はじめに

ラテン語で「自然のために」(PRO NATURA) という意味を持つ、プロ・ナトゥーラ・ファンド（略称P. N. ファンド）助成は、1990年10月に第1期の助成を開始して以来、毎年この名にふさわしい国内外の自然保護のための研究や活動に対して助成を続け、今回第10期目の報告書を出すこととなりました。

今回の第10期助成では、有効で公正な助成事業となるよう独自の審査委員会による選考を経て、国内外20の団体に1999年10月より1年間の助成を行いました。今期までに助成したテーマは、国内・海外あわせて190件になります。

本報告書は、1999年度（第10期）の各助成先からよせられた助成成果報告をとりまとめたものです。これらの成果が、各地域における自然保護のため有効に活用されるよう願ってやみません。

2001年11月1日

財団法人日本自然保護協会　理事長　田畑貞寿

財団法人自然保護助成基金　理事長　奥富　清

目　　次

プロ・ナトゥーラ・ファンド

第10期助成

第10期助成の概要

プロ・ナトゥーラ・ファンド助成事業は、自然保護のための調査研究および保護・普及活動のための市民活動に助成する、（財）自然保護助成基金と（財）日本自然保護協会による共同事業です。

99年度（第10期）は、助成対象を国内助成の「調査研究」「保護・普及活動」、海外助成の「調査研究」の3つに区分し、1999年6月に公募を開始しました。その後7月に締切り、8月と9月に各分野の専門家による審査委員会の審査を経て助成対象を決定しました。

応募総数は48件で、次項の一覧のように国内研究助成7件、国内活動助成6件、海外研究助成7件の計20件に助成を行いました。このうち継続助成は国内調査研究の1件と海外助成の1件で、助成総額は1,792万円でした。

今期の助成では、河口堰問題で注目の集まる長良川・吉野川の環境調査や、鳥獣保護法の改正などでも注目が高まっているシカ・サルの分布調査などが対象となっています。また、近年自然保護の現場でよく話題となる干潟や谷戸田など、身近な自然環境をフィールドとして活動を続けてきた地域NGOが、より多くの人に自分たちの活動や、そこでの問題を知ってもらうためのアピールや記録化を図るなど、新たなステップへ向けた活動が多く選ばれています。海外助成では過去最多の5か国7件に助成を行い、第9期と同じく過半数が鳥類に関わる調査研究となりました。内容としてはトキの人工増殖の次の課題である野生化の案件に関する研究などが選ばれました。

なお、本報告書には第10期に助成した全ての成果を掲載するとともに、第9期助成報告書に掲載できなかった下記助成成果についてもあわせて掲載しました。

第9期助成

・テレメトリー調査による出水平野の越冬ツル類の生息場所利用

１９９９年度（第１０期）Ｐ．Ｎ．ファンド助成先一覧

No.	タイトル	グループ名	代表者	助成額（千円）
	国内研究助成			
1	下北半島に生息する北限のニホンザルの生息数および全分布域の緊急実態調査	下北野生ニホンザル研究グループ	伊沢 紘生（宮城教育大学）	１，４００
2	尾瀬に侵入したシカが湿原植物群落におよぼす影響	尾瀬のシカ調査会	五十嵐 知行（東京大学）	６７０
3	吉野川下流域における環境現況調査【継続】	吉野川環境ネットワーク	石井 愃義（徳島大学）	８２０
4	長良川河口堰によって失われた環境の仮想評価	長良川のＣＶＭを実施する会	粕谷 志郎（岐阜大学）	３８０
5	長野県における草本植物の生活史研究	長野県草本植物生活史研究プロジェクト	池田 登志男	５００
6	森林施業により劣化した森林生態系の生物多様性保全を目指した復元生態学的研究	森林生態系復元研究グループ	吉田 俊也（北海道大学）	１，２００
7	金華山島のシカの高密度化による小型化と繁殖率の低下についての研究	金華山島シカ研究グループ	高槻 成紀（東京大学総合研究博物館）	７００
			研究助成小計	５，６７０
	国内活動助成			
8	早池峰フォーラム開催	早池峰フォーラム実行委員会	多田 和広	４３０
9	利根川の水と自然を守るプロジェクト	利根川の水と自然を守る取手連絡会	近藤 欣子	４００
10	八方尾根の自然観察ガイド作成のための調査	自然観察指導員長野県連絡会	小川 朱実	５００
11	谷津干潟紹介リーフレット作成	千葉の干潟を守る会	大浜 清	７５０
12	東中国山地ツキノワグマ個体群保全を目的とした「東中国クマ集会」の成果のまとめと普及活動	東中国クマ集会実行委員会	藤本 光博	６３０
13	谷戸田に基層文化を探る	山崎の谷戸を愛する会	相川 明子	５００
			活動助成小計	３，２１０
	海外研究助成			
14	トキ野生化実験および追跡調査に関する研究	席 詠梅（せき　えいばい） 河合 明宣（放送大学）	中国陝西トキ救護飼育センター	１，１１０
15	ドイインタノン国立公園における植生帯構造の研究と研究成果の環境教育への応用	Pongsak Sahunalu（ﾎﾟﾝｻｸ・ｻﾌﾅﾙ） 神崎 護（京都大学）	カセサート大学（タイ）	２，０００
16	ネパールシワリク山地の植生の生態学的研究	Dinesh Raj Bhuju （ﾃﾞｨﾈｽ・ﾗｼﾞ・ﾌﾞｼﾞｭ） 中村 俊彦（千葉県立中央博物館）	リソース・ネパール	１，３００
17	インドネシア産鳥類及び哺乳類の遺伝子バンクの蓄積	Sri Sulandari（ｽﾘ・ｽﾗﾝﾀﾞﾘ） 東 正剛（北海道大学）	インドネシア科学院	１，６３０
18	カムチャッカ半島と日本の間の鳥類の渡り解明 ー保護のための普及啓蒙ー【継続】	Yuri Gerasimov（ﾕｰﾘ・ｹﾞﾗｼﾓﾌ） 尾崎 清明（（財）山階鳥類研究所）	カムチャッカ生態研究所（ロシア）	９００
19	ネパールの熱帯地域の昆虫相とその保護管理に関す調査研究	Keshab Shrestha（ｼｭﾚｽﾀ・ｹｼｬﾌﾞ） 中池 敏之（千葉県立中央博物館）	国立トリブバン大学（ネパール）	９００
20	スラウェシ島に生息する希少鳥類セレベスクマタカ（*Spizaetus lanceolatus*）の個体数、分布、生息状況の現状に関する調査	Wahyu Raharjaningtrah （ﾜｰﾕ・ﾗﾊﾙｼﾞｬﾆﾝﾄｩﾗ） 乾 由布子（ﾊﾞｰﾄﾞﾗｲﾌ・ｲﾝﾀｰﾅｼｮﾅﾙ）	原生自然保護協会（インドネシア）	１，２００
			海外助成小計	９，０４０
	助 成 金 総 額			１７，９２０

下北半島に生息する北限のニホンザルの生息数および全分布域の緊急実態調査

下北野生ニホンザル研究グループ
伊沢紘生・足澤貞成・森治・和田久・中山裕理・松岡史朗

Extensive survey on the distribution and population size of Shimokita monkeys

Study Group of Shimokita Monkeys
Kohsei Izawa, Sadashige Ashizawa, Osamu Mori, Hisashi Wada,
Yuri Nakayama, Shiro Matsuoka

1) 1999年12月と2000年3月に、下北半島に生息する野生ニホンザルの群れの数、総頭数、分布域の実態調査を行った。
2) その結果群れの数は20群、総頭数は約800頭、分布域は約410km^{2}であることがわかった。
3) 天然記念物に指定された1970年代初頭に比べ、わずかこの30年間に、頭数は約4倍、分布域は7倍に増えた。
4) 以上のことから、猿害対策や保護対策は、これまでの市町村という行政単位を越えて、下北半島全域の問題として緊急に取り組まれるべき課題だと結論づけられる。

はじめに

下北半島に生息するニホンザルは、1970年6月に「天然記念物」に指定された。その当時は、半島の西北域に3群約120～130頭、西南域に3群約100頭しかいなかった。しかし、その後徐々に増え、1985年前後からは分裂を繰り返し、1998年までの我々研究グループの調査結果をまとめたところ、17群732＋α頭まで増えていた。また、かつては出会う機会がきわめて少なかったサルが、今では半島の広範囲で目撃されるようになり、農作物被害も頻発し、分布域の拡大も推測された。

このような現状の中で、天然記念物「北限のサル」の保護を考えるとき、半島全域での生息数と分布域を正確に知ることは、最も緊急かつ重要な項目の1つである。本研究はそのために計画され、プロ・ナトゥーラ・ファンドより調査研究助成を得て実施された。

1．調査計画の概要

下北は12月中旬に根雪になる。木の葉が落ちて見通しがよくなり、雪上に足跡が付くので、頭数を数える助けになり、一方積雪はまだ浅いので車も十分に活用できる。

したがって、①予備調査（1999年12月20～22日）：全域を車でまわって、積雪の状態や採食痕、足跡調査をもとに、調査員のグループ分け、各グループがカバーする地域の線引きを行う。②本調査（12月23～30日）：グループごとに指定された地域の山々をくまなく踏査し、足跡、食痕の発見や群れの発見につとめて生息地域を明らかにし、足跡ないし直接観察で頭数や群れの構成をおさえる。またハナレザル、オスグループ、少数グループの発見にもつとめる。③補足調査（3月13～17日）：本調査の結果を踏まえ、不足した地域の調査を行う。

2．調査経過

本調査では、恐山以西の、薬研、下風呂、大間、佐井、脇野沢、湯ノ川をグループごとのベース・キャンプにして、生息の可能性がある地域の全体をできるだけ隈なく探した。そして、グループごとに、群れを見つけたら、その群れを追い続ける調査員と、隣接地域に他群がいないかどうかを探す調査員に分かれた。その結果、本調査期間中に、サルの生息が推定された地域の8割方がカバーできた。参加者は計87名、調査期間中に人の出入りはあったが、常時60～70名体制をとれた。また、雪は海岸沿いは全くなかったが、海岸と奥山の間のサルたちが冬期間一番良く利用する地域は数10cm程度の積雪で、調査条件は割合良好だった。

補足調査では、本調査でカバーしきれなかった半島中央部・奥薬研地域一帯で未確認群の追跡を実施した。

3．調査結果

1）群と個体数

群れの名前は後々の混乱を避けるため、従来から使われている名前を踏襲した。群れごとの個体数は、足跡のカウントないし直接観察のうち最も多いものを採用した。それをまとめたのが表1である。表1のカッコ内の数字は群れごとの個体数を示す。

表1．群れの数と個体数

A−87(20)、A_2−84(61)、A_2−85(35)、Ara−1(18＋α)、A_{ra}−2(31)、B(40＋α)、IS(23)、K_a(28)、I1(13)、I_2(38＋α)、I_3(79＋α)、K_b(28＋α)、M_1(46)、M_{2a}(66)、M_{2b}(？)、M_{2c}(44)、Y(13)、Z1(33)、Z_2(66)、？(6＋α)、？(20、のちにISと合流)、O(未確認)、U(未確認)
合計20群(708＋α頭)

2）少数グループ、ハナレザル

4頭のグループが脇野沢で観察された。また6ヶ所でハナレザルが発見されたが、重複観察の可能性を除くと、最低3頭はいたといえる。広大な調査全域でハナレザルが3頭しか見つからなかったのは、交尾期直後でかれらがまだ群れに追随していたことによるのかもしれない。

3）総頭数

表1に示したように、O群とU群は今回の調査では見つからなかった。しかし、これまで継続してきた我々研究グループの調査では、1998年までずっと観察されていて、存在するのは確かである。U群は1997年8月の時点で30＋α頭、O群は1998年8月の時点で21＋α頭だった。また、今回の調査でM2b群は十分なカウントができなかったが、1998年8月の時点で27頭数えられている。

したがって、今回カウントできた群れの個体数（表1）と少数グループ、ハナレザルの頭数に、上記したO、U、M2b群の過去の頭数を借用して加えると、下北半島全体では約800頭と推定される。

4）分布域

群れが発見された地域の外周を囲むと、合計面積は約410km²であった。その結果を、比較の意味で、1923年前後、1970年代、1980年代のデータと併せて示したのが図1である。この図から、この30年間に分布域が著しく拡大したことがわかる。また、現在の分布域は1923年前後のそれと近似しているといえる。

4．考察

以上の調査結果から、1970年以後今日までの30年間で、「北限のサル」は以下のように変化したことが分かった。すなわち、群れの数は6群から20群、個体数は220～230頭から800頭へ、分布域の広さは60km²から410km²へと著しく変化した。

短期間でのこの変化は、日本の他地域のサルと比べても際立って大きいといえる。また、現在、分派行動などを頻繁に行って分裂の徴候を示している群れも最低2群（Z2とM1群）いるし、人口密度のより高い半島の東部、大畑川や川内川流域には、今のところサルの生息は確認されていないが、かれらの生息環境として良好な地域がかなりの面積ある。したがって、群れの数や個体数の増加、分

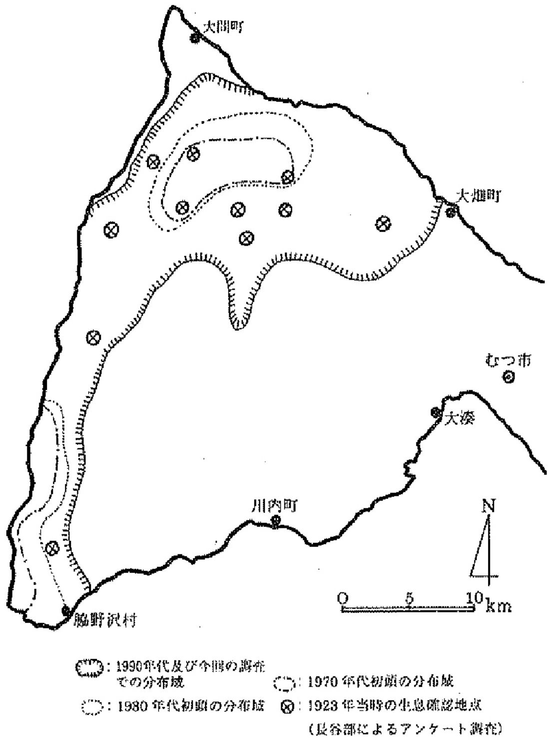


図１．下北のサルの分布の変遷

布域の拡大という傾向は今後も継続する、ないし加速化する可能性がきわめて高い。

ということは、サルによる農作物被害やその他の被害が今後さらに多発し、より深刻な社会問題へと発展していくことが予測される。それに健全に対処し、将来にわたって「北限のサル」を保護していくためには、これまでのような市町村を主たる単位とした取り組みでなく、行政区分を越えて、半島のすべての市町村と県と国とが一体となり、早急に将来への保護指針とそのための具体的対策をまとめ、下北の全住民に誠実に合意を求め、また、広く一般に公開し、NGOをはじめあらゆる方面へ支援を積極的に呼びかけるべき時が来ているといえるだろう。

Summary

1) The Shimokita monkeys were surveyed to make clear the number of groups, total population and present distribution.

2) By the survey, 20 groups with about 800 individuals were found in the area of 410 square kilometers.

3) When compared with data in 1970, population size of Shimokita monkeys increased four times and distribution area enlarged seven times.

4) It needs rapidly that the countermeasure for the conservation of Shimokita monkeys will be worked out on the whole Peninsula.

尾瀬に侵入したシカが湿原植物群落におよぼす影響

尾瀬のシカ調査会
五十嵐知行[1)]・伊藤健彦[2)]・内海有希[1)]・高田まゆら[1)]

Effects of Sika deer recently colonising into the Oze mire on the vegetation

Oze Deer Research Group
Tomoyuki Igarashi[1)], Takehiko Ito[2)], Yuki Utsumi[1)], and Mayura Takada[1)]

尾瀬の植生に対するシカの影響が懸念されている。そこで、現時点でのシカによる尾瀬の湿原への影響とシカの食性などを明らかにして、尾瀬の今後の保全の基礎資料とすることを目的とした。調査は尾瀬の長池湿原で行った。植物の葉に対するシカの採食による影響は軽微だったが、掘り起こしによる影響は強かった。長池湿原の約11.9%が掘り起こされており、掘り起こされた場所は裸地化していた。一方、シカの食性を表日光と比較すると、尾瀬では表日光よりも糞中に占めるササの割合が小さかった。尾瀬では森林にササが豊富にあるにもかかわらず、糞中のササの割合は夏の間は低く、秋に増加した。これらのことから、尾瀬ではまだシカの密度が低いにもかかわらず、掘り起こしによる影響は強く、シカは食物としても湿原植物をよく利用していることが明らかになった。今後、シカが増加すれば、湿原への影響がさらに強まることが懸念される。

はじめに

尾瀬には日本最大の山地湿原である尾瀬ヶ原およびその他の小型の湿原があり、周辺の原生林、亜高山、高山帯の高山植物を含め貴重な自然が残されている。これまでシカは尾瀬で確認されていなかったが、1995年から1997年に行われた尾瀬湿原の調査でシカの生活痕が発見された（内藤, 木村, 1998）。尾瀬では3月の平均積雪深が約2.5mにもなり（菊地, 1999）、シカは生息しないと考えられていたから、このことは驚きをもって受け止められた。シカは植生に強い影響を与えるので、尾瀬の湿原植物群落への影響が懸念されている。

これまで、尾瀬に限らずシカによる湿原植物群落への影響についてはほとんど調べられておらず、わずかにイギリスやスコットランドのヒース湿原のアカシカによる影響（Welch and Scott, 1995；Alonso and Hartley, 1998など）や青森県八甲田山域の放牧家畜による湿原植物の採食についての研究（飯泉, 日比野, 1978）などがあるにすぎない。これらの研究は有蹄類による植物の葉の採食（脱葉）による影響だが、尾瀬の湿原ではシカによる穴掘り跡が報告された（内藤ら, 1998）。本研究ではこれを「掘り起こし」と呼ぶ。掘り起こしは、シカが脚で掘り起こすものらしく、湿原の地表が田んぼを耕したようになる。脱葉であれば、通常、枝や幹が残るために、多くの植物は葉を再生し、生育しつづける。これに対して、掘り起こしの場合、植物体全体が失われる可能性が強く、ダメージが

[1)] 東京大学大学院農学生命科学研究科（Graduate School of Agriculture and Life Science, The University of Tokyo）
[2)] 東北大学大学院理学研究科（Biological Institute, Graduate School of Science, Tohoku University）

大きい。また、掘り起こしの直接的な対象となった植物だけでなく、周辺に生育する他の植物へも影響がおよぶ可能性がある。そこで、湿原植物に対するシカの採食による影響だけでなく、掘り起こしによる影響も調査した。

ところで、尾瀬は日光を分布中心とするシカ個体群（日光・利根地域個体群）の分布の北の周辺部に相当し、この個体群のシカが最近侵入した可能性が高い。分布の中心部のシカについては季節移動（Maruyama *et al.,* 1976, 本間, 1995）、食性（Takatsuki, 1983）などが知られているが、分布の前線の尾瀬のシカについては情報がない。

尾瀬全体の植生は森林が卓越しており、森林内にはチマキザサ、チシマザサが大量に生育している。日光・利根地域個体群の分布の中心部である表日光地方のシカはミヤコザサを主食としていることが知られている（Takatsuki, 1983）。もし、尾瀬のシカが表日光のシカと同じようにササを主食としており湿原植物を採食していなければ、湿原への影響はさほど問題とはならない。しかし、湿原植物を高い割合で採食していれば、シカによる湿原植物への影響を見すごすことはできないことになる。このような視点から、湿原と森林を利用するシカの食性を明らかにした。

また、森林と湿原は生育する植物の種類、地形、水条件などで大きく異なる環境である。湿原がシカにとってどのような環境であるかは今まで調べられていない。そこで、シカにとっての餌場としての湿原の特徴を明らかにするために、湿原と森林での植物の種組成を比較し、栄養価の指標として主要種の窒素含有率を分析した。

2000年現在は、尾瀬にシカが侵入したことが確認されてから5年ほど経った状況である。近年の全国各地のシカの個体数変化から推測すると、尾瀬のシカは今後さらに増加する可能性がある。その意味で、現時点でのシカによる湿原への影響、シカの食性、シカにとっての湿原の価値といったシカに関する情報を集め、尾瀬の今後の保全の基礎資料とすることを本研究の目的とした。

調査地

主な調査は尾瀬の特別保護地域の東側の長池湿原周辺で行い、シカの糞の採取は表日光のモッコ平周辺でも行った。長池湿原は標高約1540mに位置する小型の湿原である。湿原の中心部は高層あるいは中層湿原になっており、ヌマガヤが優占している。湿原の縁辺部は低層湿原で、ヨシが優占している。ヨシ群落の周りに、レンゲツツジ、ヤマドリゼンマイ、オオカサスゲ、高茎草本などが見られる。湿原周辺にはツガ属、モミ属からなる針葉樹林があり、林床には主にササが優占している。

方　法

1. シカによる湿原植物への影響

(1) 採食による影響

1999年9月に長池湿原の湿原内に5m×5mの方形区5個を設置して、その内側で主要な植物の種、約80株につき、食痕の有無と程度を2000年7月、8月、9月に記録した。食痕の程度は株ごとに、食痕がない場合には「なし」、少しだけ食べられている場合には「軽度」、ほとんど食べられている場合を「重度」、その中間を「中度」とした。

(2) 掘り起こしによる影響

1999年10月と2000年6月、7月、8月、9月に長池湿原内の掘り起こしの面積を計測した。面積は掘り起こしの最大長と最大幅を計測して算出した。長池湿原全体の面積は1999年10月にGPS機器（GeoExplore II, Trimble社）を用いて計測した。

2. シカの食性

長池湿原（以後「尾瀬湿原内」とする）では1999年9月、10月、11月および2000年6月、7月に、周辺の林内（以後「尾瀬林内」）では2000年7月に、表日光のモッコ平周辺では1999年8月に新鮮なシカの糞、5糞塊を採取した。

糞分析はStewart（1967）の方法に従った。採取した糞は、冷凍庫に約－20℃で保存した。分析前に、0.5mmメッシュのふるいを使って水洗し、植物片を1mm間隔の格子が彫られたスライドグラス

に載せ顕微鏡で観察し、交点に重なった植物片を同定し、カウントした。植物片はササの葉、ササ以外のグラミノイドの葉、グラミノイドの稈、その他の単子葉植物の葉、双子葉植物の葉、樹皮、その他に分類した。ササの葉かその他のグラミノイドの葉かを判別できなかったものは、「グラミノイド葉不明」とした。交点に重なった植物片1つを1ポイントとして、1サンプルにつき300ポイント（表日光では200ポイント）になるまで続けた。

3. シカの餌場としての群落の特徴

2000年7月に長池湿原内に設置した5個の方形区のそれぞれの四隅に1m×1mの方形区を、また、長池湿原周辺の森林内で約10m間隔で1m×1mの方形区を20個設置した。各方形区内で見られた種を同定して、各種の被度と平均高を記録した。また、湿原内と林内の主な植物の葉を採取して、70℃で48時間乾燥した。その後、乳鉢を使って植物片を粉砕して、1mmメッシュのふるいを使ってふるいにかけた。ふるいをかけた後のサンプルをCNコーダー（MT700, ヤナコ社）で分析して、窒素含有率を計測した。

結　果

1. シカによる湿原植物への影響

(1) 採食による影響

調査した主要種のうち7月のヨシを除く全ての種と月で「なし」が50%以上を占めた（表1）。ほとんどの種と月で、「なし」の次に割合が高い食痕の程度は「軽度」だった（表1）。また、7月のヨシは「軽度」が66.2%だった（表1）。ただし、7月のキンコウカでは「重度」がやや多く、11.6%であり、7月のリュウキンカは「中度」が14.6%であった（表1）。

(2) 掘り起こしによる影響

長池湿原の総面積は22,570.5m²であり、1999年10月時点での掘り起こしの面積は927.4m²（4.1%）だった。また、掘り起こしに水がたまったような沼地も観察され、その面積は1,240.8m²(5.5%)だった。掘り起こしの面積は2000年6月にはさらに拡大して1,447.7m²(6.4%)となった(表2)。その後8月、9月に狭くなり、最終的に656.1m²（2.9%）となった（表2）。掘り起こされた場所では、ほとんど植物が生育しておらず、裸地化していた（写真1）。

2. シカの食性

尾瀬と表日光におけるシカの糞中の植物片の組成を図1に示した。後述するように、ササは森林内でのみ見られ、ササ以外のグラミノイドは森林内と比べて、湿原内で多いので、特にササを森林利用の指標、グラミノイドの葉を湿原利用の指標として注目した。尾瀬湿原内、尾瀬林内、表日光で

表1. 長池湿原での主要種の採食の程度（%）

		n	なし	軽度	中度	重度
オオカサスゲ	7月	93	73.1	23.7	3.2	0.0
	8月	80	85.0	15.0	0.0	0.0
	9月	80	91.3	8.8	0.0	0.0
リュウキンカ	7月	103	57.3	28.2	14.6	0.0
	8月	90	80.0	18.9	1.1	0.0
	9月	80	76.3	23.8	0.0	0.0
ヨシ	7月	77	33.8	66.2	0.0	0.0
	8月	80	98.8	1.3	0.0	0.0
	9月	90	100.0	0.0	0.0	0.0
ヌマガヤ	7月	115	92.2	7.8	0.0	0.0
	8月	80	87.5	12.5	0.0	0.0
	9月	80	87.5	12.5	0.0	0.0
キンコウカ	7月	112	78.6	7.1	2.7	11.6
	8月	80	95.0	5.0	0.0	0.0
	9月	80	100.0	0.0	0.0	0.0
ミズバショウ	7月	112	91.1	8.9	0.0	0.0
	8月	80	93.8	1.3	0.0	0.0

*ミズバショウは9月に枯死していたので、計測しなかった

表2. 長池湿原における掘り起こしの面積と割合

	6月		7月		8月		9月	
	面積(m²)	(%)	面積(m²)	(%)	面積(m²)	(%)	面積(m²)	(%)
再度掘り起こし	1447.7	(6.7)	1324.8	(5.9)	637.8	(2.8)	641.0	(2.8)
新規掘り起こし	0.0	(0.0)	0.0	(0.0)	34.8	(0.2)	15.1	(0.1)
合計	1447.7	(6.7)	1324.8	(5.9)	672.6	(3.0)	656.1	(2.9)

*再度掘り起こしは、1999年10月に存在が確認されて、2000年にも掘り起こされた掘り起こし.新規掘り起こしは、1999年には存在が確認されず、2000年に新しく掘り起こされた掘り起こし.

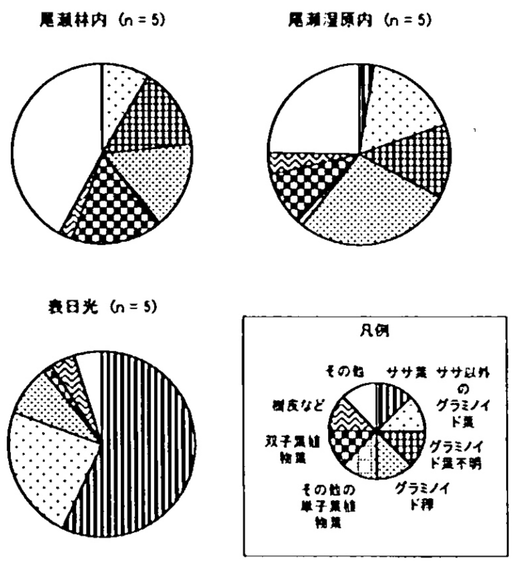


図1. 夏のシカ糞中の植物片の組成

の夏のシカの糞組成の比較ではササの割合に有意な違いが認められ（一元配置の分散分析：p＝0.0002, 図2)、表日光（56.9%）が長池湿原周辺の林内（0.1%）と長池湿原（2.7%）よりも、有意に高かった（Bonferroni法：表日光と尾瀬湿原内、p＝0.0006、表日光と尾瀬林内、p＝0.0001)。ただし、ササ以外のグラミノイドの葉の割合には有意な違いが認められなかった（p＝0.6818, 図2)。

湿原内での糞組成は季節的に変化した。ササの割合は10月に最も高く（26.0%）、季節的に有意な違いが認められた（一元配置の分散分析：p＝0.0049、図3)。ササ以外のグラミノイドの葉の割合も季節的に変化し（p＝0.0089）、7月が最大（17.0%）であった（図3)。

3. シカの餌場としての湿原の特色

森林内ではチシマザサが優占していたほか(71.1%)、木本種が多く（24.1%)、グラミノイドは少なかった(0.01%)。これに対して湿原では、グラミノイドの優占度が大きく（75.8%)、双子葉草本がこれに次いだ（13.6%)。このように、森林と湿原は対照的で、森林はササ、湿原はグラミノイドで特徴づけられた。

シカが湿原で採食するのは、湿原の植物の窒素含有率が高いからではないかと予測したが、湿原の主要な種であるヌマガヤやオオカサスゲの窒素含有率はそれぞれ1.7%、1.5%で、林内の植物の3%前後よりもやや低かった（表3)。ただし、ヨシの窒素含有率は3.1%でそれほど低くなかった。こ

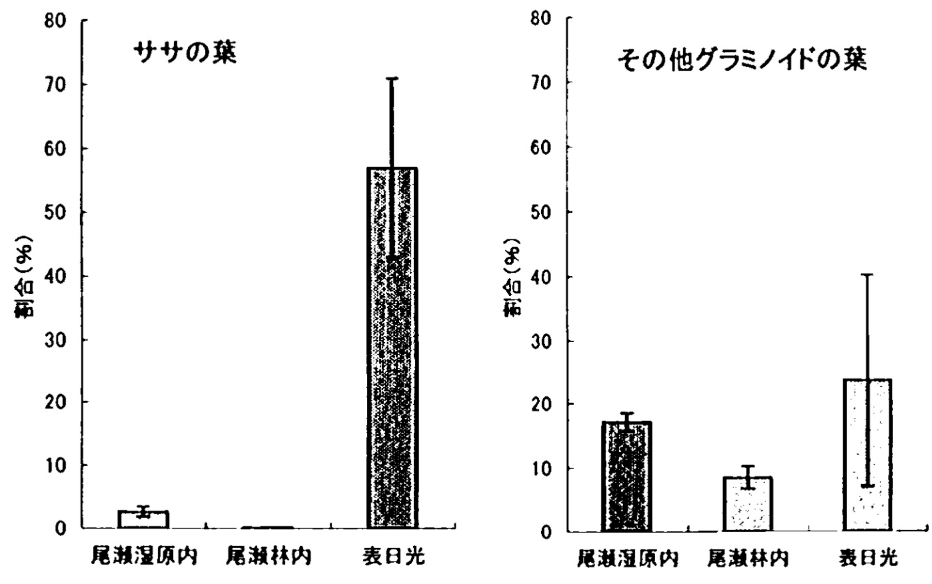


図2. 夏のシカの糞中のササとその他のグラミノイドの葉の割合。誤差棒は標準誤差。

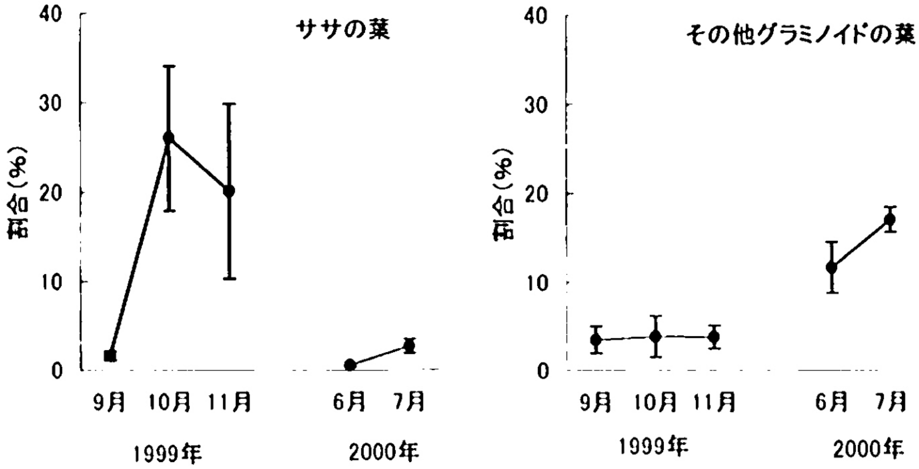


図3. シカの糞中のササとグラミノイドの葉の割合の季節変化。誤差棒は標準誤差。

表3. 主要植物の葉とミツガシワの地下部の窒素含有率

		n	平均(%)	SE
林内	チシマザサ	5	2.5	0.2
	ミズキ	5	3.9	0.6
	モミジイチゴ	5	3.1	0.3
	フジ	5	3.1	0.8
湿原	ヨシ	5	3.1	0.2
	ヌマガヤ	5	1.7	0.3
	オオカサスゲ	5	1.5	0.1
	ミズバショウ	2	3.2	0.9
	キンコウカ	5	2.9	0.8
	ミツガシワ地下部	2	6.6	1.4

れに対して、ミツガシワの地下茎の窒素含有率は6.6%と高かった（表3）。

考　察

尾瀬の湿原がシカによって影響を受けていることを初めて報告したのは内藤・木村（1998）である。これによると1995年から1997年にかけての調査でミツガシワなど15種の湿原植物にシカの食痕が認められ、掘り起こしによってミツガシワ、ヒメシロネ、ヤチスゲなどが影響を受けているとのことであった。今回の湿原における調査はシカによる湿原群落の影響だけでなく、シカの食性と採食場所としての湿原の評価なども含めた検討を行ったものである。

通常、有蹄類による群落への影響は脱葉によるものが主たるものであるが（Crawley, 1983）、今回の調査ではほとんどの植物はまったく採食を受けていないか、あっても軽度の採食を受けている程度であった。しかし、掘り起こしによる影響は非常に強いもので、完全に掘り起こされた場所では植物がまったくみられなかった。

掘り起こしが起きるのは主に春から初夏までで、以前の掘り起こしを再度掘り起こす場合が多かったが、新たな場所での掘り起こしもわずかではあるが見られた（表2）。シカが何の目的で掘り起こしをするのかは明らかでないが、少なくとも目的の一つはミツガシワの地下茎を食べるためと思われる。掘り起こされた場所はヌマガヤなどが優占する高層あるいは中層湿原ではなく、地表水のある窪地や水路沿いであることが多かった。ミツガシワはこのような場所によく見られる。ミツガシワの掘り起こしは尾瀬ヶ原の水田代、下田代などでも確認されており（内藤・木村, 1998）、大江湿原でもミツガシワが生育する場所が掘り起こされていた。今回の分析ではミツガシワの地下茎は窒素含有率が非常に高いことが示され、栄養価が高い可能性が示唆された。ただし他の植物に関しては同様の分析をしていないので、これが理由でミツガシワの地下茎が食べられているかどうかは今後の研究が必要である。

今回調査した長池湿原においては、掘り起こしと掘り起こし跡とみられる沼地を合計すると総面積は約11.9%ほどであったが、この値は湿原のタイプによって大きく違うはずである。もしミツガシワの生育に適した、地表水の多い湿原であれば掘り起こされる面積は大きくなると予想される。逆に、そのような場所が少なく、ヌマガヤが卓越するような湿原では掘り起こしはあまり見られないかもしれない。

尾瀬のシカの越冬地については現在調査の準備が進められているが、分布の状態からして日光を中心とした日光・利根地域個体群と呼ばれる集団の北端のものである可能性が大きい。分布の中心である表日光ではミヤコザサが主食であるといわれ（Takatsuki, 1983）、今回の分析でも8月の糞中でミヤコザサは56.9%を占めていた。しかし、少なくとも春から初秋（9月）の間は長池湿原周辺で生活するシカの食物中では、ササの割合は少なく、植物が枯れる時期（10月）になると、ササの割合が増加した。ササ以外のグラミノイドの葉が7月には多かったことからも、長池周辺にすむシカは少なくとも初夏（7月）には湿原植物に依存的であることが示唆された。このことから、湿原植物は、ササよりもシカの食物として何らかの優れた点があることが予想される。しかしながら、湿原の優占種であるヌマガヤやオオカサスゲなどの窒素含有率は1.5%程度であり、林内の主要種の2.5-3.9%と比べると低い値であった（表5）。今回の調査では明らかにすることはできなかったが、今後、尾瀬のシカがなぜ森林よりも湿原の植物をよく利用するのかを明らかにすることが重要である。

今回の調査によって、これまで明らかにされていなかったシカによる湿原への影響が明らかにされ、まだシカの密度が低いと考えられるにもかかわらず掘り起こしによる影響は強いこと、また、シカは夏に食物としても湿原植物をよく利用していることが明らかになった。今後シカが増加すれば湿原への影響がさらに強いものとなることが懸念される。2000年現在環境庁を中心にシカの移動や湿原への影響について調査が開始されたばかりであり、シカと湿原への影響に対する対策についても、さまざまな意見がある。今後さらなる取り組みが行われる必要があるが、本研究が2000年時点での実態記述として今後の調査に役立つ情報になることを期待したい。

謝　辞

本研究および本研究に関連した調査を遂行するにあたり下記の方々および機関に御助言、御協力戴き深謝いたします。東京大学高槻成紀助教授、宇都宮大学小金澤正昭教授、東京大学生物多様性科学研究室の皆様、宇都宮大学野生鳥獣管理学研究室の皆様、群馬県環境生活部戸塚正幸氏ら、尾瀬沼ビジターセンター関係者の方々、プロナトゥーラ・ファンド関係者の方々、七入実川荘。

引用文献

Alonso, I. and S. E. Hartley. 1998. Effects of nutrient supply, light availability and herbivory on the growth of heather and three competing grass species. Plant Ecology, 137：203－212.

Crawley, M. J. 1983. Herbivory, the Dynamics of Plant－Animal Interactions. Blackwell Scientific Publication, Oxford.

本間和敬．1995．奥日光・足尾地域におけるニホンジカ（*Cervus nippon*）の移動様式とハビタット利用選択の解析．上越教育大学修士論文．

飯泉茂・日比野紘一郎．1978．放牧家畜による湿原植物の採食について．吉岡邦二博士追悼植物生態論集：527－532.

菊地慶四郎．1999．尾瀬の気候解析－気温、降水量、積雪深について．尾瀬の自然保護、22：8－24.

Maruyama, N. 1981. A study of the seasonal movements and aggregation patterns of sika deer. Bulletin of the Faculty of Agriculture, Tokyo University of Agriculture and Technology 23：1－85.（in Japanese with English summary）

内藤俊彦・木村吉幸．1998．尾瀬のニホンジカ．尾瀬の総合研究（尾瀬総合学術調査団編），pp.

725 - 739.

Stewart, D. R. M. 1967. Analysis of plant epidermis in faeces: a technique for studying the food preferences of grazing herbivores. Journal of Applied Ecology, 4: 83−111.

Takatsuki, S. 1983. The importance of *Sasa nipponica* as a forage for Sika deer (*Cervus nippon*) in Omote−Nikko. Japanese Journal of Ecology, 33: 17−25.

Welch, D. and D.Scott. 1995. Studies in the grazing of heather moorland in northwest Scotland, VI. 20-year trends in botanical composition. Journal of Applied Ecology, 32: 596−611.

Summary

We described the effects of sika deer on a mire vegetation of Oze which is thought to be recently colonized by the deer, as well as deer food habits, to provide the information for the conservation of the mire in Oze. The study was carried out at the Nagaike mire, a small mire in Oze. The effects of defoliation by the deer was slight. However, 「digging」 by the deer severely affected the mire. There was no vegetation on the dug area, which occupied about 11.9 % of the Nagaike mire. The proportion of dwarf bamboo found in early summer faeces collected on the mire was smaller than those collected in the Nikko area, although it was abundant in the forest. The proportion of dwarf bamboo increased in October. It was suggested that the deer preferably ate the mire plants in early summer. Since the mires are considerably damaged even at the present low deer density by "digging", caution should be paid on the damages caused by "digging" as well as defoliation in relation to the possible future increase of the deer population.

