm, range 7.4 – 10.2 mm; n =20; mean weight of 20 fruits: 0.295 g.

Bird species	Feeding on	Fruits eaten where plucked (n)	Fruits dropped (n)	Fruits handled unseen (n)	n
Coracina striata	fruit, whole	100 % (3)	-	-	3
Hypsipetes philippinus	fruit, whole	66 % (6)	11 % (1)	22 % (2)	9
Loriculus philippensis	fruit, whole	100% (1)	-	-	1
Ptilinopus occipitalis	fruit, whole	100 % (4)	-	-	4
Total		82% (14)	5% (1)	12% (2)	17

Table 6: Bird species feeding on *Ficus* sp. 4. (Moraceae). 6. Sep. 1996. Soft yellow/orange fruits: height 19.7 ± 1.2 mm, range 21.8 – 16.2 mm; width 23.7 ± 1.3 mm, range 20.8 – 26.2 mm; weight 4.6 ± 0.9 g, range 3.0 – 5.6 g; n = 17.

Bird species	Feeding on	Fruits eaten where plucked (n)	Fruits dropped (n)	Fruits handled unseen (n)	n
Dicaeum bicolor	fruit parts	100% (1)	-	-	1
Hypsipetes philippinus	fruit, whole	100% (1)	-	-	1
Total		100% (2)			2

The rates of fruit handling techniques of the same bird species varied across different trees, ranging from two to four. Bulbuls were seen exploiting all four fig species while a flowerpecker, *Dicaeum bicolor,* and a fruit-dove, *Ptilinopus occipitalis* were seen at three of them (Tables 3 to 6). Yet in no case did rates of handling mode differ significantly across trees

species ($c2 = 1.847$, $p = 0.93$; $c2 = 4.83$, $p = 0.305$; $c2 = 4.176$, $p = 0.124$, all other $p = 0.386$).

However, different bird species behaved differently on one and the same tree. Thus, rates of fruit handling modes on *Ficus chrysolepis* (Table 3) and on *Ficus* sp. 2 (Table 4) differed significantly among birds ($c^2 = 38.677$, $p < 10^{-3}$; $c^2 = 24.716$, $p = 0.037$).

DISCUSSION

The fieldwork of this study covers the main fruiting season of the West Visayan region (Heideman 1989) and reveals the use of about 29 fruiting tree species by the Philippine Bulbul. Together with additional data from Hamann & Curio (1999) and Heindl & Curio (1999), 49 fruiting trees used by the bulbul for food are now known from this region (Table 2). The range of fruiting trees used by the bird would probably be even larger if a study covered a whole year (see Fukui 1995). Nevertheless, even though only a limited data set is available, one can generalize that free-living bulbuls take nearly all fruits they can handle with respect to size (see also Hamann & Curio 1999). Since bulbuls consume mainly the small fruits (Fig. 2), they can swallow most fruits whole, ingesting all seeds a fruit contains. The maximum width of the large fruits taken by the bird (< 15mm, Table 2, Fig. 2) is in general only slightly larger than its gape size ('beak width' 13.5mm, Table 1). However, some soft fruits of fig trees happen to be larger. Studies show that fruit size correlates with gape size of frugivorous birds (Herrera 1984, Johnson et al. 1985, Snow & Snow 1988). Since bulbuls rarely peck at a fruit they can not swallow whole but eat only bits of it, observations suggest a size limitation for bulbul-fruits at about 20 mm maximum in diameter. In contrast to large-fruited plants used by only a few large and obligate frugivores, the bulbul shares its range of fruit eaten with a lot of other fruit eating birds (Heindl & Curio 1999, Hamann & Curio 1999). Most of these fruit trees belong to early successional forest stages (Hamann

& Curio 1999). This fits the observation that kaingin-placed nets tend to catch more bulbuls than do primary forest nets. Unfortunately, because of the small number of mist nets used in old growth primary forest, this relation can not be quantified.

Only the small fruits of the Tiliaceae (*Microcos stylocarpus*,) were not eaten by any bird. Even after the fruits have dropped to the ground, these remained uneaten. Consequently, it would be interesting to investigate why some fruits within the size range of fruits consumed by the bulbul remain uneaten. Feeding deterrents may involve secondary plant compounds not tolerated by the bulbul/birds (Levey & Cipollini 1998). Yet birds also tend to reject fruits whose seeds are not easy to void, or those which are nutritionally unsatisfactory (Herrera 1981, Sorensen 1984, Johnson et al. 1985, Levey 1987, Stanley & Lill 2002). Today, one can only speculate that the fruit eating specialist able to overcome the feeding deterrent of the fruits of *Microcos* (see Tsahar et al. 2000, Tewksbury 2000) no longer occurs in the area (see Ng 1983).

In general bulbuls feed on the wing, plucking fruits and pecking on the pulp while perched on a branch. Hover-feeding enables bulbuls to reach fruits on slender twigs. As demonstrated by the less agile fruit doves that do not take fruits in flight, such fruits are apparently only available to birds of lesser body weight like the bulbul (Table 1). But this species is only partly frugivorous, as indicated by at least 16% of the examined faeces containing parts of insects. So, like other bulbuls, the Philippine Bulbul is omnivorous but with a clear dominance of fruits in its diet (Rabor 1986, for other *Hypsipetes* spp. see Smythies 1993 and Fukui 1995, for other Pycnonotidae Corlett 1998b, Mlingwa 1998).

If one follows the 'frugivore paradigm' suggested in the seventies (Janzen 1970, Snow 1971, Connell 1971, McKey 1975, Howe & Estabrook 1977, Howe & Smallwood 1982), the bulbul tends to belong to the group of generalist frugivores as described by Howe (1993). The bird is small (Table 1), occurs in large populations, uses many fruiting plant species (Table 2), and complements its fruit diet with a considerable proportion of insects

(Rabor 1986; this study). The bird is a gulper and, hence, does not destroy seeds during ingestion. Seeds are voided apparently intact (Schabacker & Curio 2000). It is likely that the ability of seeds to germinate is not reduced after gut passage. Such data are not available for *Hypsipetes philippinus*, but seeds defecated by *Hypsipetes amaurotis* are still able to germinate after gut passage (Fukui 1995). However, how and to what extent gut passage affects germinability of seeds (see Fukui 1995, Moore 2001) remains to be studied in any single case.

Philippine Bulbuls waste few fruits. They eat the majority of the fruits which they take from the tree. Only a few percent are dropped (Tables 3–6). Even though fruit doves (11% of all caught birds, Fig. 1) also eat the majority of fruits they pluck (Tables 3–6), their value as a seed dispersal agent is limited. First, larger frugivorous birds are much less frequent at forest edges and in the secondary growth forest they also prefer larger fruits (Fig. 1). Second, doves tend to stay in the canopy of the fruiting tree for long periods of time digesting, and hence, void a lot of seeds under the crown (Heindl & Curio 2000). Third, some doves, like *Chalcophaps indica*, are able to destroy seeds in their muscular gizzard (Lambert 1989, Corlett 1998b) and for this reason they are considered seed predators.

A close look at the actual distribution of fruit handling techniques of birds reveals that the fruit-eaters observed behaved rather uniformly regardless of the fig species involved. Bulbuls could be studied most closely because they visited all four figs under scrutiny. There were no among-tree differences in handling. This finding is consonant with the fact that individuals of different bird species exploiting one and the same tree (seven and eight species on two trees) differed significantly from each other in their use of the various handling modes. These species differences evidently translate into species-specific qualities as seed dispersers. Obviously, the handling mode 'eaten' can be fully evaluated only when also looking at visit length in the tree exploited (Heindl & Curio 2000); a species staying long enough for digestion to occur

on the spot is necessarily a lower-quality disperser.

Visit lengths of *Hypsipetes philippinus* to fruiting trees are generally shorter (5 to 10 min; Heindl & Curio 2000, pers. observation) than the average gut passage time. The gut passage time of seeds in the Philippine Bulbul varied between 5 and 51 min with a median of 14 min (Schabacker & Curio 2000). Hence, when they do not return to a feeding-tree within minutes, the bird deposits a large fraction of ingested seeds away from the immediate vicinity of the parent tree. Therefore the bird is an effective seed disperser. However, since bulbul flocks tend to stay in the vicinity of a fruiting tree they might disperse the bulk of seeds only over a few meters, therefore, providing within-habitat dispersal. By contrast, gut passage time of up to 50 min may be long enough to result in long distance seed dispersal. Because of its abundance at forest edges, the bird might therefore be a high-quality seed disperser between different habitats.

Birds of some other species disappeared with fruits in their beak into the surrounding vegetation (Table 3-6). Hence, they might disperse seeds with and without gut passage. Both Flowerpeckers observed (*Dicaeum bicolor* and *D. trigonostigma*) carried some fruits in the bill (Table 4). But because they eat only part of the pulp, they may not carry away large numbers of seeds. Also the Coleto (*Sarcops calvus*, Table 3) and a fruit dove (*Phapitreron leucotis*, Table 4) carried fruits in their bill. However, this may not happen too often, with only one observation pertaining to each species. Therefore, bulbuls are responsible for the bulk of fruits/seeds carried off in the beak and dispersed without gut passage from the fig trees examined. Yet the fraction of fruits dispersed by the bulbul without gut passage seems to be small as well (less than 9 – 22%). Although we are not able to estimate the distance the birds fly with the fruit in their beak, it seems most likely that the birds stay in the near vicinity of the observed tree (Heindl & Curio 2000). Hence, the fraction of fruits carried in the bill over long distances and so dispersed without gut passage should be negligible.

Consonant with the escape hypothesis (Janzen 1970, Connell 1971, Howe & Smallwood 1982, Clark & Clark 1984), Philippine Bulbuls provide high-quality seed dispersal. Because of their abundance in primary as well as secondary forest, they are among the most important generalist frugivores/seed dispersers in forest habitats in this region, particularly for small-fruit trees and early successional tree species (Hamann & Curio 1999). Thus they promote the regeneration of clear-felled land.

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THE NORTH NEGROS FOREST RESERVE: A BIODIVERSITY HOTSPOT AT RISK

Andreas Hamann

ABSTRACT

This report outlines the results of habitat surveys, ecological research, species inventories, and conservation efforts that have been conducted in the North Negros Forest Reserve (NNFR) in Negros Occidental between 1995 and 2000 by a team of scientists and environmental workers. The habitat survey revealed that 50 years after its establishment the reserve still holds 4,700 ha of mid-elevation oldgrowth forest, 5,200 ha of high-elevation mossy forest, and 6,600 ha of secondary forest. Mainly due to its elevational gradient, the NNFR contains a stunning diversity of habitats despite its small size. Interviews and site inspections at 20 villages in the reserve pointed towards some of the immediate threats to the reserve and its wildlife such as small-scale logging, forest extraction, and hunting. Important first steps to constructively manage and protect the reserve are discussed in this paper.

Introduction

Being the last remaining forest fragments in the Philippines, montane and submontane ecosystems have recently become the focus of attention for conservation efforts. In particular, as global centers of endemism and biodiversity, forests fragments of the West Visayas are included in the IUCN category of the highest conservation priority (Dinerstein et al 1995). Established by legislation in 1946 to protect more than 100,000 ha of virgin rainforest on Negros, the North Negros Forest Reserve (NNFR) represents perhaps the most important refuge for endemic plant and wildlife species of this region. This report outlines the results of surveys, research, and conservation efforts that have been conducted between 1995 and 2000 by the Philippine Endemic Species Project of the Ruhr-University Bochum, Germany, in collaboration with the Department of Environment and Natural Resources of the Philippines, the Provincial Environment

Management Office of Negros Occidental, and the North Negros Forest and Ecological Foundation in Bacolod, Negros Occidental. The review is meant to draw attention to the importance and problems of this little protected reserve.

Habitat survey

The NNFR is uniquely located, embraced by the volcanoes Mt. Silay and Mt. Mandalagan. The rugged topography of these two mountains has protected the area from logging in the past. The area is small compared to the remaining forests in Luzon and Mindanao, yet it is an important refuge for a great number of species endemic to the West Visayan biogeographic zone which includes the islands Panay, Negros, Guimaras, Cebu, and Masbate (Davis et al. 1995). While the last three islands have been entirely deforested, Panay contains a noteworthy range of semi-deciduous monsoon forest, and Negros has three fragments of wet tropical rainforest. The NNFR contains the largest fragment, although 50 years after its establishment only a relatively small portion (approximately 10%) of the reserve remains unlogged. A detailed aerial and ground survey revealed that all lowland dipterocarp forest of the reserve has been cleared except in a few inaccessible valleys, and 6,600 ha of secondary forest grows on areas that have been logged over in the past. The reserve, however, still contains 4,700 ha of mid-elevation oldgrowth forest and 5,200 ha of high-elevation mossy forest that is of no commercial importance (Figure 1). The two major fragments of submontane oldgrowth forest are bedded into half-craters that face each other and form arguably the most valuable watershed for quality water supply on Negros.

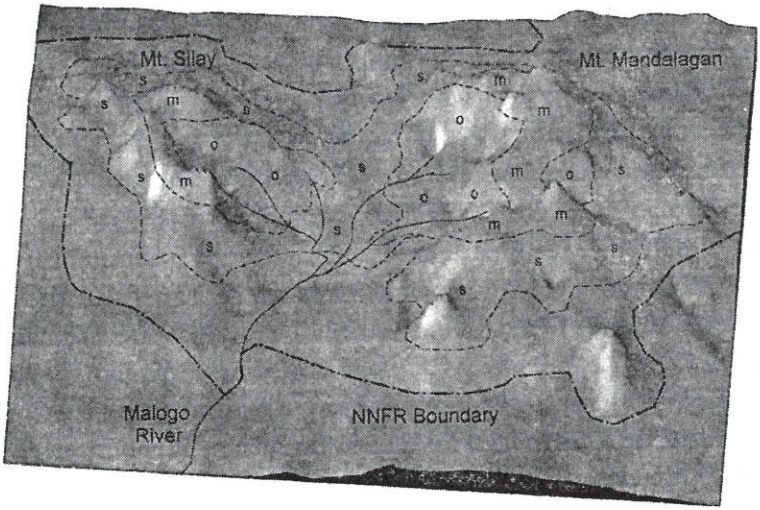

Figure 1. Digital elevation model of NNFR from 123°07' to 123°19'E and from 10°35' to 10°49'N (approximately 20´27 km). Symbols indicate oldgrowth forest (o), mossy forest (m) and secondary forest (s).

Ecology and biodiversity

Despite its small size, the NNFR contains a stunning diversity of habitats, mainly due to its elevational gradient. In some low lying valleys majestic dipterocarp forests can be found; the species-rich oak-laurel forests occur in the submontane zone; and higher up large areas are covered with mossy forest, dominated by a multitude of lichens, mosses, and other epiphytes thriving in the mist of the cloud level. In addition, sites with sulfur springs, hot springs, and temporary inundated bogs provide unique habitats for specialized life forms. The submontane forest communities have the highest plant biodiversity and support a large fruit-eating vertebrate community (Hamann and Curio 1999), including rare species such as the Visayan Tarictic Hornbills (*Pelenopides panini*) and several species of fruit pigeons and parrots. Among

the most critically endangered species of the Philippines is Writhed-billed Hornbill (*Aceros waldeni*), which has been photographed for the first time (Figure 2). Mammals living in this zone include the Visayan Warty Pig (*Sus cebifrons*), the Long-Tailed Macaques (*Macaca fascicularis*), and the highly endangered Tubenosed Fruit Bat (*Nyctimene rabori*), among other fruit bat species (Figure 2). This ecotone is the richest zone, both in terms of species of fruit trees and estimated total fruit production when compared to the Dipterocarp forests below and the mossy forest above (Hamann et al. 1999). In the higher elevation, coniferous trees such as Almaciga (*Agathis philippinensis*) and Mountain Cedars (*Podocarpus* ssp.) are more common, while the overall species diversity declines towards the mossy forest zone. With its gnarled and epiphyte covered trees, this mossy forest zone is the habitat of the Philippine Spotted Deer (*Cervis alfredi*), the most endangered species of deer in the world.

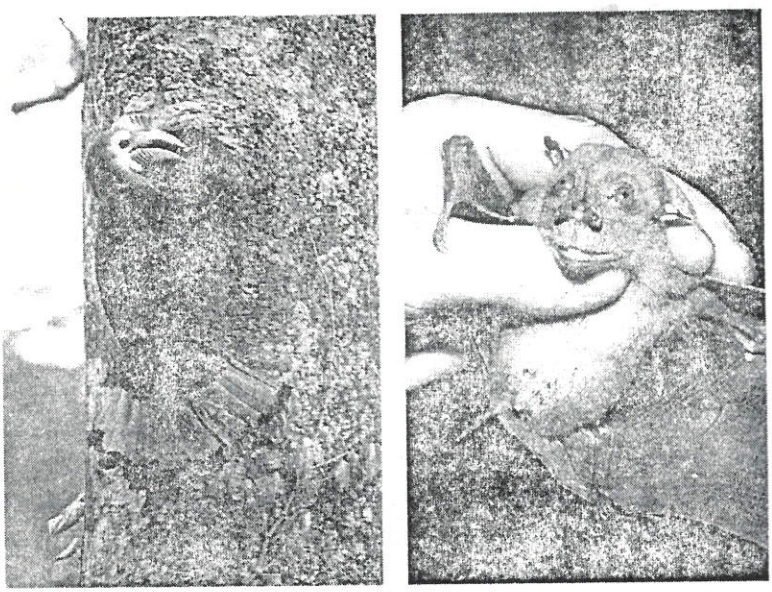

Figure 2. The two most critically endangered species found in the NNFR: the Writhed-billed Hornbill and the Tube-nosed fruit bat (Photographs by P. Heubüschl).

Threats to the reserve

Interviews and site inspections in 20 villages in the reserve pointed towards some of the immediate threats to the reserve and its wildlife: rattan collection and other forms of forest extraction were common in most villages, while at four sites, "timber-poaching" of select oldgrowth trees that are processed into rough boards on site was encountered. Almost everywhere within the regenerating forest areas, recruiting trees are cut and processed into charcoal to be sold in the cities. Hunting of wildlife has been identified as the greatest immediate threat to the ecosystem. Hornbills that feed on fruits in orchards and pigs that leave the forest area to feed on crops are sometimes shot by farmers, while sport-hunting of birds with air-rifles appear to be the most damaging and least acceptable practice. Hornbills and parrots used to be the target of sport-hunting, but the practice has diminished, according to interviews, since nests have become rare these days. Instead, hunters have turned their attention on other species, notably the Visayan Warty Pigs and the Philippine Spotted Deer which they shoot or trap and the young they sell as pets.

Deforestation rates similar to those between 1988 and 1996 can no longer be tolerated if at least a minimum of the reserve is to be saved. The probability of species becoming endangered or extinct increases with the reduction of their habitat (Brooks et al. 1997), and comparisons of our surveys with previous studies in the NNFR indicate a serious decline in bird populations that probably started in the 1980s, when the forest area reached a critical size for the maintenance of wildlife populations. We believe that today almost all large fruit-eating bird species in the NNFR experience a severe population bottleneck, and their survival and recovery will depend entirely on immediate conservation measures. It is important to realize that the decimation of wildlife is a threat to the whole ecosystem, since more than 80% of all trees depend on seed dispersal by these animals for their long-term survival.

The Oak-Laurel forest ecosystem, for example, will be unstoppably and irreversibly transformed into a simple community of small to medium-size trees, dominated by members of the families Euphorbiaceae, Moraceae, and Rubiaceae (Hamann and Curio 1999).

Conservation efforts

In recent years a number of different groups showed increasing interest in the NNFR for different reasons. Non-governmental organizations have promoted watershed improvement through reforestation to prevent the recurrence of catastrophic floods in the lowland such as that which took place in 1995, and to guarantee the irrigation of rice and sugarcane fields. Some municipal governments, on the other hand, have proposed tourism development to provide inhabitants of the polluted cities in the lowlands an attractive recreation area. Government agencies for their part have an interest in watershed management for the provision of drinking water and consequently consider the building of a water reservoir by damming the Malogo river. Land within the reserve is also being leased to farmers based on 25-year stewardship contracts, and many villagers continue to utilize forest products.

While multiple purpose land use is an attractive idea and combining conservation with utilization of natural resources has become a fashionable concept in many countries, it should be kept in mind that this type of management is recommended for extensive forest reserves. While utilization does not always conflict with conservation, outright protection should be advocated, if the last remnants of the West Visayan flora and fauna are to be rescued. Simplifying management objectives by rezoning the reserve may help to achieve this goal. Areas in the periphery of the reserve, where intensive agriculture has been practiced for decades, should be excluded from the NNFR. In the smaller manageable area,

stewardship contracts should be phased out and, based on an incentive scheme that provides the means for establishment elsewhere, farmers should be resettled after they have reforested their land. Commercial forestry enterprises in the vicinity of the core reserve could be promoted in order to create a buffer zone to satisfy local demand for wood products and to provide local employment.

An important step to constructively manage and protect the reserve was the creation of the NNFR Management Council in 1996 whose membership includes representatives of local and provincial governments, as well as non-governmental organizations. As the support of individual projects and their coordination will be crucial for the conservation of the last remnants of the West Visayan flora and fauna, the importance of such efforts cannot be over-emphasized.