付記　2001年6月に自動撮影カメラにより「掘り起こし」をするシカの姿が長池で撮影された（写真2）。

写真1. 長池の「掘り起こし」の様子（1999年7月11日）

写真2. 湿原で「掘り起こし」をするシカ（2001年6月3日　22時4分）

吉野川下流域における環境現況調査

吉野川環境ネットワーク
石井愃義[1)]・鎌田磨人[2)]・村上哲生[3)]・黒田伸郎[4)]・徳永英樹[5)]・
寺井久慈[6)]・小寺浩二[7)]・井口利枝子[8)]・森本康滋[9)]

Research of the present environmental condition in the downstream area of the Yoshino River

Yoshinogawa-river eco-network
Hiroyoshi Ishii [1)] , Mahito Kamada [2)] , Tetuo Murakami [3)] , Nobuo Kuroda [4)] , Hideki Tokunaga [5)] ,
Hisayoshi Terai [6)] , Koji Kodera [7)] , Rieko Iguchi [8)] , Koji Morimoto [9)]

吉野川の河口より約14.2～14.8kmにある斜め堰、第十堰より下流の汽水域を中心に、環境要因の調査を行った。

第十堰湛水池で、1999年7月に、堰湛水池への流入地点で堰直上よりもやや高いクロロフィルa濃度が観測された。今切川河口堰、旧吉野川河口堰におけるクロロフィルa濃度は、常に他の地点よりも高く、その浮遊性藻類発生量は、底泥に蓄積された燐の量によって規定されていると推測される。また第十堰下流でのクロロフィルa増加は、海側で発生した浮遊性藻類に由来すると考えられる。

河口からの様々な距離の、渡り鳥の飛来が多い4干潟でマクロベントスの種類、現存量などの調査を行ったところ、干潟により、またその中の流れ、底質により、分布、生息の差が見られた。

州に成立している植物群落で多いのは、河口から上流に、ヨシ群落、アイアシ群落、オギ群落とセイタカアワダチソウ群落で、イセウキヤガラ群落、ヨシ群落、アイアシ群落、オギ群落、セイタカアワダチソウ群落の順に、水面から高い所に分布する。総面積ではヨシ群落、オギ群落、セイタカアワダチソウ群落の順であった。1966年以後、年々州の面積は減少、植被面積は増加し、州面積と植被面積との間に正の相関が強くなっている。

Ⅰ．はじめに

吉野川の河口より約14.2～14.8kmにある斜め堰、第十堰より下流には干潟が広がり、汽水域に生息する多くの生物が見られる。この中には貴重な種が含まれているだけでなく、この地域は漁業の上でも重要な生産の場となっている。この汽水域最上端の固定堰である第十堰を、1km程下流に移し、可動堰化しようという動きが起こった。もし可動堰化が行われたなら、その影響はどのようなものであろうか。それを正確に予測するには、現況が正確に分かっていなくてはならない。また吉野川下流域には、第十堰可動化以外にも、農地防

1) 徳島大学総合科学部
2) 徳島大学工学部
3) 名古屋女子大学家政学部
4) 愛知県水産試験場
5) 徳島市庄町五丁目81
6) 名古屋大学大気水圏科学研究所
7) 法政大学文学部
8) 徳島市南昭和町四丁目703
9) 徳島市北佐古1番町1

災事業による大量取水、2本の道路橋架橋、が計画されており、これらが環境に及ぼす影響も考えねばならない。しかし吉野川下流域の自然環境については、過去にはごく僅かな調査しか行われておらず、この地域の自然環境がどのようなものであるのか、十分に理解出来るところまでは行っていなかった。そこで様々な面から、環境要因の調査を行うことを企図し、水質、底質、地下水、植生、植物相、動物相、生物生産量、等を調べることとした。

Ⅱ．方法

水質については、塩分濃度、水温、全窒素濃度、全燐酸濃度、クロロフィルａ量を、第十堰上流の阿波中央橋、六条大橋、第十堰直上、第十堰下流の名田橋、吉野川から流出する支流の今切川河口堰、旧吉野川河口堰、の6地点に調査地点を定め、月に1回の測定を続けた。

底質については、干潟の微地形ごとに調査地点を設け、アクリルパイプによって深さ20cmのコア・サンプルを採取し、粒度分布を調べた。

地下水については、第十堰周辺の浅層地下水の継続観測、約60個所の観測井戸における定期観測、4観測井戸における自記観測、および周辺地域での聞き取り調査、を行った。

植生については、空中写真で河口から第十堰までの河川敷の植生を区分し、代表的な部分で植生調査を行うと共に、植生図を作成することとした。また、過去における植生の存否を空中写真から読み取り、建設省の河床測量結果と合わせて、地形変動と植生変動の関係について考察した。

植物相については、調査区域内を歩き回り、視認出来た植物を記録した。

動物相については、魚類以外の脊椎動物に関しては視認により、魚類は漁業組合員による漁網、釣りによる捕獲、および漁業者からの聞き取りによって確認できた種を記録した。また底生動物については、干潟を主として、微地形に応じた各調査地点において、主に底質干出時にその底質をスコップで掘り上げ、ふるいに掛けて残った動物を同定、記録した。

生物生産量については、主要干潟において底質を採取し、明暗条件下に置いて現地で保温後、溶存酸素濃度の変化から底泥付着藻類の純生産量を求めた。

Ⅲ．結果

多くの調査が現在続行中であり、まだ結果がまとめられる、あるいは他と比較検討できる状況には至っていないが、比較的まとまりのある部分について報告することとする。

1．クロロフィルａ量の変動

前記のように、第十堰上流の阿波中央橋、六条大橋、第十堰直上、第十堰下流の名田橋、吉野川から流出する支流の今切川河口堰、旧吉野川河口堰、の6地点と、2000年4月からは六条大橋上流の西覚円を加えた7地点に調査地点を定め、月に1回の測定を続けた。なお助成を受ける以前にも同じ調査を続けていたが、本報告では、その結果の一部も含めて示すこととする。

今切川河口堰、旧吉野川河口堰におけるクロロフィルａ濃度は、常に他の地点よりも高く、2000年7月にも今切川で42.7μg／l、旧吉野川で35.2μg／lと高い値を示した（図1）。1999年は、それ以前や2000年に比べ、最高値は低かったものの、20μg／l前後のやや高い濃度が、5月から8月まで継続的に観測された。

この傾向は、本流の第十堰湛水池にも表れ、1999年5月から7月まで10μg／l前後のやや高い値が継続して観測された（図2）。また7月には、六条大橋で第十堰直上よりもやや高い値が観測された。六条大橋は第十堰湛水池への流入地点であるが、堰直上よりも湛水池への流入地点で浮遊性藻類が多く発生する例は、長良川河口堰でも観測されており、この期間には六条大橋地点で流速がかなり遅くなっていたことが推測されるが、1999年は夏期の雨量が少なく、吉野川本流、分流とも、流量が少ない状態が続いていたためと考えられる。

2000年は梅雨期に比較的雨量が多く、また9月

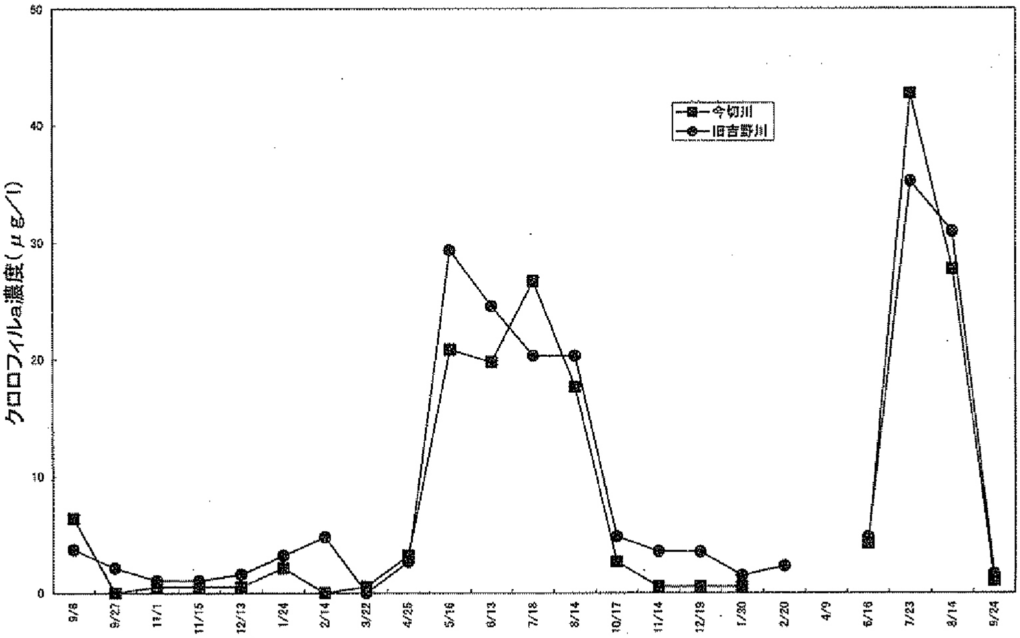


図1　今切川河口堰・旧吉野川河口堰における観測結果（1998～2000年）

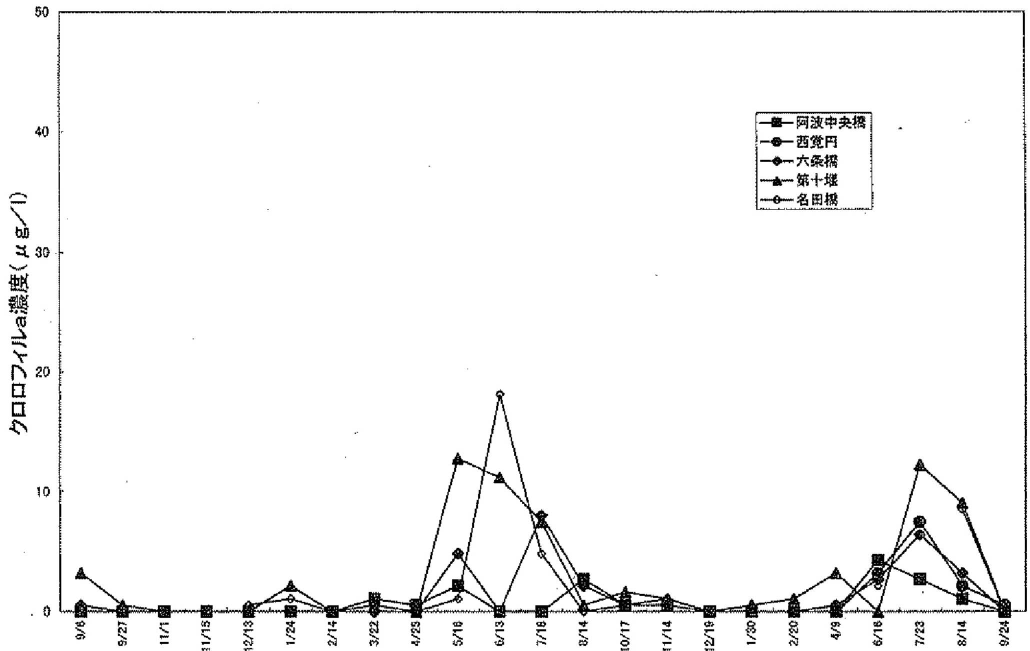


図2　吉野川各地点における観測結果（1998～2000年）

にもまとまった降雨があったことから、クロロフィルａ濃度の高い期間は短かったが、今切川河口堰、旧吉野川河口堰での最高値は、1999年より高かった。このことは、これら河口堰湛水池では、流量の違いによって年毎に浮遊性藻類の発生期間や発生ピーク量は異なるものの、年間を通しての総発生量には大きな変動が無いことを示唆している。以前我々の行った1997年までの調査で、この２地点の浮遊性藻類発生量は、底泥に蓄積された燐の量によって規定されているのではないか、と推測したが、今回の結果もこれを裏付けるものと考えられる。

第十堰下流の名田橋地点は、今回新たに調査したが、第十堰湛水池より高い値は３回観測されただけであった。したがって、第十堰湛水池で増殖した浮遊性藻類は、堰下流で希釈等により、密度が減少するものと考えられる。第十堰湛水池よりも高い値を示した2000年６月には、本流では、上流から下流に向かってクロロフィルａ濃度が減少し、第十堰では０になっていた。また今切川河口堰、旧吉野川河口堰でもそれほど高い値は出ていなかった。これらのことから、この時は流量の低下は起こっておらず、浮遊性藻類の発生がほとんど起こっておらず、本流でのクロロフィルａは、上流から剥がれて流されて来た付着性藻類に由来することが推測される。したがって名田橋で見られたクロロフィルａの増加は、河川に由来するものではなく、海側で発生した別の浮遊性藻類に由来するものと考えられる。

このように、クロロフィル量から見ただけでも、現第十堰によっても、それより上流と下流とでは環境が分断されていることは否めない。

西覚円での観測例は僅かであるが、六条大橋とほぼ同様の値を示していることから、この地点も第十堰湛水域に含まれていると考えられる。

２．干潟におけるマクロベントスの分布特性

調査対象としたのは、河口から約５km（干潟Ⅰとする)、約７km（干潟Ⅱ)、約10km（干潟Ⅲ)、約14km（干潟Ⅳ）の４個所の干潟（図３）で、いずれも渡り鳥の飛来が多い場所を選定した。

まず各干潟の表面を目視、及び踏査することにより、その表面の底質をシルト、砂、礫、粗礫に区分し、25m×25mのメッシュに分けた地図に記した。次に各干潟で、潮位60cmの際の水際で、各種底質に相当する地点に、各干潟７～８点の調査点を設定した。また各干潟ではワンド部と、流れに面した部分に調査点が配置されるように努めた。各調査点で、各辺25cmの立方体となるよう掘り

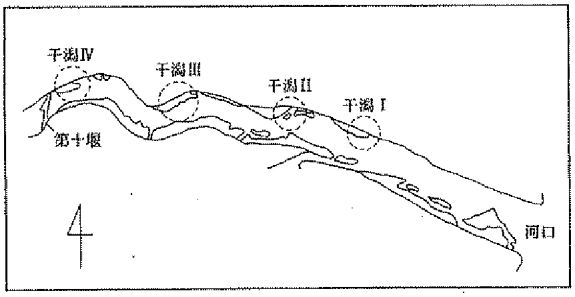


図３　マイクロベントス調査干潟

取った底質を、１mmメッシュのふるいにかけ、残留物を80％エタノールで固定して持ち帰って、マクロベントスの検査に用いた。固定したものは、水洗後取り出したマクロベントスをさらに80％エタノールで固定し、保存した。

また、調査点隣接の各辺25cmの立方体より成る底質から、ランダムに底質を採取し、酸揮発性硫化物（ＡＶＳ）濃度（嫌気化の指標として)、粒度組成の測定に用いた。ＡＶＳ濃度は、底質のシルト含有率が高い程高いことが示されたが、マクロベントスの分布に影響を与える程ではなかった。さらに、調査地点の間隙水の塩分濃度、および各干潟の横の河川（ワンドを含む）表層水塩分濃度を測定すると、流路沿いではワンド部と同じかそれよりも高かった。また間隙水は、流れ沿いの調査地では河川水と同じかそれよりも高く、ワンド部では共にばらつきが大きいが、河川水の方が間隙水よりも高い地点もあった。

マクロベントスの種類数が最も多かったのは最下流の干潟Ⅰの17種類で、上流に移れば移るほど

種類数が減少する傾向が見られた（図４）。中でも甲殻類、ゴカイ類にその傾向が見られた。

各調査地点のマクロベントス分布状況は、ワンドと流路沿い、流路沿いの中では底質がシルト、砂の部分で、違いが見られた。

各調査区当たりの湿重量による現存量を見ると、河口から約10kmの干潟において、またそのシルト環境において、多い傾向が見られた。また種によって好む底質、塩分濃度には差が見られ、たとえばヤマトオサガニは、現存量も１個体当たりの湿重量も、塩分濃度の低いシルト環境で大きいことが分かった。

各干潟で得られた底質別単位調査区当たりのマクロベントス現存量に底質メッシュ数を乗じて、各干潟全体のマクロベントスの現存量を推定すると、干潟Ⅱの現存量が高いが、分類群毎に示すと、干潟Ⅲで多いものもあることが分かった。また底質が変わるようなことがあれば、生物種間によって現存量増減が異なることも予測された。

３．植物群落の成立と立地環境の変化

調査区域内の州の上に成立している植物群落は、河口域では全域にヨシ群落が見られ、河口から２～３kmの州でも大部分がヨシ群落であった。３～８kmにかけてはアイアシ群落が多く、６～14kmにかけてはオギ群落とセイタカアワダチソウ群落が多かった。中でもオギ群落は、河口より12km、セイタカアワダチソウ群落は13.9km地点にある州に最も多く分布していた。このほかにヨモギ群落、ノイバラ群落、セイバンモロコシ群落等が広く存在していた。総面積で見ると、ヨシ群落が最も多く、オギ群落、セイタカアワダチソウ群落がこれに次ぎ、その下にアイアシ群落と裸地が同程度に見られた。

ヨシ群落は州の水際、平均潮面（0.8m）の上０～２m、特に０～0.75mに分布し、そこより上の０～2.5m、特に0.75～1.25mにアイアシ群落、さらに上の0.25～3.75mおよび4.25～５m、特に1.25～1.5mにオギ群落、0.5～4.75m、特に1.5～2.25mにセ

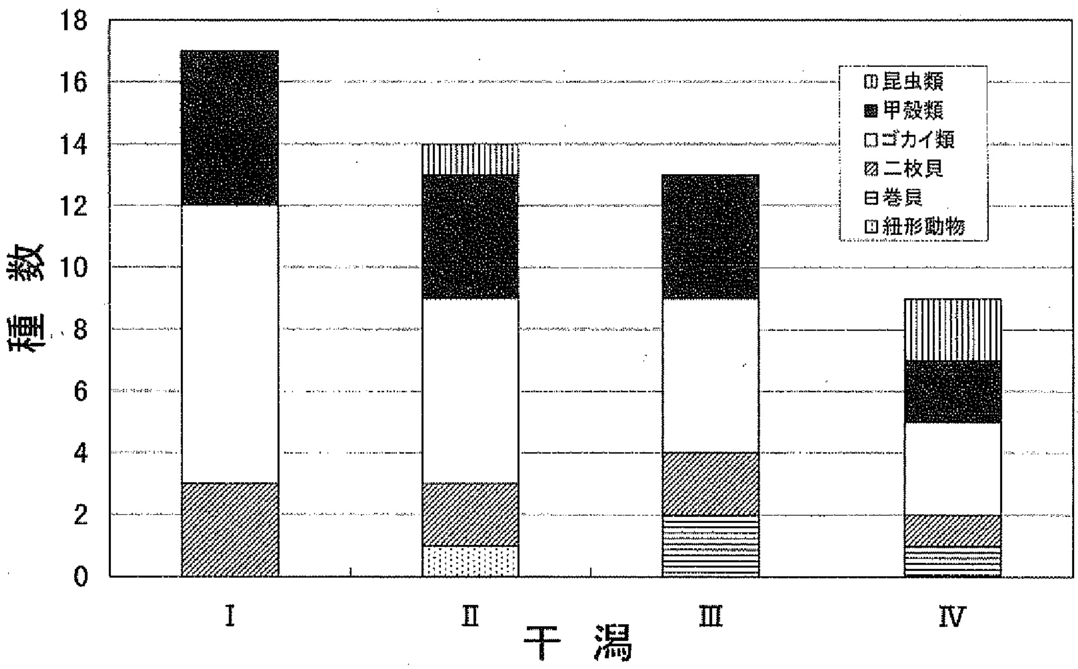


図４　各干潟の分類群別種数

イタカアワダチソウ群落が分布していた。また、州の水際には、イセウキヤガラ群落が点々と存在していた。

州の面積と植被面積との関係を見ると、1966年には州の面積が広く、植被面積との間に相関関係は見られないが、1975年になると州の面積が急激に減少するとともに、植被面積の増加が見られ、州面積と植被面積との間に正の相関が僅かに認められるようになった。さらに1986年になると、この傾向はより強まり、1999年に至っては、州面積と植被面積とは非常にはっきりした相関が示されるようになった。このことは、近年になればなるほど、州面積が狭くなり、植被面積は州面積によって決定されていることを示している。現在州が安定して来ており、植被面積が州面積に接近してきた、といえる。

建設省の河床測量結果から見ると、1966年以降、河床の最高値はごく一部で高くなる傾向が見られるだけであったが、河床の最深値は河口より7～14kmで年々深くなっており、河床の平均値も、河口より4.5～7.2kmを除いた全域で大幅に低くなっていることが示された。また、平均潮面の上0～2mにある州の面積が、1966年から1975年にかけて急激に減っていることも示された。これらは1970年代に建設が相次いだ上流のダムや、支川での砂防工事の影響と考えられる。

Ⅳ. 今後の課題等

現在なお調査を継続中のものが多いが、ここに述べたようにある程度まとまり、傾向等のつかめたものも、さらに継続して調査する必要があり、調査を繰り返す予定である。たとえばイセウキヤガラ群落については、面積等に、年によって大きな変動が見られることが分かってきており、その原因をつかむためには、さらなる調査と継続的な観測が必要である。

Summary

An environmental survey of the Yoshino River, mainly below the Daijuseki Weir, was performed.

1) The biomass of planktonic algae in the main and subsidiary channels of the Yoshino River was surveyed by measuring chlorophyll-a density, and the characteristics of multiplication pattern were determined.

2) Relationships between micro-environments on the tidal flats and the species and standing stock biomass of macro-benthos living on there were examined.

3) Types of plant communities and their distribution on the delta were surveyed.

長良川河口堰によって失われた環境の仮想評価

長良川のCVMを実施する会
粕谷志郎・後藤理絵・纐纈真奈実・増谷愛子・後藤順子・
伊藤まさよ・前田祥子・末次由佳・長坂智美

The economic value of natural environment of Nagara River which was lost by the dam at the mouth

Research group of CVM on Nagara River
Shiro Kasuya, Rie Goto, Manami Kohketsu, Aiko Masutani, Junnko Goto,
Masayo Ito, Sakiko Maeda, Yuka Suenami, Tomomi Nagasaka

Contingent Valuation Method（CVM）＝仮想市場評価法によって、河口堰によって失われた長良川の自然環境の経済的価値を推定した。東京都1000通、名古屋市1000通、流域3000通の計5000通の郵送アンケートにより、ダブルバウンド方式で、税金で拠出する仮想法案にて価値を尋ねた。回収率は22.4％で、その結果、7兆6800億円を算出した。

目的

今回の調査は、CVM（仮想市場評価法）という手法を用いて、河口堰によって失われた長良川の自然環境の経済的価値を推定することを目的とした。河口堰運用開始から5年が過ぎ、様々な環境への影響が指摘される中で、その失われた環境の価値に値段をつけようとする試みである。これによって、長良川の環境の経済的価値という新たな指標を提供し、また、河口堰運用の得失を考えるにあたって一つの手がかりを与えることができると思われる。

CVMとは

CVM手法は、現在のところ、生態系や動植物の非利用価値（存在価値）の便益を経済価値として算定する最適の手法であると考えられている。平成10年度の環境白書においても、「環境保全のために環境の機能を適切に評価する方法」として位置づけられている。米国では、CVMが様々な場面で用いられている。最近では、我が国においても、藤前干潟や吉野川下流域の自然環境の価値をCVMによって評価した例がある。

CVMはアンケートを用いて、一般市民に直接的に尋ねることで、環境の価値を金額であらわす手法である。例えば、「環境を回復させるために、あなたはいくら支払うことができますか」などと尋ね、その回答をもとに、環境改善によって得られる環境の経済的価値を評価する。

アンケートの実施

岐阜大学の学生等に、数回にわたってプレテストを実施し、アンケート内容を熟慮した上で、本アンケートを作成した。本アンケートは、2000年10月中旬に発送し、10月31日を締め切り日として実施した。総数で5000通のアンケートを郵送し、1118通の回答を得ることができた（回収率22.4％）。

岐阜大学地域科学部（〒501-1193　岐阜市柳戸1－1）

配付した地域と配付数は、東京都1000通、名古屋市1000通、長良川流域3000通（郡上郡、美濃市、岐阜市、海津町、桑名市）である。配布する地域は、長良川河口堰に対する認識度の違いや、長良川へのアクセス性等を考慮して、3つの区分に分けた。

アンケートの内容

アンケートの構成

1. アンケート調査の目的等の説明
2. 長良川河口堰の概要の説明
3. 河口堰が自然環境に与えている影響の説明
4. 設問

(1) 住んでいる地域
(2) 性別
(3) 年齢
(4) 同居している家族数と収入のある人の人数
(5) 世帯の年収
(6) 長良川を知っていたかどうか
(7) 長良川河口堰の役割について
(8) 以下の仮想法案に対する賛否

「河口堰を撤去して長良川の自然環境を回復させるという法案をつくるとします。この場合、塩害や水不足は河口堰以外の方法で解決します。この法案を実施するためには、あなたの世帯の税金が、年間____円上昇する必要があるとします。あなたはこの法案に賛成ですか、反対ですか。

この税収は、長良川の環境改善のみに使われ、この分、他の商品等が買えなくなることを念頭においてお答えください。」

質問は、長良川河口堰と同等の機能を持つ代替案によって、塩害や水不足を解決すると仮定した。これは、河口堰撤去によって、塩害や水不足が深刻化することを恐れて、法案に反対する人がでるのを防ぐためである。なぜなら、今回の調査で評価したいのは、長良川の自然環境のみだからである。回答者が自然環境の改善に対する価値のみを評価できるように質問を工夫した。また、今回のアンケートでは、支払手段に税金を用いた。税金方式を採用すると、税金に対する拒絶感等から、抵抗回答が増えると予想されたが、基金などの支払方法では、温情効果などのバイアス（ゆがみ）が生じやすいため、税金方式を採用した。さらに、ダブルバウンド住民投票方式を採用した。これは、法案に賛成の場合にはさらに高い金額を、反対の場合には低い金額を提示するという方式である。空欄に入る金額は、800円、3000円、5000円、1万円の4種類を用意し、回答者に無作為に提示されるようになっている。

支払意志額の推定方法

問8の「河口堰を撤去し、長良川の自然を回復させるために、年間____円の税金が必要な場合賛成ですか」という質問に対し、提示した金額について、(1) 2回とも賛成、(2) 1回目に賛成・2回目に反対、(3) 1回目に反対、2回目に賛成、(4) 2回とも反対とした人のみを、有効回答として扱った。有効回答とは、質問に無回答であったり、選択肢の「答えたくない」を選んだ人を除いた数である。また、(4) 2回とも反対とした人のうち、「税金で払う必要はないから」、「寄付などの自主的な方法なら支払ってもいい」とした人なども除いた。これらは、「抵抗回答」と呼ばれるものであり、アンケートの支払方法に反対であったり、また、行政が支払うべきだから反対とするものである。抵抗回答をした人の中にも、長良川に守るべき価値を認めている人は多いと考えられるため、これらの人も有効回答から削除した。今回の調査において、抵抗回答をした人は多く、その中でも、行政の責任だから税金に反対とした人が多かった。

この有効回答をもとに、地域ごとに支払意志額を推定した。今回の調査では、ダブルバウンド住民投票方式を採用したので、この方式を分析するモデルの一つである「生存分析」(Stat View：Abancus Concepts, Inc.）により推定を行った。

さらに、これらの支払意志額にそれぞれの母集団である世帯数を乗ずることによって、長良川の自然環境の経的価値を表すことができる。毎年の環境価値であるため、社会的割引率によって現在価値化した。社会的割引率は、一般的に4%が採用されている。

結果

地域ごとの回収率は東京都13.7％、名古屋市18.4％、長良川流域26.2％であり、地理的に離れると関心そのものが低くなる傾向がうかがわれた。

一世帯あたりの支払意志額は表1のように算定した。

表1. 一世帯当たりの支払意志額

東京都	6818円／年間／世帯
名古屋市	8636円／年間／世帯
長良川流域	9772円／年間／世帯

さらに、支払意志額の総和は以下のように算定された。

1. 長良川流域の支払い意志額（中央値）に岐阜県と三重県の世帯数を乗じた、二県の評価額、121億1千700万円と、
2. 名古屋市の同値に愛知県の世帯数を乗じた、愛知県の評価額202億7千700万円を加えた、323億9千万円を、流域の支払い意志額とし、さらにこれに、
3. 東京都の同値に、上記以外の地域の世帯数を乗じた、2,748億4千700万円を加えた、3,072億4千万円を流域外の意志額とした。

この値に割引率の収束値25を乗じ、7兆6,800億円を算出した。

考察

今回の調査で、一世帯当たりの支払意志額の中央値は、流域で9,772円（表1）であったが、この金額は、これまで行われた国内のCVMと比べても、比較的高額の部類に入るといえる。しかも、この金額は毎年支払ってもいいという額なので、長良川の生態系への関心の高さがうかがわれる。また、これだけの金額を払ってまでも、長良川の自然環境を回復させたいと望んでいる人が多いことがわかる。今回、50％の人が賛成と答える中央値を支払意志額としたが、平均値は一般にこれよりも高い値になる。

長良川に関して実施されたCVMは、宮野らが始めてで、流域で5,000～6,500億円の推計値を得ている。

長良川以外のCVMの結果としては、藤前干潟の自然環境、名古屋市民 6,555円／回／世帯、名古屋市民以外 10,260円／回／世帯で、計2,960億円（鷲田、栗山、竹内）、吉野川下流域の自然環境、吉野川流域 13,964円／世帯、その他 5,973円／世帯で、計2,650億円（鷲田、栗山）などがある。

今回のCVMよって7兆円以上という長良川の失われた自然環境の経済的価値が推定された。この金額の大きさは、長良川の自然には、河口堰を撤去してまでも回復させるべき価値があるとの全国的な評価が下されたものと理解できる。

地域ごとの一世帯当たりの支払意志額は、流域で最も高く、次に名古屋市、東京都の順になった。対象地域へのアクセス性や、河口堰に対する認識の違いによってこのような結果が出たと考えられるが、東京都においても毎年6,000円以上の税金を支払ってもよいと考えていることから、長良川の自然環境の存在価値は、地域特有のものでなく、全国的に価値を持つものであると考えられる。

しかし、得られた長良川の自然環境の価値に早急に社会的意味を求めることは、現段階では無理であろう。その理由として、CVMの日本における実績の少なさや、我が国の環境に対する価値観がCVM先進国の米国と異なること、また、税徴収の方法が米国と異なること等が挙げられる。だが、今回の調査により、直接的に、一部の一般市民の声を聞き、その中に、税金を新たに出してまでも長良川の環境を回復させたいと願う人々が多く存在したことは、重要な意味を持つと思われる。今回CVMによって評価した長良川の環境の経済的価値が、今後、長良川の環境を回復させたいと願う人々に新たな方向性を与えると思われる。

文献

栗山浩一. 公共事業と環境の価値. 築地書館. 1997.
鷲田豊明他. 環境評価ワークショップ―評価手法の現状―. 築地書館. 1999.

Summary

The aim of this report is to estimate the economic value of Nagara River ecosystem that has been destroyed by estuary dam by contingent valuation method (CVM). CVM is regarded as the best method for estimating the non-use value of ecosystem, such as option value and existence value, at the present time. We conducted a questionnaire survey of the basin of Nagara River, Nagoya and Tokyo. The main query of this questionnaire is " If Nagara River ecosystem were improved by removing the dam, could you pay ____ yen / year by tax." We asked each respondent with the double−bounded dichotomous choice method. If the first response is yes, the second bid is greater than the first bid. While, if the first response is no, the second bid is smaller. We mailed a questionnaire to 5,000 households in October 2000, and we got an answer from each 1,126 household. We estimated the economic value of Nagara River ecosystem at 300 billion /year by using the Survival Analysis. The value throughout the future was estimated at about 7 trillion 680 billion yen if the discount rate of the public work is made to be 4%. This price seems to be higher than the other CVM-researches. Therefore, the importance of the ecosystem of the Nagara River should be reconsidered.

第10期プロ・ナトゥーラ・ファンド助成成果報告書（2001）

長野県における草本植物の生活史研究

長野県草本植物生活史研究プロジェクト

池田登志男[1)]・中山洌[1)]・今井建樹[1)]・小林規甫[2)]・橋渡勝也[3)]・
友野増夫[1)]・千葉悟志[4)]・伊藤静夫[1)]・浅野一男[1)]・清水建美[5)]

Life History of Herbaceous Angiosperms in Nagano Prefecture

Life History Research Project of Herbaceous Angiosperms
Toshio Ikeda, Kiyoshi Nakayama, Kenju Imai, Noriho Kobayashi, Katsuya Hashido,
Masuo Tomono, Satoshi Chiba, Shizuo Ito, Kazuo Asano and Tatemi Shimizu

この研究は長野県内産草本植物について種子から種子までの生活史を明らかにしようとするものである。夏～秋におよそ70種の草本の種子を採取、また、野外の観察フィールドを選定する一方、圃場での種子からのポット栽培を行った。

一年間の観察の結果、次のような観察事項について多くのことが明らかになってきた。それぞれの対象植物について、果実や種子の形や大きさ、1果中の種子数など。また、発芽については、播種の時期が秋播きの場合は越冬前の発芽は比較的少なく、多くは翌春になって発芽すること、多くの対象植物の発芽率、同一種でも産地による発芽習性の相違などの発芽状況。芽生えの形態として子葉の位置、胚軸の長さ、子葉の形、上胚軸の長さ、本葉の付き方や形など。そして、開花・結実については開花時期や期間、果実の成熟過程や完熟率など。さらにそれぞれの対象植物のその他の特性など。

1. 目的

自然保護の究極の基盤は個々の生物の生活史を十分に理解することにある。ところが、任意にある野生植物をとりあげた場合、その生活史の全貌が概略にしろ究明されている事例は極めて少ない。

この研究では野外と栽培の両面から個々の植物の種子から種子までの生活史を観察記録し、成長、種子生産、種子および栄養器官による繁殖状況の調査を主眼におき、身近な植物をはじめ、絶滅危惧種を含めて、その生活史を観察する一方、栽培増殖の方法を検討し、ついで長野県における絶滅危惧種とされる種の育成を試みる。

究極的には長野県の生物学的フロラ、Biological Flora of Nagano Profectureの作成を目指す。

1) 長野県植物研究会
2) 長野市茶臼山自然史館
3) 長野県総合教育センター
4) 大町市立山岳博物館
5) 信州大学名誉教授

2. 方法

(1) 植物種の選定　観察・育成の対象植物を1年生、越年生、2年生、多年生の各カテゴリーから、また、身近な植物、絶滅危惧植物などの観点を考慮して選定する。

(2) 種子の採取　夏～秋に複数の個体から種子を採取､1果実当たりの種子数を数え平均種子数を求めておく。

(3) 種子の形態の観察と大きさの測定　種子の形を観察し、その特徴をメモし、大きさを測定する。

(4) 果実の観察　種子採取に際し、同時に果実も採取し、形や大きさなどの観察をし、カラーまたは白黒写真をスケールとともに写す。

(5) 播種　手近に観察・潅水できるところで育成箱かビニールポットに播種する。培養土は一般にバーミキュライトがよい。種子の半数は冷蔵庫に保存し翌春播種する。

(6) 芽生えの観察　発芽したら子葉の位置、胚軸の長さ、子葉の形、上胚軸の長さ、本葉の付き方や形をチェックする。芽生えの写真をとる。

(7) 発芽所要日数　播種後発芽までの日数を記録する。

(8) その他　それぞれの対象植物のその他の特性を把握し記録する。

(9) 野外観察フィールドの選定　対象植物の自生する野外に観察フィールドを選定しておいて、栽培するものと平行して観察を行う。

(10)標本の作製　各生活史段階における植物は写真及び液浸標本、乾燥標本を作製する。標本類は最終的には大町市立山岳博物館に保管し一般の閲覧に供する。

(11)描画の作成　植物の生活史段階の描画を作成する。

3. 対象植物

アカネ科　ヤエムグラ　ヘクソカズラ
アブラナ科　イヌガラシ
アヤメ科　カキツバタ　キショウブ
イネ科　エノコログサ　ケチヂミザサ　ササ類
イラクサ科　ウワバミソウ
オオバコ科　オオバコ
カタバミ科　カタバミ
カヤツリグサ科　クグスゲ
キキョウ科　キキョウ　ツリガネニンジン
キク科　アイズヒメアザミ　アキノノゲシ
　アレチノギク　ウサギギク
　オオハンゴンソウ　ヤチアザミ
キツネノマゴ科　キツネノマゴ
キンポウゲ科　オオカラマツ　トリカブト類
ゴマノハグサ科　コゴメグサ類
サクラソウ科　オカトラノオ　サクラソウ
シソ科　ニシキコウジュ　シナノアキギリ
タデ科　イヌタデ　ミズヒキ
ツリフネソウ科　キツリフネ　ツリフネソウ
ナデシコ科　アライトツメクサ　ウシハコベ
　エゾカワラナデシコ　エンビセンノウ
　シナノナデシコ　ハコベ　フシグロ
バラ科　キンミズヒキ　ワレモコウ
ヒユ科　ヒナタイノコズチ
ヒルガオ科　ヒルガオ
フウロソウ科　ゲンノショウコ
マツムシソウ科　マツムシソウ
マメ科　イタチササゲ　カラスノエンドウ
　クララ　ツルフジバカマ　ナヨクサフジ
　ヌスビトハギ　ミヤコグサ　ヤブツルアズキ
　ヤブマメ
ミクリ科　ミクリ
メギ科　トガクシソウ
ヤマノイモ科　オニドコロ
ユキノシタ科　ウメバチソウ
ユリ科　クロユリ　コオニユリ　ツルボ
　ヤブカンゾウ　ヤマユリ
リンドウ科　エゾリンドウ　ツルリンドウ
　ハナイカリ　アケボノソウ

4. 対象植物の観察例

(1) ヤブツルアズキ

ヤブツルアズキ *Vigna angularis* (Willd.) Ohwi et H.Ohashi var. *nipponensis* (Ohwi) Ohwi et H. Ohashiは、河原の草地や休耕田などに生える比較

的普通な1年生のつる草で、日本では本州、四国、九州に分布するほか、朝鮮半島・中国・ネパールに分布する。作物のアズキはその基準変種として扱われている。

1) 材料と方法

松本市岡田地籍のヤブツルアズキが群生する2アールほどの休耕田を野外観察地として、1999年10月から1年間生活史を観察した。現場は春から夏にかけてはコゴメギク、夏にはセリが茂る湿地で、周辺にはツユクサやヒルガオが旺盛に生育する。作物のアズキは連作困難であるが、本変種は少なくとも前年同様、今年も旺盛に繁茂を見せた。

別に、1999年10月25日に現場で採取した若干量の種子を室内にしばらく放置した後、11月18日に市販の山野草栽培用の培養土を用いて播種し、発芽状況や幼植物の観察に供した。観察時にはできるだけカラー写真を撮影した。

観察済みの試料は、芽生えは液浸標本、幼植物及び成植物は乾燥標本として保存した。

2) 観察事項と結果

①発芽状況

越冬前には発芽は皆無であったが、4月中旬に発芽し始め5月上旬までに発芽は完了した。5月10日には第3葉の展開が見られた。

②芽生えの形態

子葉は地下性で胚軸は伸長せず、上胚軸は長さ3.5～5cm、第1葉及び第2葉は小葉が1個の単葉複葉で第1節に対生し、葉軸は無毛、小葉軸には上向きの粗毛がある。この第1節の左右両側の葉柄間には長さ2.5～3mmの線形の葉柄間托葉があるが小托葉はない。第3葉以降は3出羽状複葉となり、互生し葉柄の基部左右両側に長さ5 mmほどの托葉が1個ずつつく。小托葉は小葉柄の基部につき、頂小葉では2個、側小葉では下側にのみ1個つく。

③分枝

主茎はせいぜい本葉のつく第1節までは直立するが、以降は直ちにつるとなり、かつ、盛んに分枝する。6月中旬の栽培試料では分枝は認められなかったが野生の試料では7～10節まで伸長し、第2節ないし第4節に1～14cmの分枝が見られた。第1節では腋芽は見られるものの枝は全く伸長しない。つるの巻き性は右巻（上から見て左巻）で他物に巻き付くかあるいは自らの枝に互いに巻き付いて伸長する。

④開花・結実

野外での開花開始は8月15日であった。花序がつき始めるのは下から数えて第8～12節の葉腋で、それより先の葉腋に連続して花序が生じ順次に成熟する。開花期に展開する葉は、頂小葉は3裂し、側小葉は非対称に2裂する。

花序は総梗がある緊密な総状花序で、3～14個の花が下から上に向かって伸び、はじめは鮮緑色の線状であるが、熟すると褐色を経て黒色に変色する。9月6日、任意に1個体を選び、主茎状のすべての花序7個について、下から順に花序ごとの開花・結実数を算定した（表1）。ここでは緑色の未熟の莢も果数に含めてある。

表1. 1茎の花序における開花・結実状況例

花序No.	果数	花数	蕾数	計
1	4	1	4	9
2	4	1	7	12
3	2	3	8	13
4	4	2	8	14
5	2	1	8	11
6	0	2	5	7
7	0	0	7	7

これによると初秋には一つの花序に蕾から果実まで見られること、花序は無限花序であり、したがって下方の花序ほど早く実ができること、花序当たりの花数は下方の花序と上方の花序では少ないことなどが分かる。なお、観察した花序のうち2つの花序では最下の位置に緑色の直立した1本の莢状のものが見られた。これらは長さ、太さ、色いずれも若い莢そっくりだが上向きであることが異なり1種の青虫であることが分かった。擬態の一つと思われる。莢は若いときでも直立しない。

⑤豆果の成熟過程と完熟率

表1と同一主茎の同一花序において引き続き結実

の経過を観察した（表2）。表中、花序番号1～7は表1の花序番号1～7に符合する。番号0は最下の花序を新たに観察に加えたものである。豆果は完熟すれば2片の莢片に裂開して種子を落とす。列開後も少なくとも一方の莢片は宿存するので果序に残った莢片を数えれば完熟した豆果数を知ることができる。この表では褐色の豆果は黒色に算入し、未裂開の黒色豆果は黒色の欄に入れてある。9月25日には裂開した豆果はまだなく、10月3日の観察では裂開した豆果があり緑色の未熟果は皆無となったので緑色の欄は消去し、新たに裂開の欄を設けた。

表2. 1茎の果序における結実経過例

観察日	9月17日				9月25日			10月3日			10月5日	
果序No.	黒色	緑色	開花	落下	黒色	緑色	落下	裂開	黒色	落下	裂開	黒色
0	2	1	0	6	3	0	0	3	0	0	3	0
1	1	2	0	6	3	0	0	2	1	0	2	1
2	0	4	2	6	2	2	0	3	1	0	3	1
3	0	3	6	4	2	1	0	1	1	1	1	1
4	0	2	5	7	2	0	0	1	1	0	1	1
5	0	1	4	6	1*	0	5	0	0	0	0	0
6	0	2	2	3	0	0	4	0	0	0	0	0
7	0	1	3	3	0	0	4	0	0	0	0	0

＊種子なし

表2から（ｱ）、緑色の未熟果が完熟するにはほぼ2週間を要すること、（ｲ）成熟途上花序の先の蕾花あるいは若い果実は次第に落下し、特に枝の先の果序（No.5～7）には完熟豆果が皆無となること、その結果（ｳ）表1と併せて考えると、豆果の結実率は果序No.1～4においてそれぞれ1/3、1/3、2/13、1/7、平均23%であったことなどが読みとれる。

⑥豆果と種子

野外で観察した個体のうち、つるの長さの最長は165cmであった。10月7日、この個体のつけた豆果を数えたところ、黒色果が83個、未熟果（緑色）が39個、計122個であった。果序当たり豆果は1～4個、黒色果の豆果当たりの種子数は6～10個、平均8個であった。未熟果が今後全て完熟するとすれば、この個体の種子生産量は122×8＝976個という計算になる。つまり、ヤブツルアズキは1粒の種子から約1,000粒の種子を生産することができるのである。

なお、豆果はよく乾燥すると逆V字形に裂開し枝先から見て左側の莢片は左巻きに規則正しくねじれることが観察された。このような現象は別種のツルマメの豆果でも観察することができる。

種子は短扁円柱形で黒地に白斑があり、長さ3.5～4mm、長径2.5～3mm、へそは長形、白色で長さ2～2.5mmある。

⑦受粉様式

今年8月29日～30日、栽培した5個体について蕾状態の任意の花序1個ずつに袋かけをし、結実の可否を調査した。その結果、いずれの花序にも一定量の成熟種子が得られた。本種は栽培種同様自家受精をすると結論することができる。

(2) ヤチアザミ

ヤチアザミ *Cirsium shinanense* T. Shimizu は平地から低山帯上部にかけて湿原や湿地にやや普通に生える日本固有のアザミで、長野県及び新潟県に分布する。地中に匍匐根茎を生ずる点が極めて特徴的である。門田（1995）は本種のためにSect.Onotrophe Subsect. Stolonifera Kadotaを設けている。

1999年10月から松本市において栽培し、1年間その成長過程を継続観察した。

1) 材料と方法

長野県小県郡真田町菅平の菅平湿原および同埴科郡大岡村芦沼池畔の湿地において1999年10月初旬に複数の個体から痩果を採集し、室内に保管した後、それぞれ11月18日および10月27日に、市販の山野草栽培用の培養土を用いて播種、栽培した。芽生えの成長に伴って市販の径7.5cm、9cm、および15cmの3種のビニールポットに順次植えかえた。

2) 観察事項と結果

①発芽状況

年内に芦沼池採集の2個の種子が発芽したが、その他の種子は翌年の4月に多数発芽した。5月1日に

は発芽は終了し、すでに小型の第1葉が展開し始めた。子葉の展開と本葉の展開は連続的である。

②芽生えの形態

子葉は地表性で上胚軸は伸長しない。子葉は無毛で光沢があるのに対し、第1葉は卵形、全縁で表面に光沢はなく、ほとんど無柄、葉面には短毛、葉縁に短刺針がある。

③根生葉の形態

6月中・下旬には3〜5葉まで展開した。葉身は狭卵形ないし長楕円形、細鋸歯はあるが切れ込みはなく、最大葉の葉身は長さ5.5cm、葉柄は7cmに及ぶ。中にはこの時期まで緑色の子葉をつけた個体もあった。匍匐根茎はまだ認められない。10月初旬、生存した菅平湿原産8個体、芦沼池産11個体を最終移植し観察したところ、菅平産2個体、芦沼池産の3個体で1〜2個の分けつが認められ、1個体または1ラミート当たりの根生葉の数はそれぞれ5〜10個および2〜12個であった。そのうち、1〜4個の根生葉はすでに枯死していた。成長初期の葉は無分裂であるが、ある段階から葉身の切れ込みが明らかに深くなることが観察された。最小・最多の根生葉を持つ株および分けつ株の根生葉の数と分裂の有無を表3に示す。

表3. ヤチアザミの根生葉の数と形態

個体番号	数	枯死数(内数)	無分裂葉数	分裂葉数
菅平3	10	2	4	6
6-1	7	0	0	7
6-2	9	0	4	5
6-3	12	0	6	6
7	10	1	5	5
8-1	10	0	4	6
8-2	7	0	4	3
芦沼1	5	1	5	0
3-1	13	1	2	11
3-2	5	0	2	3
4-1	2	0	2	0
4-2	12	2	4	8
4-3	5	0	5	0
6	10	2	7	3
10	12	3	12	0

個体番号中枝番号はラミート番号

④匍匐根茎

10月6日の観察では、菅平6の個体において長さ6.5cmのやや太い匍匐根茎、芦沼池3の個体において長さ3.5cmの細い匍匐根茎がそれぞれ1本ずつ認められた。表3に示したように、ともにすでに分けつを行い、合計葉数がそれぞれ28および18個を数える大きな株であった。したがってヤチアザミは発育がよければ発芽後半年内に匍匐根茎を生じ得ることが判明した。

5. 各観察事項についての観察例

以下には断片的ではあるが得られた観察結果を一部紹介しておきたい。

(1) 発芽時期

秋まきで越冬前に発芽したものはアカツメクサ、エゾカワラナデシコ、エンビセンノウ、オニノゲシ、ネズミムギ、ハコベ、マツムシソウなどで比較的少なく、その他の多くの植物は翌春になって発芽した。ただし、マツムシソウは産地により越冬前に発芽する場合と翌春発芽する場合があった。産地により発芽習性が異なるようである。

(2) 発芽率

供試資料のうち発芽率が計算された例は次の通りである。イノコズチ26%、イヌタデ60%、ウシハコベ50%、エゾカワラナデシコ9%、カタバミ25%、ゲンノショウコ90%、ツユクサ16%、ツルボ95%、ハガクレツリフネ14%、ミズヒキ55%、ミゾソバ69%

(3) 1果中の種子数

エンビセンノウ（4果）37〜71平均55、コオニユリ（3果）176〜238、シナノアキギリ4、ハコベ6〜15、ヤマユリおよそ500。

(4) 芽生えの形態

ヤチアザミ：子葉は地表性、上胚軸は伸長しない。ヤブツルアズキ：子葉は地下性で胚軸は伸長しない。

(5) 発芽から開花・結実までの記録

エゾカワラナデシコ　10月5日播種、11／22発芽（率）9%、翌年3／15発芽（率）34%、5／22本葉展開、6／16抽だい、8／2開花開始、11／1現在開花続行中。

ミズヒキ　10月4日播種、翌年4／8発芽（率）55%、5／3本葉展開、9／4、8個体抽だい、9／13、21個開花、10／2結実、11／1現在なお着果。

ゲンノショウコ　10月3日播種、翌年4／20発芽、5／2本葉展開、8／10、1個体抽だい、8／21、2個体開花、結局結実せず。

(6) 開花から痩果散布までの日数

オニノゲシの例

6月開花－6～7日　　10月開花－10～15日
11月開花－12～18日

6. おわりに

10年計画の第1年次として種子や果実の採取、計測、播種そして発芽から開花・結実までの観察をして、およそ70種の草本植物について、さまざまな観察結果が得られた。しかし、多年草などでまだ開花には至らないもの、1～2年草などでも今後さらに繰り返し観察する必要がある。

同じ種でも産地によって発芽時期の異なるもの、前年と翌年で異なるものなど、発芽習性の相違、環境条件による相違など、今後の観察を待たなければならないことも多い。

自然保護活動では、まず自然の現状を正しく理解する必要があり、そのためには植物の生育状況などに関する詳細な調査が欠かせない。

この研究の継続によって絶滅危惧種を含む多くの植物の生活史が判明し、適切な自然保護の施策や自然保護活動に貢献することが期待される。

Summary

The present research project aims to clarify the life history of herbaceous angiosperms growing in Nagano Prefecture.

In summer to autumn 1999, the participants gathered seeds of the species which were voluntarily chosen by themselves. The total number of material plant species to be studied amounts about 70. Observation was carried out over one year on the following items：①shape and size of fruits and seeds, ②germination advantages between winter-sown and spring-sown seeds, ③seedling morphology, ④flowering and fruiting phenology, ⑤pollination ecology, ⑥productivity and maturity of seeds, etc.

In this report, the life history of an annual herb, *Vigna angularis* var. niponensis. is introduced as an example. The results of observation are as follows：

① Germination of seeds which sown before winter occurred in the next spring as in the natural field.

② Cotyledons are hypogeal. First and second leaf are compound with a single leaflet, and opposite at the first node of epicotyl.

③The stem becomes twinning after the second internode. Branching occurred from every node except the first.

④ Flowering began at 8th to 12th node. The inflorescence is indefinite, consisting 3-14 flowers.

⑤ The number of seeds per plant was estimated to amount about 1,000.

⑥ The flower was proved to be self-pollinated likewise in the cultivated race.

As to any perennial herb, of course, observation of the whole life history takes more than two years. Continuous and constant observation for a lot of years will be needed for our project.

森林施業により劣化した森林生態系の生物多様性保全を目指した復元生態学的研究

森林生態系復元研究グループ
吉田俊也[1]・長池卓男[2]

Research for ecosystem restoration in forests under intensive forestry management

Research group for forest ecosystem restoration
Toshiya Yoshida[1], Takuo Nagaike[2]

択伐や皆伐母樹保残法といった非皆伐施業が行なわれた森林を対象として、生物相保全も含めた持続可能な森林管理の確立にむけた調査研究を行なった。北海道の大雪山系および天塩山地の針広混交林（択伐）と、新潟のブナ林（皆伐母樹保残法）において調査を行った。

非皆伐施業は、皆伐に比べて生態系への負のインパクトが比較的少ないと考えられるが、今回調査を行なった施業地のいずれにおいても、持続可能性という点から見ると大きな課題が残っていた。今後、森林資源の利用と生態系の保全とを両立させるためには、地域に固有な生態的プロセスを充分に考慮し、伐採率をより低く抑えた施業を検討する必要がある。本研究で示されたような林分が大面積に存在すると考えられることから、こうした林分の生態的復元を考えることがより重要な課題であろう。

1. はじめに

持続可能な森林管理の方策が世界中で模索されている。それは、木材を中心とする森林資源の持続的な管理のみならず、地域に固有の生態的プロセスや生物多様性の保全を考慮した森林管理を求める概念である（例えば、Hunter, 1999）。しかし、そのような持続的管理を実現するための科学的な知見は、未だ乏しいといわざるを得ない。森林資源の持続的な利用・管理を前提としたとき、皆伐施業と比較して、非皆伐施業は生物・非生物環境への影響が少ないと考えられることから、今後の生態的管理のあり方を考える上で、重要な施業法であるといえる（藤森, 1991）。わが国では、北海道の針広混交林域で択伐施業（単木的な抜き伐りを行う伐採法）が、また東北日本のブナ林域で皆伐母樹保残施業（皆伐に近いが種子の供給源である母樹を一部に残す伐採法）が、一般的に行われてきた。これらの非皆伐施業は、伐採時の影響を軽減し、次世代へむけた森林の更新過程を円滑に進めるために採用されたと考えられるが、このような取り扱いが、林業的な意味での有用樹種の更新のみならず他の生態的プロセスや生物多様性に与える影響については、必ずしも明らかでない部分が多い。

わが国の現在の森林資源の構成を見ると、原生林は非常に限られた面積となり、何らかの人為の

[1] 北海道大学農学部附属雨竜地方演習林
[2] 山梨県森林総合研究所

加わった森林が大きな面積を占めるに至っている。地域の生態系・生物多様性を保全していくためには、残された原生林を保護することはもちろんのこと、それに隣接し、かつ相対的に原生林に近い構造を持つと考えられる非皆伐施業地を、いかに元に近い林分に復元するかということが、重要なポイントである。本研究で、私たちはこのような非皆伐施業が、森林の構造・組成の変化に及ぼす影響を明らかにすることを試みた。かつて行われた施業地の現状を把握することを通して、生物相保全も含めた新たな森林管理の確立への道筋が示されると考えている。

2. 調査対象

本研究では、上述の針広混交林域における択伐林分、およびブナ林域における皆伐母樹保残施業林分を対象に調査を行った。

3. 針広混交林域における択伐林分

北海道の針広混交林においては、非皆伐の天然林施業、すなわち択伐施業が広く行われてきた。しかし実際に行われてきた施業の多くは、次世代への更新を考慮したものではほとんどなく、現在の収穫に重きをおいたものであった。実際、施業後に林分構造が劣化し、更新が順調でない林分が少なくないことが指摘されている（例えば、Nagaike *et al.*, 1999）。持続的な管理のためには、更新を考慮した施業法の確立が急務であるが、これに答えられる知見は限られている。

稚樹の更新は、定着サイトと光環境とに大きく左右される。北海道の針広混交林では、とくに針葉樹の定着サイトとして、林床の倒木や根株が重要であることが広く指摘されてきた（例えば、Kubota *et al.*, 1994）。しかし択伐施業が、定着サイトの量、更新プロセスに及ぼす影響についてはほとんど明らかにされていない。本研究では、長期的な継続調査と短期間での調査を組み合わせ、定着サイトおよびそれに密接に関係する林分構造と、更新や死亡などの生態的プロセスとの関係に焦点を当てて解析を行った。

3.1 調査地と調査方法

北海道の大雪山系（十勝三股）および天塩山地（雨龍）の2箇所の針広混交林において調査を行った。いずれにおいても、林内に残されている伐根の腐朽度合の違いから、調査地は過去数回にわたり択伐施業が行われた林分であると考えられる。十勝三股では、すでに設定された調査区があることから、林分のやや長期的な動態に関する調査を中心に実施した。一方、雨龍においては、択伐率の違いが、更新あるいは定着サイトの量に与える影響についての調査を行った。

十勝三股では、1995年に設定した100m×50mの調査区において、2000年に再調査を行った。調査区内部を10m×10mの小区画に分割し、小区画ごとに樹高2m以上の立木（以下、成木）を対象にして個体識別用のナンバーテープを打ち付け、地上高1.3mでの幹の周囲長と樹種名を記録した。また、樹高1m以上2m未満の個体を稚樹とし、樹種名を記録した。また、伐採された個体数（以下、伐根密度）とその直径を小区画ごとに記録した。2000年の再測定の際には、個体の成長、死亡個体や新たに稚樹に成長した個体を記録した。

雨龍では、択伐率の異なる針広混交林17林分を調査地とし、各林分に120m×10mのベルトトランセクトを設置した。これを10m×10mの小区画に分割し、十勝三股で行ったのと同様の毎木調査および伐根調査、ササの被覆率調査を行った。各小区画に1m×2mの方形区を設け、生育する稚樹の本数をカウントした。倒木の量は、線交差法（van Wagner, 1968）を用いて、単位面積当たりの体積を推定した。また幹折れ木・伐根などの倒木以外の枯死要素やマウンドについて、体積または面積を測定した。それぞれのサイト上に生育する稚樹の本数をカウントし、単位面積あたりの密度を推定した。

3.2 結果および考察

表1に、十勝三股の択伐施業林における5年間の個体数の変化を示す。成木は、約100本／ha増加しており、それは主として針葉樹（トドマツ、エゾ

表 1. 5 年間の林分の変化

針広混交林・択伐施業地（調査地： 十勝三股）

	トドマツ	エゾマツ	アカエゾマツ	オガラバナ	ダケカンバ	バッコヤナギ	合計
成木個体数（/ha）							
1995年	462	228	12	20	10	6	738
2000年	544	254	12	16	10	4	840
死亡数	48	28	0	4	0	2	82
新規加入数	130	54	0	0	0	0	184
成木胸高断面積合計							
(m^2/ha) 1995年	10.07	5.60	0.25	0.11	0.31	0.29	16.63
2000年	11.74	6.49	0.31	0.14	0.41	0.26	19.35
減少量	0.88	0.10	0.00	0.01	0.00	0.06	1.05
増加量	2.54	0.99	0.06	0.05	0.10	0.03	3.77
稚樹個体数（/ha）							
1995年	128	106	2	2	0	0	238
2000年	160	84	2	0	0	0	246
死亡数	24	8	0	2	0	0	34
新規加入数	126	36	0	0	0	0	162
進界数（稚樹→成木）	70	50	0	0	0	0	120

表 2. 定着サイトが稚樹密度に与える影響

針広混交林・択伐施業地（調査地： 雨龍）

	df	トドマツ		アカエゾマツ		ミズナラ		イタヤカエデ		ダケカンバ	
		～30cm	30cm～2m	～30cm	30cm～2m	～30cm	30cm～2m	～30cm	30cm～2m	～30cm	30cm～2m
ササ被覆率	1	6.27*	1.68	3.12	1.26	0.68	8.62**	0.78	0.13	7.18**	0.12
林床状態	2	7.63***	4.46*	1.69	2.32	0.47	0.75	0.88	0.78	5.42**	1.13
ササ被覆率×林床状態	2	6.86**	3.43*	1.69	1.36	0.12	0.56	0.92	0.19	6.39**	0.86

ANOVA F値を示す ＊p <0.05 、＊＊p <0.01、＊＊＊p <0.001
稚樹サイズ（高さ）は2区分、ササ被覆率は≦50%と>50%の2区分、林床状態は林床、CWD、マウンド・ピットの3区分で解析

マツ）の増加によっていた。この2種においては新規加入数が死亡数を上回っていた。一方、稚樹の個体数も全体でわずかに増加しており、稚樹への新規加入、稚樹から成木への進界のいずれも死亡数を上回っていた。胸高断面積合計の値で見ると、この5年間で、死亡による1.05 m^2／haの減少、および成長による3.77m^2／haの増加が見られ、調査区全体としては合計2.72m^2／haの増加であった。しかし、2000年時点における胸高断面積合計値(19.4m^2／ha) は、同じ森林タイプで原生的な林分の値（34.4−75.6 m^2／ha：春木ら, 1982, Kubota *et al.*, 1994, 久保田ら, 1994）の26−56％程度に過ぎなかった。

次に、同じく十勝三股の調査区における、林分構造と5年間の更新や死亡との関係について解析を行なった。稚樹の個体密度は、立木密度と有意な正の相関があった（R^2＝0.32、p＜0.01）が、光環境の改善を示すと考えられる伐根密度とは有意な関係がみられなかった（R^2＝0.16）。このことは、稚樹密度が光環境よりも、定着サイトに大きく左右されることを示唆している。この5年間における稚樹の新規加入個体密度は、1995年の稚樹密度（R^2＝0.32、p＜0.01）および胸高断面積合計（R^2＝0.24、p＜0.05）と有意な正の相関があった。一方、伐根密度と稚樹の新規加入個体密度との有意な相関関係は見られず（R^2＝0.02）、伐採による光環境の改善は稚樹の新規加入へほとんど貢献していないと考えられた。また、新規加入個体密度と死亡個体密度には有意な正の相関があり（R^2＝0.37、p＜0.01）、稚樹の成長・死亡が集中的に生じていることが推測された。

次に定着サイトの重要性を明らかにするために、

雨龍の調査区において定着サイト別の稚樹密度を解析した（表2）。トドマツの稚樹密度は、ササ、林床状態、ササと林床状態の交互作用のいずれにも影響を受けていた。トドマツ稚樹にとって倒木は有効な更新サイトであるが、ササの被覆率が高くなると、その有効性が大きく低下すると考えられた。アカエゾマツは、やはり倒木依存性の強い樹種であるといわれているが、本調査地では倒木上も含めて非常に稚幼樹密度が低かった。林床やササの被覆率が高い箇所では稚幼樹がほとんど確認されなかったことから、やはり倒木やマウンドへの依存や、ササによる更新の阻害の可能性が考えられた。広葉樹では、先駆性樹種のダケカンバの場合、倒木やマウンドに依存した更新をしていることが示唆されたが、一方でミズナラやイタヤカエデの稚幼樹密度は、林床状態による影響を受けていなかった。

択伐施業が、定着サイトそのものの量に与える影響についてみると、強度の択伐により、トドマツなどの樹種にとっての更新適地である倒木やマウンドの量が減少することが示された（表3)。トドマツの場合に見られたようなササとの交互作用を考慮すると、強度の択伐が行なわれた場合、生育適地の減少と更新サイトの有効性の低下が同時に起こることになり、相対的に更新の量が低下することが考えられた。

表3. 択伐率別の倒木体積・マウンド面積

針広混交林・択伐施業地（調査地： 雨龍）

	択伐率		
	<25%	≧25%	test
倒木体積** (m^3/ha)	151.6	107.7	*
マウンド面積 (m^2/ha)	115.0	56.4	*

n=17, * $p<0.05$
** 倒木体積には枯死木,切り株などの体積を含む

以上の結果から、択伐施業により変化した林分は、長期間の間には一定の回復傾向を示すものの、更新は現存量の極端な減少を補償できる範囲には達していない現状が示された。このことの原因の一部は、林分構造の変化によって有効な更新サイトの供給が減少し、その結果、稚樹の更新が局所的にしか生じ得ないことに起因すると考えられる。現在の状況は、持続可能な森林管理とはほど遠い状況にあるといえた。今後は、樹種間の更新特性の違いを考慮に入れた上で、森林に固有の生態的プロセスを模倣した管理を導入する必要がある。

4. ブナ林域における皆伐母樹保残施業地

ブナ林の天然林施業は、開発が奥山地域まで及ぶようになった1960年代以降広く行われるようになり、中でも皆伐母樹保残施業がもっとも一般的である。これは、種子を散布させる母樹を残す以外は皆伐し、更新完了後に母樹も伐採するという傘伐方式の一種である。保残される母樹の量は、林分材積比で30－70％に過ぎない。一般にブナ天然林における攪乱形態は、比較的小面積な林冠ギャップの形成であることから、このような施業は、天然林とかなり質的に異なる生態系を導く可能性が高いと予想される。本研究では、ごく近年に皆伐母樹保残施業が行われた林分において、伐採前後の植生の変化を明らかにし、今後の林分構造回復の可能性について推測した。

4.1 調査地と調査方法

調査は、新潟県と福島県の県境に位置する新潟県上川村のブナ林において行った。当初は、皆伐母樹保残施業後10年程度を経過した林分での調査を予定していたが、林道工事のために、今年度は調査を行うことができなかった。そこで、別の小流域に位置する、ごく近年（1998年）に伐採が行われた林分において調査を行った。

伐採施業が行われる直前の1998年7月に0.4haの調査区を設定した。この調査区を10m×10mの方形区40個に区切り、各方形区に1m×1mの小方形区を2個ずつ設置した。調査区内では胸高直径5cm以上の立木を対象に毎木調査を行い、小方形区内では、胸高直径5cm未満の木本種の幹数および草本種の個体数をカウントした。同年11月に皆伐母樹保残法によって伐採が行われた後、1999年秋に調査区を復元して同様の調査を行い、さらに2000

年秋にも追跡調査を行った。なお、今回の小方形区の解析は、ランダムに選択した20個の小方形区でのデータを元に行った。

4.2 結果および考察

皆伐母樹保残施業によって、ブナ林の林分構造は大きく変化した（表4）。伐採前の林分は、胸高断面積合計が43.6m²／haに達し、その約50％を占めるブナの平均胸高直径は62.8cmと、大径木の多い成熟した天然林であった。しかし、伐採後に調査区に残された胸高直径5cm以上の立木は、ブナがわずか3本だけであった。実に、胸高断面積の93％、立木密度の97％が失われたことになる。上述のように、皆伐母樹保残施業においては、最低でも材積で30％程度の樹木が保残されることとなっているが、実際にはこのように適正な母樹配置がなされていないことも少なくない。このような極端に少ない母樹密度では、ブナの天然下種更新を期待できる面積はごく限られるといえる（弘田・紙谷, 1993）。表5には、伐採前および伐採後2年間の木本および草本種の個体数の変化を示した。草本種についてみると、伐採前はオクノカンスゲとユキザサの2種に限られていたが、伐採によって多くの種の出現がみられた。しかしながらこれらの種の多くは、伐採跡地など攪乱地を好む種であり、中でも遷移初期種であるベニバナボロギクの優占が目立った。一方、木本種についても伐採は種組成に大きな影響を及ぼしていた。オオバクロモジ、コシアブラ、ササ（チシマザサ・クマイザサ）などは、伐採によって幹数がいったんは減少したものの、ふたたび増加に転じ、回復途上にある種群であった。また、ホオノキ、アブラ

表4. 伐採前後の林分構造の変化

ブナ皆伐母樹保残施業地（調査地：新潟県上川村）

	1998（伐採前）		2000	
種名	胸高断面積合計 (m^2/ha)	密度 (/ha)	胸高断面積合計 (m^2/ha)	密度 (/ha)
アブラチャン	0.0	7.5	–	–
イタヤカエデ	1.6	12.5	–	–
イヌザクラ	0.1	27.5	–	–
ウワミズザクラ	0.1	10	–	–
オオツリバナ	0.0	7.5	–	–
シナノキ	0.0	5	–	–
テツカエデ	0.1	17.5	–	–
トチノキ	15.5	37.5	–	–
ハウチワカエデ	0.3	10	–	–
ブナ	21.8	57.5	3.0	7.5
ホオノキ	4.1	32.5	–	–
合計	43.6	225	3.0	7.5

表5. 伐採前および伐採後2年間の幹・個体数

ブナ皆伐母樹保残施業地（調査地：新潟県上川村）

種名	1998（伐採前	1999	2000
木本（幹数/m^2）			
アブラチャン	1.9	3.1	2.9
イタヤカエデ	1.4	0.3	0.3
イワガラミ	0.3		
ウワミズザクラ	0.9	0.1	0.1
エゾユズリハ	0.3	0.1	0.1
オオツリバナ	0.1		
オオバクロモジ	6.3	0.4	3.7
キハダ		0.6	1.0
クマイチゴ			0.2
コシアブラ	0.7	0.2	0.3
ササ（チシマザサ・クマイザサ	11.8	1.0	4.7
シナノキ	0.1		
タラノキ		0.2	0.1
ツタ			0.1
ツタウルシ	6.3	4.0	22%*
ツノハシバミ	0.2		
ツリバナ	0.2		
テツカエデ	1.3		
トチノキ	0.3		
ハイイヌガヤ	9.9	1.7	5.4
ハウチワカエデ	0.1		
ハクウンボク	0.1		0.1
ハリギリ			0.1
ヒトツバカエデ	0.1		
ヒメアオキ	23.2	3.3	5.7
ヒメモチ	2.4		0.2
ブナ	9.1	1.0	1.0
ホオノキ	0.1	4.1	3.1
マタタビ		0.1	
ミズキ			0.3
ムシカリ	11.1	0.3	0.5
モミジイチゴ		0.1	
ミヤマイボタ	0.4		
ヤマウルシ	0.1		
ヤマブドウ			0.1
ヤマモミジ	0.1		
合計	81.7	16.1	29.5
草本			
イネ科			0.1
オクノカンスゲ	1.5	1.3	2.3
オタカラコウ		0.1	
ススキ		0.3	0.3
チジミザサ			0.3
ベニバナボロギク		4.6	71.5
ミゾソバ		0.1	
ミゾシダ			0.1
ユキザサ	0.3		0.1
合計	1.8	6.3	74.5

＊ 2000年の調査におけるツタウルシは、幹単位での把握が困難であったため、被度で把握した。

チャンなどは伐採後に幹数を顕著に増加させていた。伐採後に新たに出現した種としては、キハダ、ハリギリ、タラノキ、ミズキなどがあげられた。しかし一方で、これら以外の中・高木性樹種の多くは出現数を減少させていた。出現種数の総数でみると、伐採前に27種みられたのが、22種に減少していた。中でも、伐採以前に林床において高い密度で生育していたブナ稚樹のほとんどが伐採によって消失していた。ブナ稚樹は比較的高い耐陰性を持ち、他の植生下でも生存が可能ではあるが、確実な更新のためには、光環境改善直後の初期成長が重要である（Yoshida and Kamitani, 1991）。

この調査地では、2000年の秋にブナの種子が結実していることが観察された。この種子落下からの更新がどれだけ今後の林分構造形成に貢献できるかが今後の継続調査における重要なポイントであるが、ササや他の樹木に対する競争下において、ブナ稚樹はこの幹密度を維持することさえ困難であると予想される。一方では、伐採と種子豊作年とのタイミングが一致した場合には、ブナの優占度がある程度は維持される可能性も考えられ、そうした林分での継続調査も必要である。しかしいずれにしても、ブナ以外の草本・木本種の変化は、ほとんど皆伐地の状況と変わりないともいえ、このような強度の伐採を伴う施業では、ブナ林特有の構造や種構成を維持することは不可能であると結論せざるを得ない。

5. まとめ

針広混交林の択伐は、更新適地の減少を招く一方で、期待された光環境の改善でも、有効に寄与するとは認められなかった。これらの点からみて、調査地域においては、強度の択伐施業を持続的に継続するのは難しいと考えられた。今後こうした施業地を、健全な生態系に復元するために、ササ植被のコントロールや倒木・マウンドの確保・維持等を検討することが必要であろう。

一方、ブナ皆伐母樹保残施業地において、保残された母樹はほとんど機能していなかった。調査地は当面、中低木の疎林として推移すると考えられ、植栽などの方法を採らない限り原植生に近い生態系への復元は困難であると考えられた。

非皆伐施業は、皆伐に比べて生態系への負のインパクトが比較的少ないと考えられるが、今回調査を行なった択伐施業地、皆伐母樹保残施業地のいずれにおいても、持続可能性という点から見ると大きな課題が残っていた。今後、森林資源の利用と生態系の保全とを両立させていくためには、上述のような地域に固有な生態的プロセスを充分に考慮した施業、伐採率をより低く抑えた施業を検討する必要がある。また現実には、本研究で示されたように、すでに施業が終了しその後不十分な回復状況で放置された林分が大面積に存在すると考えられることから、こうした林分の復元を考えることがより重要な課題であろう。

6. 謝辞

本研究に助成していただきましたプロ・ナトゥーラ・ファンドに深く感謝いたします。現地調査にご協力いただいた、久保田康裕、久保田加奈、藤田真人、阿部みどり、石黒奈々、新井伸昌、野口麻穂子、藤田知則の各氏にお礼申し上げます。

7. 引用文献

藤森隆郎（1991）多様な森林施業, 全国林業改良普及協会, 東京, 191pp.

春木雅寛（1982）十勝川源流部原生自然環境保全地域のエゾマツ、トドマツの倒木更新過程, 十勝川源流部原生自然環境保全地域調査報告書, 219－230.

弘田潤・紙谷智彦（1993）天然下種更新施業後のブナ林における結実と堅果散布に与える母樹密度の影響, 日林誌75, 313－320.

Hunter Jr. M. L.（Ed.）（1999）Maintaining biodiversity in forest ecosystems. Cambridge University Press, Cambridge, 698pp.

Kamitani, T., and Yoshida, T.（1991）The growth response of beech（*Fagus crenata* BLUME）seedlings to the cutting of overstory. J. Jpn. For. Sci., 73, 154－157.

Kubota, Y., Konno, Y., and Hiura, T. (1994) Stand structure and growth patterns of understorey trees in a coniferous forest, Taisetsuzan National Park, northern Japan. Ecol. Res., 9, 333–341.

久保田康裕・渡辺展之・渡辺修・紺野康夫 (1994) 十勝川源流部原生自然環境保全地域における北方森林群集のサイズ構造と林分の更新過程, 十勝川源流部原生自然環境保全地域調査報告書, 3–16.

Nagaike, T., Kubota, Y., and Watanabe, N., (1999) The effects of selective logging on stand structure and the regeneration of subboreal forests in Hokkaido, northern Japan. J. For. Res., 4, 41–45.

van Wagner, C. E. (1968) The line intersect method in forest fuel sampling. For. Sci. 14, 20–26.

Summary

Objective of this study is to explore implications for sustainable forest management in northern and central Japan. We surveyed present ecological situations of forests where non-clearcut management had be conducted. Tokachi-mitsumata and Uryu forest in Hokkaido are subboreal mixed forests under selective logging system, and Kamikawa forest in Niigata is beech forest under shelter-wood logging system.

The results suggested that all these sites were not managed as sustainable in terms of quantity and quality of stand structure, regeneration and vegetation. We have to examine logging rates to be reduced to mitigate structural and compositional changes, and adoption of significant ecological processes applicable for an actual management (e.g. regeneration on fallen-logs in subboreal mixed forests). Because degraded managed forests, as shown in this study, considered to be frequent, restoration of such forests must be essential to maintain forest ecosystems in Japan.

金華山島のシカの高密度化による小型化についての研究

金華山島シカ研究グループ
高槻成紀[1)]・南　正人[2)]・大西信正[2)]・伊藤健彦[3)]

A study on size reduction of sika deer caused by overpopulation on Kinkazan Island

Kinkazan Sika Deer Research Group
Seiki Takatsuki[1)], Masato Minami[2)], Nobumasa Onishi[2)], and Takehiko Ito[3)]

宮城県の金華山島では1967年以来継続的にシカ個体数の調査がおこなわれており、その間に2度の大量死が確認された。2000年3月の調査結果によると448頭が生息していると推定され、1997年からの回復はすでに達成されたらしい。生け捕りによる外部計測の結果、金華山島のシカは本土のシカよりも体重でオスが30％、メスが25％も小さいことがわかった。オスのほうが小型化が著しいのは一夫多妻制における繁殖戦略の性差によるものと考えられる。この小型化は大量死後の食料条件の好転とその後の劣化とも関連していた。これらの結果にもとづいて大型獣の個体群動態の研究には長期継続調査が重要であることと、個体数のみならず個体レベルでの質的変化を明らかにすることの重要性を、保全生物学との関連で論じた。

宮城県の金華山島は面積約10km^{2}の小島であり、捕食者がおらず狩猟もないためシカが増加し高密度で生活している。そのため植生など生態系全体へ強い影響を及ぼしている。このようなキーストーン種の役割を理解することは自然保護にとっても重要であるが、ことに金華山島のシカの場合には過剰密度集団によってどのような生物学現象がみられるかを知ることができるという意味で、現在日本各地で起きているシカ問題を考える上でも有意義である。同じ主旨でこれまでにも調査を計画し、PRO NATURAファンド助成を受けることができた。この間1997年には大量死が起き、それまで500頭レベルを維持してきたシカ個体数が半減した。これはシカにとっては不幸な出来事であったが、島における長期継続研究の重要性を改めて示唆するものでもあった。その後個体数は順調に回復しており、この回復過程を正確に記録しておくことはきわめて重要な意味がある。それと同時にこれまでの個体群生態学では、個体数のみが重視されるきらいがあったが、生態学的にはシカ個体レベルで起きている現象、たとえばサイズの小型化や繁殖率の低下なども総合的にとらえられてはじめて高密度の影響を理解する事ができる。このような研究はごく限られた例しか知られておらず、自然保護にとっても貢献するところが大きい。

このような背景から、これまでも継続してきたシカの個体数調査を行った。またこれまでの調査

1) 東京大学総合研究博物館（The University Museum, The University of Tokyo）
2) ピッキオ／星野ワイルドライフリサーチセンター（Piccio／Hoshino Wildlife Research Center）
3) 東北大学大学院・理学研究科（Department of Biology, Faculty of Science, Tohoku University）

により100頭近くのシカは個体識別ができており、生け捕りにする方法も確立している。そこでこれらを生け捕りにして体重を含む外部計測を行い、本土のシカ（岩手県五葉山の集団）との比較を行った。これに加えて出生率の調査も行ったが、現在解析中なので、本報告では小型化について報告することとした。

支援いただいたPRO NATURAファンドと、困難な調査に協力いただいた東京大学、東北大学、石巻専修大学、東京環境工科学園（東洋工業専門学校）などの学生諸君、アースウォッチの皆さんに感謝します。

調査地と方法

金華山島の概況については一昨年度の報告書に記したので省略する。シカの頭数は区画法を用い、2000年3月に島を20の区画に分け、33人の調査員によって調査した。

シカの生け捕りは神社が行う「角切り行事」のために作られたパドックにシカを入れ、数頭を追い出してネットにからませて捕獲した。捕獲したシカは目隠しをしたあと、ゴムチューブで四肢をしばって保定した。このシカを家畜用体重測定機に載せ、体重を0.1kgの精度で測定した。一部の個体は人に馴れているため、餌でおびき寄せて測定機に乗せて測定した。

結果と考察

1. 個体数調査

2000年3月の個体数調査の結果は表1のとおりである。実際に発見されたのは374頭で、面積の按分により島全体には447.9頭が生息すると推定された。これは1999年の509.2頭よりかなり少なかった。内訳はメスが192頭、オスが117頭で性比は1.64：1であった。これは1999年の1.73：1と違わなかった。子ジカは40頭発見され、100頭のメスに対する子ジカの割合は20.8頭であった。これは1999年の37.6頭よりも少なく、出生率が頭打ちになったことを示唆する。

これに基づいてこれまでの金華山島のシカ個体数変動を図1に示す。これをみると、金華山島のシカ個体数は500－600頭という島の環境収容力に達すると、寒波などによって10年程度の間隔で大量死を起こし、3、4年で回復するという過程を繰り返しているようである。

シカを含む有蹄類の個体数変動については、新しい環境に導入された集団が爆発的に増加して食料を食べ尽くして崩壊するとするもの（Rasmussen, 1941； Leopold, 1943； Klein, 1968）と、同じように爆発崩壊をするが崩壊は小規模で最終的には植生とのバランスを保ちながら平衡状態に達するとする考え方（Caughley, 1977）が主流であった。しかし最近ではむしろ環境収容力に

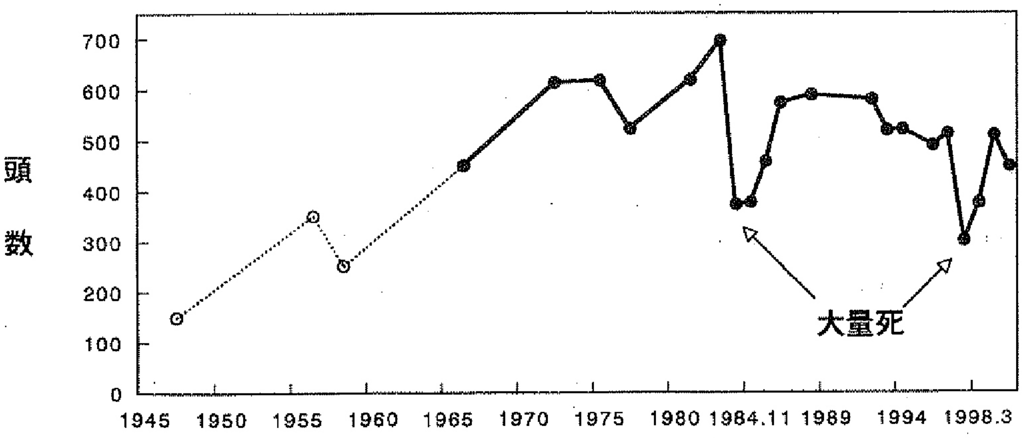


図1. 金華山島におけるシカ頭数の変化．○は推定値．

表1. 金華山島におけるシカ頭数調査結果（2000年3月11日）

Mはオスで右側の数字は枝角数. Mcは角を切られたオス, M？は角が不明なオス. Fはメス, bは子ジカ, Uは不明.

＊；調査した区画の合計面積.

区画	面積	M1	M2	M3	M4	Mc	M?	M	F	b	U	頭数	密度
								小計					
	ha												/km2
1	43.3	0	0	3	1	0	0	4	0	1	6	11	25.4
2	37.5	2	1	2	3	0	0	8	19	4	2	33	88.1
3	50.8											未調査	
4	43.3											未調査	
5	115.7	0	1	0	5	0	5	11	5	1	7	24	20.7
6	66.6	0	0	0	0	0	5	5	6	1		12	18.0
7	49.9	0	0	0	0	0	0	0	5	0	0	5	10.0
8a	40.2											未調査	
8b	28.9	0	0	0	0	0	0	0	0	0	2	2	6.9
9	48.3	3	0	4	2	0	1	10	10	2	0	22	45.6
10	29.8	0	0	0	0	0	0	0	3	0	2	5	16.8
11a	24.0											未調査	
11b	22.8	0	0	1	5	0	0	6	3	1	0	10	43.9
12	37.5	0	0	0	0	0	1	1	6	2	0	9	24.0
13	39.1	1	0	0	1	0	0	2	4	0	4	10	18.0
14	51.6	0	1	0	2	0	0	3	5	1	0	9	17.4
15	49.1	2	0	0	7	0	0	9	14	5	1	29	59.0
16	33.3	0	0	2	3	1	0	6	11	1	1	19	57.1
17北，南	61.6	0	0	1	1	1	2	5	12	3	0	20	32.5
18	29.1	5			1	9		15	45	6		66	226.8
19	37.5	1	3	3				7	26	3		36	96.1
20	19.1	8		2	12	3		25	18	9		52	
合計	800.6*	22	6	18	43	14	14	117	192	40	25	374	46.7

調査	800.6	22.0	6.0	18.0	43.0	14.0	14.0	117.0	192.0	40.0	25.0	374.0	46.7
未調査	158.3	4.3	1.2	3.6	8.5	2.8	2.8	23.1	38.0	7.9	4.9	73.9	46.7
合計	958.9	26.3	7.2	21.6	51.5	16.8	16.8	140.1	230.0	47.9	29.9	447.9	46.7

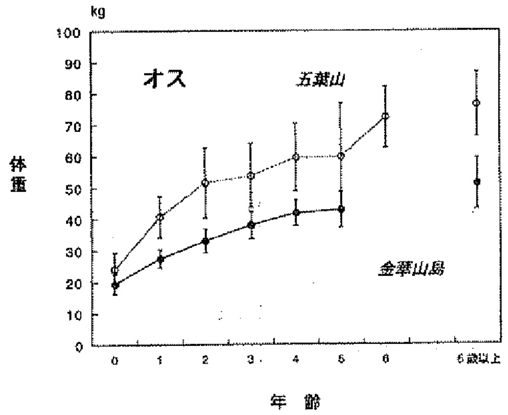


図2. 金華山島と五葉山のオスの体重増加曲線.
縦軸：標準偏差

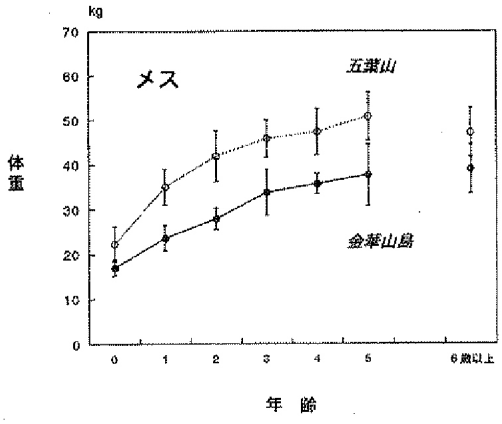


図3. 金華山島と五葉山のメスの体重増加曲線.
縦軸：標準偏差

達したのちに、環境変動に応じて減少し、また回復するという過程を繰り返すとする考え方が提出され（Clutton-Brock *et al.*, 1991)、議論は現在も続いている。金華山島の結果は後者が正しいらしいことを支持するが、このことの一般性については調査地の特性を十分に理解したうえで検討させる必要がある（高槻, 2000)。

2. 小型化

計測部位のうち、分析の終わった体重の結果をオスとメスについてそれぞれ図2と図3に示した。この数字は1991年以来の測定値を年令別にまとめたものである。オスでは4歳くらいまで体重増加が見られ、その後43kg前後で頭打ちになった。図には五葉山のオスの体重も示したが、つねに金華山島よりも大きく成獣になると80kgにもなった。一方、メスの場合、3歳でほぼ頭打ちになり38kg 前後で安定した。このパターンは五葉山のメスでも同様であったが、最終到達体重は50kgにもなった。

今回の結果でひとつ注目されたのは、金華山島のオスの体重が4、5歳で頭打ちになったが、この値が現在6歳以上の成獣の値（51.2kg）よりも16%も軽かったという事実である（図2)。これには時間的経過を考慮しなければならない。金華山島では1984年と1997年に大量死があった（Takatsuki *et al*, 1990, 1994；高槻ら, 1998)。現在成獣になっているシカは1984年以降生まれで、シカの密度が低い、比較的食料事情のよい時代に生長した集団である。これに対して現在5歳以下のシカは頭数が回復して、高密度下で食料不足の時代に生長した集団である。同じ「成獣」に達した個体にみられた体重差はこの事情を反映している可能性が大きく、今後の体重の推移が注目される。ただし、同様のことはメスにも起きてもよいはずであるが、メスの場合、その違いはわずか3.3%に過ぎなかった（図3)。このことは、環境劣化にともなう小型化がオスとメスに同じようには働かず、オスのほうに強く働くことを強く示唆する。逆にいえば環境がよくなった場合にはオスのほうがいち早く大きくなることを意味する。おそらくニホンジカのような一夫多妻制の社会をもつ種においては、大型化することの適応的意義、つまり繁殖成功度の向上が、メスよりもオスにおいてサイズ依存的なのであろう。このことは体格の大きいオスが社会的地位が高く、そのようなオスが交尾数、交尾するメスの数が多いこと（南, 未発表）によっても支持される。

以上の結果は金華山島のシカが本土のシカよりも明らかに小さいこと、その程度がオスにおいてより著しいことを示している。

3. 保全との関連

この調査によって明らかになったことを保全との関連で2つだけ指摘しておきたい。

ひとつは長期継続調査の重要性という点である。金華山島では1967年以降シカの頭数が継続的に調査されてきた。それ以前については断片的な情報しかないが、1967年以降でも30年以上経過しており、世界的にみても息の長い研究となっている。この間、少なくとも2度の大量死がおき、その実態が正確に記録された（Takatsuki *et al.*, 1990, 1994）。このこともこの研究の価値を高めている。おそらくこの研究により、従来教科書的に信じられてきた爆発・崩壊説や爆発・崩壊・平衡モデルなどは誤りであったことが証明されるであろう。これらはひとえに困難な中を多くの協力者に支えられながら根気強く調査を継続してきたことによっている。生物学の理論的研究にとって大型獣は寿命の長さゆえに困難なものである。しかし保全という観点からすれば、大型獣の保全はキーストーン種としての重要さからきわめて重大な意味をもっている。したがっていかに困難であっても時間をかけてその実態を把握しなければならない。

もうひとつは、有蹄類の個体群変動はいわゆる個体数を論じるだけでは不十分であるという点である。個体数変動の重要さはすでにふれたが、この調査で明らかになったのは、その個体数がシカのサイズと密接に関連していたということである。このことはすでに指摘されているが、本研究で明らかにされたのは、シカのサイズが同じ場所でも経時的に変化する可能性があるということ、しかもそれが雌雄で違うらしいということである。また今回報告に至らなかったが、メスの出生率も個体数変動と密接にリンクしている。これらの興味深い現象はシカ個体の食糧事情に関連し、シカの食性は生息地の植物群落の構造や動態に影響をおよぼす。これらのことが総合的に理解されなければ、単なる個体数変動だけでは生物学的な意義、そしてシカの生息する地域の保全にとって真の力にはなりえない。

以上の2点はひとり金華山島のシカの問題にとどまらず、広く有蹄類のいる生態系の保全に敷衍されることである。

文献

Caughley, G.（1977）Analysis of Vertebrate Populations. Wiley, Chichester.