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THE ADVERTISEMENT CALLS OF TWO ENDANGERED SPECIES OF ENDEMIC PHILIPPINE FROGS: *Platymantis spelaeus* and *P. insulatus* (Anura; Ranidae)

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ABSTRACT

We provide the first published accounts of the acoustic mate-recognition signals of the Negros cave frog, Platymantis spelaeus, *and the Gigante Island frog,* P. insulatus. *Both species are endemic to the Visayan Pleistocene Aggregate Island Complex (and are from Negros and Gigante islands, respectively), and both species are considered to be at some level of vulnerability of extinction due to the activities of humans in their very restricted geographical ranges.*

On the limestone outcrops of the Municipality of Basay in southern Negros Island, P. spelaeus *calls in and around caves and crevices of porous limestone karst. The mating calls of males of the species are unusually complex, consisting of paired calls of two separate syllables (=notes) each. Each note is a tonal frequency arc, and one portion of the second note is vibrational and amplitude modulated. In paired calls, the first note of the second call possesses relatively rich harmonic structure (up to five distinct harmonics of the fundamental frequency); remaining notes may have up to three harmonics.*

The Gigante Island group endemic P. insulatus *still persists despite near complete removal of original vegetation on the islands in this small land-bridge archipelago.* Platymantis insulatus *calls from crevices and small cave openings in limestone cliffs and outcrops following heavy rains. The mating call of this species is pulsed and highly amplitude-modulated, consisting of a long pulse train, with a gradually increasing pulse rate and decreasing interpulse interval throughout the call until concluding with an extremely rapid final burst of pulses. Each pulse possesses four distinct frequency components and two separate subpulses; examination of expanded waveforms indicates that each pulse is also a brief descending frequency sweep.*

We compare the mating calls of each species to other taxa in the previously-defined species group to which each belongs and we note call characteristics that uniquely diagnose each species. Call bioacoustics are

powerful techniques for studying species-specific behavioral and neurophysiological attributes of Philippine frogs; we expect that several more endemic Visayan species may be discovered in the near future through on-going application of these techniques to problems in Philippine frog taxonomy and behavioral ecology.

Introduction

Philippine frogs of the genus *Platymantis* consist of 26 currently-recognized distinct species (Alcala and Brown, 1998, 1999) embodying a wide range of morphological, ecological, and behavioral variations. On the basis of morphology, this impressive Philippine radiation has recently been organized into several species groups (Brown et al., 1997a, 1997b; Alcala and Brown, 1999), each consisting of putative clades (*sensu* de Queiroz, 1999; Brown and Diesmos, 2001) of morphologically-cohesive and presumably closely-related species. To date, no phylogenetic appraisal of these species groups has been forthcoming, but preliminary results of a comprehensive phylogenetic analysis of the genus based on mitochondrial DNA sequence data (RMB, unpublished data) suggests that not all currently-recognized species groups are monophyletic (contain lineages all stemming from a single common ancestor). A full re-assessment of the taxonomy of this group must await the completion of that study.

One body of evidence that has been brought to bear on specific problems in platymantine frog taxonomy is acoustical analyses of male advertisement calls. Several recent studies (Brown et al., 1997b, 1997c, 1999) have demonstrated the value of studying species-specific acoustic signals for elucidation of species boundaries and identification of cryptic species. In these and related studies (Brown, Diesmos, and Alcala, unpublished data), analyses of patterns of mate-recognition signals have been crucial in identifying numerous unrecognized, new species, especially in the *P. dorsalis* species group (Brown et al., 1997a, 1997c, 1999). Continuing studies utilizing acoustic techniques should complement

previous work on morphological variation (e.g., Brown and Alcala, 1970a, 1982) in an effort to provide a comprehensive review of the Philippine members of the genus and to understand patterns and processes relating to the evolution of acoustical and functional diversity in advertisement calls of this diverse assemblage of Philippine endemics.

As part of this larger effort, we have recently conducted field studies of the behavioral ecology of Visayan species on the islands of Negros, Panay, and several smaller islets associated with these larger landmasses. This work has provided us with the opportunity to study the vocalizations associated with courtship behaviors of two threatened Visayan endemics: the celebrated Negros limestone cave frog, *Platymantis spelaeus*, and the poorly-known Gigante Island frog, *P. insulatus* (Fig. 1).

Platymantis spelaeus has a distribution limited to a few limestone outcrops on southern Negros Island (Brown and Alcala, 1982). *Platymantis insulatus* is a presumably relictual species limited to a few small islets (the Gigante Group) off the NE coast of Panay (Brown and Alcala, 1970a; Alcala and Brown, 1998; Brown and Alcala, 2000; Ferner et al., 2001).

Assessments of the conservation status of these species have been hampered by a lack of basic abundance, distributional, and natural history data, but recent efforts to arrive at a consensus regarding the conservation status of Philippine amphibians have considered both *P. spelaeus* and *P. insulatus* to be at some degree of risk of extinction. The actual category of risk assessment has ranged in different accounts from "vulnerable" to "critically endangered", but all parties involved do agree that this risk must primarily be due to habitat destruction in both species' restricted geographical ranges (Alcala and Custodio, 1995; Afuang and Gonzales, 1997; Banks, 1999; Brown et al., 2001; Diesmos et al., unpublished data). In this paper we provide the first published descriptions of the mate-recognition signals in these two threatened Visayan endemics, and we discuss in detail the differences between the species in numerous characteristics of their advertisement calls.

Materials and Methods

We visited the type localities of *P. spelaeus* (Fig. 2; Tiyabanan Barrio, Municipality of Basay; Brown and Alcala, 1982) and *P. insulatus* (Fig. 2; Gigante Island; Brown and Alcala, 1970a) during the months of May and June, 2001. We concentrated informal survey efforts on hours of the day immediately prior to and immediately following sunset (approximately 1800 h) at the beginning of the rainy season on days when the local area had received heavy rains. The advertisement calls of species were recorded at temperatures between 25 and 27°C, with a Sony™ WM DC6 Professional Walkman and a Sennheiser™ ME80 condenser microphone (equipped with K3U power module). Calls were recorded at distances ranging from 1.5 to 2.0 m and ambient, cloacal, and substrate temperatures were taken immediately after acoustic recordings. Frogs were recorded, photographed, briefly captured by hand, weighed (to the nearest tenth of a gram [0.1 g]), measured (Snout-to-vent length [SVL to the nearest 0.1 mm]), and then released back into their original microhabitats.

Calls were digitized and analyzed using Soundedit© (Macromedia, 1995) and Canary© (Charif et al., 1996) software installed on a Macintosh computer. We examined oscillograms (waveforms), audiospectrograms (sonograms), and results of the Fast Fourier Transformation (frequency spectrum; FFT) for a variety of temporal and spectral characters. No temperature correction was undertaken during call analysis due to the narrow range of ambient temperatures recorded. Call rate and pulse rate were defined as: (total number of calls or pulses – 1) / time from beginning of first call or pulse to beginning of last.

Results

General observations

Platymantis spelaeus calls in large, loosely-congregated choruses, with the greatest concentration of courtship behavior

and reproductive activity in the evenings, following heavy rains. Choruses were subjectively characterized as relatively "loud" by observers who could clearly hear many calling frogs over high levels of ambient background noise during a rainstorm. Densities of calling individuals appeared to be relatively high; we subjectively estimated that between 10 and 30 individuals could be simultaneously heard by investigators at various areas in the type locality. Calling appeared to be concentrated in the several hours immediately following sunset on rainy nights. We observed frogs in small caves, around the mouths of caves and also farther from caves, on limestone hillsides, in disturbed regenerating scrubby vegetation, and calling from porous limestone boulders around the edges of fields.

Platymantis insulatus calls in small, more tightly-congregated choruses that were subjectively characterized as relatively "quiet" by observers. Observers had to strain to hear calling frogs against ambient background noise (undulating surf from a beach 20–30 m away). We only observed calling frogs on steep limestone hillsides and from karst cliffs at the sea's edge (Fig. 3). Calling activity was heard after sunset following a light rain and at dawn, again following rain. Densities of calling individuals appeared to be relatively low; we estimated that four to six individuals could be simultaneously heard by investigators at a given time in the areas we visited. On several occasions, individuals called from deep within porous limestone karst and in small caves that were inaccessible to us. Unlike nearly all other species of Philippine frogs, this species calls very close to the edge of the sea with high levels of ambient noise produced by the ocean's surf. This species appears to escape the extreme heat and aridity of the dry Gigante Island environment by retreating during the day into caves, cracks, and crevices in porous limestone karst.

Platymantis spelaeus

The mating call of *P. spelaeus* is a complex, tonal, whistling two-syllable call consisting of a higher frequency first note and a

lower frequency second note, each of similar duration. After initial single calls, *P. spelaeus* delivers paired, two-note calls with a brief pause before calling again (Fig. 4A). Calls sound to the human ear like the complex di-syllabic call of a small bird: "Pee-coh, pee-coh....pee-coh, pee-coh".

The following description is based on recordings of two individuals for which we secured high-quality recording segments of twelve and nine minutes continuous calling per individual (18 and 14 call bouts, respectively). During calling, the first individual called from a debris pile 45 cm above the ground, and the second individual called from a decaying tree stump, 30 cm above the ground (both 1.5 m from the microphone). The first individual's (49.1 mm SVL, 8.9 g) cloacal temperature was 27.6°C (25.3°C ambient, 25.3°C substrate) and the second's (41.3 mm SVL, 8.2 g) was 27.2°C (26.9°C ambient, 25.4°C substrate).

Call groups in the first frog were initiated with 2–4 ($\bar{x}$ =2.8 ± 1.1 SD; n = 18) single calls of two notes each, followed by 2–5 ($\bar{x}$ 3.3 ± 0.9 SD; n = 18) paired, two-note calls (i.e., paired calls had a total of four distinct notes). In the second frog, call groups were initiated with 2–4 ($\bar{x}$ =3.0 ± 1.1 SD; n = 14) single-note calls followed by 2–5 ($\bar{x}$ =3.4 ± 1.1 SD; n = 14) paired calls. Calling bouts lasted for 13.2–24.8 ($\bar{x}$ =18.5 ± 3.2 SD; n = 18) s interspersed with 17.1–28.5 ($\bar{x}$ =24.1 ± 5.4 SD; n = 17) s of silence in the first frog. Call groups lasted 11.1–23.3 ($\bar{x}$ =17.9 ± 4.3 SD; n = 14) s in the second frog, interspersed with 15.1–25.7 ($\bar{x}$ =18.4 ± 6.0 SD; n = 13) s intergroup intervals. Mean calling rate within bouts (including both single and paired calls) was 1.9 (± 0.09 SD; n = 18) call/s for the first frog and 1.7 (± 0.14 SD; n = 14) call/s for the second individual.

Mean call duration ranged from 130 to 138.2 ($\bar{x}$ =128.2 ± 28.1 SD; n = 32 calls) ms for single calls and 348.6 to 380.1 ($\bar{x}$ = 355 ± 26.2 SD; n = 32 calls) ms for paired calls (from two individual frogs). Intervals between paired calls were shorter ($\bar{x}$ =1.6 ± 0.4 SD, range = 1.5–2.8 s; n = 32 calls) than those between single calls ($\bar{x}$ =3.1 ± 1.6 SD; range = 1.6–8.9 s; n = 32 calls).

The audiospectrogram depicts single calls of two distinctly different inverted U-shaped frequency modulated arcs (Fig. 4B): the first a nearly symmetrical arc, consisting of a pure tone rise and fall in frequency to a final frequency just below initial. By calculating the FFT throughout different portions of the call (not shown), we determined that, for the first individual, frequency of the first note invariably began a gradual rise from 2.2 kHz, to peak frequency of 2.4 at midnote (approx. 30 ms), followed by a gradual decline to below initial frequency at 1.9 kHz. In the second frog, the first note frequency arc rose from 2.4 to 2.8 kHz at mid-note, then fell to a final frequency of 2.1 kHz.

The second note was invariably more complex, beginning with a rapid rise from ambient to nearly peak amplitude and with an initial rapidly-pulsed vibrational or amplitude-modulated element that was converted to a pure tone at mid-note (Fig. 4B). At the point where this note was transformed from vibrational to a pure tone, the first frog's peak frequency was 1.89 kHz; the second frequency arc then rose to a peak frequency at 2.1 kHz, before falling to a final frequency of 1.9 kHz. In the second frog, this second brief frequency arc rose from 1.7 to 2.1 kHz before declining to a final frequency of 1.9 kHz. In the audiospectrograms of the first note for most calls, one, two, or occasionally three faint but distinct harmonics are evident at frequency intervals that were clearly multiples of the fundamental (=emphasized) frequency.

Amplitude modulation evident in the oscillogram (waveform) for single two-note calls (as well as the first call in paired calls; see Fig. 4C) depicts two envelopes of nearly equal energy with a gradual, irregular rise to peak sound pressure levels corresponding to peak frequency, followed by a similar and opposite decline to ambient pressure. In single calls, the first note duration was greater than that of the second: in the first frog, mean first note duration ranged from 62.8 to 65.6 ($\overline{x}$ =64.6 ± 1.1 SD; n = 18) ms and in the second frog, first note duration was very similar, ranging from 60.9 to 64.3 ($\overline{x}$ = 63.4 ± 1.1 SD; n = 14) ms. Second note total duration ranged from 50.1 to 55.8 ($\overline{x}$ = 52.1 ± 1.8 SD; n = 18)

ms in the first frog and from 50.8 to 56.5 ($\bar{x}$ = 53.0 ± 2.1 SD; n = 14) ms in the second frog. The first, amplitude modulated portion (invariably with five subpulses) of the second note ranged from 25.1 to 27.6 ($\bar{x}$ = 36.5 ± 0.88 SD; n = 18) and the second, frequency modulated portion of the second note ranged from 24.2 to 27.0 ($\bar{x}$ = 26.1 ± 1.5 SD; n = 18).

In paired calls of both individuals, we observed an imperfect duplicating of the single two-note call described above. In these calls the first and second call were distinctly different in a stereotyped manner. First, whereas the interval separating two-note single calls ranged from 8.9 to 13.8 ($\bar{x}$ =12.2 ± 3.6 SD; n = 32) ms and did not differ appreciably from internote intervals in the first call of paired calls (10.1 to 14.2: $\bar{x}$ = 11.4 ± 2.4 SD; n = 32), this same interval was consistently of longer duration in the second of paired calls. In the later case, internote intervals ranged from 31.3 to 47.4 ($\bar{x}$ = 38.1 ± 3.8 SD; n = 32) ms. Also, in paired calls, mean first note duration in the second call was consistently shorter than mean first note duration in the first, and also shorter than mean first note duration in single calls (see above) ranging from 48.7 to 53.4 ($\bar{x}$ = 50.4 ± 2.2 SD; n = 32).

Additional differences between first and second calls in paired calls are evident in the waveform (Fig. 4C). Although the first note of the second call is only moderately more audible to the human ear than that of the first, it is approximately 60% greater in relative amplitude. Additionally, both frequency and amplitude of the tonal portion of the second note decline between calls in paired calls. The decline in amplitude occurs as a nearly 40% loss of relative amplitude and, as discussed above, the peak frequency of the second note declines by about 10–20%. Finally, in paired calls, harmonic structure of the second call is more complex than that of the first (Fig. 4B); in these calls harmonic structure is relatively more rich than that of single calls as well, with up to five or sometimes six distinct harmonic multiples of the fundamental (vs. two to three) on the first note of the second call.

Platymantis insulatus

The advertisement call of *P. insulatus* is rapidly pulsed and highly amplitude-modulated, with a long series of brief clicking pulses, gradually increasing in pulse rate (corresponding to a decline in interpulse interval) throughout the call, until climaxing at an extremely rapid final burst of pulses (Fig. 5A). The rapidly-delivered brief clicks, interspersed with interpulse intervals of varying duration, sound, to the human ear, like the click vocalizations of a dolphin: "tik...tik...tik, tik, tik-tik-tik".

Our description is based on two separate recordings of one frog (recorded four minutes apart), of eleven and six minutes, six and four calls respectively. During the first recording, this frog called from a limestone rock, 15 cm above the ground, and during the second, it called from the edge of a limestone cliff, 30 cm from the ground, just above the rock perch of the first recording (both recordings 2.0 m from the microphone). This individual's (39.1 mm SVL, 4.9 g) cloacal temperature was 27.1°C (26.9°C ambient, 25.4°C substrate). For the analysis, we combined data from the two recordings and analyzed them together.

The *Platymantis insulatus* in our recordings called every 28–41 s, with a calling rate of 0.03 call/s across the total recording segment. Pulse rate within calls ranged from 4.1 to 5.3 ($\bar{x} = 4.6 \pm 0.8$ SD; n = 10) pulse/s when averaged across the entire call, however, interpulse interval declined and pulse rate increased throughout the call (Fig. 6). Mean interpulse interval at the beginning (measured between 2nd–3rd pulse) of the call declined from 360 to 900 ($\bar{x} = 554 \pm 39.8$ SD; n = 10) ms to 63–97 ($\bar{x} = 74 \pm 7.9$ SD; n = 10) ms by the call's end (measured between penultimate and last pulse). Individual pulses ranged from approximately 15 to 25 ms and consisted of a near-instantaneous rise from ambient to peak amplitude, followed by a more gradual, approximately 10–20 ms decline back to ambient levels. Pulses appeared stereotyped and invariant, with only the first 2–4 pulses slightly lower (approximately 80–90%) than amplitude levels carried throughout the remainder of the call.

The power spectrum (Fig. 5 - not shown; calculated over the first few milliseconds of each pulse) allowed for the identification of four frequency components within each pulse. At the beginning of the call, these include distinct peak frequencies of 1.03 kHz (the fundamental), 2.07 (the second = dominant frequency), 3.1 (third harmonic) and 4.13 kHz (fourth harmonic). By the end of the call, peak frequency of all components increases slightly, with approximate peak frequencies of 1.2, 2.38, 3.57, and 4.78 kHz, respectively. Due to the brief duration of the pulse, these elements are barely visible in the audiospectrogram (Fig. 5B). Examination of the expanded waveform and audiospectrogram indicates that individual pulses are actually composed of two distinct subpulses, one at the beginning, and one at the end of shallow (2.4–2.1 kHz) frequency sweeps (Fig. 5B-C).

Discussion

Detailed studies of herpetological communities inhabiting isolated montane habitats, separate islands, or distinct geologic components of larger Visayan islands are warranted due to the fact that these environments appear to have contributed to the evolutionary process of speciation and often bear interesting faunal assemblages and distinct endemic species. Relatively few such detailed studies are available in the Visayas (but see Brown and Alcala, 1961, 1964, 1986, 1970b) but even simple faunal inventories (Ferner et al., 2001; Gaulke, 2001a, 2001b, 2001c) continue to produce some startling discoveries (Ferner et al., 1997, 2001; Brown et al., 1999, 2001; Gaulke and Curio, 2001; Gaulke, 2002).

Our descriptions of the vocalizations of these two endangered species should be of interest to herpetologists, behavioral ecologists, evolutionary biologists, and conservation biology specialists in the Philippines. In particular we urge future investigators to make use of advertisement calls during conservation and management studies for the purposes of population monitoring

and rapid-assessment censuses.

Our subjective characterizations of *P. spelaeus* choruses as "large, loosely-congregated, loud" calling aggregations and *P. insulatus* choruses as "smaller, tightly-congregated, quiet" aggregations require quantitative verification before they can be interpreted in a rigorous fashion. Data on natural frog densities, ambient noise levels, and absolute calling amplitude would all be a welcome improvement on our non-quantitative impressions reported here. Future studies of this sort should also focus on seasonal variation, meteorological conditions, habitat characteristics, and reproductive status of possible determinants of relative calling intensity.

Despite thetwo species' presumed common ancestry and numerous shared morphological and ecological attributes (Brown and Alcala, 1970a, 1982; Brown et al., 1997a, 1999), the mating calls of *Platymantis spelaeus* and *P. insulatus* are markedly different and share few characteristics in common. Relatively brief, complex calls with combinations of tonal frequency modulated notes and vibrational amplitude modulated notes are common to the *P. dorsalis* species group (*sensu* Brown et al., 1997a, 1997c), which includes *P. spelaeus*, whereas longer, highly pulsed, amplitude modulated calls are common to the *P. guentheri* species group (Brown et al., 1997a, 1997b; Diesmos, 1998), including *P. insulatus* (Alcala and Brown, 1998, 1999).

Other members of the *P. dorsalis* species group that possess two-note calls include *P. indeprensus, P. levigatus, P. pseudodorsalis, P. cagayanensis, P. mimulus, P. niomae* and several currently unnamed species awaiting formal taxonomic description. Other members of this complex possessing frequency modulated syllables as part of their call include *P. dorsalis*, *P. pseudodorsalis,* and a few unnamed species (Brown et al., 1997b, 1997c, 1999; Brown, Diesmos, and Alcala, unpublished data). Other *P. guentheri* group species with calls containing pulse rates approaching that of the terminal segments of the call of *P. insulatus* include *P. banahao, P. cornutus*, and several unnamed taxa

(Brown et al., 1999). Other *P. guentheri* group species possess either frequency modulated single note calls (e.g., *P. guentheri*) or slowly-delivered pulsed calls (*P. negrosenis, P. rabori*), some of which are composed of several individual brief frequency sweeps (e.g., *P. luzonensis*). A complete and detailed comparison of intra- and interspecific call variation in these and related species provides ground for future research (Brown, Diesmos and Alcala, unpublished data).