Clutton-Brock, T. O. F. Price, S. D. Albon and P. A. Jewell （1991） Persistent instability and population regulation in Soay sheep. Journal of Animal Ecology, 60：593－608.

Klein, D. R. （1968）The introduction, increase, and crash of reindeer on St. Mathew Island. Journal of Wildlife Management, 32：350－367.

Leopold, A.（1943）Deer irruptions. Wiconsin Conservation Bulletin., 8：3－11.

Rasmussen, I. D. （1941） Biotic communities of Kaibab Plateau, Arizona. Ecological Monographs, 3：229－275.

Takatsuki, S., S. Miura, K. Suzuki and K, Ito （1991）Age structure of mass mortality in the sika deer （*Cervus nippon*） population on Kinkazan Island, northern Japan. J. Mammal. Soc. Japan, 15：91－98.

Takatsuki, S., K. Suzuki and I. Suzuki（1994）A mass-mortality of Sika deer on Kinkazan Island, northern Japan. Ecological Research, 9：215－223.

高槻成紀. 2000. シカ個体群の爆発と崩壊－自然現象を見る視点について－. 科学, 70：1091-1099.

高槻成紀・南　正人・大西信正・伊藤健彦. 1998. 半野生ジカの給餌が栄養と個体群動態に及ぼす影響－1997年に起きた金華山島のシカの大量死－. プロナトゥーラ・ファンド第7期助成成果報告書：45－51.

Summary

A census of the sika deer population on Kinkazan Island, northern Japan was carried out in March, 2000, which estimated the deer number as 448 on the island (9.6 km^2). The census records for over 30 years indicate that the population dynamics of sika deer on the island show a high density which is attained by no predation, while it is reduced by density independent mortality factors including cold winters for every decades. This supports the observation on a population of wild sheep on St. Kilda, Scotland, rather than the " eruption-collapse" or " equilibrium" model. The deer on Kinkazan Island were apparently smaller than those on the main island, particularly for males. This suggests that the food shortage suppresses more strongly males than females, which must be caused by the difference in reproductive strategies between the sexes. Necessity of a long-term study including not only population dynamics but also deer characteristics, food habits, and habitat relations is stressed.

第2回早池峰フォーラムの開催

早池峰フォーラム実行委員会
多田和広・井上祐治・望月達也・千葉　和・
奥畑充幸・中嶋敬治・湯浅俊行

2 nd Forum in session HAYACHINE 1999

Executive committee of Hayachine Forum
Kazuhiro Tada, Yuji Inoue, Tatsuya Motiduki, Kazu Chiba,
Mituyuki Okuhata, Keiji Nakajima, Toshiyuki Yuasa

1. 第2回早池峰フォーラムの開催

<日時と場所>1999年11月28日　盛岡市ふれあいランド岩手（当日参加者90名）

<内容>

第一部　早池峰からの報告　13:00－14:00

○今年の早池峰地域を振り返る
○早池峰山頂避難小屋トイレ
○岩手インターハイ
○集団登山に関する報告

第二部　早池峰のこれからを考える　14:20－16:50

○県ならびに早池峰フォーラムの今後の取り組みについて
○早池峰地域保全対策懇談会について
○会場参加者のフリートーク

2. 啓発用リーフレット「早池峰入山者心得七箇条」

1万部を発行し、無料配布を行った。配布は早池峰の各登山口ならびに麓の施設においたのと、7－8月の週末に登山者に直接手渡しするという方法で実施した。また、マスコミにも宣伝し、希望者には郵送するということも行った。県外からの問い合わせが多く、かつ非常に好評であったことも付け加えておきたい。

3. 携帯トイレ無料配布キャンペーンの実施

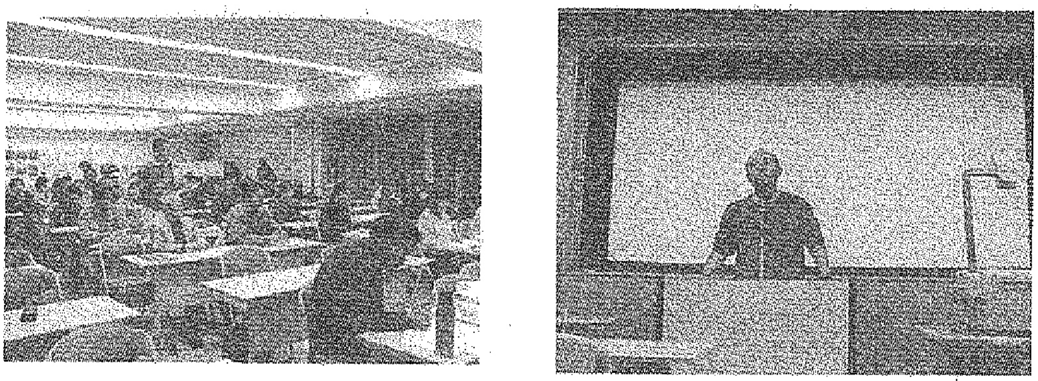
携帯トイレ（サニタクリーン）1000個を購入し、登山シーズン中の7月20日、8月15日の両日、無料配布キャンペーンを行った。早池峰の各登山口、それに山頂にも人員を配して、希望者に手渡すという手法をとったが、ほとんどの人が欲しい、使ってみたかったという反応を得られた。また、携帯トイレ（山の持ち帰り）に関する意識調査も行った。昨年から始めたキャンペーンであるが、携帯トイレの知名度も、確実に上がっていることを実感することができた。

4. 「早池峰の森と酸性雨」講演会と現地調査

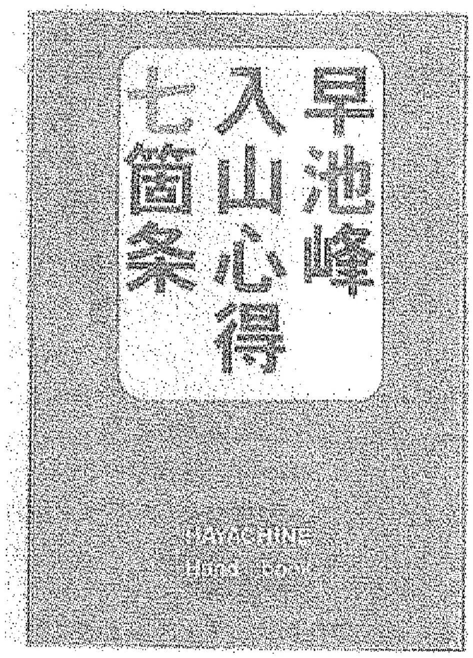
現地調査・講師　森林（やま）の会・事務局長宮下正次氏。

全国の山で酸性雨の実態を調査している宮下さんに早池峰に来てもらって、調査をしてもらうと共に、酸性雨に関する講演会を行った。

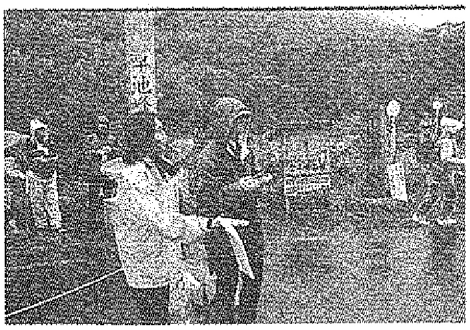
講演の中で、宮下氏は「早池峰の森が危機的状況にある」と診断し、私達も驚いた。小田越付近のオオシラビソは息絶え絶え、下のブナ林の土壌pHは3.6とこれもギリギリの線だという。早急な対策を打たねばならない時にもはや来ていることを参加者一同実感した。



第2回早池峰フォーラム会場の様子（1999.11.28）



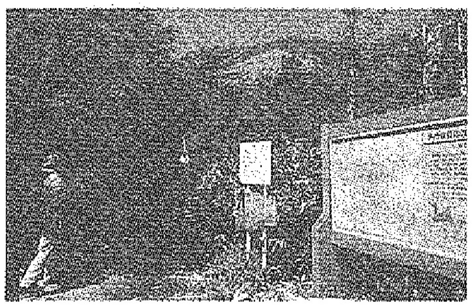
早池峰入山心得七箇条リーフレット



携帯トイレモニターキャンペーンの実施

7月20日

8月15日



フォーラムプレイベント

「早池峰の森と酸性雨」

現地調査の様子

上：講師の宮下正次氏

中：小田越登山口

下：小田越付近　梢枯れを起こすオオシラビソ

利根川の水と自然を守るプロジェクト

利根川の水と自然を守る取手連絡会
近藤欣子・武藤千鶴子・篠田信吾・香山建雄・
山田涼子・小林幸子・軽部仁・鈴木好晴・和田恒夫・
豊田惣一・町田健一・林　都・清水弘道

A Project to preserve Water & Nature of Tone River

Toride Conf. for Preservation of Water & Nature of Tone River
Yoshiko Kondo, Chizuko Muto, Shingo Shinoda, Takeo Kayama,
Ryoko Yamada, Sachiko Kobayashi, Jin Karube, Yoshiharu Suzuki, Tsuneo Wada,
Souiti Toyoda, Kenichi Machida, Miyako Hayashi, Hiromichi Shimizu

利根川河川敷の自然のすばらしさを多くの市民に知らせ守るために、また市民の飲み水となる利根川の水質に関心をもってもらうために以下の活動を行った。

1）水質調査

利根川本流5地点と、それに注がれる7カ所の排水路の化学的水質調査を6回（偶数月）行った。また、近辺にはゴルフ場が3カ所あること、ゴミ焼却場があること、田園があることから農薬散布時にヌカエビを使った農薬検査と魚の雌雄比較による環境ホルモン調査を2回行った。

化学的調査では、取手の最上流地点から最下流地点に流下するにしたがい汚染度が高くなり排水路からの汚い水が影響していることがわかった。市民より下水道処理施設から未処理の汚水が流されているとの情報を得、11月～1月の90日間、観察と一部CODおよびBODの検査をした。

農薬検査ではヌカエびの斃死がほとんどなく、散布農薬の内、殺虫剤が中止になったことと関係があると推察される。環境ホルモン調査では雌雄の比率に偏りがみられ今後も観察が必要と感じた。

2）ウオッチング

6回（奇数月）行った。5月からはウオッチング時に市役所からゴミ袋の提供を受けゴミ拾いも行った。ノウルシ、ミゾコウジュ等の絶滅危惧種やハンゲショウ、ウナギツカミ、アザミ、その他種々の植物の群落が見られた。3月のウオッチング時にはオオタカが観察でき、河川敷の自然の多様性を実感した。

3）自然教育

ともすれば自然と離れがちな現代の子供達に利根川のすばらしさを体験しながら自然のメカニズムを学んでもらい、どうすれば人間と自然が共生できるかを考えるきっかけとなるよう自然教室を実施した。今年はより良い教室が開催できるようにと3名の運営委員が霞ケ浦研究会主催の環境教育講座に参加し多くを学んだ。取手市主催の消費生活展にも「もっと利根川に親しもう」というテーマで参加し、市民の関心と共感を得た。

4）他団体との交流

3団体と機関紙交換

5）行政への要望

利根川河川敷活用懇談会へ公募意見書提出。11月～1月の下水道処理施設からの排水調査をもとに4月下水道組合へ改善要望書提出。5月要望書受理(2000年10月に汚水垂れ流しが続いていたことが判明、目下再要望書、請願書提出中)。

6）広報紙の発行

《すみれだより》9号発行。

下水道組合との話し合い　改善要求書提出時

ウォッチング＆クリーンウォーク（ゴミひろい）

自然教室　船の中にて

水質調査　pHの測定

リーフレット「ようこそ谷津干潟へ」製作

千葉の干潟を守る会
大浜　清・石川　勉・田久保晴孝・飯島滋哉・
大浜和子・川西清子・国松俊英・佐藤有子・
牛野くみ子・杉本秀樹・和波一夫

Welcome to Yatsuhigata

Save Tidal Flats in Chiba, Association to

Kiyoshi Ohama, Tsutomu Ishikawa, Harutaka Takubo, Sigeya Iijima,
Kazuko Ohama, Kiyoko Kawanishi, Toshihide Kunimatu, Yuko Sato,
Kumiko Ushino, Hideki Sugimoto, Kazuo Wanami

目的

1960年代半ばまで、東京湾湾奥の海岸は自然のままの干潟で、潮干狩りの名所でした。しかし、それから10年のうちに、あの広いゆたかな海も一気に埋められました。東京湾奥の京葉港埋立地の一画に残った干潟に生息地を失った鳥たちが集まり、私たちはここを谷津干潟と名づけ、この干潟の保全運動をすすめました。1993年、谷津干潟はラムサール条約登録湿地に指定されました。野鳥など多様な生き物が生息する谷津干潟の来歴と現状を、そして干潟の大切さを多くの人々に知っていただくために、このリーフレットを作成しました。

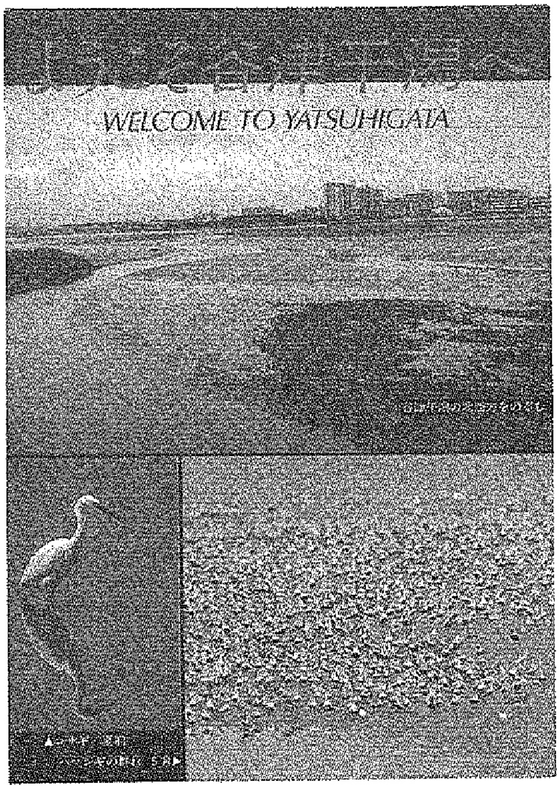
方法

千葉の干潟を守る会、千葉県野鳥の会、谷津干潟環境調査の会などの会員が中心となって、谷津干潟紹介リーフレットの構成を考え、記載内容を決定しました。谷津干潟の歴史については、東京湾の埋め立て反対運動の中心的役割をはたした千葉の干潟を守る会がまとめました。谷津干潟で観察される野鳥の記載については、千葉県野鳥の会の長期にわたる観察結果を利用し表にまとめました。これにより四季折々観察される主な野鳥の種名がわかります。また、代表的野鳥については、これまで撮った多数の写真から選定し、各季節5種をカラー写真で掲載しました。谷津干潟の魚類や底生動物、プランクトン、植物については、上記の会員が観察した結果や、各種の報告資料からデータを集め、イラスト化しました。谷津干潟の経年変化については、習志野市が毎年公表している水質測定結果を利用してまとめました。

結果

大きさA2版、表カラー、裏モノクロのリーフレットに作成しました。紙面を折り、A5版に仕上げ持ち運びしやすくしました。リーフレットは16面で次のような構成です。1）表紙：谷津干潟の風景など、2）案内図とラムサール条約登録湿地の地図、3）～6）野鳥の写真20種、7）谷津干潟の渡り鳥について、8）谷津干潟の主な鳥の種名、9）～10）谷津干潟の魚、貝、カニ、プランクトン、11）谷津干潟の植物、12）干潟の食物連鎖、13）水質、14）底質、15）谷津干潟小史、16）ラムサール条約と谷津干潟の説明、千葉の干潟を守る会などの紹介。

このリーフレットを広く活用していくために、
谷津干潟自然観察センター内にも常備し、観察会、
集会などで配布する予定です。



八方尾根の自然観察ガイド作成のための調査

自然観察指導員長野県連絡会
小川朱実・小山泰弘・大畠春代・石川一朗・斎川祐子・
高見澤信之・村上さよ子・望月明子・山中扶吉子

Reserch by Nature Conservation Educator's in Happoone

Nature Conservation Educator's network in Nagano pref.
Akemi Ogawa, Yasuhiro Koyama, Haruyo Ohata, Ichirou Ishikawa, Yuuko Saikawa,
Nobuyuki Takamisawa, Sayoko Murakami, Akiko Mochiduki, Fukiko Yamanaka

1. 目的

従来の自然観察ガイドは、自然だけを取り上げてその名前などを簡潔に述べたものが主であった。自然観察指導員の自然観察会における役割は個々の名前を言うだけではないと言われていたが、ガイドブックにおいては実現されていない。そこで、自然保護を目標とした自然観察を進めるために必要な自然観察ガイドとは何かを考えながら、自然保護に結びつく観察の視点を獲得し、ガイドブック作成の手がかりとなる調査を行い、必要な情報をとりまとめることを目標とした。

2. 方法

長野冬季五輪において話題となった長野県白馬村の八方尾根を舞台とし、県内の自然観察指導員が専門家の支援も受けながら定期的に観察して、人との関わりで生まれた自然の状況を読みとれる技術を研究した。

3. 結果

季節を変えた継続観察により、自然観察指導員が必要となる観察の視点として、自然を知るという基礎的な情報だけでなく、次の3点を注目することが重要であると判断できた。

1) 地域の自然保護を取り巻く情勢の把握

高山植生の破壊に及ぼす影響として、人の踏みつけなどの直接的影響と、スキーシーズンの利用による間接的な影響が考えられた。実際、スキー場の維持による間接的影響を及ぼす因子はいくつか見つかった。一方、歩道を歩く最盛期でも歩道の利用者が意外に少ない上ロープで守られていた。それでも、シーズンオフには道を外れた人が認められた。

2) 地域住民の意識調査

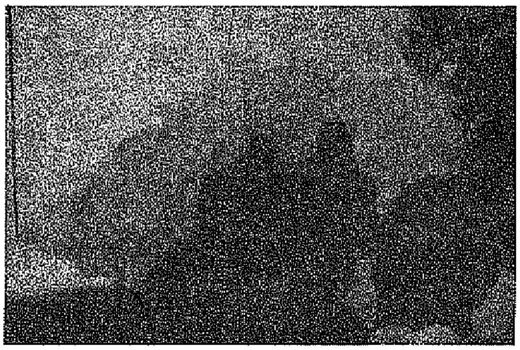
地域に見られた看板には、法規制への理解や環境保全への配慮に対して、疑問となるものが見られ、地域への普及啓発の必要性を痛感した。

3) 利用者のマナー

高標高にも関わらず装備が不十分と思われる利用者や、明らかに国立公園内で蝶を採取しようと入り込んだ人など、マナーに欠ける人間を多く観察した。自然を紹介する以前に、自然への接し方そのものに対する指導が必要になることを感じた。

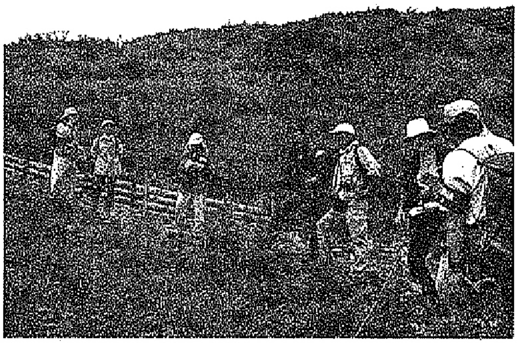
4. まとめ

このように自然だけを見るのではなく、地域で見えるものすべてに目を向けながら「人との関わり」をきっちり押さえて、長いスパンで地元の自然を見ることのでき、地元の意識を変えていく指導員が必要であることを提示することが出来た。



積雪期の断面調査

残雪期の環境調査



最盛期の歩道利用状況調査

第10期プロ・ナトゥーラ・ファンド助成成果報告書（2001）

東中国山地のツキノワグマ個体群保全を目的とした「東中国クマ集会」のまとめと普及活動

東中国クマ集会実行委員会
藤本光博・片山敦司

Wide spread of the result of "The Bear Forum In Higashi-Chugoku Mountain Area" aiming at conservation of the local population of Japanese black bears in this area

The excution committee for The Bear Forum In Higashi-chugoku Mountain Area
Mitsuhiro Fujimoto and Atsushi Katayama

はじめに

「東中国クマ集会実行委員会」は、「東中国山地のツキノワグマ個体群」の保全を主要なテーマとし、地域住民との対話を重ねながらツキノワグマの保護管理のあり方を考えてきた市民団体である。本事業は、「東中国クマ集会」の成果を多くの人に伝え、その普及啓発の機能を強化する目的で行われた。具体的な作業内容は第3回東中国クマ集会報告書の作成と活動の総括としての冊子の作成である。

第3回東中国クマ集会報告書の作成

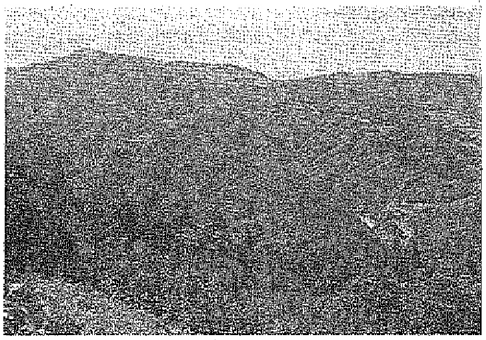
第3回東中国クマ集会は、1999年6月20日に兵庫県養父郡八鹿町で開催された。本事業ではこの集会の報告書の編集・印刷および配布作業を事業の第1段階とした。報告書はA4サイズ116ページモノクロ印刷により3,000部を印刷した。この報告書は、関係各自治体や学校、図書館、研究機関に配布したほか、その後に行った聞き取り調査の対象者に無償で配布した。また、希望者には有償で配布も行い、クマの問題を伝える媒体として役立てることができた。

地元での聞き取り調査と対話

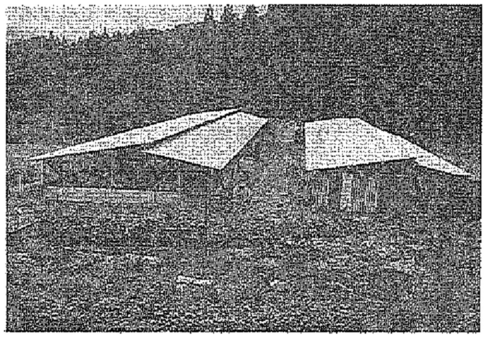
第3回東中国クマ集会の報告を兼ねて、クマの生息情報のある兵庫県下の23の市町と3ヶ所の農林事務所の鳥獣行政担当者にクマの生息状況に関する聞き取り調査をおこなった。これと同時にクマに関わるさまざまな情報を収集して問題点の抽出と地元の関係者とのつながりをもつことに努めた。調査の過程では、小冊子にも掲載した「親子グマの籠城」・「六甲・北摂地域へのツキノワグマの出没」などのトラブルが発生し、そうした事例に対しては実行委員会のメンバーが現場を訪れ、現地での調査や地元の人たちとの対話に心がけた。

小冊子の作成

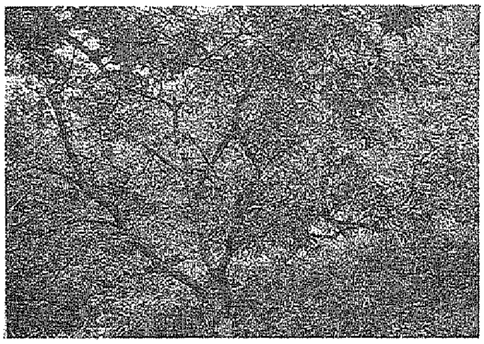
聞き取り調査や地元の人たちとの対話をまとめ、東中国クマ集会のこれまでの活動を総括するために小冊子「ツキノワグマ～東中国クマ集会の活動と保護管理の課題」を作成した。本冊子の体裁はA4版16面とし、2,000部の印刷をおこなった。この冊子は関係者に無償で配布するとともに、希望者には有償で配布し、広く人とクマの問題を考える教材として役立てる予定である。



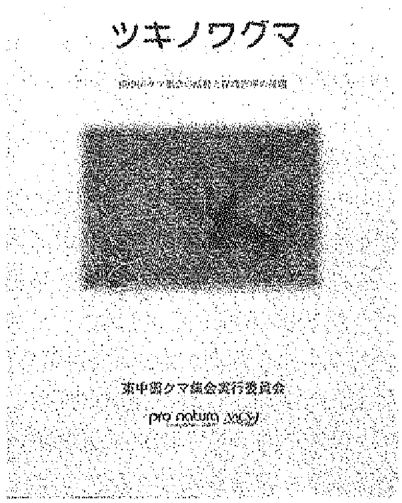
東中国山地（氷ノ山）の中核部（関宮町）



養鶏被害のあった現場（千種町）



栗の食害のあった現場（波賀町）



谷戸田に基層文化を探る

山崎の谷戸を愛する会
相川明子・石井揚子・斉藤直子・淡中京子・
坂斎　明・丸尾早苗・丸山淑子

A Study of Traditional Local Lives around Paddy Fields of Yato, Yamasaki, Kamakura

Yamasaki no Yato o Aisuru kai
Akiko Aikawa, Yoko Ishii, Naoko Saito, Kyoko Tannaka,
Akira Bansai, Sanae Maruo, Yoshiko Maruyama

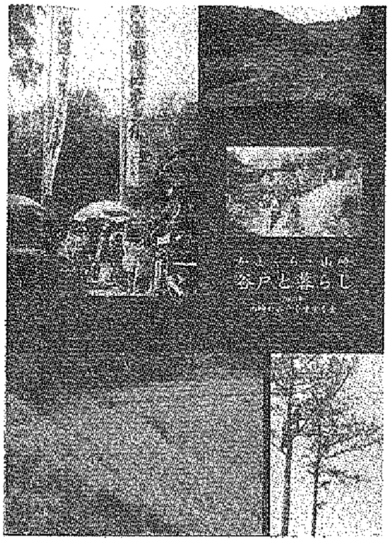
里山景観、谷戸の生態系が残る「山崎の谷戸」は、1966年の都市計画決定で鎌倉市の公園に指定されて以後、手入れが徐々に放置されたが、1990年に「鎌倉中央公園基本計画」が発表された。同時に「山崎の谷戸を愛する会」を発足させ、「谷戸を生かした市民参加の公園づくり」を目指して活動を始めた。平成の世まで残ったわずかな田んぼを維持したいために、会ぐるみで弟子入りして谷戸の米作りを習ったり、炭焼き窯づくりを古老に学んだり、会の出発点である青空自主保育「なかよし会」を中心に、子どもの遊び場としての谷戸の重要性を周知するための企画を行ったりと、様々な方法手段で目的達成のために活動してきた。

1996年に市は「修正案」を出し、田んぼや湿地が少しは残ることになったが、「防災公園」の名目で国の補助金を申請しているため、従来の土木工事による一般的な都市公園になりつつある。この時代に逆行した計画を幾らかでも食い止めるための、ほとんど最終手段として、このたびの記録集づくりが急がれた。

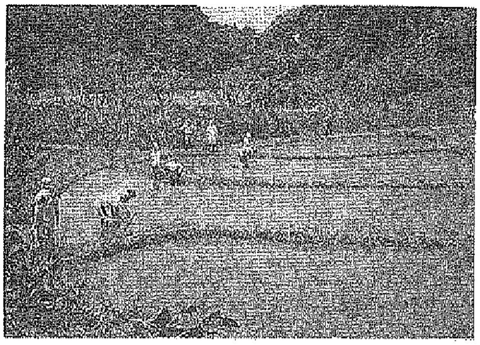
実際に山崎で、燃料革命、肥料革命以前の「谷戸の百姓」をされていた方は数少なくなっており、昔の知恵を聞き取っておく緊急性を実感していたが、目の前でどんどん破壊されていく里山景観がどれほど貴重であるかを、昔のくらし方を学び、まとめることで訴える必要も、一刻を争う状態になってきた。

聞き取り調査を約25人に行い、昭和の初めから戦前頃を中心にした谷戸での農作業の詳細を記録することから、昔の暮らしや、今も残る古式ゆかしい年中行事についてをまとめ、さらに山崎の地名や史跡の地図、今はなきかつての谷戸の写真をできるだけ多く掲載した。本来は重要な民俗調査なので、時間をかけてじっくり聞き取りを行い、質の高い記録集を出したかったし、本助成を受けるにあたってもその点を期待されていたのだが、進行する土木工事に危機感を募らせ、時期を早めて出版の運びとなった。素人の稚拙なまとめではあるが、山崎の多くの方々の積極的な協力により、地域の歴史の記録としても少しは役に立つことができたと思う。

さて、発刊して新聞等に紹介されると、注文が殺到して好評な売れ行きを示した。特に山崎の地元の方々は、「本来は自分たちがやるべきことを代わりにまとめてくれた」と、感謝の意を表された。また、地元の歴史学者は全編にわたる間違いを指摘され、2001年8月には「訂正箇所」のプリントを印刷して、ほぼ完璧な記録集となった。行政もこれを参考にして、今後の整備計画や管理運営を検討してほしい。



記録集「かまくら・山崎 谷戸と暮らし」



市民農業体験田畑

草取りをする子どもたち

元地主さんに聞き取りをする

Preliminary Research on Releasing Program of the Crested Ibis (*Nipponia nippon*)

XI Yongmei [1], LU Baozhong [1], FU Wenkai [2], SU Yunshan [3]

Summary

The present study was designed to try a possible release to the wild of the captive-bred Crested Ibis (*Nipponia nippon*). A special attention was paid on preliminary research about reproduction behavior of the endangered Crested Ibis. In breeding season, the Crested Ibis incubated eggs and feed their chicks in turn by male and female in the wild. In the case of captivated birds, they lay eggs and incubate them in turn in the early incubation period, but in captivity, the parents tended to kill the chicks during hatching not post hatching. In the present research project, therefore, we tried to introduce the hand-reared Crested Ibis to a kind of nature condition using parents and chicks which were previously raised by hand rearing in the Yangxian center. Wide range of flight cage was used for one pair to be visually isolated from the others, leading to the results of successful parental care of the Crested Ibis in the captivity. We critically evaluate the usefulness of this preliminary research on reproduction as part of reintroduction of this species, suggesting the possible propagation post-release of the captive-bred Crested Ibis.

Key words: Crested Ibis, reproduction, release

1. Introduction

The Crested Ibis was formerly found from the Russian Far East south through the Koreas and Japan to central China. It has been declining dramatically since the early part of 20th century. By the late 1970s, it was extinct in Russia and Korea (Yamashina, 1977; Archibald, 1981). The last five birds in Japan were captured for possible captive breeding in 1981 (Yamashina, 1983; Ishii, 1999). However, a single Japanese Crested Ibis survived until one pair loaned from China successfully bred at the Sado Ibis Conservation Center in 1999 (Chikatsuji, 1999; Fujihara and Xi, 2000 a,b).

In China, the Crested Ibis (*Nipponia nippon*) had declined to only seven birds, including two breeding pairs and three nestling by 1981 (Liu, 1981). Since then, a conservation project, which has included management of the free-living ibis population and a sort of basic researches, started from the seven ibises (Liu, 1981; Lu *et al.*, 1986 & 1999; Shi, 1990 & 1992; Tan, 1989; Xi and Fujihara, 2000a,b). Some of the scientific researches have been conducted using accidentally died birds (Fan *et al.*, 2000; Liu *et al.*, 1995; Liu *et al.*, 1999; Xi *et al.*, 1999; Yan *et al.*, 1999). With regard to this bird, the 1st International Symposium on this species has been held at Hanzhong, China in 1999. In which most of the researches on the Crested Ibis and some other related endangered birds were discussed from the points of future prospects of this kind of wildlife (Cao *et al.*, 1999;

[1] Shaanxi Crested Ibis Captive Breeding Center China
[2] Shaanxi Wildlife Management Department of Forestry Ministry, China
[3] Environment Culture Institute, Japan

Coulter, 1999; Li *et al.*, 1999; Wang, 1992; Xi *et al.*, 1999; Zheng, 1999). Some of the scientific researches on field observation about the ibis, including general reviews of ibis have also been reported (Cao *et al.*, 1994; Fan *et al.*, 1990; Fujihara and Xi, 2000 a,b; Su *et al.*, 1999; Lu *et al.*, 1999; Liu, 1999; Ma *et al.*, 1999; Toshio Torii, 1999; Wang, 1999; Yu, 1991; Yoshio, 1999; Zhang *et al.*, 1999; Zhai, *et al.*, 1999).

On the other hand, captive-breeding has been difficult and first successfully achieved in 1989, with two chicks survived to one week in Beijing Zoo (Li, 1991). Another captive population began to be established in Yangxian Ibis Breeding Center in 1990 by rescuing few sick and injured chicks and abounded eggs in the wild (Xi *et al.*, 1993; Xi *et al.*, 1997). The birds successfully bred since 1995, thereafter some progeny also joined breeding (Xi *et al.*, 1999).

Hitherto, captive rearing of species with release to the wild has been being an important management technique used in attempts to save species from extinction (Sccott *et al.*, 1987). Some of endangered birds have succeeded, such as Whooping Crane *Grusamericana* (Bender, 1992), California Condor *Gymnogyps californianus* (Kuehler, 1988; Bender, 1993), Hawaiian Goose *Branta sandvicensis* (Black, 1994) and Bald Eagle *Haliaeetus leucocephalus* (Simons, 1988) in United States; Bald Ibis *Geronticus eremita* in Turkey (Akcakaya, 1990; Cade, 1994), and especially Mauritius Kestrel *Falco punctatus* in Mauritius, have been increased from four known birds in 1974 to more than 331 individuals by 1994 (Jones, 1994), suggesting the possibility of rearing the endangered birds by human being in the captivity, though hard task has needed to be successful even some failed and/or are still trying to help threatened species (Clout *et al.*, 1994; Cade *et al.*, 1994; Holt, *et al.*, 1996; Richand *et al.*, 1999; Brownell, 2000).

Therefor, to establish captive population with an intention of reintroduction has been a long term considerable attempts for saving the Crested Ibis in Japan and China. Three captive populations have been built respectively with a number of 7 individuals in Sado Ibis Conservation Center in Japan, 21 individuals in Beijing Zoo and 106 individuals in Yangxian Ibis Breeding Center, resulting of 134 individuals in total. However, of 112 individuals were raised by hand rearing since the abnormality of parental care occurred in captive breeding of the Crested Ibis. It showed that the parents attend to kill the chicks during hatching. It seemed a sign of disadvantages for reintroduction in the future.

In the present research project, we conducted the reasons of this abnormality, focusing on the primary study of reintroduction. It was achieved by reestablished a new cage for one pair to be visually isolated from the others. Fortunately, one chick was successfully produced by parental incubation and care, has fledged. As the result, that the probability of the parental birds loosing the ability of parental care in captivity was rejected. The occurrences of abnormality were because of environment pressure in relatively smaller aviaries. It is indicator of the first step for hopefully reintroduction of the birds in the near future.

2. Materials and the Method

In order to leading the parental incubation and rearing, a large aviary with facility for reproduction was built in the woods in side the breeding center in November 1999 (Fig.1, Fig.2) This aviary was about 80 square meters, located in the middle of the hill. It is 50 meters far from the other breeding cages of the center so as to prevent the birds contacting with other breeding birds. The slope of the hill was used to be the ground of the cage instead of the flat ground. Outside the surrounding of the cage have many pine trees, oak and cypress. This circumstance access the naturally habitat of the wild Crested Ibis. We used the nylon net to be the fence of

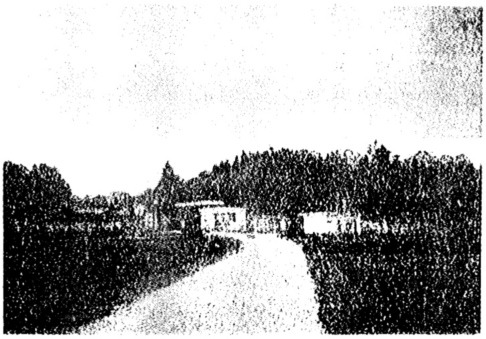


Fig.1 Shaanxi Crested Ibis Captive breeding Center

Fig.2 New breeding cage

the cage in stead of iron net which were used for the breeding cages before (Fig.3) in order to avoid crashing and accident happening. Some branches were arranged on the top of a pine tree inside the cage to be supposed the site of the nest instead of the man-made basket (Fig.4), which were used to be the nest before. A small concrete pond was also provided in the cage for drinking water, eating loach and bathing. A set of TV monitory system, which was facing the nest, was set up at the corner of cage for observing any kinds of breeding activities and reproductive behavior.

After preparation the facility for reproduction, first breeding pair was introduced to this new cage on 3 January, 2000. The male was born in 1996 by captive-bred, with red ring on the left leg and black ring on the right leg. The female was also born in the center in 1996, with blue ring on the left leg and black ring on the right leg. The fresh loach and artificial diets were provided for them (Table 1). Some branches and dried grass were placed on the ground to help the birds building nest. The pair was kept in this condition only for one month without getting any sort of breeding acting and reproductive behavior. Therefor, we moved out this pair, and another new pair was introduced again on 3 February 2000. The male of this pair was two years old and the female was three years old. They are also captive-bred in Yangxian center in 1998 and 1997, respectively.

3. Results

After half a month of setting the second pair in the new cage, the pair started displaying flying together (Fig.5), nacking each other and finally copulating on 17 March 2000 (Fig.6).

To stimulate the behavior of nesting, some of nesting materials was put in the nest site of the pine

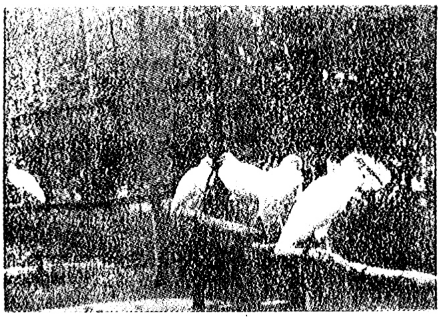


Fig.3 Former breeding cage

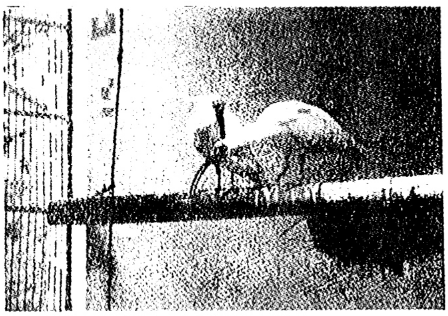


Fig.4 Former breeding nest

Table 1. Basal diet for the adult Crested Ibis breeding season.

Stage	Loach (gm)	Artificial food*(gm)	Mealworm (gm)	Total amount** (gm)
Laying	200	75	50	345
Incubation	200	75	30	315
Rearing(1-20 days)	220	75	100	395
Rearing(20-42 days)	270	75	70	415

*The component of diet for adult birds are: 75% beef, 10% boiled egg, 8% starch (26% corn, 34% wheat, 40% bean) , 5% carrot, 1% milk, 1% yeast, calcium tablets and digestive enzyme tablets.
**Amount for one bird per day

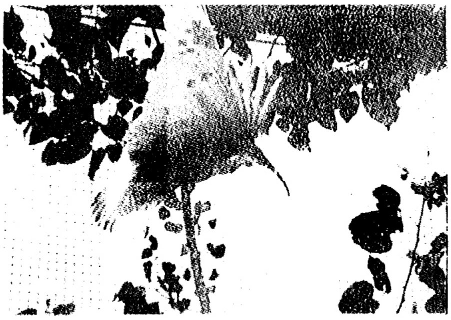


Fig.5 Flying in the new cage

Fig.6 Copulation

tree. However, the birds threw the branches, which were introduced in the nest, away. After that they started picking up the materials from the ground to build the nest by themselves on 22nd of March. In this case, usually, the male took participation in bring the materials to nest and the female prepare and arranged the nest. Sometimes, the female tried to sitting on the nest for a short time. Approximately two days after this appearance of the behavior, the female started laying eggs. The first egg was laid on 29th of March. Since then fresh mealworms were given to the birds on the basis of 100 gram per day. Until 3rd of April 3 eggs were laid, they incubated the eggs themselves in turn. During incubation period, one egg accidentally was broken in the nest on 25th of April, and another egg on 30th of April. The last one was taken out for checking the fertility because that, judging by the incubation period, this one should be hatching 4th of April. It was found this egg was infertile.

Following this treatment, another fertile egg, which was laid by the other breeding pair and just during piping stage, was introduced in the nest to test further incubation by the parental birds. Unfortunately, the pair threw this egg away during its hatching. This series of reproduction was finished for the first clutch. Following this happening, new nestling materials were prepared for the second clutch. Then on 16th of May, they started relaying and two eggs were laid (Fig.7). The parental birds incubated in turn, during this incubation period, one egg was damaged again on 26th of May, but finally, the last egg hatched on 13th of June. This series of events was monitored by TV set; unfortunately, the last chance of the chick hatching was missed by TV monitory due that the trouble happened to the facilities. However, the voice of the chick was heard by our stuff (Fig.8).

14th of June, it was found that the parental birds take care of the chick to feed the first time. The male

Fig.7 Two eggs of the new pair

Fig.8 The parents take care of chick

and female fed the chicks in turn, with about 20 times in total a day.

21st of June, at day 8 the chick's bill was found to grow a slightly long, and the behavior of bugging food from the parental birds was observed.

22nd of June, parental bird protected the chick by making a shedder with their body and feather since sunshine was exceptionally hot at that time.

23rd of June, when it was raining, the parental bird displayed the same behavior as mentioned for strong sunshine previously.

As the chick grew up, gradually increased amount of mealworms were given, together with some kinds of vitamins and artificial diet.

27th of June, the chick was observed grown up to about 800 gram of body weight, displayed moving and standing up for a short time, Since 4th of July, the male and female of parental birds tried to leave for taking food together, leving the chick alone in the nest. After spending several minutes outside the nest, the male or female returned to the nest to feed the chick .

17th of July, the chick with plumed feather could stand on the edge of the nest, showing the practice of flying.

25th of July, the chick tried to fly down on-to the ground to follow the parental birds for feeding (Fig.9). Sometimes, the chick couldn't eat the fresh loach, thus the parents fed the chick again. About 3 days after this behavior, the chick could go and back between the nest and ground to get food freely (Fig.10).

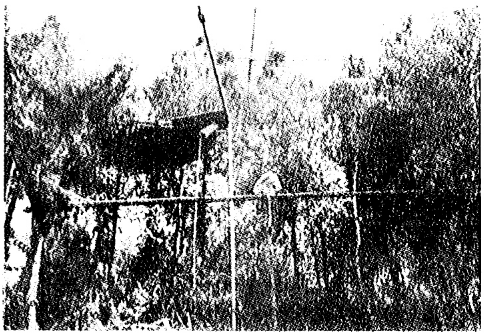


Fig.9 The chick fledged

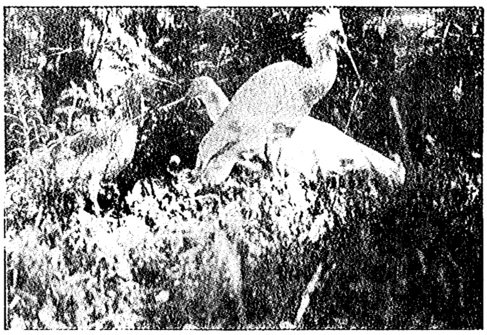


Fig.10 The chick feed by itself

4. Discussion

This experiment is the first to indicate the possibility of parental incubation and rearing, so far the 10 chicks had been killed by the parents during hatching in the previous experiments.

The parental birds killed the hatchlings was occurred in Yangxian center (Xi *et al.*, 1999) also in Beijing Zoo (Li, 1992). We had ever analyzed the reason for it. Two aspect factor probability presented for the Crested Ibises. One is because of incomplete ability of parental care since they were all taken cared by hand rearing. If so it would be fail with the reintroduction program, because that there would not be present propagation when the captive individuals are released to the nature. Another reason is because that limitation of cages size and crowding of vicinity closed breeding cages caused the environment pressure for birds. But carrying out the present experiment rejected the former reason.

As we mentioned the size of cage the former breeding cages were very small in size and very close to each other, this probably induce a kind of stress for the breeding birds. In this experiments wild range of flight cage was used. And this pair couldn't see the other breeding pairs in the center. This experiment was informative for successful parental care in captivity due to environment changes. It suggested that we have to build the breeding cages separately in the future in order to train the offspring for preparing the further reintroduction program.

As W. Conway noted, propagating birds in captivity has the potential to accomplish three main goals: (1) providing a "gene bank" to preserve the unique genetic information of species that have become greatly reduced in number or have disappeared in the wild; (2) providing a source of individuals for use in the management and restoration of rare birds in nature and (3) providing a means of public education, a fourth goal would include scientific research (Cade, 1994).

Breeding the birds in captivity to supply birds for reintroduction emerged as a goal for many endangered species. At least 83 species of falconiform birds had been bred in captivity by 1984 (Cade, 1986), and self-sustaining captive populations now exist for several species. There is every reason to expect that a self-sustaining captive population can be achieved for this species, and prospects for successful reintroduction also look good. Populations of the Peregrine Falcon have been re-established or significantly increased by fostering, cross-fostering and hacking captive-produced or captive-reared young in Germay (c. 30 pairs reintroduced to vacated range, Hussong 1993), southwestern Sweden and adfacent Norway (c. 16-17 pairs reintroduced), eastern and midwestern North American (c. 150 pairs returned to an unoccupied range) and the Greater Yellow Ecosystem (53 pairs in formerly vacant range). The Mauritius Kestrel increased from what was believed to be two surviving pairs in nature to more than 60 pairs by captive breeding, harvesting wild eggs, fostering and hacking (Cade & Jones, 1993). The Bald Eagle has been reintroduced into New York State by hacking wild eaglets mostly from Alaska (Nye, 1988).

Regard to the proposal of the project for the Crested Ibis, we planed to hopefully release some of young birds that would be reared by the parental birds, but it didn't achieved the goal due to small population size of captive birds at the present.

However, the Crested Ibis population has increased sufficiently both in the wild and in captivity. A total of 98 birds were produced in Yangxian Ibis Breeding Center during 6 years (1995-2000). In the wild, about 100 birds were proliferated during around 20 years (Lu, 1999; Shi, 1991; Zhai, 1999). It was likely it would expand into the suitable habitat by reintroduction in the future.

5. Acknowledgements

This project was financially supported by PRO NATURA Foundation that would be greatly appreciated. The authors wish to thank the staff of Yangxian Crested Ibis Breeding Center in China for their kind help throughout the present experiments.

6. Reference

Archibald, G. W. & Lantis, S.D.H. 1978. Conservation of the Japanese Crested Ibis. *Proceedings, 1978 conference of the colonial Waterbird group.* pp.2-11.

Archibald, G. W. & Lantis, S.D.H. 1981. Japanese Crested Ibis-*Nipponia nippon* (Temm.). *The present status// Rare birds of the Far East. Vladivostok.* p.37-46.

Akcakaya, H.R. 1990. Bald Ibis *Geronticus eremita* population in Turkey: an evalution of the captive breeding project for reintroduction. *Biol. Conserv.* 51:225-237.

Black, J.M. & Banko, P. C. 1993. Is the Hawaiian Goose saved from extinction ? In Olney, P. J., Mace, G. & Feister, A. (eds) Creative Conservation: Interactive management of wild and captive animals: 394-410. London: Chapman & Hall.

Black, J.M. 1994. The Nene *Branta sandvicensis* Recovery Initiative: research agains extinction. *IBIS 137:* 153-160.

Cao, Y.H. & Lu, X.Y. 1994. Status and Suggestions of Conservation of the Crested Ibis (in Chinese). *J. Environment of China.* 10 1:17.

Cao, Y.H. & Lu, X.Y., Fu, W. K. 1999. The Crested Ibis Conservation and Local community administration. *Proc. Int. Workshop on the Crested Ibis Conser. '99 Hanzhong,* pp.63-68.

Chikatsuji kokj, 1999, Breeding Crested Ibis in Japan. *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong,* pp.227-228.

Clout, M.N. & Craig, J.L. the conservation of critically endangered flightless birds in New Zealand. *IBIS* 137: 181-190.

Coulter, M.C. 1999. Conservation Status of the Ibises. *Proc. Int. Workshop on the Crested Ibis Conserv.'99. Hanzhong,* pp 219-222.

Errickson, R.C. 1975. Captive breeding of Whooping Cranes at Patuxent Wildlife Research Center. In Martin, R. D. (eds) *Breed endangered Species in Captivity:* 99-114. New York: Academic Press.

Foose, T.J. & Ballou, J.D. 1988. Management of small population. *Int Zoo Yb.* 27: 26-41.

Franklin, I.R. 1980. Evolutionary change in small populations. In Soule, M.E. & Wilcox, B.A. (eds) *Conservation Biology,* an Evolutionary-ecological Perspective: 135-150. Sunderland, Mass.: Sinauer associates Inc

Fan, G.L, Zhou, H.C, Xi, Y.M, Cao, Y.H, Fu, W.K, Lu, B.Z, NAKAYA Y, Fujuhara N. 2000. Pathological characteristics of a dead domestic Crested Ibis in China. *Jpn J Zoo Wild Med* 5: 93-97.

Fujihara N. 1997. Exploitation of valuable genetic resources from wild animals in the world. *New Food Indust,* 39:45-42.

Fujihara N. 1999. Exploitation and reutilization of useful genetic resources from wild animals in the world. *New Food Indust,* 41: 55-63.

Fujihara N, Xi, Y.M. 1999. Genetic resource conservation in the waterfowl. *Proc. World Waterfowl Conf., Taiwan,* pp. 63-69.

Fujihara N, Nakaya Y, Xi, Y.M, Zhang, M.J. 2000. Conservation and reproduction of endangered wild animals, protection of enviroments and the maintenance of biodiversity on the earth. *New Food Indust*, 42:51-59.

Fujihara N, Xi, Y.M. 2000b. Possible application of basically reproduction researches to the restoration of endangered and/or extinct wild animals. *Asian Aus J Anm Sci*, 13: 1026-1034.

Fujihara N, Xi, Y.M. 2000c. Cloned animals - an application of biotechnology, Sust Livestock Prod Human Wel, 54; 443-448.

Hill, D. & P. Ribertson. 1988. Breeding success of wild and hand-reared ring-necked Pheasants. *J. wildl. Manage.* 52: 446-450.

Holt, W. V., Bennett, P.M. & Volobluev, V. Genetic resource banks in wildlife conservation. *J. Zool., Lond.* 238, 531-544.

Ishii, S.1999. Application of modern endocrine methods to conservation biology. Adams, N.J.&Slotow, R.H (eds) Proc.22 Int.Ornithol. confr., Durban. *Ostrich* 70(1):33-38.

Jones, C. G., Heck, W., Lewis, R. E., Mungroo, Y., Slade, G. & Cade, T. 1994. The restoration of the Mauritius Kestrel Falco punctatus population. *IBIS* 137: 173-180.

Konish,M., Emlen, S.T.,Ricklefs, R.E. & Wildfield, J.C. 1989. Contributions of bird studies to biology. *Science* 246, 465-472.

Kuehler, C. M., & P.N. Witman. 1988. Artificial incubation of Califonia Condor *Gymnogyps californianus* eggs removed from the wild. Zoo biol. 7: 123-132.

Li, F. l. 1991. World's First Captive Breeding of the Japanese Crested Ibis *Nipponia nippon*. J.Yamashina Inst. *Ornithol*, 22:70-76.

Liu, Y.Z. 1981. Rediscovered of the Crested Ibis Nipponia nippon in Qinling Mountain. *J. Chinese Zool.* 27(3): 273.

Liu, Sh.X., Qiu, Zh. Zh., Xi, Y. M. A New Species of the *Genus Echinostoma* (Digenea:Echonostomatidae). ACTA ZOOTAXONOMICA SINICA, Vol.22,No.1: 6-9.

Lu, B.Zh. 1986. Food supplemented for the wild Crested Ibis (in Chinese). *Chinese Wildlife*, 1986 (5) :23-24

Perrins, C.M.1996. Eggs, egg formation and the timing of breeding. *IBIS* 138: 2-15.

Rich, V. & Carr, C. 1999. Husbandry and Captive Rearing of Barn Owls. Poultry and Avian Biology Reviews 10(2) : 91-95.

Scott, J. M. & J.W. Carpenter. 1987. Release of captive-reared or translocated endangered birds: what do we need to know ? *Auk* 104: 544-545.

Shi , D.Ch., Yu, X. P., Lu, B. Zh., Xi,Y.M. Wang, Y.J. 1991 the Growth of the nestling of the Crested Ibis. Journal of Northwest University. 21:15-24.

Shi, D. Ch., YU, X.P., Lu, B.Zh., Zai, T. Q., Geng, Zh.Zh. 1991. The diet and food abundance of the Crested Ibis in the Wandering period. *Journal of Northwest University*. 21:35-42.

Shi, D. ch., YU, X.P., Lu, B.Zh., Huang, L., Xi, Y.M. 1991. The Breeding Biology of the Grey Heron at the Northern Foot of the Daba Mountain. *Journal of Northwest University*. 21:151-159.

Shi, D.ch., YU, X.P., Lu, B.zh., Zai, T.q., Huang, L., Xi, Y.M. 1991. Records of the breeding Success of the Crested Ibis. *Journal of Northwest University*. 21:43-48.

Shi, D.ch., YU, X.P.,Xu, sh. H., Cao., Y.H., Lu, B.zh., Zai, T.q., Huang, L., Xi, Y.M. 1991. A study sketch of the Crested Ibis. *Journal of Northwest University*. 21: 1-14.

Shi, D. ch., YU, X.P., Lu, B., Huang, L., Xi, Y.M. 1991. The Behavior Traits and Growth of the nestling of the

Grey Heron. *Journal of Northwest University*. 21:143-150.

Simons, T. s. K. Sherrod, M.W. Collopy, M. A. Jenkins. Restoring the Bald Eagle. *Am. Sci. 76:* 253-260.

Su, Y.Sh., Kawai. 1998. The protection of rested ibis and their habitat and local economic development.

Su, Y.Sh. 1999. The protection of wild animals and their habitat and local economic development. *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp.34-39.

Tan, Y. 1989. The population of the Crested Ibis in China. *Strix* 8: 267-269.

Templeton, A. R. & Read, B. 1983. The elimination of inbreeding depression in a captive herd of Apeke's gazelle. *In Genetics and conservation;* a reference for managing wild animal and plant populations: 241-261.

Toshio Torii. 1999. Histry and Outlook for conservation and breeding of Crested Ibis in Japan. *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp.225-226.

Winkler, D.A. 1987. A general model for parental care. *Am. Nat.* 130: 526-543.Cade, T.J., Temple, S. A. 1994. 137: 161-172.

Wang, Q. Sh. 1999. Current status of waterbirds in China wetlands. *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp.1-10.

Xi,Y.m., Lu,B.Zh., Fu, W.K. 1995. Rescuing the Crested Ibis Nestling injured by Snack *(Elaphe Carinata)* , *Chinese Wildlife*. 83: 40-41.

Xi, Y.M., Lu, B.Zh., Geng, Zh. Zh. , Zai, T. q., Zhang, Y.M. 1997. Saving the Crested Ibis in China. *Chinese Wildlife*, 18(5): 28-30.

Xi, Y.M., Lu, B.zh., Fu, W.K., Geng, zh. Zh. , Zai, T. q., Zhang, Y.M. A Study on Captive Breeding of the rested Ibis *(Nipponina nippon). Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp.102-108.

Xi, Y.M., LU, B.Z., Zhai, T.Q., Zhang, Y.M., Cao, Y.H., Lu, X.Y., Fu, W.K. 1999. Observation and First-aid on diseases of the Crested Ibis. *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp.141-144.

Xi, Y.M., Fujihara N. 2000a. Prospective future of the Crested Ibis. *Jpn. J Zoo Wild Med*, 5: 115-122.

Xi, Y.M., Fujihara N. 2000b. Conservation of Crested Ibis. J. Human Anim. Relat, 5; 118-126.

Yamashina Y. 1966. The Status of Endangered Species in Japan. Bull.ICBP. 10:100-109.

Yamashina Y. 1975 The Feeding of Japanese Crested Ibis, *Endangered Birds*, Edited by Stanley A.Temple, University of Wisconsin Madison press. 161-164.

Yamashina Y. & Nakanishi G. 1983. Toki, *Nipponia nippon*, Kyoikusha, Tokyo (in Japanese).

Yoshio Muramoto. 1999. The Japanese Crested Ibis-the Extinct species in Japan- Its Histry and Conservation. *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp.229-232.

Yu, X.P., Shi, D.ch., Xi, Y.M., Huang, L.1991. The foraging Behavior of Little Egrets, Journal of Northwest University. 21:137-142.

Zheng, G. M. 1999. The Direction if Researches on the endangered species of Birds in China (in Chinese). *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp.23-32.

Zhang.Y.m., Lu, B.Zh., Zhai, T.Q., Xi, Y.M. 1999. Analysis on the Death reason and Conservation Measures of the Crested Ibis. *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp.122-130.

Zhai, T.q. & Wang, Zh. Y. 1994. Reproduction Ecological of the Crested Ibis Aged Two Years Old. J. Ecology of China. 14(1): 99-101.

Zhai, T.q. & Wang, Zh. Y. 1999. Reproduction Ecological of the Crested Ibis *Proc. Int. Workshop on the Crested Ibis Conser.'99 Hanzhong*, pp. 104-111.

要　旨

トキ（*Nipponia nippon*）の野生復帰プログラムに関する予備研究

席 咏梅・路 宝忠・傳 文凱・蘇 雲山

本研究の目的は、飼育下繁殖によるトキを野生復帰させる道を探ることにある。絶滅に瀕するトキの繁殖行動についての予備研究を特に重視した。野生の状態では、繁殖期にはトキは雌雄交代で抱卵し、雛に餌を与えている。飼育下の場合、産卵後、抱卵初期には交代で抱卵するが、孵化後ではなく孵化の過程において雛を殺してしまう傾向のあることが観察されている。

本研究では、それ故、洋県トキ救護飼育センターで人工飼育された親鳥と雛を用いて、人工飼育で育てたトキを自然に近い状態に置いて観察する実験を行った。繁殖ペアを他のトキから見えない、飛翔可能な大きさのケージに入れて飼育した結果、飼育下に置かれたこのペアのトキは十分な抱卵と育雛行動を行ったのである。

トキ種の生息に適した地域への再導入の一部としての繁殖行動に関するこの予備研究は、飼育下繁殖によるトキの野生復帰後の繁殖の可能性を示している。我々は、注意深く本研究の有効性を評価していかねばならない。

（推薦者：河合 明宣 訳）

Study on the Vegetation Zonation in Doi Inthanon National Park and Its Application to Environmental Education

Pongsak Sahunalu [1], Sakhan Teejuntuk [1], Chettha Sungpalee [1] and Anusit Methavararuk [2]

Abstract

Forest vegetations (trees with DBH ≧ 4.5 cm) in 46, 0.16 ha plots of six forest types; dry dipterocarp, mixed deciduous, dry evergreen, pine-dipterocarp, pine-oak and montane forests distributed along the altitudinal gradients ranging from 400 to 2320 m asl were enumerated together with soils, air temperature and humidity analyzed and recorded in Doi Inthanon National Park, Chiangmai, northwest Thailand. Two broad altitudinal zones are recognized as lowland zone at 400-1000 and montane zone at 1000 m asl upward. On the lower and part of upper zone are partially overlapped by dry dipterocarp forest and montane forest at about 1020 m asl where pine-dipterocarp and pine-oak forests are overlapped recognizing as a transition to montane zone whereas on the intermediate altitude, mixed deciduous forest is intermingled in a narrower range of altitude with a small portion of dry evergreen forest occurs along the stream bank. About 293 species, 155 genera and 70 families of trees with few unidentified species considering as minor elements in some forest types are identified. Their distributions and dominances in different forest type on the altitudinal ranges can be preliminary discriminated into groups of families, genera and species. Some physical and chemical properties of surface and subsoils are obviously different toward the altitudinal shifts in correspond to the sequence of forest type occurrences. Monthly mean air temperature during the 9-month period covering dry and wet seasons inside the forests on various altitudes exhibit the clear trends and significant decline upwardly along the altitudinal gradients. Monthly mean air humidity in dry season greatly decline in deciduous forest types on the lower altitude while maintain relatively high throughout the period in evergreen forest types on the upper altitude. Further quantitative analyses are being carried out and expected to elucidate the forest vegetation zonation in relation to altitude, soil and climatic variables.

Introduction

There are few studies of the altitudinal zonation of vegetation on mountains in Southeast Asia. The most detailed ones have been that on some tropical mountains such as on Mount Kerinci, Sumatra, Indonesia (Ohsawa *et al.*, 1985), Gunung (Mt) Kobipoto and Gunung Binaia, Seram, Maluku, Indonesia (Edwards *et al.*, 1990), Mount Kinabalu,Sabah, Malaysia (Kitayama, 1992), Gombak and Genting Highlands, Selangor, Peninsular Malaysia (Nakashizuka *et al.*, 1992), Gunung Silam, Sabah, Malaysia (Bruijnzeel *et al.*, 1993; Proctor *et al.*, 1988) and Bukit Belalong, Brunei (Pendry and Proctor, 1997). All these studies are apparently focussed in tropical rain forest and in humid regions where most areas lie closely to the equator and evergreen forest species prevail. Apart from these equatorial forests, forest vegetation types on mainland Southeast Asia are more diverse where climate is mostly alternated between dry and wet seasons and their types vary

[1] Dept. of Silviculture, Faculty of Forestry, Kasetsart University, Bangkok 10900, Thailand.
[2] Doi Inthanon National Park, National Park Division, Royal Forest Department, Chiangmai 50160, Thailand.

from those on lowland plain zone to montane zone on mountainous areas as well as from deciduous to evergreen types recognized as various formations and zonation of forest vegetation on these tropical mountains is different from that on temperate mountains (Ohsawa *et al.*, 1985). Moreover, zonation studies of vegetation in tropical forest are always concentrated on a single hill range and generally dealt with one or a particular forest type, less studies have been done in a complex hill range with different forest types and several studies did not include soils and climatic conditions in explaining the relationships between these factors with the zonation of vegetations in various ranges of altitude.

Doi (Mount) Inthanon is a representative name of a group of 15 hill ranges with different ridge height and some small plains on the valley along these mountain ridges included in an area cover of 482.4 km^2 and designated as a national park in Thailand in 1978. It is located on the Thanonthongchai range stretches along the northwest highland of Thailand (18° 24'N, 98° 24' E). Its landscape is characterized by the hilly and complex mountains which supports various types of vegetation with different physiognomic, species composition and richness. This mountain complex vary in altitude ranging from 400 m asl at the foothill up to 2565 m asl at the summit of Doi Inthanon, represents the highest peak in the country. The great difference in altitude makes up six forest types (Faculty of Forestry, 1992) distributing along the altitudinal gradients : dry dipterocarp forest (400-1000 m asl), mixed deciduous forest (400-800 m asl), dry evergreen forest (400-800 m asl), pine-dry dipterocarp forest (800-1200 m asl), pine-oak forest (1000-1400 m asl) and montane forest (1000-2565 m asl). These forest types are well preserved and represent a majority of the terrestrial plant community in Thailand. As the area lies in the northwest highland (Samapudhi, 1957), it is underlain by a granitic massive intruded into the range lying some 60 km to the southwest of Chiangmai and divides between the Ping and Maejaem rivers. Three major rock types are found in the highland according to Pendelton's reconnaissance geologic map (Pendelton, 1962). Parent materials are gneiss, connecting the northwest range with the east range of Doi Suthep, a narrow pocket of shale, siliceous sandstone, quartzite and slate around the middle part of the area and at the main hill of Doi Inthanon is a granitic massive. Climate of the area is recognized as monsoonal type with a strong alternation of wet and dry seasons. Heaviest rain falls during August and September coinciding with the wet-carrying northwest monsoon and driest month is December conforming to dry northeast monsoon. Mean annual rainfall of the northern region is 1500 mm although the detailed record of climate in Doi Inthanon is not available, only local figures are from the lowland station. Minimum temperature is 3.7-7.5℃ during November to February and maximum temperature is 39.6-41.5℃ during March to May. Annual rainfall at the nearest station outside the park is 1000-1400 mm during July to October. However, annual rainfall on the upper part of Doi Inthanon may exceed 2000 mm (Robbins and Smitinand, 1966).

Studies on forest formations of the northwest highland particularly in Doi Inthanon was initiated by Ogawa *et al.* (1961) followed by Robbins and Smitinand (1966) and Faculty of Forestry (1992). Santisuk (1988)'s account of forest vegetation of northern Thailand has also included the forest formation of Doi Inthanon and Pengklai (1996) pointed out the significance of plant species richness of this area. These studies are mainly focussed on the broad perspective of the forest in the area and provided fundamental understanding of the forest formation and plant species composition of each forest type. Ecological studies focussing on their vegetation zonation in relation to altitudinal gradient especially in association with soils and some climatic conditions have been scarcely carried out. Soils in Doi Inthanon have been studied by some investigators. This included some details of soil types (Pendelton, 1962), soil properties in some dry dipterocarp subcommunity types (Sukwong *et al.*, 1976; 1977) and in hill evergreen forest (Robbins and Smitinand, 1966). Obivously, there are no record of soils in other forest types in Doi Inthanon and also no relationships between soil properties and vegetation distribution along the altitudinal gradient to assess their interrelationships. Furthermore, climatic conditions which are generally covaried with altitude may play an important role as a profound factor determining the distribution of various forest types and species abundance have never been investigated in this site. This study is therefore aimed to explore the floristic and structural variations accounted for by the altitudinal zonation, together with the investigation of species diversity patterns along the altitudinal gradients and to relate these vegetation parameters to some edaphic and climatic variables at a range of altitude, particularly in Doi Inthanon. This paper is a preliminary report on the results of this study. The detail of study analyses will be dealt with in another paper under preparation. This study was financially supported by PRO NATURA FUND 1999 together with the mutual support and encouragement of Dr. M. Kanzaki, Kyoto University to whom the authors gratefully acknowledged.

Materials and Methods

Six study sites were selected based on the vegetation map with the altitudinal classes together with a topographic map (Faculty of Forestry, 1992). Each selected site located in each forest type was further randomly selected for 3 locations on 3 altitudinal ranges at lower, middle and upper altitudes except for one forest type; dry evergreen forest where the area cover is relatively small (less than 1 % of the total forest area), only one location and 1 plot was selected. In each location, 3 plots were set at the lower, middle and upper slope. The study plots were then composed of 9 plots each in dry dipterocarp forest (450-990 m asl), mixed deciduous forest (490-730 m asl), pine-dipterocarp forest (980-1100 m asl), pine-oak forest (1020-1180 m asl), montane forest (1340-2320 m asl) and a plot in dry evergreen forest (715 m asl). Forest type distrubution, study locations and altitudinal range are shown in Figs. 1, 2 and 3 respectively.

In each plot (40x40 m^2), trees of DBH equal to and over 4.5 cm were tagged, individuals counted and DBH measured. All individual trees were identified into species and specimens collected for unidentified ones to examine their species at Bangkok Forest Herbarium of the Royal Forest Department and herbarium of the Faculty of Forestry, Kasetsart University. Tree censuses were carried out since the middle of October, 1999, species checked and specimens collected periodically since then.

Seven sets of thermometer and hygrometer equipped with data loggers were installed for monitoring the air temperature and humidity in the sample plots representing some climatic parameters in each forest type at different altitudes. They were fixed to the inverted plastic boxes and attached to the selected trees at approximately 1 m aboveground. These seven sets were distributed one set each inside dry dipterocarp forest, pine-dry dipterocarp forest and pine-oak forest plots and two sets both inside mixed deciduous forest and montane forest plots. These loggers were set since the middle of November, 1999 and data recorded at 30-minute intervals in data loggers were further stored for every 3 months and reinstalled. This report covers only 9-month period as field data record is still continued while this report is prepared.

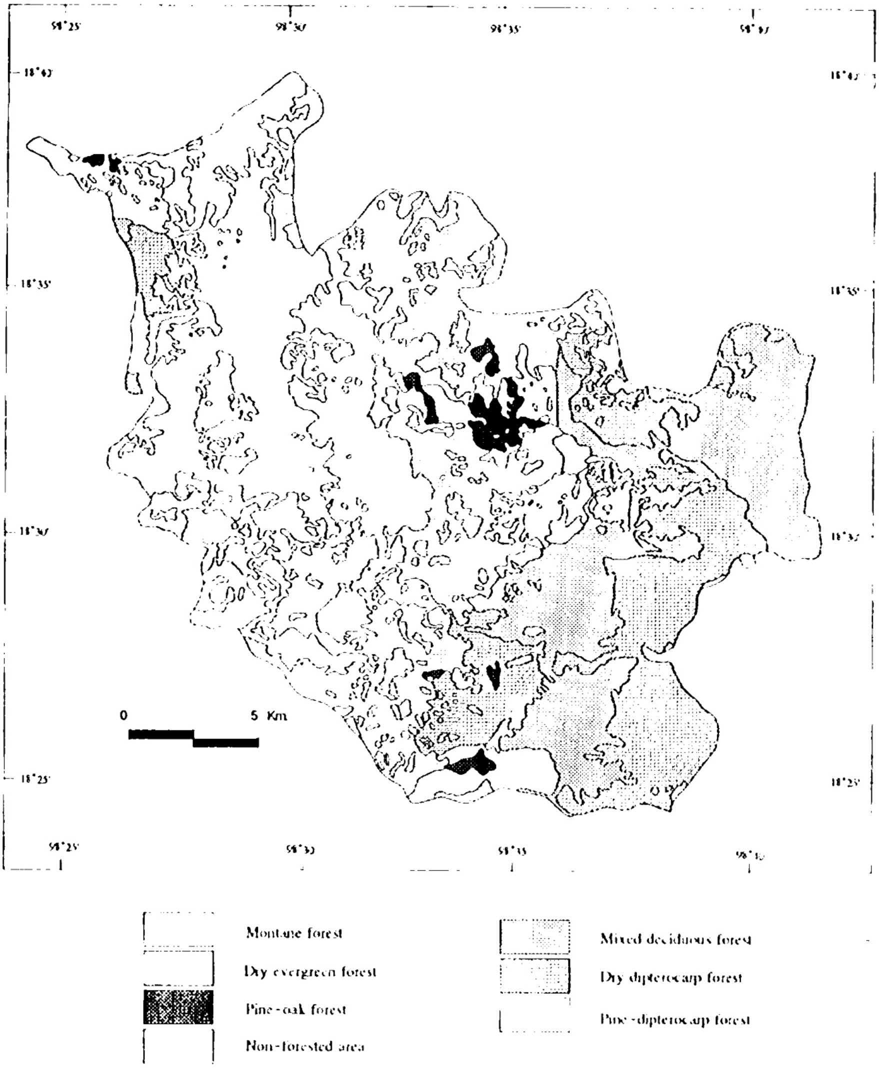
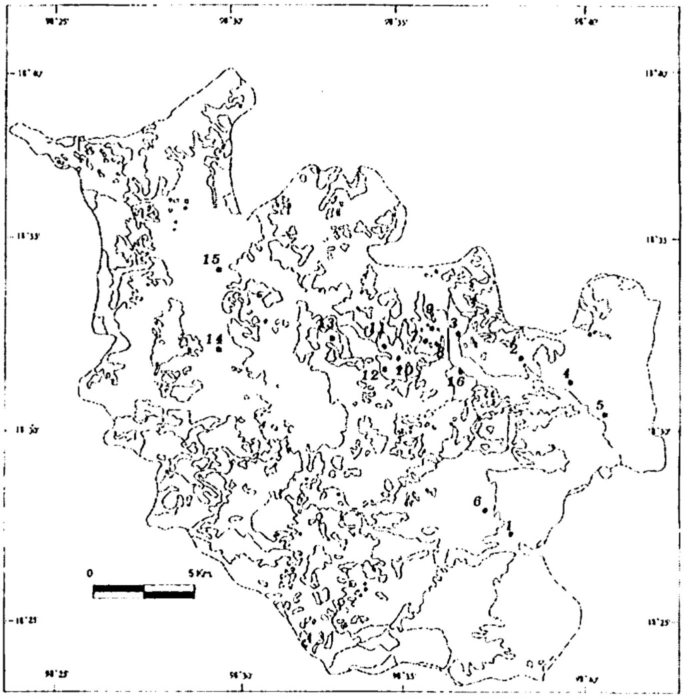
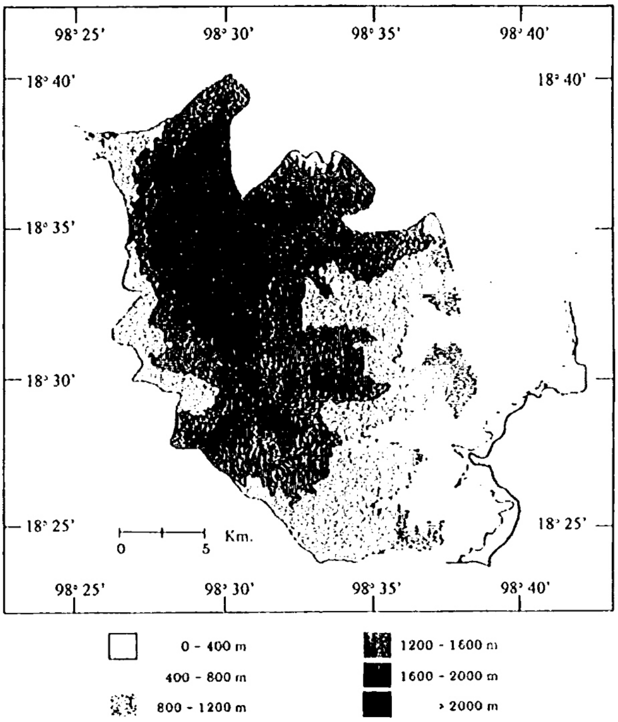


Figure 1. Vegetation map of Doi Inthanon National Park.

Soils were studied in each group of sample plots by examining soil profile at the middle part of the middle slope plot together with undisturbed soil samples collected with core samplers at the surface and subsoils (0-5 and 20-25 cm soil depth respectively) for three-phases analysis, hydraulic conductivity and moisture characteristics (pF) measurements of soils in each horizon. Disturbed soil samples were also collected from the subsoil horizons downwardly varying to depth of each profile in each forest type from the middle slope plot only for further analyses of soil chemical and physical properties. For surface soil horizon, disturbed soil samples were collected from 5 random points at the four corners and the center of the sample plot then composited into one sample for soil property analysis. For upper and lower slope plots, core sample soils were collected for surface soil from the center of plots for bulk density and hydraulic conductivity measurements and disturbed soil samples were from 5 random points at the corners and center of plots then composited into one sample, whereas surface soils were from one point at the center of plots for analyses of chemical and physical properties. Soil hardness was also investigated at the center of every plots by



Figuer 2. Location of study plots; 1-3: dry dipterocarp forest, 4-6: mixed deciduous forest, 7-9: pine-dipterocarp forest, 10-12:pine-oak forest, 13-15: montane forest, 16: dry evergreen forest.



Figuer 3. Altitude class of Doi Inthanon National Park.

using soil penetrometer. Soil analyses were carried out at the Laboratory of Forest Soils, Faculty of Forestry, Kasetsart University, Bangkok.

Results and discussion

Forest type distribution along the altitude

Six forest community types of Doi Inthanon National Park distribute partially overlap along the altitudes especially those on the altitude lower than 1200 m asl however, these forest community types can be broadly classified into 2 altitudinal zones. First one is apparently from 400 m asl to 1000 m asl recognized as lower or lowland zone and those above 1000 m asl as upper or montane zone reaching to the summit at 2565 m asl.

On the lowland zone, dry dipterocarp forest appears to distribute on wider range of altitude than mixed deciduous forest although both types are deciduous forests. While dry dipterocarp forest is found from 400 m asl up to 1000 m asl altitude, mixed deciduous forest is always found in between at the altitude of 480-750 m asl with narrow range of altitude. Within the range of altitude covering the lowland zone, dry evergreen forest is observed along the large stream bank either it flows through the flat lowland dipterocarp or mixed deciduous forests. The upper limit of dry dipterocarp forest extending up to 1000 m asl is found to overlap with the pine-dry dipterocarp forest at the altitude around 980 m asl where the transition zone between the lower and montane zones is generally postulated by Santisuk (1988). Pine-dipterocarp forest extends its upper altitude to 1100 m asl where it also overlaps with the pine-oak forest in which the lower limit of montane zone is fused together. In this lowland zone therefore comprises of 9 plots of dry dipterocarp forest at 450-990 m asl. 9 plots of mixed deciduous forest at 490-730 m asl and 1 plot of dry evergreen forest at 715 m asl (Table 1).

On the montane zone, pine-oak forest appears to distribute from below 1100 m asl which overlaps with pine-dry dipterocarp forest on the lower limit and extends to the upper limit about 1200 m asl. The 9

Table 1. Summary of the study plots in Doi Inthanon National Park, trees of DBH ≧ 4.5 cm are enumerated.

Plot parameters	Forest type [1/]					
	DDF	MDF	DEF	PDF	POF	MF
1. Plot size (ha)	0.16	0.16	0.16	0.16	0.16	0.16
2. Total number of plot	9	9	1	9	9	9
3. Altitudinal range (m asl)	450-990	490-730	715	980-1100	1020-1180	1340-2320
4. Number of family (no. type^{-1})	30	30	11	33	37	49
5. Number of genus (no. type^{-1})	61	55	13	58	61	89
6. Number of species (no. type^{-1})	85	72	14	82	82	135
7. Number of individuals (stems type^{-1})	1803	737	26	1616	1725	1729

[1/] DDF=dry dipterocarp forest, MDF=mixed deciduous forest, DEF=dry evergreen forest, PDF=pine-dipterocarp forest, POF=pine-oak forest, MF=montane forest plots of pine-oak forest are therefore located on the altitudinal range from 1020 to 1180 m asl. On the altitudinal range between 1200 to 1300 m asl, there is no primary forest except for some secondary forests and the disturbed montane forest which is the result of the swidden (shifting cultivation) practice (Faculty of Forestry, 1992). Above 1300 m asl to the summit of Doi Inthanon, montane forest is predominant type covering the widest range of altitude. The 9 plots of montane forest are therefore located on the altitudinal range between 1340 to 2320 m asl (Table 1).

In similar local habitat of the same northern region at Doi Chiangdao (2175 m asl), dry dipterocarp forest was found from the foothill (400 m asl) up to 700 m asl where two-needle pine (*Pinus merkusii*) was found mix with dry dipterocarp forest species upwardly to 1000 m asl where three-needle pine (*Pinus kesiya*) was prevailed upward but no altitudinal limit is recorded for this forest type (Khemnark *et al.*, 1972). In a more extensive area, several subcommunity types of dry dipterocarp forest are recognized from the lower altitude as low as 280 m asl where low-scrub type composing of *Shorea siamensis* is dominant species and sometimes as low as 130 m asl up to 370 m asl where medium-scrub type dominating by *S. obtusa* is found and at 350-900 m asl where *Dipterocarpus obtusifolius-S. obtusa* subtype is common (Sukwong *et al.*, 1976; 1977; Bunyavejchewin, 1983a). However, this forest type is recognized to be common confining to dry sites of northeast India, Myanmar, Thailand, Loas, Vietnam and Cambodia recorded by several authors included in a most recent publication of Santisuk (1988).

Mixed deciduous forest on Doi Inthanon is however, prevailing almost at the same altitude as for dry dipterocarp forest but in a narrower range of altitude. Doi Chiangdao mixed deciduous forest was not delimited to be at any altitudinal boundary but it might not be observed at the altitude higher than 750 m asl throughout Thailand (Khemnark *et al.*, 1972) while at a wider perspective this forest is mostly developed below 800 m asl (Santisuk, 1988) and often occurs alternately or in mosaic or transitions with dry dipterocarp forest. On the other hand, dry evergreen forest in Doi Inthanon is confined to a small area as pocket-like along large bank of main stream only where in other localities it may be found on flat area at the altitude approximately 720 m asl in the northeast region (Sahunalu *et al.*, 1979) and not higher than 900 m asl in the northern mountainous region (Santisuk, 1988). At Doi Chiangdao, this forest type was found below 600 m asl (Khemnark *et al.*, 1972). As topography in Doi Inthanon is generally rugged and steep where large area along stream bank is not frequently found except some broad valley where are always occupied by local inhabitants and devoid of primary vegetation, a small pocket-like plain with an area of dry evergreen forest less than 1% of total forest area is classified (Faculty of Forestry, 1992) therefore, it may be considered as a minor forest type in this area.