The paired two-note calls of *P. spelaeus* are unusually complex; among anurans, few other species possess calls comparable (Duellman and Trueb, 1986; Ryan, 1983; Cocroft et al., 1990; Brown and Iskandar, 2000). Although it is too early to ascertain the function of each of the elements of the call of *P. spelaeus*, in certain well-studied complexes (e.g. Ryan and Rand, 1993a, 1993b, 1993c), different call elements may be produced by distinct mechanisms and may function separately in species recognition, mate attraction, and/or territoriality (Blair, 1964; Duellman and Trueb, 1986). Additionally, the same characteristics of the male advertisement call of some species that are known to attract females (Ryan and Rand, 1993a, 1993c) not only provide cues to predators as to the location of calling males, but may contain information as to the caloric value of an individual calling male as a prey item (Tuttle and Ryan, 1982). Thus, it is conceivable that varying natural and/or sexual selective regimes may operate differently on different portions of the call. Similarly, it is conceivable that opposing selective forces may favor separate extremes in the range of variation in a single trait in separate contexts. It will be interesting to study the calls of both *P. spelaeus* and *P. insulatus* in further detail once additional recordings become available and further studies of the behavior of each species can be conducted in the field. A robust and independent phylogenetic estimate as an historical framework should make for particularly powerful comparative studies of acoustic, behavioral, and ecological variation in the future.

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Fig. 1— *Platymantis spelaeus* (above) and *Platymantis insulatus* (below) in their natural limestone habitats on S. Negros and Gigante islands (Fig. 2, 3), respectively.

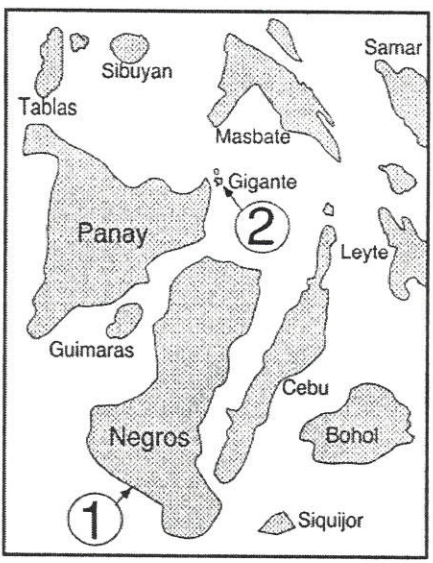

Fig. 2.— Type localities for the Visayan endemics *Platymantis spelaeus* (1: Negros Isl., Municipality of Basay) and *Platymantis insulatus* (2: Gigante Isl.).

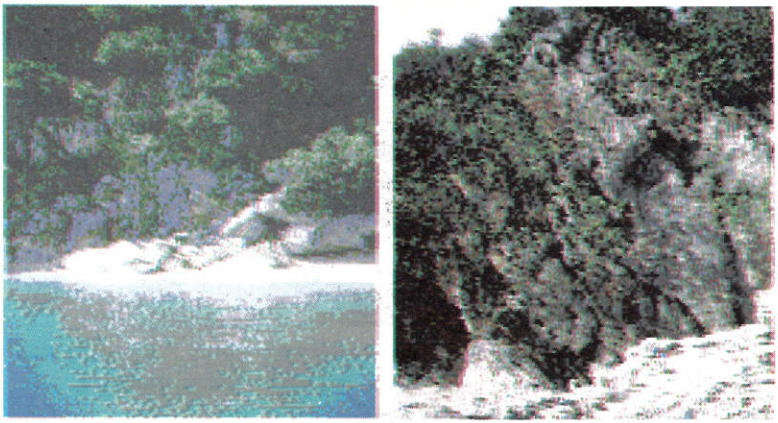

Fig. 3.— Habitat of *Platymantis insulatus* at the type locality, Gigante Island. Left, limestone karst cliff habitat jutting abruptly from the beach of Gigante North Island; right, details of porous limestone where *P. insulatus* specimens were recorded.

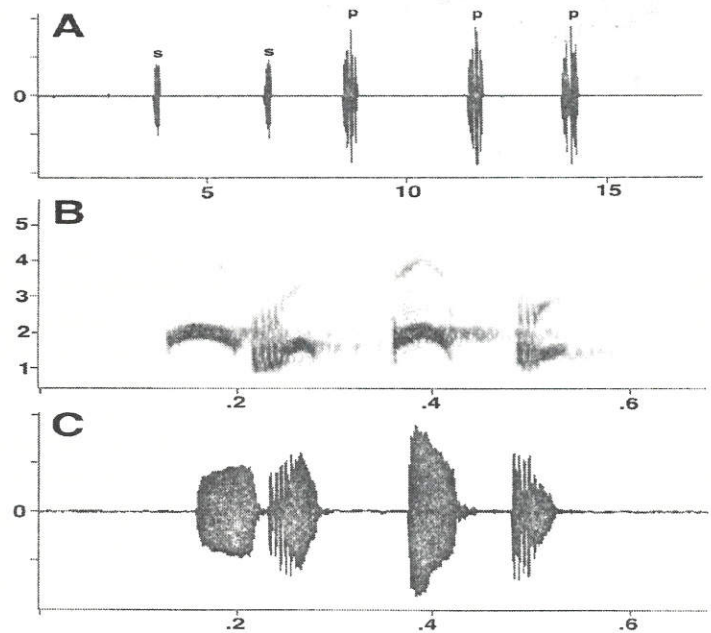

Fig. 4.— The advertisement call of the Negros Limestone Cave Frog, *Platymantis spelaeus*. (A) oscillogram (waveform: relative amplitude vs. time in s) of typical call group with two single ("s") and three paired ("p") calls; (B) audiospectrogram (sonogram: frequency in kHz vs. time in s), and (C) expanded waveform (relative amplitude vs. time in ms) of a typical paired call.

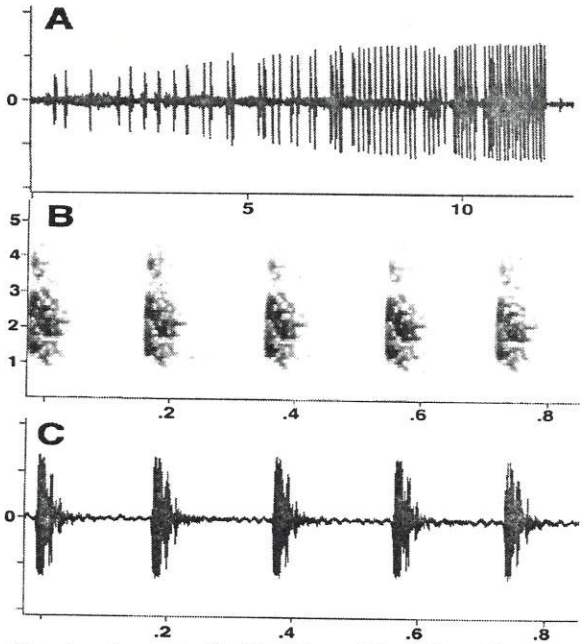

Fig. 5.— The advertisement call of the Gigante Island Frog, *Platymantis insulatus*: (A) oscillogram (waveform: relative amplitude vs. time in s) of a typical 12 s call; (B) audiospectrogram (sonogram: frequency in kHz vs. time in ms) of five pulses, and (C) expanded waveform (relative amplitude vs. time in ms).

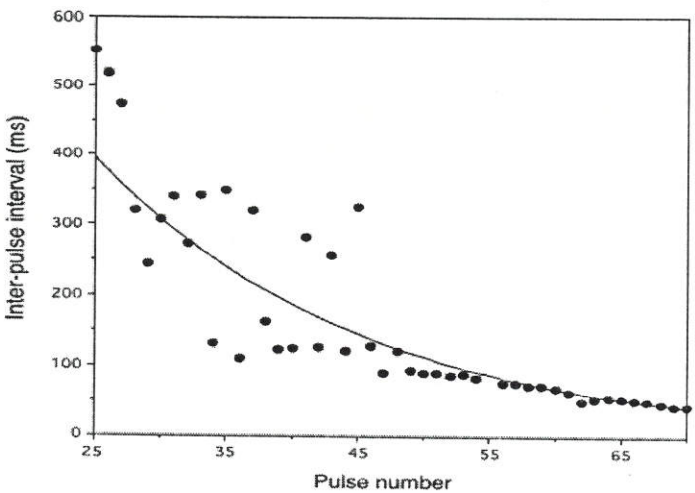

Fig. 6.— The relationship between pulse number and interpulse interval in one representative call of *Platymantis insulatus*.

BIRDS OF BAN-BAN, CENTRAL NEGROS, PHILIPPINES: THREATS AND CONSERVATION STATUS

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ABSTRACT

The forest in Ban-ban, Ayungon, Negros Oriental, Philippines, was surveyed in March to April 1999. Some 4,956 ha of extensive mature secondary forest reported in 1991 were severely reduced to mere 1,559 ha in 1999. Five of the 18 threatened species of Negros and two near-threatened species were confirmed to be present. A significant population of the Visayan Tarictic Hornbill: Penelopides panini (not recorded in 1991) was discovered. Rufous-lored Kingfisher (Halcyon winchelli), believed locally extinct on Negros, was found to be present but rare in the area. Two species of owl, Philippine Hawk Owl Ninox philippensis centralis and the distinct Philippine Scops Owl Otus megalotis nigrorum, were netted. In 1991, six individuals of White-throated Jungle Flycatcher (Rhinomyias albigularis) was observed, but during this survey the team managed to see only two individuals of Rhinomyias species. Mining, quarrying activities, and the local development of the area have increasingly devastated and divided the forest block into smaller and smaller fragments. A number of trees were observed ringed and poisoned. An assessment of long-term conservation needs of the area is long overdue. Immediate conservation action is needed for the preservation of the forest and its wildlife inhabitants.

Introduction

The Philippines ranks among the world's most important biological hotspots as its extraordinarily diverse habitat is seriously in need of comprehensive conservation attention (Mallari et al. 2001). Many of the country's unique species of birds are restricted to a few patches of lowland forest. Hence, the destruction of

lowland forest restricts the species to the upper limit of their known altitudinal range where they tend to exist at very reduced densities (Collar et al. 1999).

The history of Negros Island demonstrates the relationship between rapid destruction of forest and local extinction of species making the island one of the global priority areas for conservation. A total of eighteen threatened birds, out of the twenty-one species listed for West Visayas, are found on Negros Island. Three of these species are critically endangered (the Walden's Hornbill *Aceros waldeni*, the Negros Fruit Dove *Ptilinopus arcanus*, and the Negros Bleeding-heart Pigeon *Gallicolumba keayi*), while four species are considered endangered (the Negros Striped Babbler *Stachyris nigrorum*, the Flame-templed Babbler *Stachyris speciosa*, the Visayan Tarictic Hornbill *Penelopides panini panini*, and the White-throated Jungle Flycatcher *Rhinomyias albigularis* (Mallari et al. 1999).

The importance of the avifauna of Negros is further enhanced by the presence of endemic subspecies of birds. There are a total of 28 endemic subspecies listed for the West Visayas (Evans et al., 1993) of which fifteen subspecies occurring on Negros are shared with one or two other islands, and ten subspecies are restricted to Negros itself. Of these, three subspecies (*Phapitreron amythestina maculipectus, Otus megalotis nigrorum, Penelopides panini panini, Copsychus saularis luzionensis*) have been classified by Evans et al. (1993) as threatened.

Three significant areas of forest serve as the last strongholds of threatened species and habitat: one in the north (Mandalagan-Patag and the Mt. Canlaon range), another in the south (Mt. Talinis and the Lake Balinsasayao area), and a smaller one in the central region which is Ban-ban Forest. Of these three areas, Ban-ban has received the least attention, with only two known ornithological studies (Evans et al. 1993 and Diesmos and Pedregosa in 1996). Three of the threatened restricted-range species (Flame-templed Babbler, White-throated Jungle Flycatcher and Visayan Tarictic Hornbill) of Negros, and Panay Endemic Bird Area (Stattersfield

et al. 1998) were recently recorded in Ban-ban (Evans et al. 1993). As lowland forest is now a rare habitat in Negros, Ban-ban forest, despite its relatively small size and the degraded nature, is of crucial significance for the conservation of threatened restricted-range species. On account of the studies of Evans et al.(1993), Mallari et al.(2001) listed Ban-ban forest as an Important Bird Area (IBA). This study presents the conservation status of the forest and the endemic threatened birds of Ban-ban, Ayungon.

Conservation Overview

Ban-ban forest was logged under the concession of Philippine American Timber Company (PATIC) which ended its operation in 1979. Small-scale mining explorations followed the logging concession along with the development of roads. Designated as a Watershed Forest reserve, it is also the center of activity of the local Department of Environment and Natural Resources which is involved in improving local roads, planting commercial trees, and improving timber stands. A Community Based Forestry Management Agreement (CBFMA) works in the rehabilitation and reforestation of the areas but unfortunately utilizes exotic tree species (e.g. *Acacia mangium*, *Acacia falcata,* and *Gmelina*).

History of Ornithological Studies in Ban-ban

The extensive bird collections made on Negros in the early 19th and 20th centuries were summarized in Dickinson et al. (1991). The Cambridge-Philippines group visited Negros in 1990 (Dutson et al. 1992; Evans et al. 1993). Several threatened species were noted, including sightings of the endangered White-throated Jungle Flycatcher (*Rhinomyias albigularis*). Diesmos and Pedregosa (1996 unpublished) also conducted ethnobiological surveys of the island and reported the presence of the Visayan Tarictic Hornbill (*Penelopides panini*) and the Negros Bleeding-heart Pigeon (*Gallicolumba keayi*).

METHODOLOGY

Description of the Study Area

The forest in Ban-ban, Ayungon is located in the central portion of Negros Island in the north of Negros Oriental close to the border with Negros Occidental. Barangay Ban-ban lies at 9^0 53' 5" N, 123^0 1' 33" E, barangay Mabato lies at 9^0 51' 25" N, 123^0 2' 34" E, while Candana-ay lies at 9^0 49' 19" N, 123^0 2' 28" E. All three barangays harbor a collection of hilltop remnants of forest (sixteen forest patches) between 600 and 860 meters elevation (Fig.1). A built-up road divides the main forest area into three major blocks while the remaining patches are scattered around these forest blocks. People who commute to the other municipalities such as Bindoy and Mabinay regularly use this road. Farm-lots, plantations, and abandoned agricultural fields surround this watershed area.

Three sites within each of the three main forest blocks were selected as study sites within the watershed (Fig.1). All three sites contain remnant primary lowland forest vegetation but are characterized by disturbed regenerating secondary forest dominated by *Shorea* spp. with an average height of 20 meters (n=30, range=10-30m). In most places, the canopy is broken and the undergrowth is mostly composed of saplings of larger species of trees, herbs, ground orchids, and climbing pandans. Strangler vines and lianas are also observed. On the upper branches of large trees hang epiphytes, mostly orchids and staghorn, and bird's nest ferns. In many places the ground is covered with humus and thick layer of decaying leaves. Moss cover is almost absent and limited to areas near water.

The watershed is highly disturbed. A number of trees with an average diameter at breast height (dbh) of 167.5 cm (n=12; range: 80cm to 211 cm) were observed marked or bark-ringed. Clearings made inside the forest were planted with cassava (*Manihot esculenta*), rice (*Oryza sativa*), corn (*Zea mays*), and "gabi" (*Colocasia esculenta*). Reports of bird hunting and illegal

logging were confirmed when hunters and abandoned lumber were encountered inside the forest. Birds were also observed kept in cages in houses.

Field Research

Sampling was done from March 21 to 28, 1999 and April 8 to 15, 1999. Two-kilometer transects were established for each study site. Transects generally ran parallel with moderately used trails and built-up roads. Some transects were located inside the forest interior parallel to net locations. An average of 40 man-hours was spent gathering data at each study site. All bird species seen and heard were recorded. Information gathered included the birds' feeding habits, food items taken, habitat type, associations with other species and individuals, and participation in mixed-species flocks. Birds were identified with the use of 8 x 45 binoculars. Observation records did not include the use of sound recording equipment or the playback of calls.

Mist nets measuring 6 meters long by 4 meters high were used to catch cryptic and elusive species. Nets were set in the understory of mature secondary forest in gaps of ten to 300 meters with some distributed along ridge tops and near fruiting trees at the forest edge. The nets were set at least one meter above the ground and at most 8 meters above ground. Nets were checked regularly to minimize any adverse impact of the survey. Standard biometrical data were obtained for each bird species caught before released.

A total of 73 net-days was spent at Site 1 (Mt. Tiholtihol), 71 net days at site 2 (Manlawa-an) and 43 net days at site 3 (Katungaw-tungawan). A net-day is measured by multiplying the number of nets operated by the number of days nets were set in operation. A single 6 x 4 meter net set from 6am to 6pm is counted as one-half net day.

RESULTS

Species Composition and Species Richness

Altogether 95 species of birds were recorded of which 48 species (50%) were non-endemic breeding residents, 41 species (43 %) were endemic to the Philippines, and twenty-four were endemic subspecies of West Visayas (Table 1). Three Negros-Panay endemic species (Visayan Tarictic Hornbill *Penelopides panini,* Visayan Writhed Hornbill *Aceros waldeni,* White-winged Cuckooshrike *Coracina ostenta,* Flame-templed Babbler *Stachyris speciosa*) were observed in the area.

Five threatened and two near-threatened species were observed, one of which, the endemic Rufous-lored Kingfisher of the subspecies *nigrorum* endemic to the West Visayas, was not reported in previous studies (Evans et al.1993; Diesmos and Pedregosa, unpublished). Three of the threatened species recorded (White-winged Cuckoo-shrike, Visayan Tarictic Hornbill, and Flame-templed Babbler) were observed at all three sites.

Four species listed in 1991 (*Pernis ptilorhyncus, Hieraaetus kienerii, Megapodius cumingii* and *Ptilinopus occipitalis)* were not encountered (Appendix 1).

Table 1. Bird species composition of Ban-ban,Ayungon. Numbers refer to the individuals reported while numbers in parenthesis refer to the percentage of individuals observed within the category.

Category	Number
Non-endemic Resident species	48 (50%)
Philippine endemic species	41 (43%)
West Visayas threatened endemic	3
Threatened species	9
Total number of species	95

Netting Results

Fifty seven (57) individuals of 18 species were netted in the study sites but this figure underestimates the number of species in the area since most of the birds observed foraged and were active at canopy level (above the nets) at all three sites. The Philippine Bulbul (*Hypsipetes philippinus guimarasensis*) was the most frequently captured bird followed by the Blue-headed Fantail (*Rhipidura cyaniceps albiventris*), Balicassiao (*Dicrurus balicassius mirabilis*), and then by the Lemon-throated Warbler (*Phylloscopus cebuensis*). The Philippine Hawk-Owl (*Ninox philippensis centralis*), White-vented Whistler (*Pachycephala homeyeri winchelli*), and the Crimson Sunbird (*Aethopyga siparaja magnifica*) were caught four times. Other species were represented by single individuals. A migrant, the Chinese Goshawk (*Accipiter soloensis*), was also caught on a ridge-top near the forest edge.

The abundance of the various species captured varied at two of the sites sampled. Eighteen (18) species were netted at all three sites of which six species were netted at both Mt. Tihol-tihol and Manlawa-an. Thirty-four (34) individuals of 13 species were netted at both Mt. Tihol-tihol while 28 individuals of 14 species were caught at Manlawa-an. Nine endemics were caught at Manlawa-an compared to seven at Mt. Tihol-tihol (7 endemic species). Three of the Philippine endemic species (*Otus megalotis nigrorum, Parus elegans albescens,* and *Zosterops nigrorum nigrorum)* were caught only in Manlawa-an while five individuals of Philippine Hawk Owl (*Ninox philippensis centralis*) were caught at Mt. Tihol-tihol. The Scops Owl was caught once in a net set two meters above ground in the forest interior. The most significant bird captured was the Flame-templed Babbler (*Stachyris speciosa*). A total of three individuals were caught in the understory of mature secondary forest.

It should be taken into account that all species caught were observed in all the sites visited and thus variations in the number of individuals and species caught do not reflect differences in the avifauna of the three sites.

Table 2. Bird species netted in Ban-ban, Ayungon (March-April 1999). The species marked with *is not included in the discussion.

Scientific name	Common name	Number of individuals caught
Accipiter soloensis	Chinese Goshawk	1
Phapitreron leucotis	White-eared Brown Dove	1
Chalcophaps indica	Emerald Dove	1
Ducula poliocephala	Pink-bellied Imperial Pigeon	1
Ninox philippensis	Philippine Hawk Owl	4
Otus megalotis nigrorum	Philippine Scops Owl	1
Caprimulgus manillensis	Philippine Nightjar	1
Parus elegans	Elegant Tit	1
Hypsipetes philippinus	Philippine Bulbul	15
Dicrurus balicassius	Balicassiao	6
Stachyris speciosa	Flame-templed Babbler	1
Phylloscopus cebuensis	Lemon-throated Warbler	5
Orthotomus castaneiceps	Philippine Tailorbird	1
Rhipidura cyaniceps	Blue-headed Fantail	8
Pachycephala homeyeri	White-vented Whistler	4
Aethopyga siparaja	Crimson Sunbird	4
Zosterops nigrorum	Golden Yellow White-eye	1
*Lonchura malacca**	Chestnut Mannikin	1
Total number of species		18

Threatened Species

Five species in total, out of the 20 threatened forest birds listed in Negros by Dickinson et al.(1991), were recorded during the sampling. Of the threatened species observed, the White-winged Cuckooshrike (*Coracina ostenta*) was the most frequent followed by Visayan Tarictic Hornbill (*Penelopides panini*), and the Flame-templed Babbler (*Stachyris speciosa*) (Table 3). However, one of these, the Visayan Tarictic Hornbill, has not been

previously recorded in the area, indicating the difficulty in obtaining complete lists of forest birds during a relatively short visit. Comparisons of the data obtained during this survey with other surveys should take this into account.