Above 900 m asl altitude, three-needle pine (*Pinus kesiya*) is common in association with several dry dipterocarp tree species in Doi Inthanon and the area extends upward to c. 1200 m asl but does not clearly separate from pine-oak forest where it always distributes overlapedly at c. 1010 m asl as the lower limit. This pine-dipterocarp forest will gradually change to pine-oak forest as some members of Fagaceae are found co-occurrently. It is postulated that dry dipterocarp forest is advanced into hill evergreen or montane forest (Stott, 1974; Santisuk, 1988). At Doi Chiangdao, two local pines are found to be associated with dry dipterocarp forest tree species at two different altitudes starting one from 700 m asl and another one from 1000 m asl upward but pine-oak forest was not observed (Khemnark *et al.*, 1972).

Area of montane forest in Doi Inthanon is reported to be largest being approximately 54% of total forest area (Faculty of Forestry, 1992). This forest type is generally classified into two types: lower montane and upper montane forests by Santisuk (1988). Pine-oak forest classified in this study is therefore considered to be correspondent to lower montane forest and montane forest reported here is upper montane forest under forest type nomenclature of Santisuk (1988). These two types are generally known as hill evergreen forest while it was recognized as moist lower montane forest by Smitinand (1965) in Doi Chiangdoa, a limestone massive at 1300-1800 m asl altitude as well as always found in several mountain ranges under the management of the national parks, wildlife sanctuaries and watershed management units in Thailand (Royal Forest Department, 1962; Robbins and Smitinand, 1966; Smitinand, 1977; Santisuk, 1988). It is known as oak forest in Myanmar (Stamp, 1925) and montane humid evergreen broad-leaved forest in central and west Yunnan, China (Xiwen and Walker, 1986) in a vicinity of Doi Inthanon area northward.

Floristic composition along the altitude

About 293 species in 155 genera and 70 families of trees with DBH $\geqq$ 4.5 cm are recorded in 46 plots with few unidentified ones which are considered as minor component species of some forest types only. Species numbers in all plots vary from 14 to 135 among each forest type. Table 2 shows the taxonomic break down in each forest type.

Number of family of trees is most spectacular in montane forest (49) follow by pine-oak forest (37) and identical in dry dipterocarp and mixed deciduous forests (30). Although in pine-dry dipterocarp forest is almost identical in number of family to dry dipterocarp forest but some families are found in both forest types, some are in separate forest type and the least is in dry evergreen forest (11).

Five families are found widely distribute and the most important families as indicated by highest relative basal area cover in all forest types (Table 2) are Bignonaceae, Euphorbiaceae, Labiatae, Leguminosae and Rubiaceae while other families are found in at least four forest types and some families in only a single forest type although each forest type has different dominant families such as Dipterocarpaceae in dry dipterocarp and dry evergreen forests in which in the latter forest it may be considered as a monodominant type of Dipterocarpaceae family forest in this area. Labiatae and Leguminosae are dominant families in mixed deciduous forest, Pinaceae in pine-dry dipterocarp and pine-oak forests, Fagaceae and Lauraceae in montane forest (Table 2) suggesting their predominating characteristics in correspondence to the altitudinal range differentiation governing each forest type.

With 55 genera of trees, there are no tree genus frequently found in all forest types but 5 genera : Dalbergia, Phyllanthus, Schima, Stereospermum and Vitex are found in widest range of occurrence across 5 forest types. 10 genera: Albizzia, Anneslea, Aporusa, Callicarpa, Canarium, Dalbergia, Gardenia, Glochidion, Stryrax and Wendlandia are frequently found in 4 forest types. Other genera are found in 3 or 2 types and the rest are only in a specific forest type (Table 3).

Table 2. Relative basal area cover (%) by families in each forest type.

Family	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Aceraceae	-	-	-	-	-	0.866
Actinidiaceae	-	-	-	-	0.639	0.578
Anacardiaceae	0.475	0.168	-	0.482	0.145	0.363
Annonaceae	-	0.823	-	-	-	0.153
Apocynaceae	-	0.368	-	-	0.270	-
Aquifoliaceae	-	-	-	0.945	0.689	0.995
Araliaceae	-	-	-	-	-	0.293
Betulaceae	-	-	-	-	-	0.154
Bignoniaceae	0.257	0.575	0.112	0.159	0.473	0.665
Bombacaceae	0.654	0.345	-	-	-	0.642
Boraginaceae	-	0.193	-	-	-	-
Burseraceae	0.285	0.340	-	0.131	0.141	0.263
Capparidaceae	-	-	-	-	-	0.326
Caprifoliaceae	-	-	-	0.190	0.270	-
Celastraceae	0.157	-	-	0.124	0.322	-
Combretaceae	0.199	0.754	-	0.168	-	-
Connaraceae	0.286	-	-	0.348	-	-
Cornaceae	-	-	-	-	-	0.753
Daphniphyllaceae	-	-	-	-	-	0.123
Dilleniaceae	-	-	-	0.729	0.498	0.146
Dipterocarpaceae	0.521	0.466	0.864	0.185	-	-
Ebenaceae	-	0.189	0.112	0.815	-	0.112
Elaeocarpaceae	-	-	-	-	0.958	0.618
Ericaceae	0.123	-	-	0.175	0.380	0.149
Euphorbiaceae	0.174	0.250	0.711	0.270	0.540	0.486
Fagaceae	0.118	-	-	0.151	0.956	0.242
Flacourtiaceae	-	-	0.412	-	0.212	0.323
Gesneriaceae	-	-	-	-	0.177	-
Guttiferae	0.142	0.223	-	0.355	0.446	0.265
Hippocastanaceae	-	0.756	-	-	-	-
Icacinaceae	-	-	-	-	-	0.964
Juglandaceae	-	0.959	-	0.276	0.241	0.278
Labiatae	0.146	0.186	0.758	0.425	0.498	0.218
Lamiaceae	0.672	0.176	-	0.397	-	-
Lauraceae	0.842	0.189	-	0.531	0.233	0.255
Lecythidaceae	-	0.360	-	0.475	-	-
Leguminosae	0.712	0.327	0.470	0.297	0.383	0.284
Lythraceae	0.255	0.164	0.398	0.490	-	-
Magnoliaceae	-	-	-	-	0.820	0.534
Melastomataceae	0.527	-	-	-	-	-
Meliaceae	0.257	0.128	-	-	-	0.123
Meliosmaceae	-	-	-	-	0.386	-
Moraceae	0.317	-	-	0.199	0.352	0.464
Myricaceae	-	-	-	-	-	0.267

Table 2. (Cont.)

Family	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Myrsinaceae	0.595	-	-	0.253	-	0.189
Myrtaceae	0.434	-	-	0.331	0.266	0.458
Nyssaceae	-	-	-	-	-	0.200
Ochnaceae	0.243	-	-	-	-	-
Oleaceae	0.738	-	0.553	-	0.438	0.456
Pinaceae	0.262	-	-	0.483	0.579	-
Podocarpaceae	-	-	-	-	-	0.123
Proteaceae	-	-	-	0.551	0.834	0.215
Rhamnaceae	-	0.581	-	-	-	0.236
Rhizophoraceae	-	-	-	-	-	0.562
Rosaceae	-	-	-	-	-	0.584
Rubiaceae	0.258	0.226	0.620	0.338	0.247	0.167
Rutaceae	-	0.264	-	-	-	0.344
Sapindaceae	-	0.231	-	-	-	-
Sapotaceae	-	0.464	-	-	0.646	0.767
Sarcospermataceae	-	-	-	-	0.257	0.767
Saxifragaceae	-	-	-	-	-	0.788
Sterculiaceae	-	-	-	-	0.145	0.337
Strychnaceae	0.646	0.680	-	-	-	-
Stryraceae	-	0.435	-	0.663	0.874	0.250
Symplocaceae	0.133	-	-	0.133	0.318	0.127
Theaceae	0.218	0.123	-	0.345	0.137	0.574
Tiliaceae	0.189	0.139	-	0.215	0.252	-
Ulmaceae	-	-	0.444	-	-	-
Verbenaceae	-	-	-	-	0.214	-
Unidentified	-	-	0.158	-	0.173	0.225

For forest type abbreviations see Table 1.

Most widely distribute species represented by frequent occurrence across the 5 forest types are *Dalbergia dongnaiensis, Phyllanthus emblica, Schima wallichii, Stereospermum neuranthum, Vitex peduncularis* and *Wendlandia tinctoria*. The rest may be found only in some or even in one forest type. These species are the most dominant component species in separate forest type. The most dominant species in terms of % basal area cover in each forest type as shown in Table 3 are *Dipterocarpus tuberculatus, Quercus ramsbottomii, Shorea obtusa* and *S. siamensis* in dry dipterocarp forest. *Dipterocarpus costatus, Homalium ceylanicum* and *Xylia xylocarpa* var. *kerrii* are in dry evergreen forest. *Lagerstroemia calyculata, Milletia leucantha, Pterocarpus macrocarpus* and *Tectona grandis* are predominant species in mixed deciduous forest. Pine-dry dipterocarp forest which is on the highest altitude of dry dipterocarp forest is dominated by *Aporusa villosa, D. tuberculatus, Gluta usitata, Pinus kesiya, Q. ramsbottomii* with minor dominance of *S. siamensis* and *W. tinctoria*. In pine-oak forest where most of evergreen tree species are found are dominated by *A. villosa, Lithocarpus elegans, P. kesiya* and *S. wallichii*. Most evergreen broad-leaved tree species occupying the high altitude in montane forest are *Actinodaphne* sp., *Castanopsis ferox, C. tribuloides, L. aggregatus, Litsea dubele, Mangleitia garettii, Mastixia euonymoides, Neolitsea pallens, Q. lenticellata, S. wallichii* and *Syzygium ankae*. These floristic composition which only trees were enu-

Table 3. Species composition and relative basal area (%) of trees (DBH equal or over 4.5 cm) in six forest types. Each type is consisted of 9 study plots except for dry evergreen forest, only 1 plot is investigated.

Species	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Acer laurinum	-	-	-	-	-	0.866
Actinodaphne henryi	-	-	-	-	0.122	6.944
Actinodaphne sp.1	-	-	-	0.490	-	-
Adenandra integerrima	-	-	-	-	-	0.428
Adenanthera pavonina	-	0.466	-	-	0.494	-
Adinandra sp.	-	-	-	0.378	-	0.185
Aegle marmelos	-	0.264	-	-	-	-
Aesculus assamica	-	0.756	-	-	-	-
Aidia yunnanensis	-	-	-	-	-	0.857
Albizia chinensis	-	-	-	0.516	0.158	-
Albizia lebbeck	0.792	0.863	-	0.343	-	-
Albizia odoratissima	0.621	0.324	-	0.444	0.278	-
Anneslea fragrans	2.121	-	-	1.184	0.975	0.155
Anogeisus acuminata	-	4.417	-	-	-	-
Antidesma acidum	0.624	1.776	-	-	-	-
Antidesma ghaesembilla	0.464	0.282	-	0.854	-	-
Aporusa nervosa	-	-	-	-	-	0.234
Aporusa octandra var.yunanensis	-	-	-	-	-	0.241
Aporusa villosa	1.116	-	0.711	2.513	4.920	-
Archidendron clypearia	-	-	-	-	0.999	0.172
Ardisia rubro-glandulosa	-	-	-	-	-	0.196
Ardisia sp.	-	-	-	-	-	0.667
Artocarpus chaplasha	-	-	-	-	0.374	0.464
Artocarpus lakoocha	0.317	-	-	0.195	-	-
Artocarpus lanceolata	-	-	-	-	0.314	-
Artocarpus sp.	-	-	-	0.390	-	-
Atalantia monophylla	-	-	-	-	-	0.344
Bauhinia variegata	-	0.246	-	-	-	-
Beilschmiedia assamica	-	-	-	-	-	0.192
Beilschmiedia gammieana	-	-	-	0.122	-	0.695
Beilschmiedia globularia	-	-	-	-	-	0.184
Beilschmiedia roxberghiana	-	-	-	-	-	1.698
Betula alnoides	-	-	-	-	-	0.154
Bhesa robusta	0.964	-	-	1.231	-	-
Bombax ancep	-	-	-	-	-	0.642
Bombax ceiba	0.654	0.345	-	-	-	-
Brassiopsis speciosa	-	-	-	-	-	0.727
Bridelia retusa	-	0.312	-	0.264	-	-
Buchanania lanzan	0.450	-	-	0.375	1.262	-
Callicarpa arborea	0.672	0.176	-	0.397	0.214	-
Calophyllum polyanthum	-	-	-	-	-	2.446
Camellia oleifera	-	-	-	-	-	0.982
Camellia siamensis	-	-	-	-	-	0.692

Table 3. (Cont.)

Species	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Cananga latifolia	-	0.823	-	-	-	-
Canarium denticulatum	-	-	-	-	-	0.238
Canarium strictum	-	-	-	-	-	0.278
Canarium subulatum	2.693	1.732	-	0.131	0.141	-
Canthium coffeoides	-	-	-	-	-	0.452
Canthium dicoccum	0.328	-	-	-	-	-
Canthium parvifolium	0.292	0.264	-	-	-	-
Canthium sp.	0.189	-	-	0.234	-	-
Capparis sabiifolia	-	-	-	-	-	0.326
Carellia braciata	-	-	-	-	-	0.562
Careya sphaerica	-	0.360	-	0.475	-	-
Cassia fistula	0.248	0.289	-	-	-	-
Castanopsis acuminatissima	-	-	-	-	0.484	0.197
Castanopsis argyrophylla	0.265	-	-	0.865	-	-
Castanopsis armata	-	-	-	0.756	1.472	-
Castanopsis calathiformis	-	-	-	-	0.356	1.949
Castanopsis cerebrina	-	-	-	-	0.149	-
Castanopsis ferox	-	-	-	-	-	9.487
Castanopsis indica	-	-	-	-	0.173	-
Castanopsis purpurea	-	-	-	-	-	0.655
Castanopsis roxkii	-	-	-	-	-	0.189
Castanopsis sp.1	0.129	-	-	0.962	-	-
Castanopsis sp.2	-	-	-	0.200	-	-
Castanopsis tribuloides	-	-	-	-	1.118	2.435
Catunaregum tomentosa	0.524	-	-	-	-	-
Chionanthus ramiflorus	-	-	0.553	-	0.438	0.456
Chionanthus sp.	0.738	-	-	-	-	-
Chukrasia velutina	-	1.279	-	-	-	-
Cinnamomum bejolghota	-	-	-	-	-	0.228
Cinnamomum caudatum	-	-	-	-	-	0.529
Cinnamomum glaucescens	-	-	-	-	-	0.298
Cinnamomum javanicum	-	-	-	-	-	0.248
Claoxylou longiflolia	-	-	-	-	-	0.311
Cleidon javanicum	-	-	-	-	0.111	-
Colona flagrocarpa var. *siamica*	0.175	-	-	0.426	-	-
Colona floribunda	-	-	-	-	0.252	-
Cordia dichotoma	-	0.289	-	-	-	-
Cordia sp.	-	1.477	-	-	-	-
Craibiodendron stellatum	0.223	-	-	0.624	0.763	-
Cratoxylum cochinchinensis	-	-	-	0.299	0.446	-
Cratoxylum formosum	1.444	2.230	-	0.555	-	-
Croton oblongifolius	-	0.619	-	-	-	-
Cryptocarya dencifolia	-	-	-	-	-	1.427

Table 3. (Cont.)

Species	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Cryptocarya sp.	-	-	-	-	-	0.612
Dalbergia assamica	-	-	0.519	-	-	-
Dalbergia cochinchinensis	-	-	-	-	0.488	-
Dalbergia cultrata	0.421	0.657	-	1.317	0.435	-
Dalbergia dongnaiensis	2.729	2.227	0.392	0.863	0.148	-
Dalbergia floribunda	-	-	-	-	0.142	-
Dalbergia fusca	-	-	-	-	1.700	-
Dalbergia nigrescens	-	1.251	-	0.998	-	-
Dalbergia oliveri	0.189	0.716	-	-	-	-
Dalbergia rimosa	0.335	-	-	0.644	-	-
Dalbergia sp.	-	-	-	-	0.184	-
Dalbergia velutina	-	-	-	-	0.142	0.142
Daphniphyllum sp.	-	-	-	-	-	0.123
Dillenia obovata	-	-	-	0.236	-	-
Dillenia ovata	-	-	-	0.493	-	-
Dillenia parviflora	-	-	-	-	0.498	0.146
Diospyros ehretioides	-	-	-	0.815	-	-
Diospyros ferrea	-	-	1.120	-	-	-
Diospyros glandulosa	-	-	-	-	-	0.112
Diospyros mollis	-	0.175	-	-	-	-
Diospyros montana	-	0.144	-	-	-	-
Dipterocarpus costatus	-	-	86.438	-	-	-
Dipterocarpus tuberculatus	21.679	-	-	14.954	-	-
Drypetes sp.1	-	-	-	-	-	0.194
Drypetes sp.2	-	-	-	-	-	2.250
Drypettes hoaensis	-	-	-	-	-	0.393
Ehretia sp.	-	0.251	-	-	-	-
Elaeocarpus floribundus	-	-	-	-	-	0.271
Elaeocarpus lanceaefolius	-	-	-	-	-	0.259
Elaeocarpus sp.1	-	-	-	-	0.674	0.322
Elaeocarpus sp.2	-	-	-	-	0.231	-
Eleaocarpus branciana	-	-	-	-	-	0.787
Eleaocarpus lanceaefolius	-	-	-	-	-	0.534
Ellipanthus tomentosus	0.286	-	-	0.348	-	-
Engelhardtia serrata	-	-	-	-	0.257	-
Engelhardtia sp.	-	-	-	-	0.363	0.569
Engelhardtia spicata	-	0.959	-	0.276	-	0.157
Eriolaena candollei	-	-	-	-	-	0.265
Erythrina subumbrans	-	-	-	-	-	0.124
Euonymus cochinchinensis	-	-	-	-	0.319	-
Euonymus similis	-	-	-	-	0.321	-
Eurya acuminata	-	-	-	-	0.387	0.238
Eurya nitida	-	-	-	-	-	0.955

Table 3. (Cont.)

Species	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Flacourtia jangomas	-	-	-	-	0.212	-
Garcinia sp.	-	-	-	-	-	0.159
Gardenia obtusifolia	0.117	-	-	-	-	-
Gardenia sootepensis	0.397	0.362	0.620	0.257	-	-
Garuga pinnata	0.155	1.666	-	-	-	-
Glochidion acuminatum var.siamensis	-	-	-	-	-	0.923
Glochidion rubrum	-	-	-	-	0.135	-
Glochidion sp.	-	-	-	-	-	0.111
Glochidion sphaerogynum	0.167	-	-	0.349	0.212	0.135
Gluta usitata	1.394	-	-	3.590	0.592	-
Gmelina arborea	-	1.334	-	-	-	-
Gomphandra quadrifolia	-	-	-	-	-	0.964
Gordonia dalglieshiana	-	-	-	-	0.627	-
Grewia eriocarpa	0.171	1.388	-	0.198	-	-
Haldina cordifolia	-	0.137	-	-	-	-
Helicia atteneuta	-	-	-	-	-	0.145
Helicia formosana var.oblane	-	-	-	-	-	0.557
Helicia nilagirica	-	-	-	0.545	0.794	1.373
Helicia sp.	-	-	-	-	0.444	0.777
Heliciopsis terminalis	-	-	-	0.637	-	-
Heterophragma sulfureum	0.787	-	-	-	-	-
Holarrhena pubescens	-	0.326	-	-	-	-
Homalium ceylanicum	-	-	4.119	-	-	0.323
Hymenodictyon excelsum	0.831	0.652	-	-	-	-
Ilex sp.	-	-	-	-	-	0.923
Ilex triflora	-	-	-	-	-	0.900
Ilex umbellulata	-	-	-	0.945	0.689	-
Lagerstoemia sp.	-	-	0.398	-	-	-
Lagerstroemia balansae	-	0.913	-	-	-	-
Lagerstroemia calyculata	1.274	14.323	-	-	-	-
Lagerstroemia macrocarpa	0.596	-	-	0.490	-	-
Lagerstroemia speciosa	0.185	-	-	-	-	-
Lagerstroemia villosa	-	1.153	-	-	-	-
Lannea coromandelica	2.279	0.134	-	-	0.167	-
Lasianthus kurzii	-	-	-	-	-	0.245
Lindera metacafaena	-	-	-	-	-	0.477
Lindera missneri	-	-	-	-	-	0.634
Lindera sp.	-	-	-	-	0.821	0.550
Lithocarpus aggregatus	-	-	-	0.456	0.318	2.653
Lithocarpus annamensis	-	-	-	-	0.235	-
Lithocarpus ceriferus	-	-	-	-	-	0.212
Lithocarpus dealbatus	-	-	-	-	-	0.548
Lithocarpus elegans	-	-	-	-	4.990	0.521

Table 3. (Cont.)

Species	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Lithocarpus polystachyus	0.312	-	-	2.537	-	-
Lithocarpus sp.	-	-	-	0.479	-	-
Lithocarpus tomsonii	-	-	-	-	-	0.252
Lithocarpus triboides	-	-	-	-	-	1.337
Litsea beusekomii	-	-	-	-	-	0.536
Litsea chatacea	-	-	-	-	-	0.246
Litsea dubele	-	-	-	-	-	4.474
Litsea glutinosa	0.842	0.189	-	-	0.367	-
Litsea lancifolia	-	-	-	-	-	0.143
Litsea sp.1	-	-	-	-	-	0.413
Litsea sp.2	-	-	-	-	-	0.194
Litsea umbellata	-	-	-	-	-	0.126
Lophopetalum wallichii	0.963	-	-	0.496	-	-
Maesa sp.	0.595	-	-	0.253	-	-
Mallotus khasianus	-	-	-	-	-	0.233
Mangifera caloneura	0.143	-	-	0.118	-	-
Mangleitia garrettii	-	-	-	-	-	4.664
Mastixia euonymoides	-	-	-	-	-	7.529
Maytenus curtisii	-	-	-	0.373	-	-
Meliosma simplicifolia	-	-	-	-	0.386	-
Memecylon scutellatum	0.527	-	-	-	-	-
Millettia brandisiana	0.222	0.139	-	-	-	-
Millettia leucantha	1.276	6.966	-	-	-	-
Mitragyna brunonis	0.493	0.683	-	-	-	-
Morinda coreia	0.191	-	-	-	-	-
Morinda elliptica	0.814	0.286	-	-	-	-
Myrica esculenta	-	-	-	-	-	0.267
Myrsine semiserrata	-	-	-	-	-	0.168
Neolitsea pallens	-	-	-	-	-	6.972
Nyssa javanica	-	-	-	-	-	1.996
Ochna integerrima	0.243	-	-	-	-	-
Oroxylum indicum	-	0.620	0.112	-	-	-
Ostodes paniculata	-	-	-	-	-	0.956
Paramichelia bailonii	-	-	-	-	0.820	-
Parenaria camelliflora	-	-	-	-	-	0.370
Pavetta aspera	-	-	-	-	-	0.265
Pavetta tomentosa	-	-	-	-	0.694	-
Payena paralleloneura	-	-	-	-	0.646	-
Phoebe lanceolata	-	-	-	-	0.131	0.323
Phoebe sp.	-	-	-	-	0.147	-
Phyllanthus emblica	0.856	0.732	-	0.366	0.199	0.543
Pinus kesiya	0.262	-	-	4.831	57.946	-
Podocarpus nerriifolius	-	-	-	-	-	0.123

Table 3. (Cont.)

Species	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Polyalthia sp.	-	-	-	-	-	0.153
Polyosma integrifolia	-	-	-	-	-	0.788
Premna sp.	-	0.114	-	-	-	-
Premna villosa	-	-	-	0.272	-	0.126
Protium serratum	-	-	-	-	-	0.255
Prunas placostictus	-	-	-	-	-	0.584
Pterocarpus macrocarpus	0.672	5.326	-	0.180	-	-
Pyrenaria camalliflora	-	-	-	-	-	0.454
Quercus glabricupula	-	-	-	-	-	0.513
Quercus indica	0.244	-	-	-	-	-
Quercus kerrii	2.720	-	-	1.917	0.571	-
Quercus kingiana	0.640	-	-	0.173	-	-
Quercus lenticellata	-	-	-	-	-	4.377
Quercus ramsbottomii	8.289	-	-	8.353	-	-
Quercus sp.	-	-	-	0.542	-	-
Rapanea yunnanensis	-	-	-	-	-	1.467
Rhus chinensis	-	-	-	-	0.119	0.363
Rhynchotechum obovatum	-	-	-	-	0.177	-
Rubiaceae	0.289	-	-	-	-	-
Sarcosperma arboreum	-	0.464	-	-	0.257	0.767
Savravia napaulensis	-	-	-	-	0.639	0.578
Schefflera hypoleucoides	-	-	-	-	-	0.286
Schima wallichii	0.621	0.123	-	2.247	7.746	4.721
Schleichera oleosa	-	0.154	-	-	-	-
Shorea obtusa	5.119	-	-	0.366	-	-
Shorea siamensis	25.335	0.466	-	3.183	-	-
Sindora siamensis	0.333	-	-	-	-	-
Spondias pinnata	0.665	1.575	-	-	-	-
Sterculia rubiginosa	-	-	-	-	0.145	-
Sterculia sp.	-	-	-	-	-	0.298
Sterculia villosa	-	-	-	-	-	0.127
Stereospermum cylindricum	-	0.128	-	-	0.219	-
Stereospermum neuranthum	0.178	0.432	-	0.159	0.188	0.665
Strychnos nux-vomica	0.646	0.680	-	-	-	-
Styrax benzoides	-	0.435	-	0.663	0.874	0.250
Symplocos cochinchinensis	-	-	-	-	0.318	0.227
Symplocos longifolia	-	-	-	-	-	0.874
Symplocos macrophylla	-	-	-	-	-	0.217
Symplocos racemosa	0.343	-	-	0.118	-	-
Symplocos sp.	0.695	-	-	0.149	-	-
Sympocos hookerii	-	-	-	-	-	0.796
Syzygium angkae	-	-	-	-	0.473	4.118
Syzygium balsamea	-	-	-	-	-	0.465

Table 3. (Cont.)

Species	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Syzygium cumini	1.963	-	-	0.261	-	-
Syzygium siamense	0.274	-	-	0.135	-	-
Syzygium sp.1	-	-	-	0.998	-	-
Syzygium sp.2	-	-	-	-	0.272	-
Tarenna collinsae	0.328	-	-	-	-	-
Tarenna disperma	-	-	-	-	-	0.387
Tectona grandis	-	14.828	-	-	-	-
Terminalia chebula	0.352	0.995	-	0.168	-	-
Terminalia dafeuillana	-	0.153	-	-	-	-
Terminalia sp.	0.989	1.774	-	-	-	-
Terminalia triptera	1.552	1.112	-	-	-	-
Ternstroemia gymnanthera	-	-	-	0.184	1.247	0.952
Trema tomentosa	-	-	0.444	-	-	-
Tristania rufescens	2.177	-	-	2.434	1.256	-
Tristaniopsis burmanica	-	-	-	0.740	1.124	-
Unidentified	-	-	1.579	0.465	1.732	2.259
Vaccinium sp.1	0.649	-	-	0.253	-	-
Vaccinium sp.2	-	-	-	0.162	-	-
Vaccinium sprengelii	0.942	-	-	1.718	0.337	0.149
Vaccinium whitmove	-	-	-	0.142	-	-
Viburnum inopinatum	-	-	-	0.190	0.270	-
Vitex canescens	-	0.612	-	-	-	-
Vitex peduncularis	0.568	0.453	0.758	0.365	0.498	-
Vitex pinnata	0.839	1.162	-	0.325	-	-
Vitex vestita	-	0.114	-	-	-	-
Walsura trichostemon	0.257	-	-	-	-	-
Walsura trijuga	-	-	-	-	-	0.123
Wendlandia tinctoria	0.812	-	-	3.117	2.463	0.155
Wrightia arborea	-	0.424	-	-	0.270	-
Xantolis burmanica	-	-	-	-	-	0.183
Xantolis sp.	-	-	-	-	-	0.756
Xylia xylocarpa var. kerrii	0.363	13.522	4.612	-	-	-
Zizyphus oenoplia	-	0.581	-	-	-	-
Zollingeria acuminata	-	2.214	-	-	-	-
Zyzyphus incuwa	-	-	-	-	-	0.236

For forest type abbreviations see Table 1.

merated are observed to be more or less diverse than ever previously reported by Pengklai (1996) in this area, especially for trees with D $\geqq$ 4.5 cm.

Obviously these species distribute along the altitudinal gradients differently suggesting their amplitude responses and preferences in occupying the different breadth of habitat so as to correspond to their most favourable habitat conditions. Their quantitative structural characteristics, distribution, species diversity as well as other ecological parameters will be analyzed in relation to soils and some climatic variables in order to discriminate their zonations along the altitudinal range of Doi Inthanon national park.

Soil properties along the altitude

Soils of Doi Inthanon differ in their textural compositions in both horizons across forest types located on different altitudinal range, varying from sandy loam to sandy clay loam in surface soils and clay or clay loam in subsoils. Their average gravel contents as well as other physical properties also vary considerably among the 6 forest types (Table 4).

Soils of dry dipterocarp forest and montane forest are more gravelly and sandy in surface horizons than those in other forest types. As gravel contents are large downwardly to subsoils of dry dipterocap forest but on the contrary they decrease considerably in subsoils of montane forest while sand compositions are large in both forest types. Dry evergreen forest soils, on the other hand and although investigated from 1

Table 4. Soil texture and some physical properties in Doi Inthanon forests.

Properties	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Surface soils (0-5 cm)						
Gravel (%)	24.09	15.46	0.50	5.96	3.76	26.15
Sand (%)	61.16	47.73	46.40	51.51	56.43	66.48
Silt (%)	18.13	26.67	23.40	19.22	18.89	17.44
Clay (%)	20.71	25.60	30.20	29.27	24.68	16.08
Bulk density ($g\ cm^{-3}$)	1.29	1.13	0.99	1.09	0.81	0.71
Particle density ($g\ cm^{-3}$)	2.72	2.76	2.61	2.68	2.71	2.56
Porosity	0.52	0.59	0.62	0.59	0.70	0.72
Subsoils (20-25 cm)						
Gravel (%)	22.16	19.18	0.70	3.78	3.34	7.28
Sand (%)	43.58	44.40	52.40	26.40	35.32	49.26
Silt (%)	17.38	24.00	18.00	13.00	15.11	18.56
Clay (%)	39.40	31.60	29.60	60.60	49.57	32.91
Bulk density ($g\ cm^{-3}$)	1.38	1.19	1.24	1.27	1.17	0.91
Particle density ($g\ cm^{-3}$)	2.74	2.83	2.58	2.65	2.64	2.75
Porosity	0.50	0.57	0.52	0.52	0.56	0.67

For forest type abbreviations see Table 1.

plot only, are exceptionally low in gravel and sand particles in surface soils but greatest sand particles are found in subsoils. Silt compositions are most abundant in both horizons in mixed deciduous forest but least in surface soils of montane forest and in subsoils of pine-dipterocarp forest. Clay fractions are abundant in surface soils of dry evergreen and pine-dry dipterocarp forests and few in montane forest but most abundant in subsoils of pine-dipterocarp forest and fewest in dry evergreen forest.

Bulk density of soils in dry dipterocarp forest are greatest in both horizons and lowest in montane forest although the coarse particles such as gravel and sand are large in both forest soils. Their organic matter contents may be greatly different as indicated by their porosities which are most porous in both horizons suggesting their loose structure in soils of montane forest but more compact in both horizons of soils in dry dipterocarp forest. Bulk density of surface soils in dry dipterocarp, mixed deciduous and dry evergreen forests are found higher than in similar forest types in Doi Chiangdao (Khemnark *et al.*, 1972) but fall within the ranges of bulk densities in soils of dry dipterocarp forest of several subcommunity types in Thailand (Sukwong *et al.*, 1976; 1977; Bunyavejchewin, 1983a) but lower than in mixed deciduous and dry evergreen forests elsewhere (Bunyavejchewin, 1985; 1986). However, bulk densities in soils of pine-dipterocarp, pine-oak and montane forests are lower than in Doi Chiangdao soils investigated by the above workers.

Although particle density of soils in both horizons of mixed deciduous forest are observed to be greatest but all soils may not be greatly different in their values in the six forest types. However, particle densities of soils in dry dipterocarp and mixed deciduous forests are found to be greater than in similar forest types elsewhere recorded by Bunyavejchewin (1983a; 1985; 1986). These physical properties of soils although have been partly analyzed, they may exhibit some significant effects to the distribution of different tree species, diversity and community type on altitudinal gradients as postulated by Burnham (1974).

Some soil chemical properties have been investigated (Table 5) and found that soil pH range from neutral to strong acidity in surface soils and all strong acidity in subsoils of all 6 forest types. pH of both surface and subsoils are likely to follow the similar trend, being relatively high in the former and low in the latter horizons and the tendency of soil acidity obviously increase from those underneath the lower to the upper altitude forests except for dry evergreen forest which always distribute on soils along the stream bank at moderate low altitude where moderate acidity of soils in both horizons are observed as compared to other forest types.

Carbon and nitrogen contents of soil in both horizons are virtually different among the 6 forest types distribute along altitudinal gradients, being lowest in dry dipterocarp forest and largest in montane forest (Table 5). However, while carbon and nitrogen contents are found to be closely associated and decline downwardly in the similar magnitude in subsoils of all forest types, their average contents in surface soils are slightly different especially in soils of mixed deciduous and pine-dry dipterocarp forests where carbon contents of the former forest are low next to that in soils of dry dipterocarp forest but nitrogen contents of latter forest are lower than that in the former forest. This difference may be due to surface soils of mixed deciduous forest may have some influences from its species composition as it is found that members of Leguminosae tree species; *Dalbergia nigrescens, Millettia leucantha, Pterocarpus macrocarpus* and *Xylia*

Table 5. Soil reaction (pH) and some chemical properties in Doi Inthanon forests.

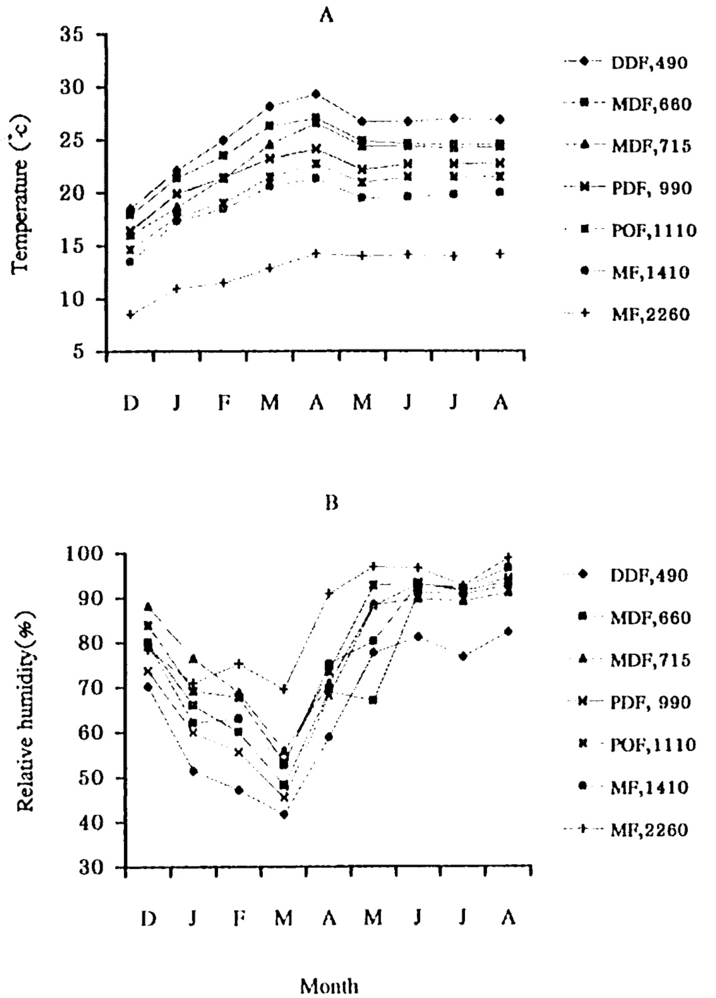
Properties	Forest type					
	DDF	MDF	DEF	PDF	POF	MF
Surface soils (0-5 cm)						
pH	6.21	7.04	5.05	5.72	5.30	4.73
C (%)	1.93	3.26	4.95	4.07	7.13	9.19
N (%)	0.12	0.24	0.26	0.19	0.29	0.63
C/N ratio	16.35	13.88	18.83	21.75	24.54	14.91
Subsoils (20-25 cm)						
pH	5.77	6.17	5.50	5.69	5.34	5.05
C (%)	0.72	1.45	1.33	0.77	1.57	2.71
N (%)	0.06	0.12	0.09	0.07	0.14	0.16
C/N ratio	12.01	11.49	14.60	11.43	22.41	16.60

For forest type abbreviations see Table 1.

xylocarpa var. *kerrii* are found exceptionally abundant in this forest type (Table 3) which may provide better nitrogen contents to soils than those in dry dipterocarp forest as it is clearly observed that average nitrogen contents in soils of pine-dipterocarp forest are similarly low as in soils of dry dipterocarp forest even in the subsoils of this forest type also exhibit the same magnitude. C/N ratios of soils are found to be highest in pine-oak forest for both horizons (Table 5) but lowest in mixed deciduous forest for surface soils and in pine-dipterocarp forest for subsoils. However, tendency of C/N ratios in soils of forests distributing in xeric habitat on lower altitudes toward those in mesic habitat on upper altitudes are similar to that recorded by Ogawa *et al.* (1961). Other soil properties included soil moisture characteristics, moisture permeability, hardness, minerological properties and some chemical contents: P, K, Ca, Mg, Na, Si, Fe and Al are being analyzed. pH and some chemical properties of soils in various forest types in Thailand show similar trend with some variations in different localities as studied elsewhere in alternate dry and wet season sites (Khemnark *et al.*, 1972; Sukwong *et al.*, 1976; 1977; Bunyavejchewin, 1983a; 1985; 1986; Sahunalu *et al.*, 1994; Sakurai *et al.*, 1998). Doi Inthanon soil properties as variably differentiated due to altitude and vegetation zonation will be assessed as part of environmental factors determining their species composition and diversity distribution along the altitude.

Temperature and humidity along the altitude

Monthly mean air temperature inside the forests during the 9-month period from December, 1999 to August, 2000 vary clearly among the forest cover types of each measuring site along the altitudinal gradients, being highest in dry dipterocarp forest at lower altitude, lowest in montane forest at upper altitude and intermediate between the two lower and upper altitudes where they are mixed deciduous, pine-dipterocarp and pine-oak forests which distribute upwardly by altitudes suggesting temperature lapse rate pronounce clearly along the altitudinal difference. While mean air temperature in the lower altitude where two deciduous forest types are located rise up greatly in dry season (December through April), those in evergreen forest especially in pine-oak and montane forests do not greatly change (Fig. 4A). During wet season (May to August), while mean air temperature inside all forest types do not fluctuate much but inside those on lower altitude; dry dipterocarp and mixed deciduous forests maintain their mean air temperature



Figuer 4. Monthly mean air temperatuer (A) and relative humidity (B) during the 9-month period in 7 locations varying in different altitude (m asl) of Doi Inthanon from December, 1999 to August, 2000.

as high as above 24℃ but those on upper altitude especially in pine-dipterocarp, pine-oak and montane forests are always lower than 23℃. On the uppermost site of montane forest, it has never exceed 15℃ all over the period of 9 months and being almost constant at 14℃ throughout the wet season. These temperature measurements may not directly show the real air temperature regime over the sites as they are inside the forests and their fluctuations may not as great as in the area outside the forests but in the relatively open forests such as in dry dipterocarp and mixed deciduous forests, daily fluctuations are observed to be great as compared to the closed and evergreen forests; pine-oak and montane forests.

Available climatic data at a weather station situated at 1300 m asl which may be comparable to those measured inside pine-oak forest at 1110 m asl in this study, mean monthly air temperature in 1992-1997 during the 9 corresponding months are always greater than these observed values in the range of 0.5-3℃. On the basis of temperature lapse rates, tentative assessment during cold and dry seasons (December to April) and wet season (May to August) found that there are small variation during the two periods being about 0.7 ℃/100 m estimated by $y = 27.509-0.00701\ x$, $r^2 = 0.976$ and $y = 29.735-0.00709\ x$, $r^2 = 0.977$, where y = monthly mean air temperature, ℃; x = altitude, m asl; r^2 = coefficient of determinations during the two periods respectively. It is noted that these estimations are from air temperature measurements inside the forests. This lapse rate is close to the value given by Whitmore (1984) for the tropical rain forests in the Far East of 0.67℃/100 m. However, several evidents from studies in Malaysia, lapse rates varied between 0.55 to 0.61℃/100 m (Burgess, 1969), 0.6℃/100 m from sea level to 2000 m asl and 0.5℃/100 m above 2000 m asl in Malaysian mountains (van Steenis, 1962), 0.7 and 0.51℃/100 m for maximum and minimum of mean weekly air temperature and 0.44 and 0.43℃/100 m for maximum and minimum of mean of 2-year data in Selangor, Malaysia (Nakashizuka *et al.*, 1992) but it was 0.43℃/100 m in Equador (Grubb and Whitmore, 1967). In temperate region for instance; in Mount Emei, Sichuan, China, Tang and Ohsawa (1997) observed as 0.54℃/100 m in mean annual air temperature, 0.6℃/100 m in May, 0.45℃/100 m in December being low in winter and high in summer while in Wenchuan, Baoxing and Yaan, China, as 0.49℃/100 m in mean annual temperature, 0.58℃/100 m in May and 0.45℃/100 m in December.

Monthly mean air humidity inside the forests during the same period show large difference in dry (December to April) and wet (May to August) seasons especially in the open and on lower altitude forests (Fig. 4B). Forests on upper altitudinal zone especially pine-oak and montane forests maintain high air humidity almost all over the period as these zones are always wet and foggy days often prevail. These differences in air humidity suggest the atmospheric condition controlling forest type clearly. These climatic parameters will be further studied in relation to moisture condition both inside and outside the forest conditions together with soil parameters in association with the distributional patterns of tree species and forest community types along the ranges of altitude in Doi Inthanon.