Table 3. List of threatened forest bird species of Ban-ban, Ayungon with corresponding IUCN status. (Adapted from Collar, *et al.* 1999). Numbers represent individuals observed while numbers in parentheses refer to individuals netted. West Visayas endemic species are in bold. Not sighted is presented as ——. X means the bird was observed in the area.

Scientific Name	Common name	IUCN 2000 Threat Category	Status 1991	1992
Spizaetus philippensis	Philippine Hawk-Eagle	Vulnerable	--	--
Ducula poliocephala	Pink-bellied Imperial Pigeon	Near-threatened	X	8 (1)
Ducula carola	Spotted Imperial Pigeon	Vulnerable	--	--
Ptilinopus arcanus	Negros Fruit Dove	Critically Endangered	--	--
Gallicolumba keayi	Negros Bleeding-Heart Pigeon	Critically Endangered	--	--
Cacatua haematuropygia	Philippine Cockatoo	Critically Endangered	--	--
Tanygnathus lucionensis	Blue-naped Parrot	Threatened	--	--
Aceros waldeni	Visayan Writhed Hornbill	Critically Endangered	--	H
Penelopides panini	Visayan Tarictic Hornbill	Endangered	--	11
Todiramphus winchelli	Rufous-lored Kingfisher	Vulnerable	--	1
Stachyris nigrorum	Negros Striped-Babbler	Endangered	--	--

Table 3 (cont'd)

Scientific Name	Common name	IUCN 2000 Threat Category	Status 1991	1992
Stachyris speciosa	Flame-templed Babbler	Vulnerable	X	7 (3)
Mearnsia picina	Philippine Needletail	Near-threatened	--	5
Coracina ostenta	White-winged Cuckoo-shrike	Vulnerable	X	13
Rhinomyias albigularis	White-throated Jungle Flycatcher	Critically Endangered	X	2
Muscicapa randi	Ashy-breasted Flycatcher	Vulnerable	--	--
Hypothymis coelestis	Celestial Monarch	Vulnerable	--	--
Dicaeum haematostictum	Visayan Flowerpecker	Vulnerable	--	--
Erythrura viridifacies	Green Parrotfinch	Vulnerable	--	--

The Rufous-lored Kingfisher (*Halcyon winchelli nigrorum*) is confined to forest habitats below 1000 meters elevation. The continuing clearance of lowland forest throughout the Philippines poses a very significant threat to this species. The bird was observed once beside a small creek in the forest interior, perched and calling from one of the lower branches of a *Shorea* sapling. It is similar to the White-collared Kingfisher except for the general bright cobalt blue coloration and its rufous hind collar.

The White-throated Jungle Flycatcher is an inhabitant of the understory (usually 2-10m from the ground, occasionally in the subcanopy) of tall, deeply shaded forest in lowland and mid-montane regions (Dickinson et al. 1991; Brooks et al. 1992; Kennedy et al. 2001). It was observed twice in the under-story inside the forest, silently perched on a branch and occasionally flycatching. As very little lowland forest exists on Panay and Guimaras Island is already completely denuded, the remaining

lowland forest on Negros is extremely important to the survival of this species.

The Visayan Tarictic Hornbill is a bird of primary dipterocarp forest sometimes wandering into mid-montane, secondary forest, or isolated fruiting trees (Collar et al. 1999). It was observed occasionally in the area, with a total of 27 individuals, either singly or in small groups of 3-5, usually near the forest edge. Surprisingly, it was not observed during the 1990 survey (Evans et. al. 1993) but was reported in the area in 1996 (Diesmos and Pedregosa 1995). Local reports revealed the rampant hunting of this species and poaching of its young for the pet trade as well as forest destruction are a major threat to this bird.

There were reports of another species of hornbill that closely fit the description of the Walden's Hornbill (*Aceros waldeni*). Calls closely resembling those of Walden's Hornbill were also heard four times during sampling although the individual was not observed. Further observations are needed to verify whether this critically endangered species occurs here.

Although observed in great numbers in 1991, the White-winged Cuckoo-shrike was rare in the areas visited. Most encounters were at the forest edges where it was observed to participate in mixed-species flocks with the Coleto *Sarcops calvus*, the Bar-bellied Cuckoo-shrike *Coracina striata panayensis*, the Balicassiao *Dicrurus balicassius mirabilis,* and the White-bellied Woodpecker *Dryocopus javensis philippensis*.

The exquisite Flame-templed Babbler *Stachyris speciosa* was also observed to participate in mix-species feeding flocks in both the interior and edge of the forest. The flocks included the Blue-headed Fantail *Rhipidura cyaniceps*, the Velvet-fronted Nuthatch *Sitta frontalis*, the White-eyes (*Zosterops* spp.), Warblers (*Phylloscopus* spp.), the Crimson Sunbird *Aethopyga siparaja*, the Bicolored Flowerpecker *Dicaeum bicolor*, the Black-naped Monarch *Hypothymis azurea*, the White-bellied Whistler *Pachycephala homeyeri*, the Verditer Flycatcher *Eumyias panayensis*, the Citrine Canary Flycatcher *Culicicapa*

helianthea, and the Visayan Flowerpecker *Dicaeum haematostictum.* Nine (9) individuals of Flame-templed Babblers were observed and three were caught in mist nets set in the understory of forest interior.

Larger species of doves, particularly the Imperial Pigeons *Ducula poliocephala,* and *the D. aenea* were mostly targeted for hunting. About eight individuals of Pink-bellied Imperial Pigeon *Ducula poliocephala* were observed kept in cages to be sold for trade or merely for consumption. Other species of doves (Metallic Wood Pigeon *Columba vitiensis*, White-eared Brown Doves *Phapitreron leucotis,* and Amethyst Brown Doves *Phapitreron amythestina*, Fruit Pigeons) also suffered the same fate. These hunting activities pose a threat to endangered doves like the Negros Bleeding-heart Pigeon *Gallicolumba keayi* which was reported at the site in 1992 (Diesmos and Pedregosa, unpublished). The latter was not observed during the survey but there were reports of doves caught that resembled it. Interviews further revealed that this species was rarely seen and its description was familiar only to a handful of locals. The species is often confused with the Emerald Dove *Chalcophaps indica.* It appears that the Negros Bleeding-heart Pigeon is rare in the area and even throughout its range (Curio et al. 1997; Klop et al. 1999; Collar et al. 1999).

THREATS AND CONSERVATION

Much of the original forests in the West Visayas has been destroyed while Masbate and Guimaras Islands are both 100% deforested (Evans et al. 1993). As very little lowland forest is left on Panay, the importance of the remaining lowland forest in Negros becomes essential to the survival of threatened endemic species. The drastic contraction and fragmentation of Ban-ban forest from 4,956 ha in 1991 to a mere 1,559 ha in 1999 poses a grave danger to a number of threatened birds dependent on the presence of mature forest (Table 4). In the three areas sampled, a number of trees with an average diameter of 30-80 cm were observed

bark-ringed. Some of the illegally cut lumber was seen hidden among bushes or abandoned in the forest interior. If the current intensity of cutting trees and forest clearance continues unabated, the eighteen threatened species will be the first to go and with them much of the valuable watershed area.

Table 4. Habitat requirements of selected forest dependent birds observed in Ban-ban Ayungon (March-April, 1999). The observed threats are also presented.

Common Name	IUCN 2000 Threat Category	Habitat preferences and observed threats
Philippine Hawk Eagle	Vulnerable	Tall forest dependent
Pink-bellied Imperial Pigeon	Near-threatened	Tall forest dependent, severe hunting pressure
Spotted Imperial Pigeon	Vulnerable	Tall forest dependent, severe hunting Pressure, Ecological requirements poorly understood but rarely reported
Negros Fruit Dove	Critically Endangered	Forest dependent maybe extinct - no records since collection in 1953
Negros Bleeding-heart Pigeon	Critically Endangered	Tall forest dependent, very few records, severe hunting pressure and hunting
Philippine Cockatoo	Critically Endangered	Pet trade and hunting
Blue-naped Parrot	Threatened?	Forest dependent, pet trade and hunting
Visayan Writhed Hornbill	Critically endangered	Tall forest dependent, hunting
Visayan Tarictic Hornbill	Endangered	Forest dependent, hunting
Rufous-lored Kingfisher	Vulnerable	Forest dependent, tolerates secondary forest
Negros-striped Babbler	Endangered	Forest dependent with very restricted-range
Flame-templed Babbler	Vulnerable	Forest dependent but tolerant of degraded forest

Table 4 (cont'd)

Common Name	IUCN 2000 Threat Category	Habitat preferences and observed threats
Philippine Needletail	Near-threatened	Forest dependent
White-throated Jungle Flycatcher	Critically Endangered	Tall forest dependent
Ashy breasted Flycatcher	Vulnerable	Tall forest dependent
Celestial Monarch	Vulnerable	Tall forest dependent
Visayan Flowerpecker	Vulnerable	Forest dependent but tolerant of degraded forest
Scarlet-collared Flowerpecker	Vulnerable	Forest dependent, intolerant of degraded forest
Green Parrotfinch	Vulnerable	Forest dependent and closely associated with seeding bamboo

The mining and quarrying activities observed in the area as well as the local development have increasingly devastated and continuously divided the forest block into further smaller fragments. The presence of built-up roads and trails showing continual usage and high levels of disturbance has further worsened the fragmentation of the forest. Moreover, the road and trails are also used in the transport of illegally cut timber from the forest to nearby municipalities and cities.

In view of these problems, an assessment of the conservation requirement of the area is long overdue. Without immediate intervention, protection of the forest and prevention of wildlife extinction will be a thing of the past. Much work still needs to be done and with time running out it is essential to start conservation intervention right now.

CONCLUSION

Ban-ban forest in Ayungon, Negros Oriental, Philippines stands as the last remaining significant patch of low altitude forest on Negros Island. Some 4,956 ha of extensive mature secondary

forest reported in 1991 have been severely reduced to mere 1,559 ha in 1999 (CVRP-ISF Report, AFMOI) Report). This massive forest destruction in less than ten years indicates an alarming rate of global loss of forest and its endemic wildlife.

Until quite recently, Ban-ban was the only known locality to harbor a population of the endangered White-throated Jungle Flycatcher (*Rhinomyias albigularis*) on Negros. Only two individuals were observed in the area during sampling. A total of eight threatened forest species reported in Negros was not sighted including the Philippine Cockatoo *Cacatua haematuropygia*, the Negros-bleeding heart Pigeon, the Walden's Hornbill, the Celestial Monarch, the Spotted Imperial Pigeon *Ducula carola,* and the Ashy-breasted Flycatcher *Muscicapa randi*. With the rate of forest destruction and cutting of trees in the area, the prospects for survival of such species as well as that of the rest of the wildlife beyond the next few years is extremely low.

Recommendations

1. Priority Areas for Research

More research and ecological studies are needed to determine the extent of disturbance and identify detrimental factors affecting threatened species. The use of sound recording equipment is recommended in order to determine more effectively the presence of cryptic species (e.g. Ashy-breasted Flycatcher, Celestial Monarch, White-throated Jungle Flycatcher).

A patch of forest located on very steep, rocky slopes exists northeast of Ban-ban at 800 to 1000m elevation. It is recommended that studies should include this section. Studies on other vertebrate groups are also recommended,

particularly amphibians, reptiles, and mammals. Reports from the locals revealed that hunting of wild pigs and monitor lizards was quite common.

2. Habitat Rehabilitation and Reforestation Activities

Habitat rehabilitation measures should put emphasis on utilizing endemic species of trees rather than exotic trees which have been planted at both the edge and inside the forest.

Harvesting wild plants including ferns and orchids should be discouraged. The survey revealed that trees were cut just to get access to orchids and hanging ferns. Portions of the forest had been cleared for subsistence agriculture (corn, *Manihot esculenta* and *Colocasia esculenta*) and the cultivation of *Zingiber* (the flowers are harvested for making brooms). Such activities should be managed to allow maximum gain without sacrificing wildlife loss.

3. Information, Education, and Communication

Multiplier audiences (educators, corporate sectors, journalists, and the scientific community) should be the primary initiators of conservation education and awareness programs. Information on biodiversity, conservation, and the importance of species should be provided to Local Government Units (LGU) to enhance conservation awareness. Such information should also incorporate legal advocacy. Information disseminated to direct stakeholders should be in the form that is understandable to them. Thus explaining the concept of biodiversity to local people in their own language is recommended to help them fully understand the concepts. In this effort, it should be remembered that local people have their own version of explaining the importance of biodiversity.

4. Forest Protection Measures

While built-up roads and trails provide many the much-needed access between places as well as the means to transport goods and other farm produce, they ironically also facilitate the

illegal traffic of forest products. Reporting these illegal forest activities to the concerned authorities is a problem. In the first place many local people may not even be aware of what is considered an illegal forest activity and when they do, they do not know where to report these illegal activities. Moreover, most concerned offices are not easily reached and processing the report takes a long time. Massive education campaign among the local community is therefore a must. Only then can they be utilized to participate in patrolling the forests. The locals who live right in the target sites can best protect their natural resources. The barangay *tanods* and members of people's organizations should be tapped and their responsibilities delineated. NGOs working in the sites can collaborate with with the PAMB and the DENR to strengthen the capabilities of local communities in protecting their environment.

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APPENDIX 1

The table on the following pages lists all forest species found on Negros and shows bird species recorded in Ban-ban, Central Negros, Philippines.

Note that the amount of effort and time of sampling was different for the two sets of data presented.
Numbers represent individuals observed during sampling (March-April 1999), WITH THOSE IN PARENTHESES REPRESENTING INDIVIDUALS CAUGHT.

— means not sighted.

Species marked with * are migrants, while species in bold are Philippine endemic species.

1) These totals include aural records.

2) Not recognized by Dickinson *et. al*, (1991) as full species although Kennedy *et. al*, (2001) considers these as full species. The records for the Visayan Writhed Hornbill should be treated with caution as only CALLS resembling THOSE of the Writhed Hornbill WERE heard. Further studies are needed to confirm the true status of the species.

3) A new record for Negros (Curio *et. al*, 1996a) although despite the alleged occurrence in Negros, this survey found no evidence of the species presence.

(see table next page)

Scientific Name	Common Name	Cambridge--Philippines 1991 survey	1999 survey
*Gorsachius melanolophusi**	Malayan Night Heron	-	-
*Pernis ptilorynchus**	Oriental Honeybuzzard	21	-
Pernis celebensis	Barred Honeybuzzard	-	-
Haliaaetus leucogaster	Whitė-bellied Sea Eagle	-	-
Spilornis holospilus	Crested Serpent Eagle	3	26
*Accipiter soloensis**	Chinese Goshawk	-	6 (1)
*Accipiter gularis**	Japanese Sparrowhawk	-	50
Accipiter trivirgatus	**Crested Goshawk**	-	6
Accipiter virgatus	**Besra**	2	7
*Butastur Indus**	Grey-faced Buzzard	-	-
Hieraaetus kienerii	Rufous-bellied Eagle	1	-
Spizaetus philippensis	**Philippine Hawk Eagle**	-	-
Microhierax erythrogenys	**Philippine Falconet**	21	27
Megapodius cumingii	Tabon Scrubfow	R	
Gallus gallus	Red Junglefowl	5	7
Treron pompadora	Pompador Green Pigeon	-	-
Treron vernans	Pink-necked Green Pigeon	-	-
Phapitreron amethystina	**Amethyst Brown Dove**	-	4

Scientific Name	Common Name	Cambridge--Philippines 1991 survey	1999 survey
Phapitreron leucotis	**White-eared Brown Dove**	17	25 (1)
Ptilinopus occipitalis	**Yellow-breasted Fruit Dove**	3	-
Ptilinopus leclancheri	**Black-chinned Fruit Dove**	-	1
Ptilinopus arcanus	**Negros Fruit Dove**	-	-
Ducula poliocephala[1]	**Pink-bellied Imperial Pigeon**	14	26
Ducula aenea	Green Imperial Pigeon	-	2
Ducula carola	**Spotted Imperial Pigeon**	-	-
Ducula bicolor	Bicolored Pigeon	-	-
Columba vitiensis	Metallic Wood Pigeon	-	1
Macropygia phasianella	Reddish Cuckoo Dove	23	35
Chalcophaps indica	Common Emerald Dove	9	13 (1)
Gallicolumba keayi	**Negros Bleeding-heart**	-	-
Caloenas nicobarica	Nicobar Pigeon	-	-
Cacatua haematuropygia	**Philippine Cockatoo**	-	-
Prioniturus discurus	**Blue-crowned Racquet-tail Parrot**	9	25
Tanygnathus lucionensis	**Blue-crowned Parrot**	-	-
Loriculus philippensis	**Philippine Hanging Parakeet**	-	1
*Cuculus sparveroides**	Large Hawk Cuckoo	-	14

Scientific Name	Common Name	Cambridge--Philippines 1991 survey	1999 survey
Cuculus fugax	Hodgson's Hawk Cuckoo	-	-
Cacomantis merulinus	Plaintive Cuckoo	-	-
Cacomantis variolosus	Brush Cuckoo	-	26
Chrysococcyx russatus	Gould's Bronze Cuckoo	-	-
Surniculus lugubris	Drongo Cuckoo	-	1
Centropus viridis	**Philippine Coucal**	3	54
Eudynamys scolopacea	Koel	-	6
*Ninox scutulata randi**	Brown Hawk Owl	-	-
Ninox philippensis[1]	**Philippine Hawk Owl**	3	31 (4)
Otus megalotis nigrorum[1]	**Philippine Scops Owl**	-	5 (1)
Batrachostomus septimus	**Philippine Frogmouth**	-	5
Caprimulgus manillensis*	**Philippine Nightjar**	-	18 (1)
Hemiprocne comata	Lesser Tree Swift	3	-
Collocalia vanikorensis	Island Swiftlet	-	19
Collocalia mearnsi	**Philippine Swiftlet**	+	100
Collocalia esculenta	Glossy Swiftlet	+	52
Collocalia troglodytes	**Pygmy Swiftlet**	+	47
Mearnsia picina	**Philippine Needletail**	-	29

Scientific Name	Common Name	Cambridge--Philippines 1991 survey	1999 survey
Hirundapus celebensis	Purple Needletail	29	-
Alcedo argentatus	**Silvery Kingfisher**	-	-
Alcedo cyanopectus	**Indigo-banded Kingfisher**	-	-
Ceyx lepidus	Variable Dwarf Kingfisher	-	-
Halcyon winchelli	**Rufous-lored Kingfisher**	-	1
Halcyon chloris	White-collared Kingfisher	-	14
Actinoides lindsayi	**Spotted Wood Kingfisher**	-	3
Eurystomus orientalis	Dollarbird	-	18
Penelopides panini	**Visayan Tarictic Hornbill**	-	27
Aceros waldeni[2]	**Visayan Writhed Hornbill**	-	4
Megalaima haemacephala[1]	Coppersmith Barbet	-	6
Dryocopus javensis	White-bellied Woodpecker	2	39
Dendrocopus maculatus	**Philippine Pygmy Woodpecker**	18	16
Chrysocolaptes lucidus	Crimson-backed Woodpecker	-	11
Pitta erythrogaster[1]	Red-breasted Pitta	-	32
Pitta sordida	HOODED Pitta	-	-
Coracina ostenta	**White-winged Cuckoo Shrike**	40	22

Scientific Name	Common Name	Cambridge--Philippines 1991 survey	1999 survey
Coracina striata	Bar-bellied Cuckoo-shrike	-	4
Pericrocotus flammeus	Scarlet Minivet	57	1
Hypsipetes philippinus	**Philippine Bulbul**	326	416 (15)
Dicrurus balicassius	**Balicassiao**	228	202 (7)
Oriolus steeri	**Philippine Oriole**	25	29
Parus elegans albescens	**Elegant Tit**	146	178 (1)
Sitta frontalis	Velvet-fronted Nuthatch	116	93
Rhabdornis mystacallis	**Stripe-headed Rhabdornis**	6	16
Rhabdornis inornatus	**Stripe-breasted Rhabdornis**	2	11
Stachyris speciosa	**Flame-templed Babbler**	10	9 (3)
Brachypteryx montana	White-browed Shortwing	22	5
Copsychus lucionensis	**White-browed Shama**	-	4
Turdus poliocephalus	Island Thrush	-	-
Phylloscopus olivaceous	**Philippine Leaf Warbler**	-	8
Phylloscopus cebuensis	**Lemon-throated Warbler**	80	34 (5)
Phylloscopus trivirgatus	Mountain Leaf Warbler	-	-
Orthotomus castaneiceps[1]	**Philippine Tailorbird**	78	79 (1)
Rhinomyias albigularis	**White-throated Jungle-Flycatcher**	6	-

Scientific Name	Common Name	Cambridge--Philippines 1991 survey	1999 survey
*Muscicapa grisiesticta**	Grey-streaked Flycatcher	-	2
*Muscicapa dauurica**	Asian Brown Flycatche	-	3
Muscicapa randi	**Ashy-breasted Flycatcher**	-	3?
Eumyias panayensis	Verditer Flycatcher	5	9
Ficedula westermanni	Little Pied Flycatcher	-	-
*Ficedula narcissina**	Narcissus Flycatcher	-	-
Ficedula hyperythra	Snowy-browed Flycatcher	2	2
*Ficedula mugimaki**	Mugimaki Flycatcher	-	-
Cyornis rufigastra	Mangrove Blue Flycatcher	1	3
Culicicapa helianthea	Citrine Canary Flycatcher	50	3
Rhipidura cyaniceps	**Blue-headed Fantail**	174	68 (8)
Hypothymis azurea	Black-naped Monarch	4	1
Hypothymis coelestis	**Celestial Monarch**	-	-
Tersiphone cinnamomea	**Rufous Paradise-Flycatcher**	-	-
Pachycephala homeyeri	**White-vented Whistler**	67	31 (4)
Artamus leucorhynchus	White-bellied Wood Swallow	-	27
Sarcops calvus[1]	**Coleto**	21	128

Scientific Name	Common Name	Cambridge--Philippines 1991 survey	1999 survey
Anthreptes malaccensis	Plain-throated Sunbird	-	-
Nectarinia sperata	Purple-throated Sunbird	7	-
Nectarinia jugularis	Olive-backed Sunbird	-	-
Aethopyga flagrans	**Crimson Sunbird**	3	19
Aethopyga shelleyi	**Lovely Sunbird**	-	-
Aethopyga siparaja	Magnificent Sunbird	-	52 (4)
Dicaeum haematostictum	**Visayan Flowerpecker**	-	-
Dicaeum retrocinctum[3]	**Scarlet-collared Flowerpecker**	-	-
Dicaeum aeruginosum	**Striped Flowerpecker**	-	-
Dicaeum trigonostigma	Orange-bellied Flowerpecker	27	14
Dicaeum pygmaeum	**Pygmy Flowerpecker**	2	4
Dicaeum bicolor	**Bicolored Flowerpecker**	-	-
Zosterops everetti	Everett's White-eye	-	-
Zosterops nigrorum	**Golden-yellow White-eye**	13	110 (1)
Zosterops montanus	Mountain White-eye	17	21
Erythrura viridifacies	**Green-faced Parrotfinch**	-	-
Total number of forest species		50	93
Total number of observation hours		NO DATA	NO DATA

THE STATUS OF THREATENED AND ENDEMIC BIRDS OF SIQUIJOR ISLAND, PHILIPPINES

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ABSTRACT

Bird survey on remaining forest patches of Siquijor Island, Central Visayas, Philippines was conducted last September 11 to 25, 2001. Mist netting and line transects with ethnobiological survey were used during the study. A total of 53 species of birds and four of the five endemic subspecies were observed namely: Yellow-bellied Whistler (Pachycephala philippensis siquijorenses), *Orange-bellied Flowerpecker:* (Dicaeum trigonostigma besti), *Everett's White-eye* (Zosterops everetti siquijorensis), *and Streak-breasted Bulbul* (Ixos siquijorensis siquijorensis). *The critically endangered Streak-breasted Bulbul was the only threatened species observed in all studied sites.*

The forest in Canghaling showed the highest record of species followed by Bandila-an and then Salagdo-ong. Bandila-an harbors the highest number of birds observed and netted. Habitat destruction, along with hunting, is the observed threats on the island.