Literature cited

Bruijnzeel, L.A., M.J. Waterloo, J. Proctor, A.T. Kuiters and B. Kotterink. 1993. Hydrological observations in montane rain forests on Gunung Silam, Sabah, Malaysia, with special reference to the Massenerhebung effect. J. Ecol. 81: 145-168.

Bunyavejchewin, S. 1983a. Canopy structure of the dry dipterocarp forest of Thailand. Thai. For. Bull. 14:1-132.

Bunyavejchewin, S. 1983b. Analysis of the tropical dry deciduous forest of Thailand, I. Characteristics of the dominant types. Nat. Hist. Bull. Siam Soc. 31(2):109-112.

Bunyavejchewin, S. 1985. Analysis of the tropical dry deciduous forest of Thailand, II. Vegetation in relation to topographic and soil gradients. Nat. Hist. Bull. Siam Soc. 33(1):3-20.

Bunyavejchewin, S. 1986. Ecological studies of tropical semi-evergreen rain forest at Sakaerat, Nakhon Ratchasima, northeast Thailand, I. Vegetation patterns. Nat. Hist. Bull. Siam Soc. 34(1):35-57.

Burgess, P.F. 1969. Ecological factors in hill and mountain forests of the states of Malaya. Malayan Nat. J. 22:119-128.

Burnham, C.P. 1974. The role of the soil forming factors in controlling altitudinal zonation on granite in Malaysia. pp. 59-74. In : J.R. Flenley (ed.). Altitudinal Zonation in Malesia. Dept. of Geography, University of Hull, Institute for Southeast Asian Biology, University of Aberdeen.

Edwards, I.D., P.W. Payton, J. Proctor and S. Riswan. 1990. Altitudinal zonation of the rain forests in the Manusela National Park, Seram, Maluku, Indonesia. pp. 161-175. In : P. Baas, K. Kalkman and R. Geesink (eds.). The Plant Diversity of Malaysia. Kluwer Academic Publishers. Dordrecht, The Netherlands.

Faculty of Forestry. 1992. Master plan for management of Doi Inthanon National Park, Chiangmai. Kasetsart University, Bangkok.

Grubb, P.J. and T.C. Whitmore. 1967. A comparison of montane and lowland rain forests in Equador. II. The light reaching the ground vegetation . J. Ecol. 55:33-57.

Khemnark, C., S. Wacharakitti, S. Aksornkoae and T. Kaewla-iad. 1972. Forest production and soil fertility at nikom Doi Chiangdao, Chiangmai province. For. Res. Bull. No. 22. Faculty of Forestry, Kasetsart University, Bangkok.

Kitayama, K. 1992. An altitudinal transect study of the vegetation on Mount Kinabalu, Boneo. Vegetatio 102:149-171.

Nakashizuka, T., Z. Yusop and A.R. Nik. 1992. Altitudinal zonation of forest communities in Selangor, Peninsular Malaysia. J. Trop. For. Sci. 4:233-244.

Ogawa, H., K. Yoda and T. Kira. 1961. A preliminary survey of the vegetation of Thailand. Nature and Life in Southeast Asia 1:21-157.

Ohsawa, M, P.H.J. Nainggolan, N. Tanaka and C. Anwar. 1985. Altitudinal zonation of forest vegetation on Mount Kerinci, Sumatra:with comparisons to zonation in the temperate region of east Asia. J. Trop. Ecol. 1:193-216.

Pendelton, L. 1962. Thailand, aspects of landscape and life. Duell, New York.

Pendry, C.A. and J. Proctor. 1997. Altitudinal zonation of rain forest on Bukit Belalong, Brunei : soils, forest structure and floristics. J. Trop. Ecol. 13:221-241.

Pengklai, C. 1996. A preliminary survey of plant diversity at Doi Inthanon. A paper presented to symposium on plant resources of the Himalayan foothills. Queen Sirikit Botanical Gardens, Chiangmai (mimeographed).

Proctor, J.,Y.F. Lee, A.M. Langley, C.M. Munro and T. Nelson. 1988. Ecological studies on Gunung Silam, a small ultrabasic mountain in Sabah, Malaysia. I. Environment, forest structure and floristics. J. Ecol. 76:320-340.

Robbins, R.G. and T. Smitinand. 1966. A botanical ascent of Doi Inthanon. Nat. Hist. Bull. Siam Soc. 21:205-227.

Royal Forest Department. 1962. Types of the forests of Thailand. RFD Bull. No. R. 44, Bangkok.

Sahunalu, P., M. Jamroenpruksa, B. Puriyakorn, P.Dhanmanonda, W.Suwannapinunt and B. Prachaiyo. 1979. Comparative structural characteristics of three forest types at Namphrom basin, Chaiyaphoom province. For. Res. Bull. No. 63. Faculty of Forestry, Kasetsart University, Bangkok.

Sahunalu, P., P. Dhanmanonda and C. Khemnark. 1994. Discriminant analysis of soil and plant relationships in dry dipterocarp forest. Thai J. For. 13:98-113.

Sakurai, K., S. Tanaka, S. Ishizuka and M. Kanzaki. 1998. Differences in soil properties of dry evergreen and dry deciduous forests in the Sakaerat Environmental Research Station. TROPICS 8(1/2):61-80.

Samapudhi, K. 1957. The forests of Thailand and forestry programs. Royal Forest Department Publication No. R. 20. RFD, Bangkok.

Santisuk, T. 1988. An account of the vegetation of northern Thailand. Geoecological Research 5. U. Schweingurth (ed.). Franz Steiner Verlag Wiesbaden GMBH, Stuttgart.

Smitinand, T. 1965. The vegetation of Doi Chiangdao, a limestone massive in Chiangmai, north Thailand. Nat. Hist. Bull. Siam Soc. 21:43-128.

Smitinand, T. 1977. Vegetation and ground cover of Thailand. Dept. of Forest Biology, Faculty of Forestry, Kasetsart University, Bangkok.

Stamp, L.D. 1925. The vegetation of Burma from an ecological standpoint. American Baptist Mission Press for the University of Rangoon and Published by Thacker, Spink and Co., Calcutta.

Stott, P.A. 1975. Recent trends in the classification and mapping of dry deciduous dipterocarp forest in Thailand. pp. 22-56. In : P.M. Ashton (ed.). The Classification and Mapping of Southeast Asian Ecosystems. Dept. of Geography, University of Hull, Institute for Southeast Asian Biology, University of Aberdeen.

Sukwong, S., L. Chantanaparb, U. Kutintara, P. Sahunalu, S. Pongumphai, B. Thaiutsa, S. Thammincha, S. Siripanadilok and W. Kaitpraneet. 1976, 1977. Quantitative studies of the seasonal tropical forest vegetation in Thailand. Annual Report No. 1 and 2. Faculty of Forestry, Kasetsart University, Bangkok.

Tang, C.Q. and M. Ohsawa. 1997. Zonal transition of evergreen, deciduous, and coniferous forests along the altitudinal gradient on a humid subtropical mountain, Mt. Emei, Sichuan, China. Plant Ecol. 133:63-78.

Van Steenis, C.G. G. J. 1962. The mountain flora of the Malaysian tropics. Endeavour 21:183-193.

Whitmore, T.C. 1984. Tropical Rain Forest of the Far East. 2nd ed., Oxford University Press, Oxford.

Xiwen, L. and D. Walker. 1986. The plant geography of Yunnan province, southwest China. J. Biogeogr. 13:367-397.

要　旨

ドイインタノン国立公園における植生帯構造の研究と研究成果の環境教育への応用

ポンサク　サフナル

タイ北西部チェンマイ県のドイインタノン国立公園において、標高400mから2320mの範囲に46個の0.16haの調査区を設置し、胸高直径4.5cm以上の樹木種を対象に森林植生の調査を行った。また、同じ調査区を利用して土壌調査と、林内気温ならびに空中湿度のモニタリングを行った。調査した標高の範囲には、乾燥フタバガキ林、混合落葉林、乾燥常緑林、マツーフタバガキ林、マツーカシ林、山地林などの森林タイプが含まれていた。調査地域では、大きな2つの垂直分布帯が認識でき、標高400mから1000mの低地帯と、標高1000m以上の山地帯に区分できた。低地帯で優占する乾燥フタバガキ林と山地林は標高1020m付近で重複しており、さらにこの標高帯では、マツーフタバガキ林とマツーカシ林が混在し、低地帯と山地帯の移行帯を特徴づけていた。低地帯では乾燥フタバガキ林が最も広く分布し、混合落葉林の分布する標高帯はこれに比べれば狭かった。また河川に沿って乾燥常緑林がわずかに混在していた。46個の調査区からは、70科、155属、293種の樹木が出現した。これ以外に科レベルで同定されていない優占度の低い数種が出現した。このデータをもとに、科、属、種のそれぞれのレベルで、各森林タイプへの出現状況を予備的に解析し整理した。また、表層土と下層土の物理的、化学的な特性も、標高の推移とそれに伴う森林タイプの変化とともに明瞭に変化していった。乾期と雨期を通じて9カ月間連続して測定した、林内気温と空中湿度の測定結果も、標高傾度に沿って変化した。気温は標高の上昇とともに明瞭に低下した。空中湿度の月平均値は、低標高の落葉性の森林タイプで乾期に明瞭に低下するのに対し、高標高の常緑林では乾期を通じて相対的に高い湿度を維持していた。今後、定量的な解析をすすめることによって、森林植生の帯状分布の様子を、標高・土壌・気候条件と関連づけて明らかにすることができると期待している。

（推薦者：神崎　護　訳）

SPECIES MAINTENANCE IN DYNAMIC LANDSCAPE OF THE CHURIYA, EASTERN NEPAL

D. Bhuju[1) .and P. Yonzon[2)

SUMMARY

The Churiya Hills are the youngest and southernmost mountain chain of the Himalaya. They conjoin two ecological regimes : the tropical in the south and temperate in the north. In Nepal, the Churiya Hills cover 12.7% of the total land area and contribute to 25.8% of the forest cover of the country. As the human encroachment continues to increase, the fragile landscape of Churiya is in danger. However, ecological information on Nepal Churiya is almost non-existent. The present study covering the Churiya of eastern Nepal is an initiation of creating ecological data base of Nepal Churiya. The study dwells on six major areas: (i) GIS analysis of change in landuse pattern between 1958 and 1992, (ii) floristic composition, forest structure and regeneration, (iii) tree species association at various altitudes, (iv) local knowledge on plant uses among the resident ethnic groups, (v) distribution of butterflies, and (vi) baseline information on birds.

BACKGROUND

The Churiya comprise the youngest and the southernmost mountain chain of the Himalayan system (Bhatt 1977, Hagen 1998) and conjoin two distinct ecological regimes: the tropical environs of Gangetic plains in the south and the temperate mountains which extend to the alpine in the north (Fig. 1). Also known as the Siwaliks, the Churiya consist of Tertiary unconsolidated and highly erodible fluviatile sediments ranging from relatively fine-grained gray wackes in the south (Lower Siwalik), through soft of clay (Middle Siwalik) to very coarse sands and conglomerates (Upper Siwalik) in the north (Carson 1985). The Churiya Hills extend from Afganisthan to Assam with an average summit of less than 1500 m asl and the width varying from 8 to 50 km.

The Churiya rocks are rich in vertebrate fossil contents. Churiya's unearthed fossils of later Tertiary have provided basis for much of our present knowledge of the evolution of Asian flora and fauna (Itihara *et al.* 1972). Major fossil fauna includes primates, carnivores, ungulates, elephants, rodents, birds, reptiles and fish. The primate collection from the Churiya formations includes a number of genera of Anthropoids. A comparative study indicates that the animals of that period were the immediate ancestors of the present-day

---

1) Royal Nepal Academy of Science and Technology, GPO BOX 3323, Kathmandu
2) Resources Himalaya, GPO BOX 2448, Kathmandu

species. Furthermore, the variety that existed then was greater than what exists today.

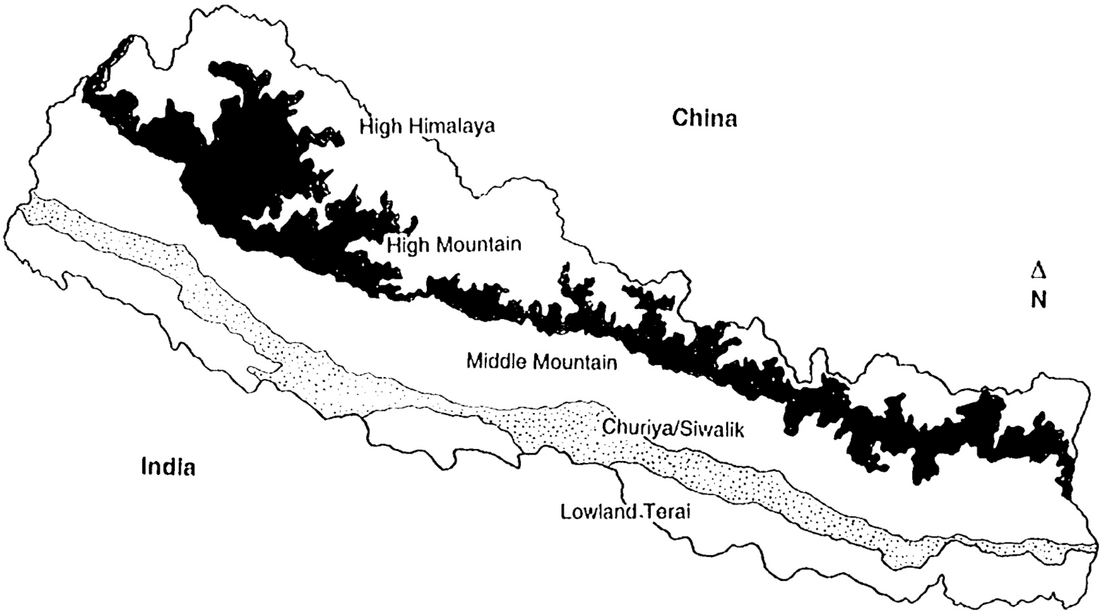


Fig. 1. Physiographic zones of Nepal

In Nepal (area: 147,181 km^2), the Churiya Hills cover 12.7% of the total land area and contribute to 25.8% of the forest cover of the country (LRMP 1978). Churiya's hardwood component (*Shorea robusta* and *Terminalia* spp) is the highest in the country which comprises 37% of the total (HMGN 1988). The existing protected network does not encompass the Churiya Hills but at least two protected areas in the south, Chitwan and Bardia, are bordered with the Hills. At some places the Churiya Hills could also make biological corridor such as between Bardia and Shukla Phanta in the far-western Nepal.

There is a growing concern on rapid deterioration of the Churiya Hills in Nepal. As the human encroachment continues to increase, the fragile landscape of Churiya is in danger. However, ecological information on Churiya Hills of Nepal is almost non-existence, except a few studies conducted in support of development activities. The present study, conducted in eastern Nepal, covered the Churiya Hills between Mechi and Saptakoshi. The study included six major areas, viz. (i) change in land-use pattern in 1958, 1978 and 1992, (ii) floristic composition, forest structure and regeneration, (iii) tree species association, (iv) local knowledge on plant use, (v) distribution of butterflies, and (vi) baseline information on bird species.

METHODOLOGY

Study area

The study area is a part of the Churiya in east Nepal (26°40'N-2753'N, 87°08'E-88°11'E) extending 105 km from the Mechi River (Nepal's eastern border) to the Saptakoshi River covering a total area of 779.24 km^2(width: 500 m - 20 km; elevation: 115-1300 m) (Fig. 2). There were 390 villages (settlements) under 37 Village Development Committees of the five districts: Jhapa (32.9 km^2), Morang (211.3 km^2) and Sunsari (89.4 km^2) districts and Ilam (443.9 km^2) and Dhankuta (1.8 km^2) districts.

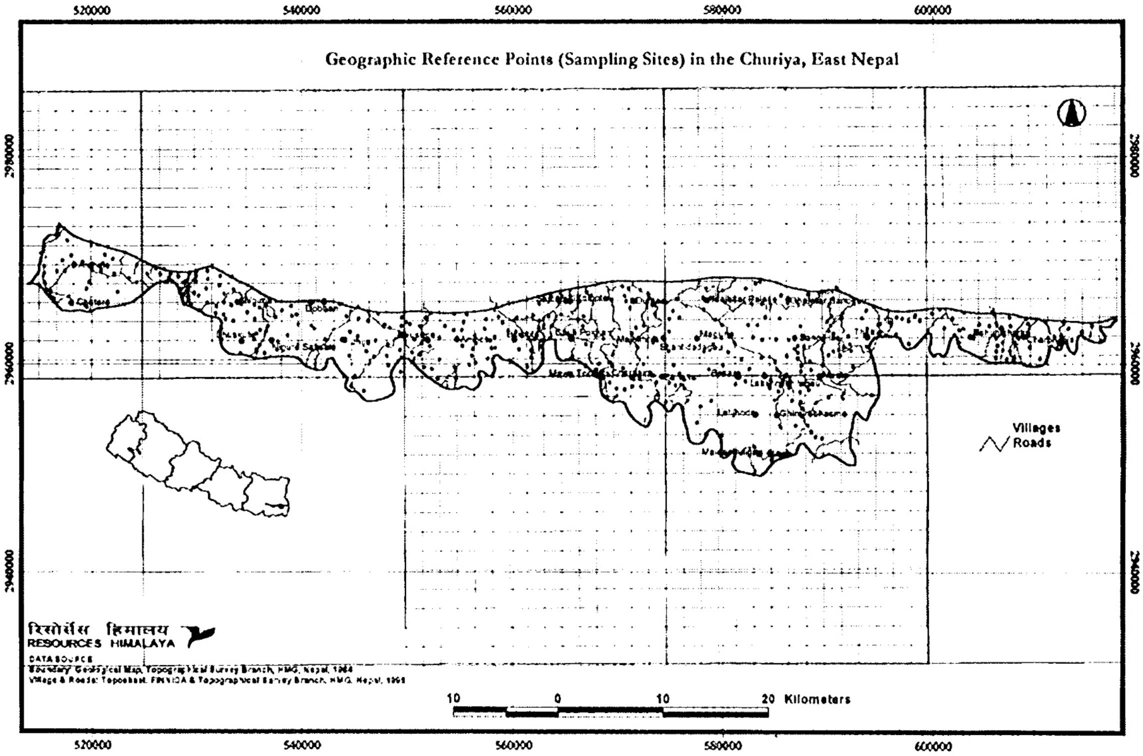


Fig.2. Geographic reference points for sampling in the Churiya of eastern Nepal.

Sampling methods

For GIS (Geographic Information System) analysis, three time-series maps of 1958 (scale 1:63,360; Govt. of India 1961), 1978 (scale 1:50,000; LRMP/HMGN 1986) and 1992 (scale 1:25000; HMGN/FINNIDA 1996) were digitized using ArcInfo 3.52 and Arcview 3.2. Land-use categories were agriculture, forest, shrub, grazing, barren, and sand/gravel. Information were also assessed for urban area, swamp, tea/coffee plantation, orchard and infrastructure such as canals.

Sampling plots for field data collection were ascertained using geographical grids on 1992 map using random table of Rohlf and Sokal (1969). In the field the grids were located with the help of Global Positioning System. There were altogether 35 geographic reference points (sampling grids). Field surveys were completed between January - April, 2000.

Vegetation samplings were done in quadrates, each grid based site comprised of two large quadrates (25m x 25m) representing two different slopes where applicable. For shrub stratum, each such quadrate had two sub-quadrates of 5m x 5m, and four small quadrates of 1m x 1m for ground vegetation. Sampling parameters included height, DBH, coverage, seedling and sapling density of plant species. Beside, noting site condition, soil samples were collected from the study plots. Recorded plants were identified at species level where possible and specimen were confirmed at the National Herbarium, Godavari (KATH). Nomenclature follows Press *et al* (2000).

Occurrence of bird and butterfly were recorded en-route to the sampling plots. Ethnobotanical information were gathered from the nearest village/settlements of the sampling plots for which rapid ethnobotanical appraisal (Martin 1995) was applied. Vegetation data were also collected from 64 selected points in an elevational difference of 100 m en-route to the sampling grids which ranged from 200-800 m.

RESULTS

Landuse pattern

GIS analysis of the recent map 1992 showed that the major land in the Churiya in the eastern Nepal was occupied by the forests with an area of 477.28 km^2 covering 61.25% of the total area (779.24 km^2) and the agriculture land was 221.71 km^2 (28.45%). Sand and gravel covered nearly 6.0% indicating the presence of a large network of rivers and streams. Shrub and grazing land occupied 1.5% each, and the rest land-use including urban area made 1.5%. Both the forests and agriculture lands varied in similar pattern in their altitudinal distribution which were high in lower elevation (< 300 m) and decreased gradually in the higher elevation showing an interrelationship between the forests and agricultural practices in Nepal. (Fig. 3).

Analysis showed that the forest cover has decreased by over 25% in less than 35 years. In 1958, the total area of the forests in the Churiya was 631.6 km^2 sharing 81.0% of the total area. By 1978, it decreased by 10% or an area equivalent to 63.5 km^2. In 1992, it further deteriorated and the forests shrunk to a total area of 477.2 km^2. During the same period, the agriculture land had increased by more than 120%, i.e. from a total area of 101.8 km^2 in 1958 to 221.7 km^2 in 1992. Also, increment in agriculture land was high comparatively between 1978-1992 than 1958-1978. While the highest gain was for agriculture with 127.1 km^2 or 56% of the total changed area, and a marginal change for urban area with a gain less than 0.1% of the total changed area. Similarly, grazing land and shrub land had increased during the period at the expense of forests. On the other hand, there was a little gain (48.9 km^2) for the forests which included some forms of plantations (Table 1).

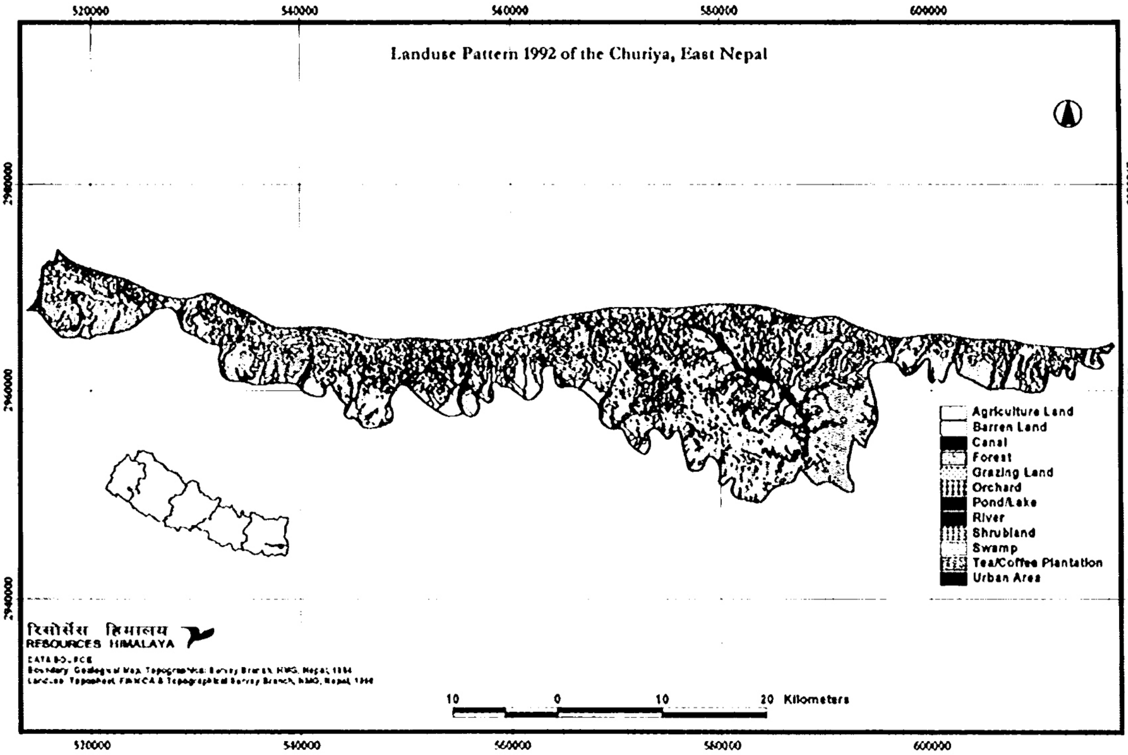


Fig.3. Landuse pattern of the Churiya in 1992, eastern Nepal

Table 1
Landuse pattern in 1958, 1978 and 1992 in Churiya, eastern Nepal

Landuse	1958		1978		1992	
	Area (km²)	Area (%)	Area (km²)	Area (%)	Area (km²)	Area (%)
Forest	631.55	81.0	568.02	72.9	477.23	61.2
Agriculture Land	101.84	13.1	138.14	17.7	221.71	28.5
Shrub Land	4.96	0.6	18.70	2.4	11.52	1.5
Grazing land	5.27	0.7	3.56	0.5	10.87	1.4
Others	35.62	4.6	50.82	6.5	53.12	6.8
Total	779.24	100.0	779.24	100.0	779.24	100.0

Floristic composition and forest structure

Over 265 vascular plant species, belonging to 85 families and 178 genera, were recorded from the study sites. Family Leguminosae included the highest number of species (25 spp.) which included rare/threatened tree species like *Dalbergia latifloia* and *Acacia catechu*, and endemic species *Ormosia glauca*. Other families comprising high number of species were Gramineae (16 spp.), Compositae (12 spp.) and Euphorbiaceae (10 spp.). By habit, tree and sub-tree species comprised the highest composition with 45% of the total species, followed by Herbs (22%), Shrubs (20%), Liana (10%) and Fern (3%).

Out of 16 plants of Nepal included in CITES, three species (*Cyatheacea sp., Cycas pectinata* and *Rauvolfia serpentina*) were found in the studies area of Churiya. A total of 36 individuals of *C. pectinata* were observed which were found growing mostly in the *Schima* and/or *Shorea* forests in association with *Phoenix* sp. and/ or *Pandanus fascicularis*. Similarly, 19 individuals of *Cyathea* sp. were also noted. The recorded individuals of both species were growing near streams and in the eastern sites in the altitudinal range of 300-750 m. Seven rare and/or endangered species identified by IUCN, and several species of specific scientific interest were also noted.

The forests of Churiya in eastern Nepal were estimated with a basal area (BA) of 37.28 m^2 ha^{-1} and a density of 786.5 n ha^{-1}. The predominant tree species at canopy stratum (height >10 m) were *Shorea robusta* (relative basal area: 44.0%), *Terminalia alata* (RBA: 6.8%), *Lagerstroemia parviflora* (5.0%), and *Adina cordifolia* (5.0%). Mean DBH (diameter at breast height) of these species was 26.4 cm, though a few *S. robusta* had a maximum DBH of 124.0 cm. The dominant species presented a sporadic type of size-class distribution indicating the variation in sample plots and/or presence of species with different age groups. Beside these species, the most frequently occurring (Freq. >40%) trees were *Semecarpus anacardium*, *Albizia lebbeck*, *Syzygium cumini, and Schima wallichii*. *S. wallichii* was observed up to 300 m, a lowest record of its occurrence which could be attributed to the moister environs of eastern Nepal. (Fig. 4, Table 2).

The understory stratum (Ht. <4 m), had species like *Colebrookea oppositifolia* (Freq. 32.9%), *Eupatorium* spp. (Freq. >22%), *Leea* sp. (Freq. 18.6%), *Maesa montana* (Freq. 17.1%), and *Boehmeria platyphylla* (Freq. 15.7%). The highest density, however, was that of *Clerodendrum viscosum* with 2940 n ha^{-1}. *Eupatorium* sp., *C. oppositifolia*, and *Phoenix sylvestris*, a tree species but occurring in the understory in the study site (Average Ht. 1.3 m), shared comparatively a high basal area, each having RBA over 3.0%. The ground stratum was poorly devel-

Table 2

Structural parameters of major tree species in the Churiya, eastern Nepal

SN	Species	Freq %	BA cm²	RBA %	Dens /ha	Stem N	DBH (cm) mean	DBH (cm) max	Height (m) mean	Height (m) max
1	*Shorea robusta**	85.7	702871.1	44.0	162.4	696	28.0	124	9.1	26
2	*Lagerstroemia parviflora**	70.0	80047.0	5.0	37.3	160	20.6	83	8.9	25
3	*Terminalia alata**	51.4	108941.8	6.8	24.3	104	29.8	96	10.6	22
4	*Semecarpus anacardium*	44.3	36692.2	2.3	16.1	69	21.8	70	8.8	22
5	*Albizia lebbeck*	42.9	29240.9	1.8	19.1	82	15.5	82	6.6	20
6	*Syzygium cumini*	42.9	23944.4	1.5	10.7	46	21.0	77	8.0	18
7	*Schima wallichii**	40.0	79181.5	5.0	19.8	85	26.8	100	8.7	22
8	*Sterculia villosa*	35.7	9569.3	0.6	12.1	52	11.6	53	5.3	15
9	*Adina cordifolia**	34.3	56638.2	3.5	14.0	60	27.0	106	8.3	20
10	*Grewia optiva*	31.4	8860.3	0.6	8.2	35	15.8	34	7.3	14
11	*Lannea coromandelica*	31.4	36715.8	2.3	8.2	35	31.4	77	11.6	20
12	*Mallotus philippensis*	31.4	9204.1	0.6	7.2	31	16.1	47	5.5	14
13	*Dendrocalamus hamiltonii*	28.6	15744.9	1.0	116.7	500	6.1	16	8.2	13
14	Putali Kath#	24.3	8423.4	0.5	7.7	33	15.2	45	7.0	15
15	*Terminalia bellirica*	22.9	28605.8	1.8	5.6	24	31.5	105	11.2	20
	TOTAL		1597312.0	100.0	786.5	3370	17.8	124	7.4	75

*dominant species by RBA # Local name

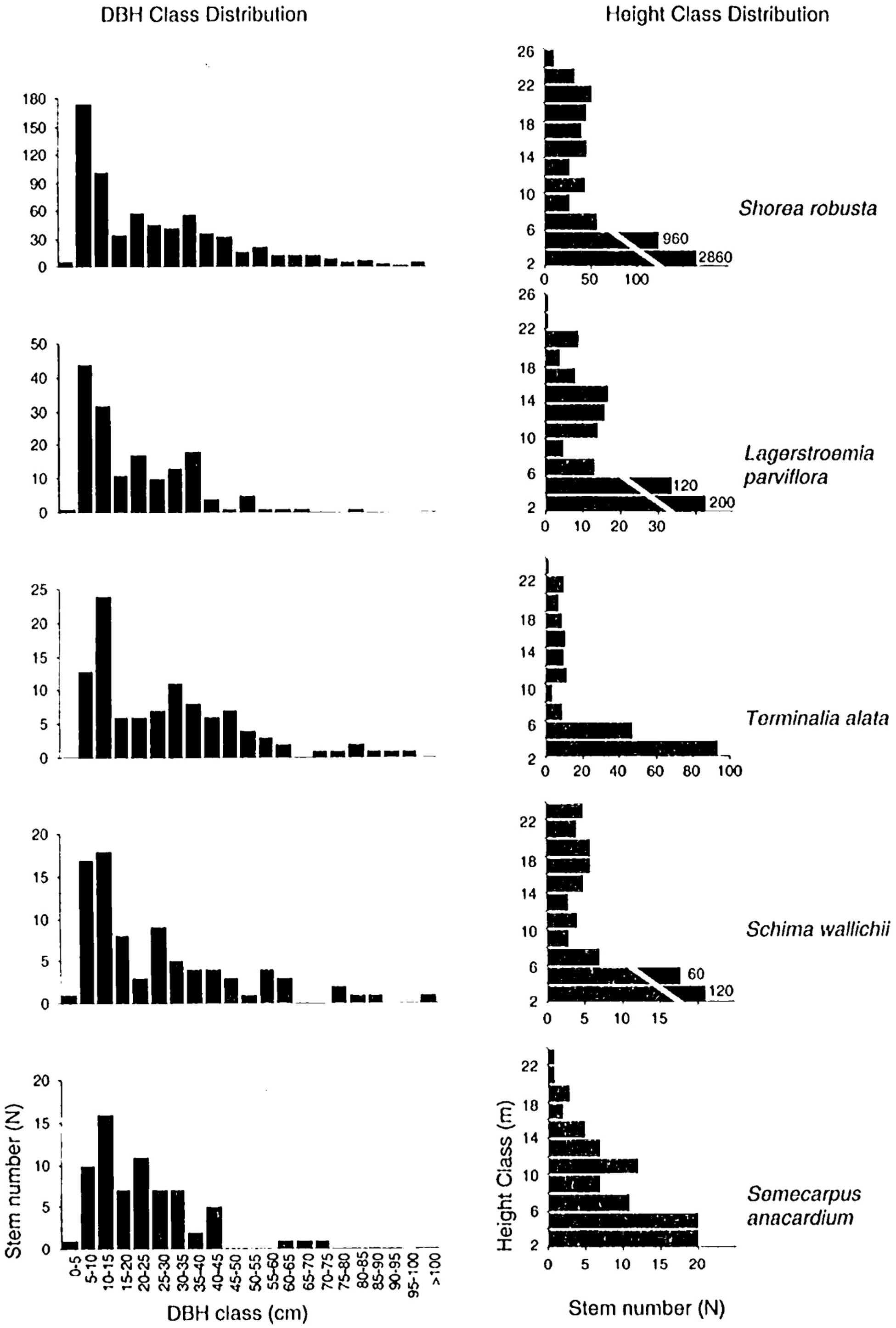


Fig. 4. Diamter at breast height (DBH) and height class distribution of major tree species in the Churiya, eastern Nepal

oped with a coverage of 15.4% in average which can be attributed to prevailing dry season during the investigation and wide spread over-grazing. The most abundant species by frequency of occurrence were *Oplismenus* sp. (Freq. 23.46%), *Capillipedium assimile* (Freq. 16.54%), and *Sida cordata* (Freq. 10.38%). By relative dominance, *C. assimile, Arundinella nepalensis, Oplismenus* sp., *Ageratum conyzoides* and *Carex cruciata* were most prevalent in the area.

Tree Species association

A dendrogram from similarity analysis based on RBA and floristic composition categorized the study site into seven groups with varying diversity index. The major groups were that of dominated by *Shorea robusta, Terminalia alata, Lagerstroemia parviflora, Adina cordifolia, Schima wallichii* and *Bombax ceiba.* The predominant species was *S. robusta* in the studied site indicating its higher germination percentage, higher adaptability and higher rate of survivorship. The species was recorded as dominant species in 24 sites (37.5% of the total), and co-dominant in at least 11 sites. However, as also shown by the dendrogram, *S. robusta* appeared along with other dominant and/or co-dominant trees in those sites (Table 3).

Table 3
Association frequency (%) of major tree species in the Churiya, eastern Nepal

	Association Freq. %					Associated
Species	*T.alata*	*L.parviflora*	*S.anacardium*	*S.wallichii*	*A.cordifolia*	Total spp.
Shorea robusta	42.18	35.93	32.81	21.88	20.31	46
Terminalia alata		28.13	17.19	9.38	17.19	42
Lagerstroemia parviflora			20.31	7.81	17.19	44
Semecarpus anacardium				9.38	7.81	32
Schima wallichii					7.81	20
Adina cordifolia						39

Out of 64 sampling sites, *S. robusta* was found associated with one or more species in 49 sites, and was growing with 46 types of tree species in total. While *L. parviflora* and *T. alata* had an association with 44 and 42 types of species. *S. robusta* showed the highest association with all dominant species; with *T. alata* 42.2% frequency, with *L. parviflora* 35.9%, with *S. anacardium* 32.8%, with *S. wallichii* 21.9%, and with *A. cordifolia* 20.3%. A high association was also seen between *T. alata* and *L. parviflora* (28.1%). On the other hand, *S. wallichii* showed lesser association frequency (<10%) except with the *S. robusta*. Among the dominant species, *S. robusta* had the widest distribution range and occurred from 200-800 m altitudes, while *S. wallichii* was basically a midhill element mostly distributed above 500 m.

Local knowledge and ethnic groups

The present study documented 82 species of medicinal plants and 76 wild edible plants. Altogether

30 types of diseases were found to be treated by phyto-therapy using the reported 82 plant species in the Churiya of east Nepal. *Azadirachta indica* (Neem) was reported to be used for the highest number (10) of diseases as antiseptic, analgesic, antispasmodic and antipyretic. The species was found also effective to cure diabetes, gastric, snake bite and fever due to typhoid, malaria, pneumonia. Three species, viz. *Phyllanthus emblica* (Amala), *Aegle marmelos* (Bel), and *Phlogacanthus thyrsiflorus* (Chuwa) were reported to be used for six different diseases. Similarly, *Rauvolfia serpentina* (Chandmaruwa), *Butea minor* (Bholetro) and *Terminalia bellerica* (Barro) were also found for multi-uses treating at least six different types of complaints and disorders.

Among the four major ethnic groups interviewed, Limbu reported a total of 64 medicinal plants (78.1% of the total plants reported for medicinal purposes) while Bahun-Chhetri informed 55 such species (67.1% of the total). Similarly, Rai and Magar informed 43 and 37 species respectively (Fig. 5). In average, each individual belonging to Limbu, Rai and Magar was familiar with less than four species of medicinal plants, while each individual belonging to Bahun-Chhetri was familiar with more than five such plants. The Limbus were the pioneering and still dominant inhabitants of the Churiya in East Nepal. Bahun and Chhetris, dominating social Hindu class have given them access to better their education. They had knowledge on Ayurved and other Hindu literature which contain a wealth of knowledge on plants and plant uses.

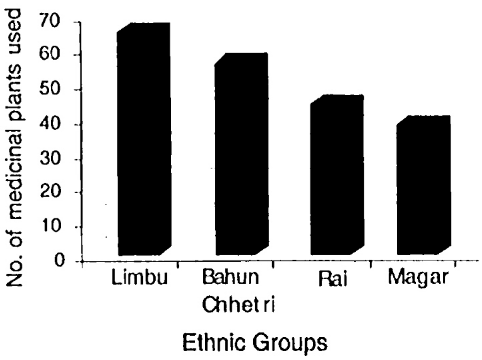


Fig. 5. Number of medicinal plants used by various ethnic groups living in the Churiya of East Nepal

Distribution of butterflies

Altogether 35 species belonging to 28 genera and 8 families were enumerated from the present study site of the Churiya of eastern Nepal (Table 4). The documented species comprised 5.3% of the total species of butterflies known to Nepal. Genus *Precis* was found to be the most common with its four species, while *Athyma, Danaus, Delias* and *Elymnias* were also common in this part; the rest were single species genus. Figure 2 shows that the majority of recorded species come from Nymphalidae family which comprised 34.3% followed by Lycaenidae (20.0%), Pieridae (14.3%) and Satyridae (11.4%).

Considering seasonal change, the species richness of butterfly was found to increase from winter to spring season. Out of 35 species collected, 15 species (42.85%) were found in winter season and the rest in spring. A significant correlation was found between the species richness and the months indicating that the abundance of butterfly was positively affected by approaching warmer days and availability of more food that is the nectar. Similarly, the species richness of butterfly in the Churiya of east Nepal gradually increased up to 500 m, then it decreased. This tendency corresponds with the area of shrub-land in the studied area indicating the habitat preferences of the butterflies. However, the habitat loss is adversely affecting the butterfly diversity in Nepal.

Table 4

Distribution of butterfly species in different altitudes (m) and seasons in the Churiya, eastern Nepal

	Altitude (m)										Season	
Family/species	250	350	450	550	650	750	850	950	1050	1150	Winter	Spring
Palilionidoe												
Pachiliopta aristolocae		+	+	+	+	+	+	+				+
Papilio demoleus		+	+	+	+	+	+	+	+			+
Pieridae												
Delias descombesi				+	+	+	+	+	+	+	+	+
Delias hyparete			+	+	+	+	+	+	+	+		+
Eurema hecabe	+	+	+	+	+	+					+	
Gonepteryx rhamni								+	+	+	+	
Pieris brassicae	+	+	+	+	+	+	+	+	+	+	+	+
Lycaenidae												
Amblypodia areste			+	+	+	+	+					+
Aprophala pseudocentaurus						+					+	
Celastrina puspa			+	+	+							+
Heliophorous epicle		+	+	+								+
Jamnides alecto						+	+				+	
Lampides boeticus				+							+	
Zizeeria maha		+	+	+	+	+	+				+	
Nemeobiidae												
Abisara fylla			+	+	+							+
Nymphalidae												
Athyma jina						+	+	+	+	+		+
Athyamna selenophora					+	+	+	+	+	+	+	
Junonia almana				+	+	+	+					+
Neptis hylas				+	+						+	
Precis iphita	+	+	+	+	+	+	+	+	+	+		+
Precis lemonias		+	+	+	+	+	+	+			+	
Precis almana	+	+	+	+	+	+	+	+	+	+		+
Pantoporia hordonia			+	+								+
Tanaecia lepidea			+	+							+	
Symbrentha lilea	+	+	+	+	+	+					+	
Precis hierta		+	+	+								+
Satyridae												
Elymnias malelas		+	+	+	+							+
Elymnias hypermnistra			+	+							+	
Lethe confusa			+									
Melanitis leda	+	+	+	+	+	+	+	+	+	+	+	+
Orsotrioena medus			+	+	+	+	+					+
Danaidae												
Danaus aglea		+	+	+	+	+	+					+
Danaus chryssipus		+	+	+	+	+						
Eupleoa core	+	+	+	+	+	+	+					+
Hesperidae												
Tagiades litigiosa				+	+	+	+	+	+	+		+
Total	7	16	25	29	24	23	19	13	11	10	15	21

Note: + denotes presence

Baseline information on birds

A total of 150 bird species were recorded totaling 2,374 birds during the field study. From the observed data, it was inferred that a species/time curve is of interest because it not only indicates species richness per unit time investment but also ascertains whether time investment in the field was adequate. Of the 255 observation, birds were predominantly observed either in forests (38%) or in farm lands (31%). Additional 24 observations were not included in the analysis as birds were seen flying out of a given habitat type. Majority of the birds were found in agriculture fields, especially at the edge of cultivation or degraded shrubberies.