Introduction

Siquijor Island is geographically located 19 km east of the southern tip of Negros, 30 km southeast of Bohol, and 45 km north of Zamboanga peninsula (located at 9° 11' and 123° 35' E). Only four significant blocks of forest remain on the island covering a total of 781 hectares (Mallari 2001). All forest blocks are declared nature reserves controlled by the Department of Environment and Natural Resources (DENR). The survey was conducted on three of the four forests (Bandilaan, Canghaling, and Salagdo-ong).

The forests in Siquijor support the most important surviving population of the endemic species of Streak-breasted Bulbul, *Ixos*

siquijorensis siquijorensis (Collar et al. 1999). There are four more bird subspecies endemic to the island: Yellow-bellied Whistler (*Pachycephala philippinensis siquijorensis),* Orange-bellied Flowerpecker (*Dicaeum trigonostigma besti),* Philippine Hanging Parakeet (*Loriculus philippensis siquijorensis)* and Everett's White-eye (*Zosterops everetti siquijorensis).* Other threatened species recorded include Rufous-lored Kingfisher (*Halcyon winchelli*), Japanese Night-Heron (*Gorsachius goisagi),* Philippine Hawk Eagle (*Spizaetus philippensis),* Philippine Cockatoo (*Cacatua haematuropygia),* and Spotted Imperial Pigeon (*Ducula carola).* The most recent of previous surveys established the threatened status of the above species on Siquijor as secondary areas (s096) by Birdlife International.

This study aims to update this information and determine the current conservation status of the threatened and endemic taxa of birds in three of the remaining forest patches of Siquijor Island.

Ornithological Surveys

Siquijor was visited by Steere in 1888 and by the Menage Expedition in 1891. Celestino collected in 1907 and 1908 for the Philippine Bureau of Science now the Philippine National Museum. Rabor collected in 1949, 1952, 1953, 1954 and usefully summarized all collecting in Rand and Rabor (1960). In the early 1990s the Cambridge-Philippines group visited the island and results were presented in two publication (Evans *et al.* 1991, Evans et al. 1993). A team from the Center for Tropical Conservation Studies (CenTrop) of Silliman University visited the island for a thorough vertebrate sampling with results published in separate papers (Lepiten 1996 for mammals; Paalan 1994 for birds). Subsequently there have been several visits by independent birdwatchers such as D. Allen in 1994, 1999, and 2001.

Methodology

Habitat Description

Mt. Malbahoc in Bandila-an Natural Park is the highest point of Siquijor at 557m ASL fig. 1 (see attached map). This is a local tourist spot made accessible by a provincial road that bisects

the forest. It is surrounded by farm lots and abandoned agricultural fields. The area contains some remnant primary lowland forest dominated mainly by Ficus spp., molave (*Vitex parviflora*), dapdap (*Erythrina sp.),* and tangile (*Shore polyserma*) along with some exotic species such as lanutan, mahogany (*Macrophylla sweitenia),* gmelina (*Gmelina arborea*), and teak (*Tectona grandis*). In most places, the canopy is discontinuous, and the undergrowth is thick with saplings of large trees, shrubs, and grasses. Surveying was conducted on 11-17 September 2001.

The forest in Canghaling is characterized by a more plain topography at an elevation of 250m ASL (see attached map). The vegetation in this area is somewhat similar to that of Bandilaan although here more natural forest species are present including, ilang-ilang (*Cananga odorata*), and various *Ficus* sp. such as bahi, taloot, and labnog. The undergrowth is thick with shrubs, herbaceous plants, and weeds. A small patch of less than 10 ha still retains mature secondary limestone forest with canopy trees at 20m or higher and a palm-rich understory. This forms a continuous block with the second growth and plantation areas. A barangay road situated between two ridges leads to the water source inside the forest area and appears to be constantly in use. Domesticated animals (cows, goats, and pigs) are also found in the area. Surveying was conducted between 18-20 September 2001.

Salagdoong forest is located on the eastern side of the island and is characterized by limestone and sandy substrates (see attached map). Large trees are composed of planted species such as lumbang (*Aleurites moluccana*) and molave (*Vitex parviflora*). A minimal layer of undecayed leaves covers the relatively dry substrate. Agricultural fields are found within and around the plantation. A trail that cuts through the area provides access to the other side of the plantation. The area is also used as the main grazing grounds for cattle. Surveying was conducted from 21 to 23 September 2001.

Field Techniques

Five hundred meter transects line were established for each study sites and were regularly traversed for thirty minutes 3 times in a day. Point counts were employed in rough and ragged terrain. Information gathered includes bird species seen and heard calling as well as ecological notes for feeding habits, habitat type, association with other species and participation in mixed-species flocks. Identification was aided by the use of the *Field Guide to the Birds of the Philippines* (Kennedy et al. 2000).

Mist nets measuring 6 m long and 4 m wide were used and were distributed along ridge tops, near fruiting trees and in the canopy. Nets were checked regularly to minimize the ecological impact of the survey. Biometrical data were obtained and each species caught was photographed before release. Fieldwork was conducted from September 10 to 25, 2001.

Ethnobiological Survey

Ethnobiological surveys were conducted to determine significant patches of ecologically important areas and to gather further information on species readily obtained by direct observation. Information on land use, threats, and presence of species was gathered and informal discussions were conducted to solicit local community support.

Table 1. Field efforts allocated for each site during the sampling (September 11-25, 2001)

Site	Transect Count (Man-hours in the forest)	Diurnal Mist- netting (hrs)
Bandila-an	31	618
Canghaling, San Juan	25	204
Saladoong, Maria	13	144
Total	69 hrs	966 hrs

A total of 69 man-hours and 966 net-hours were allocated in thethree sampling sites. A mist-netting measuring 6 x 4 m operated in one whole day was considered as one half net-day.

Results and Discussion

Endemic Subspecies: Abundance

There are five endemic subspecies found only in Siquijor. These are the Streak-breasted Bulbul (*Ixos siquijorensis siquijorensis),* Yellow-bellied Whistler (*Pachycephala philippinensis siquijorensis),* Orange-bellied Flowerpecker (*Dicaeum trigonostigma besti),* Everett's White-eye (*Zosterops everetti siquijorensis), and* Philippine Hanging Parakeet (*Loriculus philippensis siquijorensis*).

Table 2. Abundance scores of subspecies of endemic birds of Siquijor Island. Numbers outside parenthesis refer to individuals observed while numbers inside parenthesis refer to individuals caught. Not sighted is presented as —.

Common name	*1.Scientific Name*	Bandilaan	Canghaling	Salagdo-ong
Philippine Hanging Parakeet	*Loriculus philippensis siquijorensis*	---	---	---
Streak-breasted Bulbul	*Ixos siquijorensis siquijorensis*	78 (2.51)	32 (1.03)	37 (1.19)
Yellow-bellied Whistler	*Pachycephala philippensis siquijorensis*	22 (0.70)	8 (0.25)	---
Orange-bellied Flowerpecker	*Dicaeum trigonostigma besti*	38 (1.22)	7 (0.22)	3 (0.09)
Everett's White-eye	*Zosterops everetti siquijorensis*	14 (0.45)	---	---
Total observation hours		31	25	13
Total number of species recorded		36	39	32
Total number of individuals observed		271	240	216

This table shows the endemic subspecies of Siquijor with their relative abundance. The number outside the parenthesis is the number of bird observed while the number inside represents their relative abundance. Of the 5 subspecies endemic to the island, only 4 subspecies were observed during the survey. The Philippine Hanging Parakeet (*Loriculus philippensis siquijorensis*) was not sighted in all 3 sites and appears to be extinct (Dickinson et al. 1991). The Everett's White-eye (*Zosterops everetti siquijorensis*) was recorded only in Bandila-an while the Yellow-bellied Whistler (*Pachycephala philippinensis siquijorensis)* was recorded in only 2 sites: Bandila-an and Canghaling). Both the Streak-breasted Bulbul *(Ixos siquijorensis siquijorensis*) and the Orange-bellied Flowerpecker (*Dicaeum trigonostigma besti*) were observed in all 3 sites.

Species Composition and Richness

A total of 55 species of birds (excluding shorebirds and migrants) have been unofficially recorded from Siquijor Island (Evans et al. 1993; Paalan 1994, and Mauro 1998). A total of 53 species of birds, including migrants, were observed during the survey. Four of the five endemic subspecies of birds: Streak-breasted Bulbul (*Ixos siquijorensis siquijorensis),* Yellow-bellied Whistler (*Pachycephala philippinensis siquijorensis),* Orange-bellied Flowerpecker (*Dicaeum trigonostigma besti)* and Everett's White-eye (*Zosterops everetti*) were identified. The endangered Streak-breasted Bulbul was recorded in all three sites. Winter visitors totaling 5 species (Arctic Warbler, Asian Brown Flycatcher, Grey-Streaked Flycatcher, Yellow Wagtail, and Brown Shrike) were also encountered. Canghaling recorded the highest number of species (39 species) followed by Bandila-an (36 species) while Salagdoong recorded a total of 32 species (Table 2).

Threatened Species

Of all the threatened species listed in Siquijor, only the Streak-breasted Bulbul *(Ixos siquijorensis siquijorensis)* was

observed in all 3 sites visited. During the Cambridge Philippines Rainforest Project 1991 (Evans et al. 1993a) *Ixos siquijorensis* were observed in the three study sites, namely Lilo-an, Bandila-an, and Canghaling forest while two juvenile Rufous-lored Kingfisher were observed in Lilo-an forest. Paalan also visited the island 1994 (*Avifaunal Survey of Siquijor Island*). The Japanese Night-Heron (Gorsachius goisagi) and Philippine Hawk Eagle (*Spizaetus philippensis)* have not been recorded in Siquijor since 1896 and presumed to be extinct (Rand and Rabor 1960). Philippine Cockatoo (*Cacatua haematuropygia)* and Spotted Imperial Pigeon (*Ducula carola)* were recorded in 1959 (Rand and Rabor 1960).

Table 3. List of threatened species of birds in Siquijor Island. Numbers in parenthesis refer to species mist-netted and numbers outside refers to individuals observed during the study. Not sighted is presented as —.

Species	Common Name	IUCN Status	Bandila-an	Cang-haling	Salagdo-ong
Gorsachius goisagi	Japanese Night-Heron	Vulnerable	-	-	-
Spizaetus philippensis	Philippine Hawk Eagle	Vulnerable	-	-	-
Ducula carola	Spotted Imperial Pigeon	Vulnerable	-	-	-
Cacatua haematuropygia	Philippine Cockatoo	Critically endangered	-	-	-
Halcyon winchelli	Rufous-lored Kingfisher	Vulnerable	-	-	-
Ixos siquijorensis siquijorensis	Streak-breasted Bulbul	Critically Endangered	78 (10)	32 (2)	37 (4)

Threats and Conservation

The sites the team visited in Siquijor are forest reserves actively managed by the local DENR. Bandila-an and Salagdoong are both local tourist attractions. Endemic species of forest trees were observed planted under developed plantations in some areas within the reserve. This reforestation project should be extended to the other forested sites of Siquijor such as Canghaling, Lilo-an, and Salagdoong.

Trails created inside the forest for ecotourism purposes ironically also provide exits and entry for local hunters. Netting and hunting of both larger species of bats and birds were observed in all sites visited. Live-trapped birds were sold to nearby islands of Cebu and Negros. Commonly seen in cages was the subspecies *brevirostris* of White-eared Brown Dove.

The status of the endemic form of Everett's White-eye is of considerable concern given the fact that this genus has received little regional taxonomic attention in the Philippines. As well, the distinctness of the separate island forms has not been fully studied (D. Allen in litt.) while the Bohol and Cebu forms seem noticeably distinct.

Conclusion

Of the six threatened species listed on Siquijor only the Streak-breasted Bulbul was observed on all three sites visited. In terms of subspecies endemic to Siquijor, four of the five subspecies were confirmed, two of which have limited distribution. The Everett's White-eye (*Zosterops everetti siquijorensis*) was recorded in Bandila-an while the Yellow-bellied Whistler (*Pachycephala philippensis siquijorensis*) was observed in both Bandila-an and Canghaling.

Recommendations

Research

Continued monitoring of the populations of threatened and forest wildlife of Siquijor is of immense important and should be

conducted. To this end the collaboration of the DENR, Silliman University through the Center for Tropical Conservation Studies, other NGOs and institutions and the local government of Siquijor cannot be overstressed. In particular, the population status and habitat requirement of the Siquijor Everett's White-eye is a priority.

Habitat Conservation

It has been observed that most local government offices have great difficulty in stemming the increase in forest clearance. Consequently, government efforts to enforce the legal protection assigned to most of the remaining forests such as patrolling the forest, relocating *kaingineros,* and prosecuting illegal loggers should be supported by various sectors with a stake in biodiversity conservation.

Studies have shown that government reforestaion projects aimed at improving the natural forest stands for commercial timber production have deleterious effects on the threatened birds of these forests. Planting forest with commercial species of timber (often alien species), fruit trees, or other crops, causes severe short-term changes to the understory and long-term replacement of the forest. Forests managed by this method are likely to lose a proportion of the species they support as a direct result of habitat change. Reforestation projects of DENR utilizing endemic species of plants to other potential sites in Siquijor should be intensified.

The plan of the DENR, and the provincial and local governments to declare the remaining forest of Siquijor, especially Bandila-an Natural Park, a protected area (for inclusion in NIPAS) must be vigorously pursued into reality.

Conservation Education

Various institutions like the DENR, local govenrnment units, non-governmental organizations, as well as academic institutions in the area must work together to carry out extensive information and education drive promoting the conservation of Siquijor's unique

wildlife and its habitat.

The foresters in the Bandila-an Forest Reserve could well serve to disseminate information on the endemic taxa in the area. At the Nature Cente, the staff must require visitors to log their names as well as provide them a short lecture on the wildlife and unique species before they are allowed to enter the reserve. Consequently, appropriate guidelines should be provided along with rules defining the limits of what is allowable within the reserve.

Topics related to the importance of biodiversity and species conservation should be incorporated in the curricula at the elementary and high school levels. The local Department of Education Culture and Sports, and academic institutions such as Silliman University, University of the Philippines-Cebu, University of the Philippines at Los Banos, as well as Haribon Foundation, and the local government could collaborate to provide a teachers' training program on the techniques of incorporating environmental concerns in the curricula.

The Department of Tourism (DOT) of Siquijor plans to include important facts about the island in its promotional brochures. The inclusion of information on endemic wildlife for a wider public dissemination in these tourist brochures is a step in the right direction.

Ecotourism

The Local government of Siquijor as well as Siquijor Province are actively promoting the island's potential for ecotourism. Dive tours and white sandy beaches are already starting to attract attention, while Bandila-an and the other areas have potential for terrestrial nature tours and birdwatching. This will be a good opportunity to generate public awareness on the endemic taxa of Siquijor and to highlight the urgent need to conserve their habitats.

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Table 4 (following pages). List of birds recorded in Siquijor. Records do not include shorebirds. Species in bold are Philippine endemic species. Species marked with * are threatened species; ** means the bird was not recorded in Dickinson et al. (1991); R means the species was reported by locals but was not observed during the survey. Numbers in parenthesis refer to species mist-netted and numbers outside parenthesis refer to individuals observed during survey. Year indicated refers to the expedition of Rand and Rabor (1959), Cambridge-Philippines Rainforest Project (1992), and Paalan (1994); not sighted is presented as — and the sighted is indicated as X.

SPECIES NAME	COMMON NAME	1959	1992	1994	BANDI-LA-AN	CANGH-ALING	SALAG-DOONG
*1.Gorsachius goisagi**	Japanese Night Heron	X	---	---	---	---	---
2.Gorsachius melanolophus	Malayan Night Heron	---	---	---	---	---	---
3.Haliaeetus leucogaster	White-bellied Sea Eagle	---	---	---	---	---	---
4.Haliastur indus	Brahminy Kite	X	X		---	1	1
5.Accipiter virgatus	Besra	---	X	---	----	----	---
6.Accipiter gularis	Philippine Sparrow Hawk	----	---	X	---	---	---
*7.Spizaetus philippensis**	Philippine Hawk Eagle	----	---	---	----	----	----
8.Falco severus	Oriental Hobby	---	---	R	---	---	---
9.Falco peregrinus	Peregrine Falcon	X	---	---	---	---	---
10.Gallus gallus	Red Junglefowl	X	---	---	2	---	---
11.Coturnix chinensis	Blue-breasted Quail	---	---	---	2	1	---
12.Gallirallus torquatus	Barred Rail	---	---	---	3	4	---
13.Porzana euryzonoides	Slaty-legged Crake	---	---	---	---	3	---
14.Treron pompadora	Pompadour Pigeon	X	---	---	---	---	---
15.Treron vernans	Pink-necked Green Pigeon	X	---	X	---	X	---
16.Ptilinopus leclancheri	Black-chinned Fruit Dove	X	---	X	---	---	---
*17.Ducula carola**	Spotted Imperial Pigeon	X	---	---	---	---	---
18.Ducula aenea	Green Imperial Pigeon	---	---	---	---	---	---
19.Ducula bicolor	Pied Imperial Pigeon	X	---	---	---	---	---
20.Columba vitiensis	Metallic Wood Pigeon	X	---	---	---	---	---
21.Phapitreron leucotis brevirostris	White-eared Brown Dove	X	X	X	16 (3)	6 (1)	(1)
22.Macropygia phasianella	Reddish Cuckoo-dove	X	X	X	---	1	---
23.Chalcophaps indica	Emerald Dove	X	X	X	7	3	2 (1)
24.Streptopelia chinensis	Spotted Dove			X	---	3	5
25.Geopelia striata	Zebra Dove	---	X	X	1	4	8 (1)
26.Caloenas nicobarica	Nicobar Pigeon	X	X	---	---	---	---
*27.Cacatua haematuropygia**	Philippine Cockatoo	X	X	---	---	---	---
28.Tanygnathus lucionensis	Blue-naped Parrot	X	---	---	---	---	---

SPECIES NAME	COMMON NAME	1959	1992	1994	BANDI-LA-AN	CANG-HALING	SALAG-DOONG
29.Loriculus philippensis siquijorensis	Philippine Hanging Parakeet	---	---	---	---	---	---
30.Ninox philippensis centralis	Philippine Hawk Owl	X	X	X	12	6	3
31.Centropus viridis	Philippine Coucal	X	X	X	12	15	2
32.Tyto capensis	Grass Owl	---	---	---	---	---	---
33.Cacomantis sepulcralis	Rusty-breasted Cuckoo	X	---	---	---	---	---
34.Eudynamys scolopacea	Koel	X	X	---	---	---	---
35.Centropus bengalensis	Lesser Coucal	---	---	---	---	---	---
36.Caprimulgus affinis	Savannah Nightjar	---	---	---	---	---	3
*37.Collocalia esculenta***	Glossy Swiftlet	X	X	X	15	24	36
38.Collocalia troglodytes	Pygmy Swiftlet	---	X	X	12	8	3
*39.Collocalia vanikorensis***	Island Swiftlet	---	X?	---	---	---	4
40.Cypsiurus balasiensis	Asian Palm Swift	---	X	---	5 (1)	3	---
41.Hirundapus celebensis	Purple Needletail	---	---	---	---	2	3
42.Ceyx lepidus	Variable Dwarf Kingfisher	---	---	---	---	---	---
*43.Halcyon winchelli**	Rufous-lored Kingfisher	---	X	---	---	---	---
44.Halcyon smyrnensis	White-throated Kingfisher	X	---	---	---	---	---
45.Halcyon coromanda	Ruddy Kingfisher	---	---	X	---	---	---
46.Halcyon chloris	White-collared Kingfisher	X	X	X	2	2	3 (1)
47.Hirundo rustica	Barn Swallow	X	X	---	---	---	2
48.Hirundo tahitica	Pacific Swallow	X	X	X	---	---	3
49.Megalaima haemacephala	Crimson Barbet	X	X	X	3	---	---
50.Pitta sordida	Black Hooded Pitta	X	X	X	18 (1)	5 (1)	6
51.Pitta erythrogaster	Red-bellied Pitta	X	---	---	---	---	---
52.Merops philippinus	Blue-tailed Bee-eater	X	---	---	---	---	---
53.Eurystomus orientalis	Dollarbird	---	---	X	---	---	---
54.Lalage nigra	Pied Triller	X	X	X	---	---	6
55.Pycnonotus goaivier	Yellow-vented Bulbul**	---	---	---	---	3	6
*56.Hypsipetes siquijorensis** *siquijorensis*	Streak-breasted Bulbul	X	X	X	78 (10)	32 (2)	37 (4)
57.Corvus macrorynchus	Large-billed Crow	X	X	X	---	---	---
58Oriolus chinensis	Black-naped Oriole	X	X	X	18	1	5

SPECIES NAME	COMMON NAME	1959	1992	1994	BANDI-LA-AN	CANG-HALING	SALAG-DOONG
59.Copsychus saularis	Oriental Magpie-Robin	X	X	X	---	7	2
60.Saxicola caprata	Pied Bushchat	X	X	X	---	3	2
61.Phylloscopus borealis	Arctic Warbler	---	---	---	3	---	---
62.Cisticola exilis	Bright-capped Cisticola	X	X	X	---	4	2
63. Megalurus timoriensis	Tawny Grassbird	---	---	---	---	---	---
64.Gerygone sulphurea	Yellow-bellied Flyeater	---	X	---	---	---	---
65.Muscicapa dauurica	Asian-Brown Flycatcher	---	---	---	3	---	---
66.Muscicapa grisiesticta	Grey-streaked Flycatcher	---	---	---	2	---	---
67.Cyornis rufigastra	Mangrove Blue Flycatcher	X	X	X	38 (5)	8 (1)	---
68.Rhipidura javanica	Pied Flycatcher	X	X	X	8	4	10 (2)
69.Pachycephala philippinensis siquijorensis	Yellow-bellied Whistler	X	X	X	22 (8)	8 (3)	---
70.Hypothymis azurea	Black-naped Monarch	X	X	X	18 (1)	4	---
71.Ficedula hyperythra	Thicket Flycatcher	---	---	--	---	---	---
72.Motacilla flava	Yellow Wagtail	---	X	---	2	2	---
73.Anthus novaseelandiae	Richard's Pipit	X	---	---	---	---	---
74.Artamus leucorynchus	White-breasted Wood Swallow	X	X	X	6	7	9
75.Lanius cristatus	Brown Shrike	X	---	X	3 (2)	7 (1)	10 (4)
76.Lanius schach	Long-tailed Shrike	X	X	X	---	---	---
77.Aplonis panayensis	Asian Glossy Starling	X	X	X	4	11 (1)	13
78.Sarcops calvus	Coleto	X	X	X	7	6	10
79.Anthreptes malacensis	Plain-throated Sunbird**	---	---	---	13	3	---
80.Nectarinia jugularis	Olive-backed Sunbird	X	X	X	41	13	3
81.Nectarinia sperata	Purple-throated Sunbird	X	X	X	12	2	---
82.Aethopyga siparaja	Crimson Sunbird	---	---	R	17	1	2
83.Dicaeum trigonostigma besti	Orange-bellied Flowerpecker	X	X	X	38	7	3
84.Dicaeum australe	Red-keeled Flowerpecker	---	---	--- •	3	---	---
85.Dicaeum pygmaeum	Pygmy Flowerpecker	X	---	X	---	---	---
86.Zosterops everetti siquijorensis	Everett's White-eye	X	X	X	14	---	---
87.Lonchura malacca	Chestnut Munia	X	X	X	6	16	13
88.Lonchura leucogastra	White-bellied Munia	X	X	X	5	1	---
Total Number Species		53	45	44	36	39	32
Total Observation Hours					31	25	13
Netting Results					31	10	14
Number of Individuals					271	240	216

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THE MANGROVE COMMUNITIES OF DANJUGAN ISLAND, CAUAYAN, NEGROS OCCIDENTAL, PHILIPPINES

Richard King, Craig Turner, Terence Dacles, Jean-Luc Solandt, and Peter Raines

ABSTRACT

The mangroves of the Philippines have declined by 75% over the past 80 years due to a range of anthropogenic pressures. However, there is relatively little information available on mangrove stands in the central Visayas region of the Philippines. This paper represents the first detailed inventory of the mangrove resources of Danjugan Island, Cauayan, Negros Occidental, an island with relatively undisturbed mangal communities. The results of the completed inventory of all mangroves of the island suggest that the island supports very diverse (14 true mangrove species identified) and abundant communities that vary with location on the island. These are discussed in terms of the geographic location and potential conservation value.

Introduction

The diversity of coastal plants in the Philippines is one of the richest in the world (Calumpong & Menez 1996). One of the most important components of the coastal ecosystem is the mangal community (dominated by mangroves) on the landward side of the coastal zone, usually located within the inter-tidal zone. Approximately sixty to seventy mangrove and associated mangrove species from twenty-six families are found in the Philippines. An estimated forty species (from sixteen families) are considered true mangroves (CV-CIRRD 1993; Primavera 2000) which can be defined as those which are restricted to the mangrove community, while associated species may also grow in other habitats (Melana & Gonzales 1996). In the Philippines, the most common genera are *Rhizophora, Avicennia, Bruguiera* and *Sonneratia* (Calumpong & Menez 1996) and at least fourteen species have previously been recorded from Negros Island (Calumpong 1994; Walters 2000).

Mangals are one of the most diverse communities in the coastal area, harboring a variety of fauna and providing a range of ecological goods and services. Services include provisions of nurseries for fisheries, nutrient and sediment buffers for fringing reefs, and coastal defence, whereas goods include edible products (e.g. shellfish and crustaceans), fuel wood, construction materials and medicine (Bandaranayake 1998). Their importance to fisheries in the Philippines is indicated by a positive correlation between near-shore yields of fish and/or shrimp and relative densities of mangrove areas (Primavera 2000).

However, despite their environmental importance, mangroves have suffered considerable degradation in the Philippines because of their relative accessibility and the long history of conversion to aquaculture ponds in the country (Primavera 2000). Such conversion in combination with over-exploitation has caused the Philippines to lose over 70% of its original mangrove forest (Walters 2000) and 50% of the remaining forest cover is deemed to be threatened (DENR/UNEP 1998). Many of the larger mangrove areas of south-western Negros and small coastal islands have practically disappeared because of the creation of salt-beds and fish ponds (Roque et al. 2000).

It has been suggested that conservation of the country's remaining 100,000 hectares of mangrove should be prioritized and existing stands should be evaluated for possible application of community-based management schemes within the context of a wider integrated coastal zone/area management (Primavera 2000). Clearly a precursor to such applied action is identification and baseline assessments of existing mangrove stands within a particular area.

Danjugan Island provides an ideal candidate location for such work (Harborne et al. 1996; Turner et al. 2002). It is a small (approximately 43 hectares), coral fringed island covered in tropical limestone forest, 3km west of Cauayan, Negros Occidental 3 km off the coast of Barangay Bulata in the Sulu Sea (Figure 1). The island has six lagoons, of which two are open to the sea and all but one is surrounded by mangrove stands. Danjugan Island was granted reserve status and designated as the Danjugan Island Marine Reserve and Sanctuaries (DIMRS) by the municipal government of Cauayan and provincial government of Negros

Occidental in February 2000. It has three sanctuaries or "no-take zones" within the reserve boundary which has a total area of 104.2 hectares, approximately 50% of the total coastline and reef area of the island. Since 1995 the island has been managed by the Philippines Reef and Rainforest Conservation Foundation, Incorporated (PRRCFI) which is adopting an integrated community-based approach to resource management (Ledesma et al. 1999). However, the abundant mangrove resources have never been assessed beyond partial species listings completed by PRRCFI staff.

The current study forms part of the wider reaching Danjugan Island Biodiversity Survey whose objective was to survey the flora and fauna of terrestrial and mangal commuities (Turner et al. 2002). The specific objective of this study was to quantify the abundance and distribution of each mangrove species on Danjugan Island by comparing and contrasting the mangal communities at different locations.

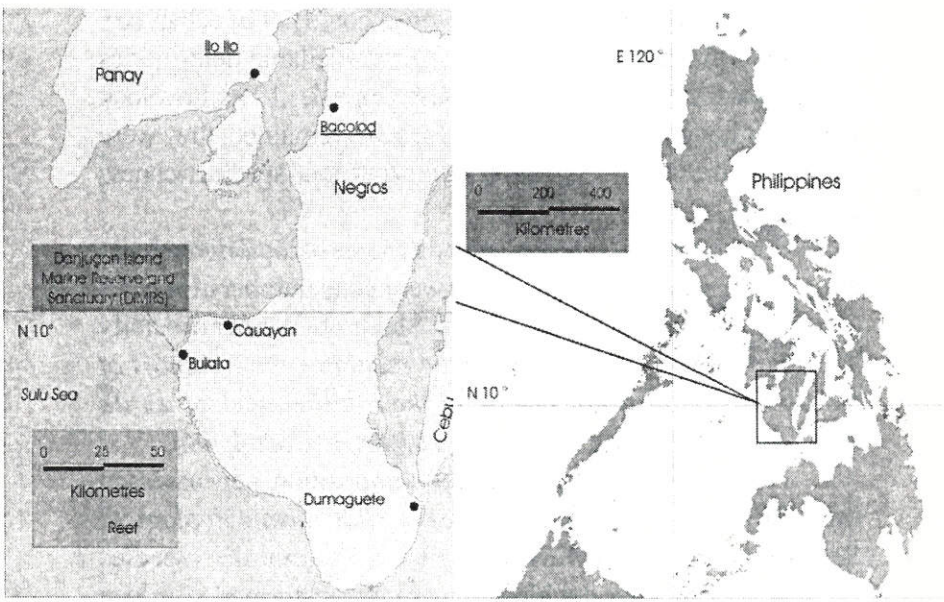


Figure 1. Location of the Danjugan Island Marine Reserve and Sanctuary, Philippines.

Methods

An initial survey of the Island identified a total of seven locations supporting mangrove stands (Figure 2). However, it should be noted that the site referred to as lagoon 7 is not a true lagoon, but a small tidal pool between Tabon Beach and Southwest Bay. Nevertheless, it is included in the initial inventory since it supports mangroves. Each lagoon was then inventoried between August and September 2001 using a total count method (Bullock 1996). The lagoons were surveyed in sections which corresponded broadly to the north, south, east, and west shores of each location. Within each section, a count of all size classes of all established true mangrove plants was made with all individuals identified to species level. Associated mangrove species were also recorded and identified to species level where practicable. However, only presence/absence data are presented. A number of unidentified associated mangrove species were documented as morpho-types (where resolution to family level or lower could not be achieved).

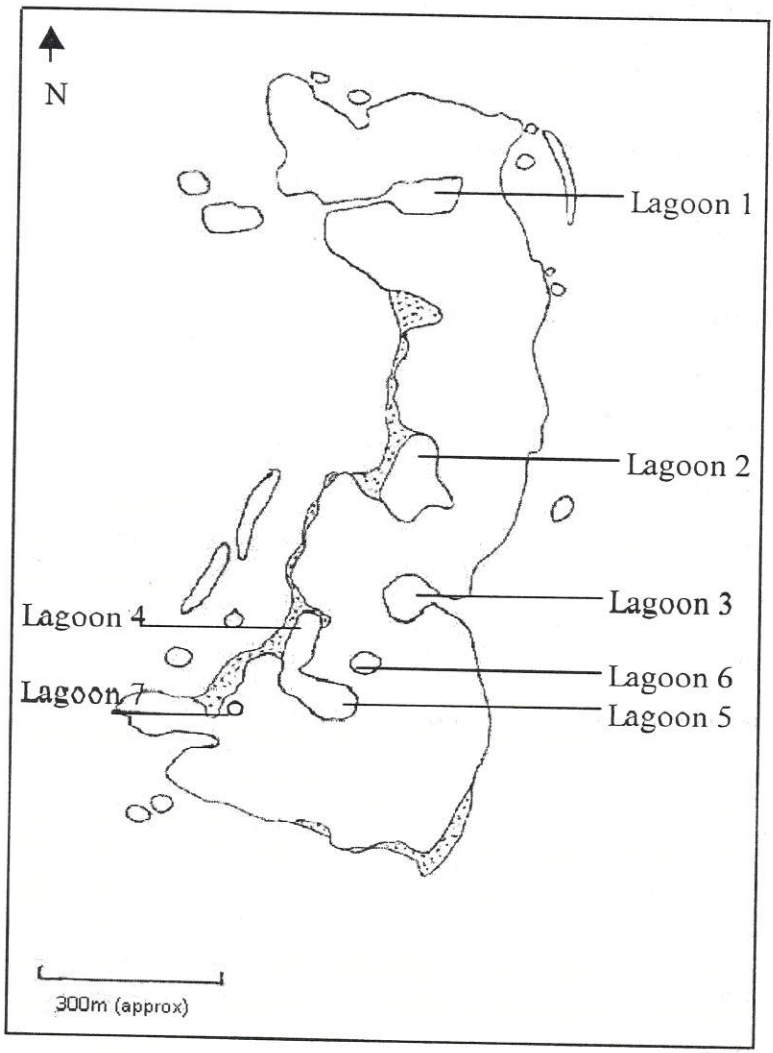
Identifications were made using the available field-guides (Calumpong & Menez 1996; Melana & Gonzales 1996; Lovelock 1969). Although a few unidentified species remained, they were included in the inventory in order to illustrate total species richness at each site.

For each major location, four measures of local diversity of true species were calculated. These were: total number of species (S); total abundance of individuals; Shannon-Weiner diversity $H=\Sigma(P_i*Log_e(P_i))$ *(where* P_i *is the number of individuals of the ith species as a proportion of the total number of all ith species); and Pielou's eveness* $J=H/Log_eS$ *(Carr 1996).*

Further patterns in community composition were assessed using PRIMER *(Plymouth Routines in Multivariate Ecological Research) (*Clarke & Warwick 1994*a).* Community (species abundance) data were double-square root-transformed to reduce the influence of dominant and rare species. The Bray-Curtis similarity measure was then calculated between every permutation

of sample pairs (Clarke & Warwick 1994b). The relationship between samples (lagoons) was displayed using hierarchical agglomerate clustering technique (Figure 4) (Clarke & Green 1988).

Figure 2. Schematic outline map of Danjugan Island with location of lagoon areas where mangrove stands were identified.



Results

A total of fourteen true mangrove species from eight families and twelve associated mangrove species (or morpho-types) were identified on Danjugan (Table 1). A further true species, *Lumnitzera racemosa*, only distinguishable from *L. littorea* by its white flowers, is believed to occur at low-density in lagoon 2 (Vincent Lumbab pers. comm.), but this could not be confirmed during the present study.

Table 1. Total abundance of true mangrove species in each lagoon on Danjugan Island

Family	Species	Lagoon						
		1	2	3	4	5	6	7
Avicenniaceae	*Avicennia marina*	-	-	45	-	-	-	-
Combretaceae	*Lumnitzera littorea*	-	193	-	-	-	-	-
Euphorbiaceae	*Excoecaria agallocha*	4	51	2	-	-	-	-
Meliaceae	*Xylocarpus granatum*	-	335		172	46	-	-
Meliaceae	*Xylocarpus moluccensis*	23	16	6	4	53	-	3
Myrsinaceae	*Aegiceras sp.*	-	-	9	-	-	-	
Palmae	*Nypa fruticans*	-	-	-	-	-	4	-
Rhizophoraceae	*Bruguiera cylindrica*	3	-	-	218	67	-	-
Rhizophoraceae	*Bruguiera gymnorrhiza*	1	-	3	13	277	-	-
Rhizophoraceae	*Ceriops decandra*	1	-	1	-	-	-	-
Rhizophoraceae	*Rhizophora apiculata*	6	124	24	31	-	-	-
Rhizophoraceae	*Rhizophora mucronata*	7	1	121	204	4	-	-
Sonneratiaceae	*Sonneratia alba*	-	-	6	-	-	-	-
Sonneratiaceae	*Sonneratia caseolaris*	-	-	6	-	-	-	-

Rhizophora mucronata was the most common species at both lagoons 3 and 4 (Table 1). However, at lagoon 2, just a single established *R. mucronata* was recorded, with *R. apiculata* being the most common Rhizophoraceae. *Bruguiera gymnorrhiza* dominated lagoon 5, but only a few individuals were found elsewhere. *B. cylindrica* was never the most dominant species, but was well represented in lagoons 4 and 5, and was also recorded at lagoon 1. Just two individuals of *Ceriops decandra* were recorded, one in each of the lagoons open to the sea.

Within the Meliaceae family *Xylocarpus granatum* was the most common species overall, but was restricted to the three large closed lagoons, while *X. mollucensis* was much less frequent but more widely distributed. The remaining true species tended to be established in just a single lagoon, for example *Lumnitzera littorea* in lagoon 2 and *Avicennia* marina in lagoon 3.

Of the associated species (Table 2), *Pongomia pinnata* was the most widely distributed, being recorded from each lagoon. *Pemphis acidula*, a threatened species, (Domingo Madulid pers.comm.) was common in lagoon 3 and present in lagoon 1, but was not recorded from any of the closed lagoons. It should be noted, however, that this species is also distributed widely on low exposed rock all around the coast of the island.

Table 2. Presence/absence of identified associated mangrove species located within each lagoon.

Family	Species	Lagoon						
		1	2	3	4	5	6	7
Combretaceae	*Terminalia cattapa*	Y	-	Y	-	Y	-	-
Fabaceae	*Aganopa heptaphylla*	Y	-	Y	-	-	Y	-
Fabaceae	*Pongomia pinnata*	Y	Y	Y	Y	Y	Y	Y
Lecythidaceae	*Baringtonia asiatica*	-	-	Y	-	-	-	Y
Lythraceae	*Pemphis acidula*	Y	-	Y	-	-	-	Y

Distribution, abundance, and species richness all varied with location. While lagoons 2 and 4 supported the highest number of individuals (Table 3), lagoons 1 and 3 demonstrated the highest cumulative (true and associated) total species richness (Table 3). For both true species and associated species, lagoon 3 was the most species rich (including morpho-types). Lagoon 6 supported just one true species (*Nypa fruticans*), a species located nowhere else on the island. This lagoon, and lagoon 7 which also supported just one true species (*Xylocarpus moluccensis*), were both excluded from further analysis.

The diversity analyses (Table 3) show Lagoon 3 to be the most diverse location with the highest species richness and Shannon-Weiner value. However, it also has the lowest evenness value since it is dominated by 3 species. The analysis of community composition (Figure 3) confirmed that lagoons 4 and 5 are most similar to one another (>65% similarity) as are lagoons 1 and 3 (>50% similarity), with lagoon 2 clearly separated from both pairs at a much lower level of similarity (<40%).

Figure 3. Total cumulative species richness for 'true' and 'associated' species within all lagoons.

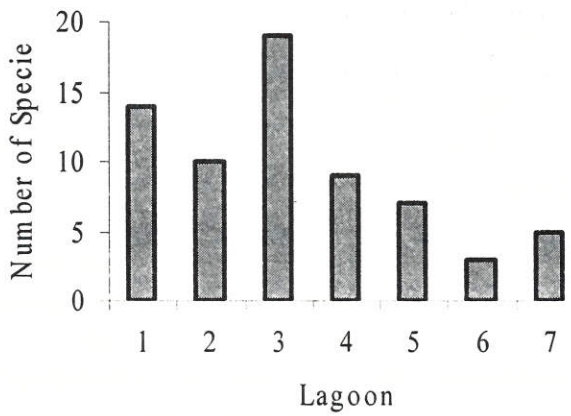


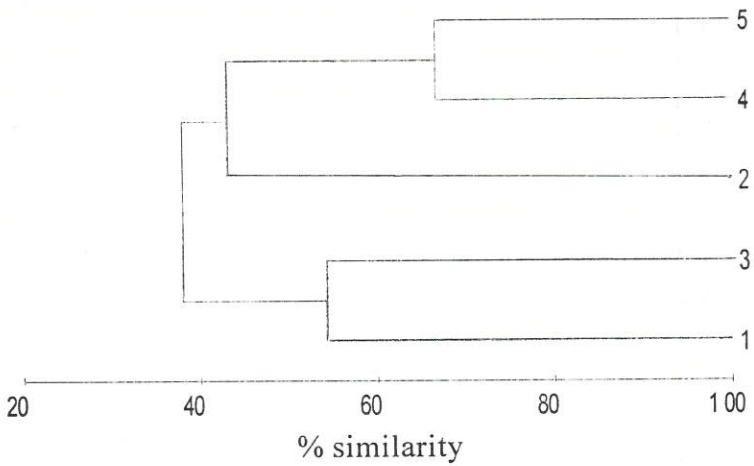
Table 3. Mangrove community metrics for each major lagoon.

Community Metric	Lagoon 1	Lagoon 2	Lagoon 3	Lagoon 4	Lagoon
Approx. mangrove stand area (sqm)	2000	5000	3000	2000	1500
True Species richness	6	6	10	6	5
Total Abundance	44	720	223	642	447
Shannon-Weiner diversity	1.32	0.76	1.66	0.77	0.66
Pielou's Eveness	0.78	0.72	0.63	0.75	0.69
Associated species richness	4	1	5	1	2
+Morphotype species richness	3	3	4	2	0
*Total Species Richness	13	10	19	9	7

+Morphotype: where resolution to family level or lower could not be achieved.

*Total Species Richness = sum of True, Associated and Morphotype species richness for each location.

Figure 4. Dendrogram of mangrove community composition at the five lagoons calculated using group-average linking of Bray-Curtis similarities (calculated from √√-transformed data) and labelled according to lagoon location.



Discussion

Where at least fourteen species have been recorded, Danjugan Island has a diverse mangrove flora comparable in species richness to other sites on Negros, but fewer than the most diverse sites in the Philippines where as many as twenty-nine species have been identified (Calumpong 1994). The lagoons have surprisingly different species compositions within their mangrove communities. The two lagoons open to the sea (1 & 3) had the highest species richness while the three enclosed lagoons (2, 4 & 5) had the highest abundance of mangrove stems. The recorded abundance and diversity measures within each lagoon may partially be explained by the size of the area

sampled (Table 3), however, there is no clear correlation between these factors. Therefore, the reasons for the observed patterns may be explained by three additional factors. Firstly, lagoons 1and 3 are potentially exposed to increased natural recruitment of diverse propagules via transportation on the tidal flow. Secondly, it may be that the varying water circulation patterns and tidal flushing into and out of lagoons 1 and 3 presented the widest range of physical conditions and may have increased the levels of disturbance that could promote greater species diversity (Connell 1978).

This suggests that at low levels of disturbance, a few competitively superior species will dominate communities resulting in lower levels of diversity, as found in the 'enclosed' system represented by the other lagoons (2, 4 & 5). Whilst at intermediate disturbance levels, physical, chemical, or biological disturbance creates space for new species to colonize, resulting in higher species diversity. While Connell (1978) has shown that diversity is often higher in habitats that are subjected to some disturbance than in undisturbed habitats, this would clearly require further investigation in the context of the lagoons of Danjugan.

Such a theory has some foundation based on the observed results from lagoons 1 and 3 which had few abundant species and contained a cross-section of family groups with differing habitat preferences such as those that prefer tidal streams (e.g. *Sonneratia alba* and *Sonneratia caseolaris),* or deeper mud habitats (e.g. *Rhizophora mucronata),* or landward edges of mangal communities (e.g. *Avicennia marina).* Additionally lagoons 2, 4 and 5 were dominated by just two families that either prefer fine substrates (e.g. Rhizophoraceae spp.) or are typical of more inland areas (e.g. Meliaceae spp.*).* Fine substrates are more

indicative of areas with less current, which is likely given the lack of opening to the sea from these lagoons. The predominance of *Rhizophora* species demonstrated similarities with other areas of Negros (Walters 2000) and the Philippines (Calumpong 1994). However, *Avicennia* and *Sonneratia* species were not common in the present study as they have been at other locations (Walters 2000; Calumpong 1994) and this may be explained by the observed general preference for many species in these families for tidal stream areas and hence they were only located in lagoon 3 (Calumpong 1994).

The underlying causal mechanisms for the observed ecological patterns clearly requires further investigation with respect to the role of disturbance and abiotic conditions (e.g. water quality) which was not possible during the present study. Additionally, the ecological role of the mangrove communities in lagoons 1 and 3 with respect to habitat provision and trophic support for juvenile fish communities would be worthy of further research particularly in light of the protected area status of surrounding coral communities of the island. Similarly, the size and age structure of existing trees should be more thoroughly investigated, and the number of seedlings inside and outside lagoons should be counted to investigate the potential for further growth of the mangal.

The mangroves of Danjugan are clearly an important conservation resource in terms of their species diversity and the fact that the island harbors relatively high numbers of *Pemphis acidula* which is considered a threatened species due to over-collection for the bonsai trade *(Philippines National Herbarium, pers. comm.)*. Additionally, these communities are not only potentially important for juvenile fish but the Philippine Reef and Rainforest Conservation Foundation Incorporated which manages Danjugan Island

has been using the mangrove seedlings of the island to re-seed areas of the adjacent mainland coastline. A nursery for species such as *Sonneratia*, and *Rhizophora* has been established in the second lagoon beach (not assessed in this study). Successful 'growing-on' of these seedlings has occurred in the nearby mainland communities, and the long-term goal is to use the re-established mainland mangal as a nursery and habitat for mud crabs (*Scylla* spp.), and thereby create an alternative income to the coral reef fishery. Therefore, the lagoons of Danjugan Island potentially provide a rich resource for ecological restoration and do not only provide habitat for species-rich mangrove forests, but could be used to apply coastal zone regeneration of associated mangals. Future environmental management of the island should be mindful of these values.

Acknowledgments

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PRELIMINARY NOTES ON MANTIGUE ISLAND CAPTURE FISHERIES: IMPLICATIONS OF A MARINE RESERVE

Aileen P. Maypa, Angel C. Alcala and Gary R. Russ

ABSTRACT

Marine reserves are often advocated as tools for sustainable fishery management. However, evaluation techniques on the effectiveness of established reserves are few. Although the Before-After-Control-Impact Pair (BACIP) experimental designs are most appropriate in detecting marine reserve impacts, they are rarely used. This study reports the first part of the BACIP results for Mantigue Island fishery yield. Based on daily roving creel surveys total estimated yield of the reef/seagrass fishery for 2000 was 4.88 t/km²/yr. Reef associated fish yield is 0.82 t/km²/yr and non-reef is 5.76 t/km²/yr. Of the 42 fish families caught, Belonidae (42%), Scaridae (10.3%), Engraulidae (7.6%), Labridae (7.28%) and Caesionidae (4.77%) dominated the annual catch. Four fishing gears were used in Mantigue: gill net, spear gun, hook and line and fish pots. Highest estimated total annual catch was also from gill nets, yielding 8.11 t of fish. Reef-associated fish catch per unit effort was significantly higher compared to reef/seagrass and non-reef catches but catch was lower than non-reef. Low reef/seagrass fish yield and data on fish lengths of some species caught suggest that the reef/seagrass fisheries of Mantigue Island may have reached growth overfishing. If unsustainable fishing practices are continued, further degradation of fishery resources may move up to the higher levels of overfishing. Immediate management action is therefore essential. Establishment of a marine reserve in the area is now being undertaken through community based management. With BACIP used as the experimental design, the impacts of the Mantigue I. marine reserve on its fishery will be readily quantified over time.

Introduction

High population growth, fishery over exploitation, and lack of skills and tools for resource management have resulted in the decline and collapse of marine fisheries in many areas (FAO 1995, Vitousek et al. 1997,

Fogarty and Murawski 1998, Lauck et al. 1998). Marine reserves, defined as areas protected from all forms of fishing and extractive activities (Bohnsack 1998), have been advocated worldwide as a tool for sustainable fishery management (e.g. Alcala and Russ 1990, 1996a, Allison et al 1998, Lauck et al. 1998, Done and Reichelt 1998, Murray et al. 1999, Maypa 2002). Evidence is accumulating that higher diversity and abundance, and larger sizes of fish and other organisms are direct effects of protection (Alcala and Russ 1990, Russ and Alcala 1996a, 1996b, 1998, Edgar and Barrett 1999, Epstein et al.1999, Johnson et al. 1999, McClanahan and Mangi 2000). Moreover, the maintainance of high reef and reef associated fish yields, in the order of 15-30 t/km^2/yr over 20 years in Apo I. suggests the effectiveness of marine reserves as a tool for fishery rehabilitation and enhancement (Alcala and Luchavez 1981, White and Savina 1987, Bellwood 1988, Maypa et al. 2002). However, in order to quantify the effectiveness of a marine reserve, the condition of the resources of a selected area must be evaluated. Often, Rapid Resource Assessments are the only source of baseline information and it is very seldom that fishery catch is studied in detail.

Some of the most detailed documented reef fish yields in the Philippines are from small coral islands. From Apo Island, total reef /reef associated yields range from 16.69 to 31.8 t/km^2/yr (Maypa et al 2002), Sumilon: 14 to 36.9 t/km^2/yr (Alcala 1981, Alcala and Russ 1990), Selinog: 6 to 18 t/km^2/yr (Alcala and Gomez 1985, Cruz, unpubl. data), Pamilacan: 17.9 t/km^2/yr, including gleaning (Savina and White 1986), San Salvador: 7 to 14 t/km^2/yr (Christie and White 1994). These studies provide valuable information for experimental designs such as Before-After Control-Impact-Pair (BACIP). Yet, although such designs are most appropriate for detecting impacts of marine reserves, they are rarely used (Russ 2002). This study is the first part of the BACIP experimental design for Mantigue Island. We report the fish yield, seasonal changes in catch, catch per unit effort (CPUE) of different fish groups, and volume of catch of the different

fishing gears used around Mantigue Island for the year 2000 prior to the formal protection of its marine reserve.

Materials and methods

Study site

This report was based on fish catch data from Mantigue Island (9°10.3'N, 124°49.5' E; Fig. 1) from January to December 2000. Mantigue is a 0.07 km² island. Located 3.7 km southeast of Camiguin Island in the Mindanao Sea, it is under the jurisdiction of the municipality of Mahinog. A 0.45 km² multispecies seagrass bed and a 0.55 km² fringing reef surround the island. Mantigue has a population of approximately 178 individuals, a majority of whom depend on fishing and shell collecting as a primary source of income.

A marine reserve, 0.037 km² in area, was established on August 21, 2000 through the efforts of Silliman University-Angelo King Center for Research and Environmental Management, the Camiguin Polytechnic State College, the province of Camiguin, the local government of Mahinog, and Mantigue Island fisherfolk. Efforts to protect started immediately after establishment, though illegal fishers were still reported. Total protection was achieved in January 2001.

Fish yield and catch per unit effort (CPUE) estimation

Fish yield and CPUE estimates were computed from data gathered daily through roving creel surveys from January to December 2000. Recorded fish catches were reported by fishers to have been caught within the 80m isobath. Data were collected by a researcher and a fish enumerator trained in fish identification using local fish names. CPUE data collection included interviewing of fishers on fishing hours and fishing grounds daily, per landing. Landed fish were weighed to the nearest 10 grams using commercial fish weighing scales. Mantigue Island fishing gears included: (a) gill nets, (b) hook and line, (c) spear guns, and (d)

fish pots. Fish yield for reef/seagrass species was calculated using the combined coral reef and seagrass areas of 1.0 km^2, and for reef associated species, the 0.55 km^2 coral reef area was used. Samples for genus or species level identification were collected. Identifications were based on Masuda et al. (1984), Randall (1997), Smith and Heemstra (1986), and Fish Base 2000 (Froese and Pauly 2000). Major fish groupings followed Bellwood (1988) and Choat and Bellwood (1991).

Fish catch during the main fishing seasons in Mantigue Island was compared using weekly replicates consisting of weights of fish caught daily. This analysis was limited to the 10 major fish families which comprised 86% of the catch for the year 2000. Weekly replicates for each season were n=27 for the northeast monsoon (NE; November to early April), n=16 for the southwest monsoon (SW; June to September), and n=6 for the calm interim period (INT; October, late April to May). A Two-Way ANOVA was used in comparing differences between families during fishing seasons, and for finding significant differences in CPUE between fish groups. A Bonferroni Post Hoc Test revealed where the significance lay. All data were tested for normality and homoscedasticity using Kolmogorov's Test and Levene's Test, respectively (Velleman 1997). A Box-Cox transformation was applied to non-normal or heteroscedastic data.

Fish Length

Caesio caerulaurea was chosen for detailed study since it is a reef species and its local name is specific to the species, therefore minimizing identification mistakes. It is also harvested throughout the year in Mantigue I. Further, caesionids are known for their resiliency in fishing, though they decline rapidly in abundance when fished heavily (Russ and Alcala 1998). These characteristics therefore serve as good indicators of the current fishing intensity and pressures in the area. Fork lengths (FL) of individual *Caesio caerulaurea* were derived from weights of individual fish using the formula in Fish Base 2000 (Froese and

Pauly 2000): $W=a.L^b$ (where: W=weight, a=constant, L=FL, b=constant). No significant difference was seen in fish sizes between seasons (ANOVA, p=0.7529), thus, mean FL of *C. caerulaurea* was computed by combining all derived FL data from NE, SW monsoons and INT periods (n=163). *Caesio caerulaurea* FL from Mantigue was then compared with *C. caerulaurea* FL from Apo Island (n= 185) for the year 2000. The fishery yield of Apo I. is known to be fairly large (Maypa et al 2002). Apo I. is also situated in the Mindanao Sea with a well managed reserve protected for almost 20 years (Russ and Alcala 1999). This well documented fishery provided a good point of reference and comparison for fish length studies in Mantigue I.

Results

Fish yield, catch composition, seasonality and length

Forty four families in approximately 65 genera comprised the fish caught from Mantigue Island in the year 2000. Of these families, 42 were finfish and two were mollusks (Table 1). Estimated non-reef fish yield was 5.76 t/yr, seagrass/reef fish yield was 4.88 t/km^2/yr and that of reef associated fish 0.82 t/km^2/yr. In spite of the diversity of families caught, Belonidae (42.12%), Scaridae (10.3%) Engraulidae (7.6%), Labridae (7.28%) and Caesionidae (4.77%) dominated. Mantigue I. residents rely mainly on non-reef fish as their source of food and income. Belonids, *Tylosurus* spp., are caught all year round using gill nets and hook and line. The volumes of belonids caught during NE (110.5±14.71 kg/wk) and SW (139.3±19.09 kg/wk, respectively; Fig. 2) was significantly higher than that of other families caught in all seasons (ANOVA, $p \leq 0.0001$, Table 2). In addition, Engraulids (INT: 17.59± 4.89 kg/wk) and Clupeids (INT: 14.8±33.14 kg/wk) also contributed to the bulk of the non-reef catch. Among the dominant reef/seagrass fish species were scarids (INT: 27.25±4.54 kg/wk), labrids (INT: 24.89±5.54 kg/wk) and caesionids (INT:18.75±4.14 kg/wk).

The majority of the reef/seagrass fish species caught were small which can be readily attributed to the mesh sizes of the gill nets commonly used (≤5 cm; A. Maypa, pers. obs.). The average length (FL) of sampled *Caesio caerulaurea* from Mantigue was significantly smaller (18.42±0.17 cm) than those measured from Apo Island (24.94±0.16 cm; T-test, $p<0.0001$). This species reaches up to 35 cm (TL), based on Randall et al. (1997). Furthermore, scarids such as *Scarus ghobban*, with a total length of 20 cm was considered large by Mantigue I. residents. This species reaches 75 cm (Randall et al. 1997).

Gear types and catch rates

Gill net catch on a per trip basis (annual mean catch= 8.33±0.39 kg/trip) was significantly higher compared to the catch using other gears in all seasons (Fig.3, Table 2). In contrast, fish pot catch during the northeast monsoon was significantly lower ($p<0.0001$) compared to the catch using the rest of the gears in various seasons (hook and line $_{SW/NE/INT}$: 3.63±0.29 kg/trip, spear gun, $_{SW/NE/INT}$: 2.99±0.15 kg/trip, fish pot $_{SW\&INT}$: 2.21±0.12 kg/trip, fish pot $_{NE}$: 1.19±0.21 kg/trip). Highest estimated total annual catch was from gill nets, yielding 8.11 t; 76% of the total fish caught in 2000 (Table 3).

Catch per unit effort (CPUE) of major fish groups

The catch per unit effort for different fish groups on a per gear basis is shown in Figure 4. No significant differences were found between gears (Table 2). However, significant differences existed between fish groups (Table 2). Reef associated catch, although comprising only 4.09% of the total annual yield, had a significantly higher CPUE than those among coastal and non-reef species (Table 2).

Discussion

The total estimated annual yield of fish from Mantigue I. was

dominated throughout the year by belonids and other non-reef species. Among the reef fishes, labrids and scarids made up most of the bulk of the annual catch. Reef associated catch provided the smallest contribution to the total catch, but had the highest CPUE among major fish groups (Fig. 4). Gill net catch contributed 76% of the total annual yield while hook and line, spear gun and fish pot catch made up the rest of the 24%.

Reefs worldwide such as those in Jamaica and the Philippines are rapidly approaching or have reached Malthusian overfishing, i.e., fishers resort to resource destruction due to a large population of fishermen with declining catch (Russ 1991). In the South Jamaican Shelf, fishing effort over a span of 15 years increased with no corresponding increase in catch (Koslow et al. 1988). In Mantigue I., fishers reported dynamite fishing practiced in the late 1970s to early 1980s. Previously blasted coral reefs around the island show little recovery today. Sand/rubble areas are still evident.

These data suggest that Mantigue Island's reef/seagrass fishery resources are overfished. Residents are currently dependent on non-reef fish species, particularly belonids which comprised almost half of the annual catch in the year 2000. The island's estimated total annual yield of coastal fisheries is very low compared to other nearby islands in the Mindanao Sea. In Mantigue, only 4.38 t/km^2/yr of coastal fish are caught even though fisherfolks fish all year round, unlike other areas in the Philippines (e.g., Apo Island) where fishing activities are limited by strong winds and rough waves generated by the NE monsoon. From November to April, Apo Island's major fishing ground is hit by the northeast monsoon, drastically reducing fishery. However, fish yields in Apo range from almost 16.69 to 31 t/km^2/yr of reef and reef-associated species. (Maypa et al. 2002). Sumilon Island has yielded more than 30 t/km^2/yr of reef fish, dominated by caesionids (Alcala and Russ 1990, Russ and Alcala 1998). Both Sumilon and Apo Islands have protected marine reserves since 1974 and 1982, respectively (Russ and Alcala 1999).

Our results suggest that Mantigue island has reached the condition of growth overfishing. This is defined as the point where there is a substantial reduction in the proportion of large size classes of fish caught (Russ 1991). Although the catch per unit effort of different gears and of various fish groups caught in Mantigue is comparable to other islands in the Mindanao Sea (Alcala and Luchavez, 1981, White and Savina 1987, Alcala and Russ 1990, Maypa et al 2002), sizes of fish caught are smaller. *Caesio caerularea* caught from Mantigue reefs had an average size of 18.42±0.17 cm (FL) and comparatively smaller than *C. caerulaurea* from Apo Island (24.94±0.16) and reported maximum sizes (to 35 cm, TL; Randall et al. 1997, Froese and Pauly 1996, Kuiter and Debelius 1997). However, Russ and Alcala (1998) documented that when fished intensively the abundance of caesioinids also declines rapidly. Small sizes of *C. caerulaurea* in areas known to be fished intensively may therefore indicate potential overfishing. Further evidence of potential growth overfishing in Mantigue I. comes from observed lengths of other fish species. Scarids of 20 cm in total length, such as *Scarus ghobban* (maximum TL=75 cm; Randall et al.1990) are considered large by Mantigue I. residents. It was also observed that 90% of the *Plectorinchus* spp. sampled from the catch were only 10 to 15 cm. *Plectorinchus lineatus* reaches a TL of 60 cm (Kuiter and Debelius 1997). Gill nets, especially three-ply nets (mesh sizes: 5 to 1 cm) are very popular in the area. These catch all fish sizes, including juveniles. Continued fishing using small mesh sizes will reduce and deplete both density and biomass of fish populations. This may lead to impairment of larva production and subsequent recruitments, a condition otherwise known as recruitment overfishing (Russ 1991). Immediate action is therefore essential to prevent further degradation of Mantigue's coastal resources. The establishment of a 0.037 km^2 reserve is expected to improve the condition of the coastal fishery resources of the island through protection of fish habitat and spawners, education, and changes in fishing policies.

A growing body of evidence supports that long-term protection of marine reserves results in higher diversity and abundance, and larger sizes of fish and other organisms (e.g., Alcala and Russ 1990, Russ and Alcala 1996a, 1996b, 1998, Edgar and Barrett 1999, Epstein et al. 1999, Johnson et al. 1999, McClanahan and Mangi 2000). Further, evidence on adult fish biomass export and enhancement of fish stocks from the reserve to adjacent fishing grounds (spillover) is also accumulating. Russ and Alcala (1996a, b) documented an exponential increase in biomass of large predatory fish inside Apo I. marine reserve over time. In addition, they also documented the decrease of large predatory fish biomass as distance from the reserve increased. McClanahan and Mangi (2000) also found that fish catch per trap, mean size of trapped fish and diversity of fish species caught per trap declined with increasing distance from the reserve. Long term high reef and reef associated fish yields have also been documented in fishing grounds adjacent to Apo I. marine reserve (Maypa et al. 2002).

Although some Mantigue residents are still opposed to the concept of a marine reserve, support for the project is growing. With continued technical support from the academe, local government, and the influence of fishing communities with successful marine reserves, changes toward sustainable practices and marine reserve protection commitment are expected to improve the coastal fishery resources of Mantigue I. in the near future. When monitored individually through time, catch per unit effort of coral reef species time will be a good indicator of the effectiveness of the marine reserve. However, the continued use of gill nets as the major fishing gear in Mantigue poses some limitation. Consequently, a detailed study on fish lengths of the demersal fishery is recommended. Monitoring of the biomass and density of reef-associated species over time in conjuction

with CPUE may provide some insights into the role of this fish group on marine reserve spillover issues.

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Table 1. Total sample yield (TSY) and per cent contribution (%TY) of all fish families caught in Mantigue I., Camiguin southern Philippines from January to December 2000.

Family	%TV	TSY(kg)	Genera/Family
Reef/Seagrass	**43.99**		
Acanthuridae	3.68	391.60	*Acanthurus, Ctenochaetus, Naso*
Apogonidae	0.02	2.36	*Apogon*
Atherinidae	0.02	2.5	*Hypoatherina*
Balistidae	0.22	23.44	*Balistoides, Melichthys*
Bothidae	0.01	1.2	*Pardachirus pavoninus*
Caesionidae	4.77	508.44	*Caesio*
Chaetodontidae	0.04	4.34	*Chaetodon*
Dasyatididae	1.51	160.55	*Dasyastis*
Diodontidae	0.67	71	*Diodon*
Epipphidae	0.11	11.8	*Platax*
Fistulariidae	0.04	4.85	*Fistularia*
Gereidae	0.25	26.72	*Gerres*
Haemulidae	0.06	6.3	*Plectorhinchus*
Holocentridae	0.19	20.34	*Myripristis, Sargocentron*
Kyphosidae	0.87	93.5	*Kyphosus*

Labridae	7.28	775.82	*Cheilinus, Cheilo, Halichoeres, Stethojulis,Thalassoma*
Lethrinidae	0.76	81.1	*Lethrinus*
Lutjanidae	0.06	6.93	*Lutjanus, Aprion*
Monocanthidae	0.02	2.7	*Aluterus*
Mugilidae	0.05	5.35	*Liza/Mugil*
Mullidae	1.90	200.52	*Mulloidichthys, Parupeneus*
Muraenidae	1.22	130.05	*Gymnothorax*
Nemipteridae	0.41	43.37	*Scolopsis*
Ostraciidae	0.02	2.65	*Ostracion*
Plotosidae	0.13	14.05	*Plotosus*
Pomacentridae	1.86	207.07	*Amblyglyphidodon, Amphiprion, Chromis, others*
Scaridae	10.3	1097.27	*Scarus*
Scorpaenidae	0.13	13.60	*Synanceia*
Serranidae	0.08	9.20	*Epinephelus, Cephaloholis*
Siganidae	1.40	148.9	*Siganus*
Synodontidae	0.35	37.55	*Synodus*
Tetraodontidae	0.12	12.5	*Arothron*
Terapontidae	0.02	1.85	*Terapon*
Loligonidae (Mullusca)	2.00	212.52	*Sepia, Sepioteuthis*
Octopidae (Mullusca)	0.92	97.55	*Octopus*

Table 1. (Continued)

Yield (t/km2/yr)		4.88	
Reef associated	4.09		
Carangidae	4.13	440	*Decapterus,Carangoides, Caranx, Elagatis*
Sphyraenidae	0.13	14.05	*Sphyraena*
Total		454.05	
Yield (t/km2/yr)		0.82	
Non-reef species	51.92		
Belonidae	42.12	4478.95	*Tylosurus*
Clupeidae	2.49	261.25	*Herklotsichthys*
Elopidae	0.09	9.25	*Elops*
Engraulidae	7.60	808.85	*Stolephorus*
Exocoetidae	0.07	7.20	*Cypselurus*
Hemiramphidae	0.16	16.75	*Hemiramphus*
Scombridae	0.96	102.25	*Grammatorcynus, Ruvettus, Scomberoides, Thunnus*
Lutjanidae	0.76	80.40	*Aphareus*
Total		5764.9	
Yield (t/yr)		5.76	

Table 2. Results of Two-Factor Analysis of Variance (μ=0.05). Only significant post hoc results are presented. SW=Southwest monsoon, NE=Northeast monsoon, INT=Interim period, bel=Belonidae, eng=Engraulidae, g=gill net, h=hook and line, s=spear gun, p=fish pot, all others= all families in Fig. 2, RA=reef associated, CF=coastal fish, NR=non-reef.

Factor tested	Test (ANOVA)		Bonferonni *post hoc* (significance)
Yield/family	F	*P*	
Season	4.6055	p< 0.0105	SW >NE; p=0.00
family	47.114	p< 0.0001	bel > all other
season*family	3.3881	p< 0.0001	SWbel=NEbel >INTbel ;p =0.0046 =SWeng = all others
Catch/gear			
season	0.36948	p= 0.6911	Not significant
gear	45.502	p< 0.0001	g>h; p=0.0000, g>p; p=0.0000
season*gear	1.4262	p= 0.2007	Not significant
CPUE/fish group			
fish group	548.75	p< 0.0001	RA>NR; p=0.0026, RA>CF; p=0.0017
gear	12.294	p= 0.6698	Not significant
Fish group*gear	1.8446	p= 0.1371	Not significant

Table 3. Total annual catch, per cent contribution and overall catch per unit effort (CPUE, mean±SE) of different fishing gears used in Mantigue Island, southern Philippines in 2000. ND=no data.

Gear	% Total catch	Total catch (kg)	Annual CPUE (kg/man-h)
Gill net	76.21	8,114.91	1.1±0.04
Hook & line	9.04	962.64	1.61±0.08
Spear gun	13.08	1,392.55	1.15±0.05
Fish pot	1.67	178.34	ND
Total (sample)	100	10,648.44	

Figure 1. Map of Mantigue I., Camiguin, southern Philippines.

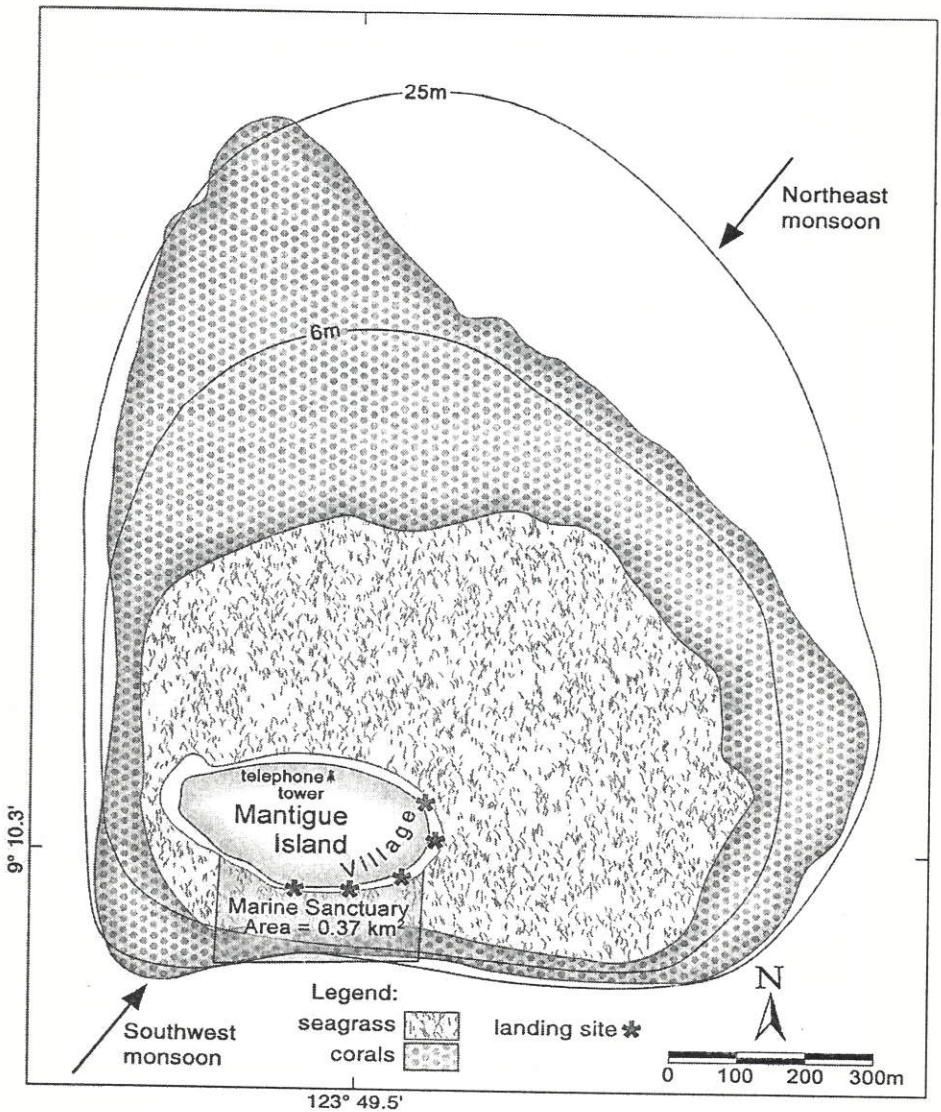


Figure 2. Seasonal patterns in the mean weekly yields (mean?SE) of major fish families comprising 86% of the total annual yield in the year 2000, from Mantigue , Camiguin, southern Philippines (NE=northeast monsoon, SW=southwest monsoon, INT=interim period).

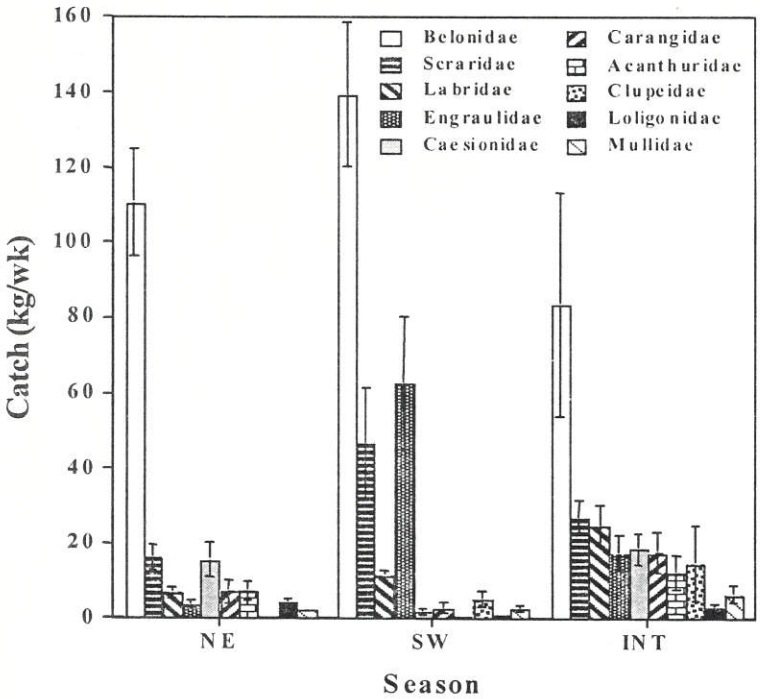


Figure 3. Seasonal patterns in gear catches per trip (mean?SE) in the year 2000 from Mantigue I., Camiguin, southern Philippines (NE=northeast monsoon, SW=southwest monsoon, INT=interim period).

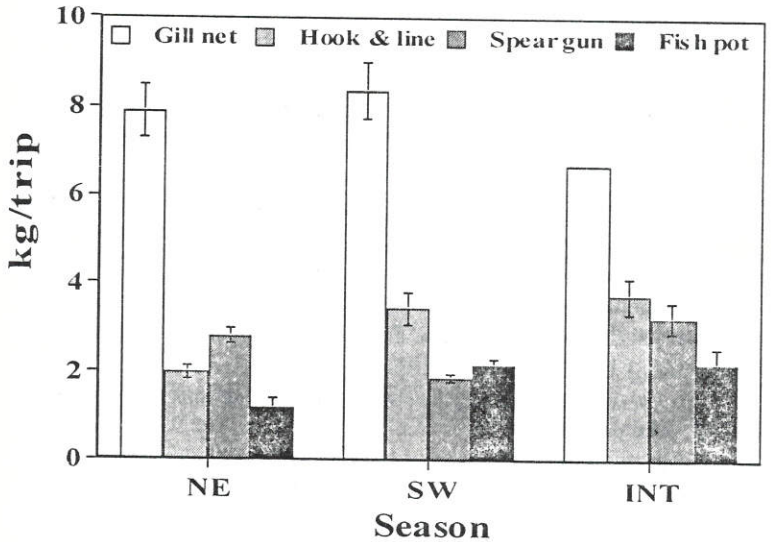
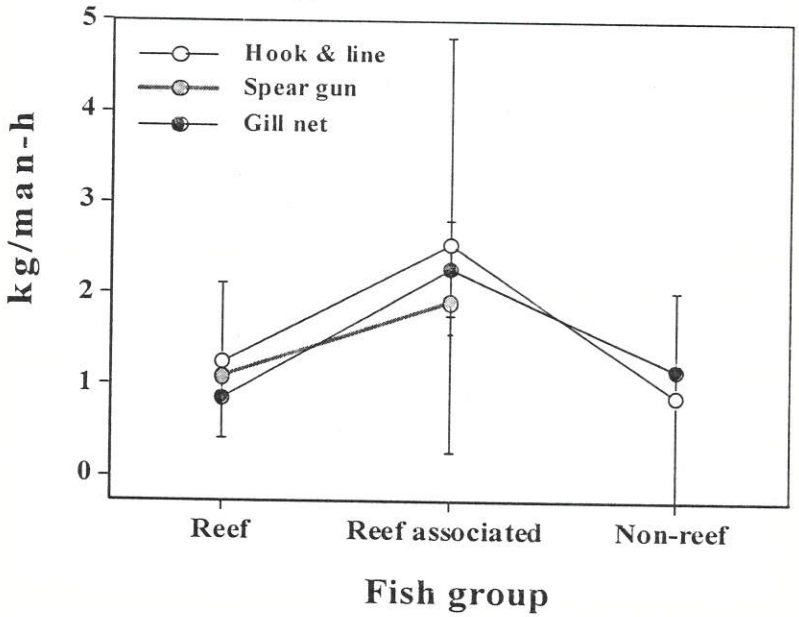


Figure 4. Trends in catch per unit efforts (mean?SE) of different fish groups caught by different geartypes in the year 2000 from Mantigue I., Camiguin, southern Philippines.



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Mery Jean C. Gadiana, is a BS Biology graduate of Silliman University. As a Graduate Fellow of the Biology Department in Silliman University, she worked as a junior researcher for the Center for Tropical Conservation Studies in 1996 and 1999. She has been involved in a number of conservation work and biodiversity research projects in West Visayas. She is currently working as the Assistant Manager of Crocolandia Foundation, Inc.

Maren Gaulke, Ph.D., is the project herpetologist of the Philippine Endemic Species Conservation Project in Panay. It was mainly through her research that the rare arboreal lizard, *Varanus mabitang*, came to be known to science only in 2001. An authority on the biology of the Philippine water monitor, she has been working as a herpetologist for the Forschungsinstitut and Naturmuseum Senckenberg in Frankfurt and at the Zoologische Staatssammlung in Munich. Her main work focuses on population status and behavioral ecology with the main aim conservation. She has conducted surveys for IUCN and for some time now has been serving as consultant for the Bundesministerium für Naturschutz und Reaktorsichereit in Bonn, Germany for reptiles and reptile leather.

Felimon Geronimo is with the Philippine Endemic Species Conservation Program in Panay Island.

Juan Carlos T. Gonzales, finished his M. Sc. in Zoology from University of the Philippines in Los Baños. His wide-ranging interests include ornithology, biodiversity, vertebrate biology, and systematics, and he has authored a number of articles ranging from birds to freshwater fishes. He is currently the Curator for birds and mammals of the Dr. Dioscoro S. Rabor Wildlife Collection in the Museum of Natural History in UPLB and at the same time teaches at the Institute of Zoology in UPLB.

Andreas Hamann earned his B.Sc. from the University of Hamburg in Germany, his M.Sc. at New York State University in Syracuse, and his Ph.D. from the University of British Columbia in Vancouver. Currently he is a research associate at the Centre for Forest Gene Conservation at the University of British Columbia. Previously, he carried out research work on clonal forestry with Westvaco Corporation in South Carolina, conservation work in the Philippines with Ruhr University Bochum, and land reclamation and reforestation with Bamburi Cement in Kenya.

Philip Godfrey C. Jakosalem is a biologist with the Protected Areas and Wildlife Division (PAWD) of the Department of Environment and Natural Resources (DENR) Region 7 and a volunteer/researcher for Cebu Biodiversity Conservation Foundation (CBCF). His experience in biodiversity conservation includes waterfowl census and conservation education in Olango Island and biodiversity research in Cebu and other islands of West Visayas.

Richard King is an accomplished field scientist who studied biology with Craig Turner at the University of Southampton (UK) before completing his masters degree in Edinburg (Scotland). He has previously worked in rainforest conservation research in Central America and Central Africa. He was Project Scientist for the Negros Rainforest Conservation Project coordinated by Coral Cay Conservation.

Stefan Luft, Ph.D., studied at the Ruhr-University in Bochum, Germany. As a co-researcher of Prof. Dr. E. Curio (PESCP), he came to the Philippines for the first time in 1997 and continued his research on animal-plant relationships in NW-Panay until late 2001. In his field work Dr. Luft enjoyed the friendship and untiring help of his Filipino field assistants Henry Urbina, Benjamin Tacud, and Felimon Gerronimo of Libertad, Antique.

Aileen P. Maypa is presently the Rapid Assessment Programme Coordinator of Project Seahorse-Haribon Foundation. In this role, she formulates methods, trains, and supervises a team of lantern fishers to gather data on seahorse populations all over the Philippines as part of a participatory coastal resource assessment on the national level. Her field of expertise is on coral reef ecology and marine reserves.

Narciso Paulino has been one of the wardens of Southern Panay Forest and since July 2002 has been part of the BIOPAT-Mabitang Project as field researcher for the Philippine Endemic Species Conservation Program in Panay. Together with Gersom Operiano and Felizardo Gernonimo, he conducts observations and takes data like elevation, food trees used by the Mabitang, and the like in three different areas of the NW Panay Peninsula and two in the northern part of the West Panay Peninsula.

Lisa Marie J. Paguntalan finished her BS and M. Sc. in Biology from Silliman University in Dumaguete City, Philippines. She was the recepient of the BP Conservation Bronze Award for Negros Threatened Avifauna Project in 2000 and again as a Co-project leader for Project Ixos in 2001. She has participated in several wildlife research studies in Negros and Cebu, most of which were in collaboration with Cebu Biodiversity Conservation Foundation Inc (CBCF). Her research interests include birds and bats. In addition she has been involved in a number of conservation education activities in the West Visayas. Currently, she works for

the conservation of Cebu's forest and endemic wildlife as a Field Project Officer of Cebu Biodiversity Conservation Foundation.

Marisol dG. Pedregosa is with Cebu Biodiversity Conservation Foundation and is a Wildlife Biologist. She has a BS Zoology and M. Sc. in Wildlife Studies degrees from the University of the Philippines in Los Baños. She has done extensive conservation work in the Philippines, particularly on the island of Cebu. She was a recipient of the Bronze award of the BP Conservation Programme grant in 2001 for her work on generating baseline information on small islands in the West Visayas.

Peter Raines is a marine biologist by training and is also the managing director and founder of Coral Cay Conservation. He has established a number of long-term community-oriented coral reef and tropical forest conservation projects in Belize, Honduras, Indonesia, Malaysia, the Philippines, and Fiji, all working closely with local partner organizations. As such, he has been working with PRRCFI throughout the Philippines for the last seven years.

Garry R. Russ is currently a Professor at the School of Marine Biology and Aquaculture, James Cook University in Townsville, Australia. An authority on fisheries and marine reserves, Dr. Russ has done long-term studies and monitoring of the Apo and Sumilon Islands fisheries. Together with Dr. Angel C. Alcala, he has been awarded a grant by the Pew Charitable Trusts for Marine Conservation.

Jens Schabacker is a specialist on the function of plant secondary metabolites in fruits, in particular the function of plant secondary metabolites on gut function in animals, while pursuing his interest in seed dispersal from a pharmaceutical point of view. After working as researcher with PESCP for his Diploma in Biology, he worked on his PhD thesis at the Institute of Pharmacy

and Molecular Biotechnology, Department of Biology at the University of Heidelberg.

Jean-Luc Solandt has a Ph.D. in coral reef ecology and has worked for various coral reef conservation research projects in Australia, Jamaica, Tanzania, and most recently in the Philippines and Fiji with Coral Cay Conservation (CCC). In his role as marine science coordinator for CCC, Jean-Luc also oversaw many recent surveys assessing the health of coral reefs in Danjugan Island.

Benjamin Tacud is a field research assistant of the Philippine Endemic Species Conservation Program in Panay Island.

Craig Turner completed his Biology degree at the University of Southampton (UK) and his masters degree in ecology at the University of Aberdeen (UK). After working in North America, Costa Rica, and Tanzania in tropical and temperate forest conservation, he has recently completed his Ph.D. on the Ecosystem Approach to Biodiversity Conservation. Currently he coordinates the terrestrial scientific activities of Coral Cay Conservation, predominantly in the Philippines.

Henry Urbina is a field research assistant of the Philippine Endemic Species Conservation Program in Panay Island in charge of the project's captive birds.