All observed bird species were grouped into four categories to determine their status: endangered (E), vulnerable (V), rare and common. The first two categories (E and V) constitute 4% of the total species (Table 5). Of the observed bird species, giant hornbill (*Buceros bicornis*), pale blue flycatcher (*Muscicapa unicolor*), and long-tailed broadbill (*Psarisomus dalhousiae*) are endangered. Species that are vulnerable were crow-billed drongo (*Dicrurus annectans*), pintail green pigeon (*Treron apicauda*) and large necklaced laughing-thrush (*Garrulax pectoralis*). The orange-breasted green pigeon (*Treron bicincta*) was considered rare. Some six habitat sites where all endangered and vulnerable species were found, were considered important for birds and these sites need to be monitored to check if these species continue to exist in such adverse settings.

Table 5
Bird status and observation frequency in the Churiya, eastern Nepal

Status	No. of species	No. of observations
Endangered	3	6
Vulnerable	3	8
Rare	1	1
Common	143	2359

ACKNOWLEDGMENT

The study was supported by Pro Natura Fund to the first author. GIS facility and GPS were made available by the Resources Himalaya, Kathmandu. Sincerest thanks are to Dr T. Nakamura of Natural History Museum and Institute, Chiba and Prof. Dr M. Ohsawa of University of Tokyo for their kind cooperation.

All GIS work was conducted by Bidur Baidya. Giri Joshi and Bhesh oli did floristic survey. Daya Bhusal conducted butterfly survey. Gokarna Khanal conducted bird survey. We thank them all.

REFERENCES

Bhatt, D.B. 1977. Natural History and Economic Botany of Nepal. Orient Longman Ltd. New Delhi

Carson, B. 1985. Erosion and sedimentation processes in the Nepal Himalaya. *ICIMOD Occasional Paper 1.* International Centre for Integrated Mountain Development, Kathmandu.

Govt. of India 1958. *Indian Survey Map 1958.* Survey of India Offices, Govt. of India.

Hagen, T. 1998. *Nepal.* Himal Books, PO Box 42, Lalitpur, Nepal. Forth ed.

HMGN 1988. *Master Plan for Forestry Sector Nepal Main Report.* Ministry of Forests and Soil Conservation, His majesty's Govt. of Nepal/ Govt. of Finland, Kathmandu.

Itihara, M., Tatsuo, S. and Noboru, M. 1972. Photogeological survey of the Siwalik ranges and Terai plains, southeastern Nepal. J. *Geosciences,* Osaka Univ. 15: 77-98.

HMGN/FINNIDA 1996. *Landuse Map 1992*. His Majesty's Govt. of Nepal / Govt. of Finland, Kathmandu

LRMP/HMGN 1986. Landuse Map 1978. Land Resources Mapping Project. Dept. of Forests, His Majesty's Govt. of Nepal / Govt. of Canada / Keating Earth Sciences, Kathmandu.

Martin, G.J., 1995. *Ethnobotany: A Methods Manual*, Chapman and Halls, London.

Press, J.R., Shrestha, K.K. and Sutton, D.A. 2000. *Annoted Checklist of the Flowering Plants of Nepal.* Natural History Museum, London.

Rohlf. J.F. and Sokal, R.R. 1969. *Statistical Tables.* W.H. Freeman and Co..

第10期プロ・ナトゥーラ・ファンド助成成果報告書（2001）

要　旨

ネパールシワリク山地の植生の生態学的研究
動的景相域（ランドスケープ）における生物種管理

ブジュ・ディネス、ヨンゾン・プロラド

シワリク地区は、ヒマラヤ山脈の最南域に位置する。地史的には最も若い山域である。ここは、南から熱帯、北から温帯と二つの生態域の結節域でもある。

シワリク高地はネパールの国土の12.7%、森林面積の25.8%を占めている。現在、土地開発が増加し続ける状況の中で、シワリク地区の自然環境の分断化が深刻化している。しかし、これまで、ネパール、シワリク地区の生態学的情報は極めて少なかった。この調査研究は、東ネパールのシワリク地区の生態学的基礎情報の収集を主たる目的としつつ、以下の6つのテーマについて詳しく研究された。①GISによる1958年と1992年の土地利用状況の比較、②植物相および森林の構造と更新、③様々な標高域における樹種構成、④地域民族の植物利用、⑤チョウ類の分布、⑥鳥類相のベースライン調査。

Establishing DNA bank of mammalian and bird faunae in Indonesia

Sri Sulandari, Dwi Astuti, Maharadatunkamsi,
Muhammad Syamsul Arifin Zein

INTRODUCTION

Indonesia is one of the megadiversity countries in the world. It has at least 47 distinct natural ecosystems ranging from the ice fields and alpine meadows of Papua (formerly Irian Jaya) to a wide variety of humid lowland forests, from deep lakes to shallow swamp, and from the spectacular coral reefs to sea-grass beds and mangrove swamps.

Indonesia is rich in species and possesses up to about 17% of the total number of species in the world. Aprroximately 12% of the world's mammals, 15 % of all amphibians and reptiles, 17 % of all birds and at least 37 % of the world's fish are available in Indonesia. In vertebrata group, Indonesia is the first rank for diversity of birds and the fourth rank for that of mammal with total number of 1531 and of 515 species respectively (Mittermeier *et al.* 1998) as shown in Table 1 below.

Table 1. Total species and total endemic species in Indonesia for vertebrata group in the world

Vertebrata	Total species in Indonesia	Total Endemic In Indonesia	Indonesian Rank in the world	
			Diversity	Endemic
Mammal	515	201	4	4
Bird	1,531	307	1	5
Reptile	511	150	2	Unknown
Amphibian	270	100	Unknown	Unknown

Source: Mittermeier *et al.*1998

These biological resources are not only important for Indonesia but it has been an international concern as well since they may have importantly unknown genetic materials for future generation. With excellent techniques on DNA technology available, *ex-situ* conservation of the biological resources may be developed in the form of DNA bank. This approach is believed to be more important in the case of endemic and endangered species.

With the presence of DNA bank composing total genomic DNA from various mammalian and bird faunae of Indonesia, further genetic research will be effectively conducted. Further collaborative research on genetic aspects between Indonesia, as a rich country for biological resources, and Japan, as a technologically and financially rich country would be ideal one. Therefore, an initial effort in establishing of DNA bank of mammalian and bird faunae in Indonesia is designed for this study.

METHODOLOGY OF RESEARCH

Two activities were conducted in this study. The first activity was to collect sample from various captive breeding sites. The second activity was to extract genomic DNA in laboratory and to measure concentration of DNA obtained.

Effort to get entrance permission:

In this study, samples from endangered and protected animals are collected because number of those animals are limited and tends to decrease on their natural habitat. Those animals are partly kept in captive breeding sites as an *ex-situ* conservation including in Indonesian Safari Park, bird park or zoo. Those are managed by either government or private organization. Others are still in their natural habitat and protected under government's regulation.

In most cases, a procedure to get sample of those animals from captive breeders is required. An official letter signed by head of Zoological Division is delivered to every captive breeder. A short proposal describing purpose of this study is also attached to the letter and it was sent to: 1. Bird Park (TMII, Jakarta), 2. Jakarta Ragunan Zoo (Ragunan Margasatwa Park, Jakarta), 3. Indonesian Safari Park (Cisarua, Bogor), 4. Bird Trader (Jakarta), 5. Yogyakarta Zoo (Central Java), 6. Surabaya Zoo (East Java), 7. Bali Bird Park (Denpasar, Bali) and 8. Gibbon Foundation Center (Denpasar, Bali). Response's letter was obtained after 20 - 40 days. It was a time-consuming procedure for entrance permission to the captive breeding sites. Sample collection at Bird Park (TMII, Jakarta), Jakarta Zoo (Ragunan Margasatwa Park, Jakarta) and captive breeding (division of zoology, Bogor) were conducted on Phase II.

Collection of Samples:

Sample collection for this study was conducted in Indonesian Taman Safari Park (Cisarua, Kab. Bogor), Jakarta Bird Trader (Condet, Jakarta), Yogyakarta Zoo (Yogyakarta, Central Java), Surabaya Zoo (Surabaya, East Java), Bali Bird Park (Denpasar, Bali Island), Gibbon Foundation Center (Denpasar, Bali Island), Bird Park (TMII, Jakarta), Margasatwa Ragunan Park (Jakarta) and captive breeding (Division of Zoology, Bogor). For this purpose, we also obtained blood samples of Russa deer (*Cervus timorensis;* see Table 4) which was donated by M.S.A.Zein.

Samples were collected in the form of blood, tissue, liver, shed feathers, hair-root , feces or saliva. In case of died animals, samples were obtained from tissue and liver while blood, shed feathers, hair root and saliva were obtained from living animals. Blood whenever possible were collected followed the procedures from the zoo. Total volume of blood was taken 0.05 - 0.10 ml from individual of bird and 0.10 - 5.0 ml from individual of mammal. If collection of blood was technically difficult or sometimes was not permitted to be taken, shed feather, hair root, feces or saliva was collected.

After collecting samples, each sample was preserved with 96% of ethanol absolute in a 1.5ml of eppendorf tube. These collected samples were brought to the genetic laboratory, RDC for Biology, LIPI and kept in refrigerator(4℃). These samples were ready for further processing in laboratories.

Extraction of DNA and measuring concentration of DNA:

This activity was done in genetic laboratory, Zoological Division, Research and Development Center for Biology - LIPI, Cibinong - Indonesia. Total genomic DNAs of blood, tissue, liver or saliva was extracted using a standard protocol (Sambrook *et al.*, 1989). Total genomic DNAs of shed feathers or hair root was extracted using ISO Hair Kit (Nippon Gene, Made in Japan).

All extracted samples were subjected to measurements of DNA concentration. It is important to quantify DNA molecules obtained for further analysis. There are two methods that are widely used to measure the amount of nucleic acid in preparations (Sambrook *et al.*, 1989). In this study, the amount of nucleic acid was measured using a spectrophotometer (Beckman DU 650, Made in USA) based on the amount of ultraviolet irradiation absorbed by the bases and also was estimated from the intensity of fluorescence emitted by ethidium bromide.

The spectrophotometric readings of Optical Density (OD) was taken at wavelength of 260 and 280 nanometer (nm). The ratio between the reading at 260 nm (OD_{260}) and 280 nm (OD_{280}) gives a measure of the purity of the DNA sample, with pure DNA having a ratio of 1.8. The OD_{260} allows calculation of the concentration of nucleic acid in the sample. An OD of 1 corresponds to approximately 50 μg/ml for double stranded and 40 μ g/ml for single stranded DNA or RNA (Sambrook *et al.*, 1989).

Conversion of OD 260 into a concentration unit (μ g/ml or ng/ μ l):

$$\text{Concentration} (\mu g/ml) = OD_{260} \times 50 \times 50 \ \mu g/ml$$

Where: A_{260} = value of OD_{260}

50 = a dilution factor

50 = value equivalent to 1 of OD_{260}

RESULTS and DISCUSSION

Results and Discussion of this study was presented into 2 parts, collection of samples on birds and mammals.

Sample Collection on birds:

Samples collection of birds which collected under Pro Natura Fund was obtained from a bird trader (Jakarta), Indonesian Safari Park (Cisarua-Bogor, West Java), Yogyakarta Zoo (Yogyakarta, Central Java), Surabaya Zoo (Surabaya, East Java) and Bali Bird Park (Denpasar, Bali Island), Bird Park (TMII, Jakarta) and Margasatwa Ragunan Park (Jakarta). A summarized result from this study was shown in Table 2 and also presented in Appendixes 1, 2, 3, 4, 5, 6, 7, 8 and 9.

Three hundreds and sixty three (363) material DNA samples from birds were collected during this study (see Appendixes 1-9). From the summarized results (Table 2), the 363 samples are obtained from 87 species and 23 families of bird, consisting of 40 protected, 23 endemic, 18 threatened and 4 near threatened species. The collected 87 species of bird is about only 6 % from all Indonesian birds. Since sample collection of material DNA for DNA Bank has established this year in division of zoology (RDC for Biology - LIPI), we have received samples from other projects, including receiving of 214 samples (consisted of 57 bird species) from Biodiversity Conservation Project (JICA and LIPI) and 76 samples (consisted of 14 bird species) from Nishiumi and Darjono's Project. The detail donated species is not reported in this study, however, species of birds from the donated samples are totally different from our collected bird species. So far, if we calculated the total collected samples, it has shown about 9 % from all Indonesian birds. From this study suggested that collection of samples for DNA bank is required to be continued.

Since most captive breeders in Indonesia keep parrots in their captivity, the biggest number of sample collection was 30 species and 4 subspecies of parrot birds. Nowadays the popularity of parrot is worldwide. Indonesia has 76 species of parrots. Of these, 32 species are endemic to Indonesia (Andrew, 1992). It will be interesting, if DNA bank just established at the Zoological Division -LIPI has complete collection of DNA parrots from

Table 2. Collected blood samples from Indonesian Safari Park (ISP), Bird Trader Jakarta (BTJ), Yogyakarta Zoo (YZ), Surabaya Zoo (SZ), Bali Bird Park (BBP), Margasatwa Ragunan Park (MRP) , Bird Park-TMII (BP-TMII)and Zoological Division (ZD) for DNA Bank.

No	Family	Species	Collected from	Status*)		
				(1)	(2)	(3)
1	Pcittacidae	1. *Lorius lory*	SZ,MRP, BP-TMII	Protected	Endemic	-
		2. *Lorius garrulus*	SZ, BP-TMIIBP-TMII	-	Endemic	Threatened bird: Vulnerable
		3. *Trichoglossus haematodus*	SZ, BTJ,MRP	-	-	-
		4. *Alisterus amboinensis*	BBP	-	Endemic	Near Threatened bird: Vulnerable
		5. *Pseudeos fuscata*	SZ, BTJ	Protected	-	-
		6. *Eos bornea*	SZ, MRP	-	Endemic	-
		7. *Eclectus roratus*	SZ, ISP.,MRP, BP-TMII	Protected	-	-
		8. *Probosciger aterrimus*	SZ, ISP, YZ, BBP, MRP, BP-TMII	Protected	-	Threatened bird: Vulnerable
		9. *Cacatua goffini*	SZ, ISP,MRP, BP-TMII	-	Endemic	Threatened bird: Vulnerable
		10. *Cacatua moluccencis*	SZ, ISP, YZ, BBP, MRP, BP-TMII	-	Endemic	Threatened bird: Vulnerable
		11. *Cacatua alba*	SZ, YZ, MRP, BP-TMII	-	Endemic	Threatened bird: Vulnerable
		12. *Cacatua sulphurea*	S Z, ISP, BBP, MRP	Protected	Endemic	Threatened bird: Endangered
		13. *Cacatua sanguinea*	BBP, BP-TMII	Protected	-	-
		14. *Cacatua galerita*	SZ, BBP, MRP	Protected	-	-
		15. *Psitrichas fulgidus*	SZ, ISP, BBP, BP-TMII	Protected	-	Threatened bird: Vulnerable
		16. *Tanygnatus sumatranus*	BT	Protected	-	-
		17. *Psittaculirostris edwardsii*	BT	Protected	-	-
		18. *Psittaculirostris desmarestii*	BT, MRP	Protected	-	-
		19. *Chalcopsitta atra*	BT, MRP	-	Endemic	-
		20. *Chalcopsitta duivenbodei*	BT, MRP	Protected-	-	-
		21. *Cyclopsitta diopthalma*	BT	-	-	-
		22 .*Charmosyna placentis*	BT	-	-	-
		23. *Trichoglossus eutheles*	BT		Endemic	
		24. *Chalcopsitta scintillata*	BT	Protected		
		25. *Alisterus chloropterus*	BT		Endemic	
		26.*Aprosmictus erythropterus*	BT			
		27. *Loriculus pusillus***)	Origin place (Java Island)		Endemic	
	Psittacidae	28. *Loriculus galgulus***)	Origin place (Sumatra Island)		Endemic	
		29. *Lorius garrulus garrulus***)	Origin place		Endemic	
		30. *Lorius garrulus plavopalliatus***)	Origin place		Endemic	
		31. *Psittacula alexandri alexandri*	DZ	-		
		32. *Tanygnathus megalorynchos*	MRP	-		
		33. *Trichoglossus haematodus coeruleiceps*	BT	-		

Table 2. Continued

No	Family	Species	Collected from	Status*) (1)	(2)	(3)
		34. *Trichoglossus haematodus haematodus*	BT	-		
2	Accipitridae	1. *Milvus migrans*	SZ	Protected	-	-
		2. *Spilornis cheela*	SZ, YZ, MRP	Protected	-	-
		3. *Accipiter trivirgatus*	SZ	Protected	-	-
		4. *Ictinaetus malayensis*	SZ, YZ,MRP	Protected	-	-
		5. *Haliastur indus*	SZ, YZ,MRP	Protected	-	-
		6. *Pandion haliaetus*	SZ	Protected	-	-
		7. *Haliaeetus leucogaster*	SZ, MRP	Protected	-	-
		8. *Spizaetus cirrhatus*	MRP	Protected		
		9. *Spizaetus bartelsi*	BP-TMII	Protected		
3	Cuculidae	1. *Centropus bengalensis*	SZ	-	-	-
		2. *Phaenicophaeus curvirostris*	SZ	-	-	-
4	Falconidae	1. *Falco tinnunculus*	SZ	Protected	-	-
5	Strigidae	1. *Strix seleputo*	SZ	-	-	-
		2. *Otus lempiji*	SZ	-	-	-
		3. *Bubosumatranus*	SZ	-	-	-
		4. *Ketupa ketupu*	SZ, YZ	-	-	-
6.	Corvidae	1. *Corvus macrorhynchos*	SZ	-	-	-
		2. *Corvus enca*	SZ	-	-	-
7	Meliphagidae	1. *Philemon buceroides*	SZ	-	-	-
8	Phasianidae	1. *Gallus gallus bankiva*	SZ	-	-	-
		2. *Gallus varius*	SZ	-	Endemic	-
		3. *Pavo muticus*	SZ, MRP	Protected	-	-
		4. *Argusianus argus*	YZ	Protected	-	-
		5. *Lophura ignita*	YZ	-	-	Threatened bird: vulnerable
9	Irenidae	1. *Irena puela*	SZ	-	-	-
10	Sturnidae	1. *Leucopsar rothschildi*	ISP, BBP, BP-TMII	Protected	Endemic	Threatened bird: Critically endangered
		2. *Sturnus melanopterus*	BBP, BP-TMII	Protected	Endemic	Near threatened bird
		3. *Mino dumontii*	BTJ	-	-	-
		4. *Scissirostrum dubium*	BP-TMII		Endemic	
11	Paradisaeidae	1. *Cicinnurus regius*	SZ	Protected	-	-
		2. *Paradisaea minor*	ISP, BP-TMII	Protected	-	-
		3. *Paradisaea rubra*	ISP, BP-TMII	Protected	Endemic	Near threatened bird
		4. *Seleucidis melanoleuca*	ISP	Protected	-	-
12	Pycnonotidae	1. *Pycnonotus jocosus*	SZ	-	-	-

Table 2. Continued

No	Family	Species	Collected from	Status*) (1)	(2)	(3)
13	Columbidae	1. *Geopelia striata*	SZ	-	-	-
		2. *Goura cristata*	YZ, BBP, BP-TMII	Protected	Endemic	Threatened bird: Vulnerable
		3. *Goura victoria*	BBP, BP-TMII	Protected	-	Threatened bird: Vulnerable
		4. *Goura scheepmakeri*	BBP, BP-TMII	Protected	-	Threatened bird: Vulnerable
14	Ploceidae	1. *Padda oryzivora*	SZ	-	Endemic	Threatened bird: Vulnerable
		2. *Padda fuscata*	BP-TMII		Endemic	
15	Timaliidae	1. *Garrulax leucolophus*	SZ	Protected	-	-
16	Dicruridae	1. *Dicrurus macrocercus*	SZ	-	-	-
17	Picidae	1. *Picus mentalis*	SZ	-	-	-
18	Megapodiidae	1. *Macrocephalon maleo*	SZ	Protected	Endemic	Threatened bird: Vulnerable
19	Bucerotidae	1. *Anthracoceros albirostris*	YZ	-	-	-
		2. *Anthracoceros malayanus*	YZ	Protected	-	Near threatened bird
		3. *Rhyticeros undulatus*	SZ,YZ,MRP	Protected	-	-
		4. *Buceros rhinoceros*	YZ			
		5. *Aceros subruficollis*	SZ	-	-	Threatened bird: Vulnerable
		6. *Rhyticeros plicatus*	MRP			
		7. *Anthracoceros corverus*	MRP			
20	Oriolidae	1. *Oriolus chinensis*	SZ	-	-	-
21	Casuaridae	1. *Casuarius unappendiculatus*	BBP, BP-TMII	-	-	Threatened bird: Vulnerable
		2. *Casuarius casuarius*	BBP, BP-TMII	-	-	Threatened bird: Vulnerable
22	Ciconiidae	1. *Leptoptilos javanicus*	YZ	Protected	-	Threatened bird: Vulnerable
23	Ardeidae	1. *Ardea cinera*	YZ	-	-	-
		2. *Bubulcus ibis*	YZ	Protected	-	-

*) Source : (1). Protected by Indonesian Government (based on wildlife Conservation Law)
(2). According to Andrew (1992)
(3). Shannaz *et al.* (1995)

**)The sample is from origin place and collected by Dwi Astuti.

Indonesia. As mentioned earlier, only half of the total parrot species was collected from this study. Although we collected samples from the three biggest zoos in Indonesia, but we could not obtain a complete collection of 76 species- parrot samples. Because the zoos or bird trader which we visited for sample collection has almost the same variety of parrot species. They only kept famous parrots which often used for bird trading or commercial use. Information of collection site for other parrots has being tried through non government organization (NGOs), unfortunately, there is no response yet. In addition, most Indonesian parrots are classified in CITES Appendix 2 meaning that "export of this species must be based on annual quota".

The birds for commercial use are usually obtained from natural habitat. Uncontrol exploitation makes significant decrease in number of population of birds and lead to be threatened species in Indonesia. As mentioned above, fortunately some of the (near) threatened species has also just been collected for DNA bank. It is important to have all genetic information before the threatened species are extinct.

Collecting samples in Maluku and Nusa Tenggara Timor province were cancelled in this study, because Maluku and Nusa Tenggara Timor was not safe place for visit in this year.

Not all collected samples of birds were extracted. The genomic DNA of the sample is extracted, if the extracted sample will be used for further DNA analysis. For example, the extracted samples which seen in Appendixes 1-9 were already used for bird sexing using DNA analysis and showed good amplification. Thus, the extracted samples (appendixes 1-9) has good quality DNA. This study is preferred to keep samples for long period in the form of material DNA such as blood or tissue.

A famous name of our institute (division of zoology) is Indonesian Natural History Museum which has 1,200,000 specimens and consist of 17,500 species of fauna. The collected specimens is good potential to contribute in establishing of DNA bank on fauna. In this case, we have to improve our capability to extract samples from skin specimens.

Sample Collection of mammals:

Mammal samples collection which collected under Pro Natura Fund was obtained from Indonesian Safari Park (Cisarua-Bogor, West Java), Yogyakarta Zoo (Yogyakarta, Central Java), Surabaya Zoo (Surabaya, East Java), Ragunan Zoo (Margasatwa Ragunan Park, Jakarta) and Gibbon Foundation Center (Denpasar, Bali Island). As mentioned in Table1, Indonesia is one of the most diverse countries in mammal species. Considering the importance of the species richness, conservation at large must be in our responsibility. Yet, the majority of them remain unexplored in term of genetic information. At the same time, the priority for conservation of biological resources is focussed on the conservation species, ecology and genetic diversity. DNA bank for mammal species has been established in this study. A summarized result from this study is shown in Tables 3. and 4.

All collected mammal samples has been extracted well (Table 3. and 4.), except for donated samples from Gibbon Foundation Center (Bali). On the Phase I, a total of 43 samples of DNA mammals, and consisted of 15 samples from Indonesian Safari Park, 9 samples from Yogyakarta Zoo, 15 samples from Surabaya Zoo and 8 samples from Gibbon Foundation. While on the phase II, a total of 54 samples of DNA mammals were collected, and consisted of 21 samples from Ragunan Zoo (Margasatwa Ragunan Park) and 24 donated Rusa deer samples. At the last minute of writing this report, we received 9 samples of Primate from Gibbon Foundation, Bali. Detail of Phase II samples collection and their status are presented in Table 4. Systematic arrangement followed Corbet and Hill (1992) and Suyanto *et al.* (1998).

Table 3. Mammalia samples collected from Indonesian Safari Park, Yogyakarta Zoo, Surabaya Zoo, Gibbon Foundation Center for DNA Bank

No.	Sample No.	Species	Sex	Kind of Sample	Collection Place	Origin Place	Distribution (In Indonesia)	Date of Extraction	DNA Con-centration	Status*)
1.	TSI 1.1	*Hylobates moloch*	♂	Hair	TSI, Cisarua - Bogor	Jawa	Jawa	03.04.2000	125.75	Protected, CI:1
2.	TSI 2.1	*Hylobates muelleri*	♂	Hair	TSI, Cisarua - Bogor	Kalimantan	Kalimantan	31.03.2000	1257.50	Protected, CI:1
3.	TSI 3.1	*Hylobates agilis*	♂	Hair	TSI, Cisarua - Bogor	Sumatra	Kalimantan, Sumatra	31.03.2000	63.50	Protected, CI:1
4.	TSI 4.1	*Hylobates syndactylus*	♀	Blood	TSI, Cisarua - Bogor	Sumatra	Sumatra	27.03.2000	5996.75	Protected, CI:1
5.	TSI 5.1	*Hylobates syndactylus*	♀	Blood	TSI, Cisarua - Bogor	Sumatra	Sumatra	27.03.2000	113.25	Protected, CI:1
6.	TSI 6.1	*Hylobates moloch*	♀	Blood	TSI, Cisarua - Bogor	Jawa	Jawa	27.03.2000	94.50	Protected, CI:1
7.	TSI 7.1	*Tapirus Inducus*	♂	Hair	TSI, Cisarua - Bogor	Unknown	Jawa	03.04.2000	912.50	Protected, CI:1
8.	TSI 8.1	*Dicerorhinus sumatrensis*	♂	Liver	TSI, Cisarua - Bogor	Sumatra	Sumatra	11.04.2000	253.25	Protected, CI:1
9.	TSI 9.1	*Tarsius bancanus*	♀	Liver	TSI, Cisarua - Bogor	Unknown	Kalimantan, Sumatra	11.04.2000	184.50	Protected, CI:2
10.	TSI 11.1	*Bubalus depressicornis*	Unknown	Hair	TSI, Cisarua - Bogor	Palu, Sulawesi	Sulawesi	03.04.2000	109.00	Protected, CI:1
11.	TSI 12.1	*Bubalus depressicornis*	Unknown	Hair	TSI, Cisarua - Bogor	Unknown	Sulawesi	03.04.2000	90.25	Protected, CI:1
12.	TSI 13.1	*Bubalus depressicornis*	Unknown	Hair	TSI, Cisarua - Bogor	Unknown	Sulawesi	03.04.2000	115.00	Protected, CI:1
13.	TSI 14.1	*Panthera tigris sumatrae*	Unknown	Hair	TSI, Cisarua - Bogor	Unknown	Sulawesi	03.04.2000	165.25	Protected, CI:1
14.	TSI 15.1	*Pongo abelii*	Unknown	Hair	TSI, Cisarua - Bogor	Sumatra	Sumatra	31.03.2000	40.00	Protected, CI:1
15.	KBY 1.1	*Panthera tigris sumatrae*	♂	Hair	Yogyakarta Zoo.	Sumatra	Sumatra	03.04.2000	125.75	Protected, CI:1
16.	KBY 4.1	*Pongo pygmaeus*	♀	Hair	Yogyakarta Zoo.	Kalimantan	Kalimantan	31.03.2000	141.75	Protected, CI:1
17.	KBY 6.1	*Cervus unicolor*	♀	Hair	Yogyakarta Zoo.	Unknown	Kalimantan, Sumatra	31.03.2000	87.00	Protected
18.	KBY 7.1	*Hylobates moloch* (?)	♂	Blood	Yogyakarta Zoo.	Unknown	Jawa	11.04.2000	136.75	Protected, CI:1
19.	KBY 8.1	*Hylobates syndactylus*	♂	Blood	Yogyakarta Zoo.	Unknown	Sumatra	27.03.2000	170.50	Protected, CI:1
20.	KBY 9.1	*Muntiacus muntjak*	♀	Blood	Yogyakarta Zoo.	Unknown	Kalimantan, Sumatra, Jawa, Lombok	27.03.2000	5489.50	Protected
21.	KBS 1.1	*Tragulus Jawanicus*	♂	Blood	Surabaya Zoo.	Jawa	Kalimantan, Sumatra, Jawa, Lombok	27.03.2000	26.00	Protected
22.	KBS 2.1	*Hylobates agilis*	♂	Blood	Surabaya Zoo.	Unknown	Kalimantan, Sumatra	27.03.2000	6924.50	Protected, CI:1
23.	KBS 3.1	*Babyrousa bayrussa*	♀	Blood	Surabaya Zoo.	Sulawesi	Sulawesi, Maluku	27.03.2000	55.00	Protected, CI:1
24.	KBS 4.1	*Axis kuhli*	♂	Blood	Surabaya Zoo.	Bawean	Bawean	27.03.2000	80.00	Protected, CI:1
25.	KBS 5.1	*Muntiacus muntjak*	♂	Blood	Surabaya Zoo.	Unknown	Kalimantan, Sumatra, Jawa, Lombok	27.03.2000	147.25	Protected

Table 3. **Continued**

26.	KBS 6.1	*Elephas maximus*	♀	Blood	Surabaya Zoo.	Way Kambas, Sumatra	Sumatra	26.03.2000	440.75	Protected, CI:1
27.	KBS 7.1	*Pongo abelii*	♀	Blood	Surabaya Zoo.	Sumatra	Sumatra	26.03.2000	485.00	Protected, CI:1
28.	KBS 8.1	*Hylobates moloch*	♀	Blood	Surabaya Zoo.	Jawa	Jawa	26.03.2000	499.00	Protected, CI:1
29.	KBS 9.1	*Hylobates syndactylus*	♂	Blood	Surabaya Zoo.	Unknown	Sumatra	26.03.2000	734.75	Protected, CI:1
30.	KBS 10.1	*Cervus unicolor*	♂	Blood	Surabaya Zoo.	Unknown	Kalimantan, Sumatra	26.03.2000	108.00	Protected
31.	KBS 11.1	*Panthera pardus*	♂	Blood	Surabaya Zoo.	Unknown	Jawa	26.03.2000	1263.50	Protected, CI:1
32.	KBS 12.1	*Helarctos malayanus*	♂	Blood	Surabaya Zoo.	Unknown	Kalimantan, Sumatra	26.03.2000	425.50	Protected, CI:1
33.	KBS 13.1	*Panthera tigris sumatrae*	♀	Blood	Surabaya Zoo.	Sumatra	Sumatra	26.03.2000	250.25	Protected, CI:1
34.	KBS 14.1	*Bubalus depressicornis*	♂	Blood	Surabaya Zoo.	Sulawesi	Sulawesi	26.03.2000	77.50	Protected, CI:1
35.	KBS 15.1	*Bos Jawanicus*	♂	Blood	Surabaya Zoo.	Unknown	Kalimantan, Jawa	26.03.2000	18.50	Protected
36.	GF 1.1	*Hylobates agilis*	♀	Hair	Gibbon Foundation, Denpasar.	Kalimantan	Kalimantan, Sumatra	03.04.2000	53.50	Protected, CI:1
37.	GF 2.1	*Hylobates muelleri*	♀	Hair	As above.	Kalimantan	Kalimantan	10.04.2000	52.25	Protected, CI:1
38.	GF 3.1	*Hylobates agilis*	♂	Hair	As above.	Sumatra	Kalimantan, Sumatra	03.04.2000	264.50	Protected, CI:1
39.	GF 4.1	*Hylobates syndactylus*	♀	Hair	As above.	Sumatra	Sumatra	10.04.2000	88.00	Protected, CI:1
40.	GF 5.1	*Trachypithecus auratus*	♀	Hair	As above.	Unknown (Jawa?)	Jawa, Lombok	03.04.2000	62.25	CI:2
41.	GF 6.1	*Hylobates syndactylus*	♂	Hair	As above.	Sumatra	Sumatra	10.04.2000	67.75	Protected, CI:1
42.	GF 7.1	*Trachypithecus cristatus*	♂	Hair	As above.	Sumatra	Kalimantan, Sumatra	10.04.2000	58.00	CI:2
43.	GF 8.1	*Hylobates klossi*	♀	Hair	As above.	Mentawai I, Sumatra	Mentawai	10.04.2000	75.50	Protected, CI:1

*) Protected by Indonesian Government.
CI:1 CITES Appendix 1.
CI:2 CITES Appendix 2.

Collector:

No. 1 – 9, and 15 - 43: M. Syamsul Arifin Zein and Maharadatunkamsi.
No. 10 -14: Sri Sulandari and Dwi Astuti.

Table 4. Details of mammals species collected at Phase II from Jakarta Ragunan Zoo and donated samples.

No.	Sample No.	Species	Family	Sex	Kind of Sample	Collection Place	Origin Place	Distribution (In Indonesia)	Date of Extraction	DNA Concentration	Status*)
1.	KBR 01	*Hylobates syndactylus*	Hylobatidae	♂	Blood	Ragunan Zoo, Jakarta	Unknown	Sumatra	5 October 2000	15097.75	Protected, CI:1
2.	KBR 02	*Macaca fascicularis*	Cercopithecidae	♀	Blood	as above	Jawa	Kalimantan, Sumatra, Jawa, Lesser Sunda	5 October 2000	3097.75	CI:2
3.	KBR 03	*Hylobates moloch*	Hylobatidae	♀	Blood	as above	Jawa	Jawa	5 October 2000	960.50	Protected, CI:1
4.	KBR 04	*Hylobates moloch*	Hylobatidae	♂	Blood	as above	Jawa	Jawa	5 October 2000	3086.75	Protected, CI:1
5.	KBR 05	*Paradoxurus hermaphroditus*	Viverridae	♂	Blood	as above	West Jawa	Kalimantan, Sumatra, Jawa, Lesser Sunda, Sulawesi, Maluku	5 October 2000	7105.25	CI: 3
6.	KBR 06	*Tragulus napu*	Tragulidae	♂	Blood	as above	Kalimantan/Sumatra (?)	Kalimantan/Sumatra	5 October 2000	11430.75	Protected
7.	KBR 07	*Elephas maximus* "Melky"	Elephantidae	♂	Blood	as above	Sumatra	Sumatra	5 October 2000	14524.50	Protected, CI:1
8.	KBR 08	*Elephas maximus* "Lovi"	Elephantidae	♀	Blood	as above	Sumatra	Sumatra	5 October 2000	30391.25	Protected, CI:1
9.	R 1	*Arctictis binturong*	Viverridae	♂	Hair	as above	Sumatra	Kalimantan, Sumatra, Jawa	5 October 2000	1275.80	Protected
10.	R 2	*Arctictis binturong*	Viverridae	♀	Hair	as above	Sumatra	Kalimantan, Sumatra, Jawa	5 October 2000	1093.10	Protected
11.	R 3	*Herpestes brachyurus*	Herpestidae	♂	Hair	as above	Sumatra	Kalimantan, Sumatra	5 October 2000	502.80	
12.	R 4	*Arctictis binturong*	Viverridae	♀	Hair	as above	Kalimantan	Kalimantan, Sumatra, Jawa	5 October 2000	915.55	Protected
13.	R 5	*Arctictis binturong*	Viverridae	♀	Hair	as above	Kalimantan	Kalimantan, Sumatra, Jawa	5 October 2000	648.00	Protected
14.	R 6	*Herpestes javanicus*	Herpestidae	♀	Hair	as above	Jakarta	Jawa	5 October 2000	631.90	CI:3
15.	R 7	*Herpestes javanicus*	Herpestidae		Hair	as above	Jakarta	Jawa	5 October 2000	727.75	CI:3
16.	R 8	*Manis javanica*	Manidae	♀	Hair	as above	Jawa	Kalimantan, Sumatra, Jawa, Lesser Sunda	5 October 2000	1918.10	Protected, CI:2
17.	R 9	*Hystrix brachyura* (?)	Hystricidae	Unknown	Hair	as above	Kalimantan (?)	Kalimantan, Sumatra	5 October 2000	1863.95	Protected
18.	R 10	*Hystrix brachyura* (?)	Hystricidae	Unknown	Hair	as above	Kalimantan (?)	Kalimantan, Sumatra	5 October 2000	357.1610	Protected
19.	R 11	*Tragulus javanicus*	Tragulidae	♀	Hair	as above	Jawa	Kalimantan, Sumatra, Jawa, Lombok	5 October 2000	696.90	Protected
20.	R 12	*Tapirus indicus*	Tapiridae	♂	Hair	as above	Sumatra	Sumatra	5 October 2000	791.85	Protected, CI: 1
21.	R 13	*Panthera tigris sumatrae*	Felidae	♂	Hair	as above	Sumatra	Sumatra	5 October 2000	629.45	Protected, CI: 1
22.	NTT 01	*Cervus timorensis*	Cervidae	♀	Blood	Camplong, Timor	Alor	Kalimantan, Jawa, Lesser Sunda, Sulawesi, Maluku	12 May 2000	37940.00	Protected
23.	NTT 02	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	42388.25	Protected
24.	NTT 03	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	35687.75	Protected
25.	NTT 04	*Cervus timorensis*	Cervidae	♀	Blood	Kupang, Timor	Timor	as above	12 May 2000	43289.25	Protected
26.	NTT 05	*Cervus timorensis*	Cervidae	♀	Blood	Kupang, Timor	Alor	as above	12 May 2000	35390.75	Protected
27.	NTT 06	*Cervus timorensis*	Cervidae	♀	Blood	Oebelo, Timor	Alor	as above	12 May 2000	36410.50	Protected
28.	NTT 07	*Cervus timorensis*	Cervidae	♂	Blood	as above	Alor	as above	12 May 2000	41306.25	Protected
29.	NTT 08	*Cervus timorensis*	Cervidae	♀	Blood	Oesao, Timor	Timor	as above	12 May 2000	33786.25	Protected

Table 4. Continued

No.	Sample No.	Species	Family	Sex	Kind of Sample	Collection Place	Origin Place	Distribution (In Indonesia)	Date of Extraction	DNA Concentration	Status*)
30.	NTT 09	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	32415.25	Protected
31.	NTT 010	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	21108.25	Protected
32.	NTT 011	*Cervus timorensis*	Cervidae	♀	Blood	Camplong, Timor	Timor	as above	12 May 2000	30371.75	Protected
33.	NTT 012	*Cervus timorensis*	Cervidae	♂	Blood	as above	Timor	as above	12 May 2000	16184.25	Protected
34.	NTT 013	*Cervus timorensis*	Cervidae	♀	Blood	Kupang, Timor	Timor	as above	12 May 2000	37772.50	Protected
35.	NTT 014	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	30990.00	Protected
36.	NTT 015	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	24618.75	Protected
37.	NTT 016	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	30416.00	Protected
38.	NTT 017	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	39933.25	Protected
39.	NTT 018	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	37329.75	Protected
40.	NTT 019	*Cervus timorensis*	Cervidae	♂	Blood	as above	Alor	as above	12 May 2000	34010.75	Protected
41.	NTT 020	*Cervus timorensis*	Cervidae	♂	Blood	as above	Timor	as above	12 May 2000	26716.25	Protected
42.	NTT 021	*Cervus timorensis*	Cervidae	♂	Blood	Bena, Timor	Timor	as above	12 May 2000	30502.75	Protected
43.	NTT 022	*Cervus timorensis*	Cervidae	♀	Blood	as above	Timor	as above	12 May 2000	26984.00	Protected
44.	NTT 023	*Cervus timorensis*	Cervidae	♀	Blood	Kupang, Timor	Pantar	as above	12 May 2000	28769.50	Protected
45.	NTT 024	*Cervus timorensis*	Cervidae	♀	Blood	as above	Pantar	as above	12 May 2000	25681.25	Protected
46.	GF 13	*Trachypithecus cristatus* "Iggy"	Cercopithecidae	♂	Blood	Gibbon Foundation, Bali.	Unknown	Kalimantan/Sumatra	—	—	CI:2
47.	GF 14	*Hylobates syndactylus* "Cesar"	Hylobatidae	♀	Blood	as above	Unknown	Sumatra	—	—	Protected, CI:1
48.	GF 15	*Hylobates agilis* "Cheetah"	Hylobatidae	♂	Blood	as above	Unknown	Kalimantan, Sumatra	—	—	Protected, CI:1
49.	GF 16	*Hylobates muelleri* "Cenik"	Hylobatidae	♀	Blood	as above	Unknown	Kalimantan	—	—	Protected, CI:1
50.	GF 17	*Trachypithecus auratus* "Julia"	Cercopithecidae	♀	Blood	as above	Unknown	Jawa, Lesser Sunda	—	—	CI:2
51.	GF 09	*Trachypithecus auratus* "Cleo"	Cercopithecidae	♀	Blood	Gibbon Foundation, Bali.	Unknown	Jawa, Lesser Sunda	—	—	CI:2
52.	GF 10	*Trachypithecus auratus* "Beryl"	Cercopithecidae	♀	Blood	as above	Unknown	as above	—	—	CI:2
53.	GF 11	*Trachypithecus auratus* "Tini"	Cercopithecidae	♀	Blood	as above	Unknown	as above	—	—	CI:2
54.	GF 12	*Trachypithecus auratus* "Zarina"	Cercopithecidae	♀	Blood	as above	Unknown	as above	—	—	CI:2

*) Protected by Indonesian Government.
CI:1 CITES Appendix 1.
CI:2 CITES Appendix 2.

Collector:
No. 1 – 21 : M. Syamsul Arifin Zein and Maharadatunkamsi.
No. 22 – 45 : Donated by M. Syamsul Arifin Zein.
No. 46 – 54 : Donated by Gibbon Foundation, Bali.

Our results of Phase I and II was summarized, a total of 33 mammals species were sampled for DNA bank, which about only 4.9% from all Indonesian mammals (± 681 species, Suyanto *et al.* 1998). In term of protected species, our collection resulted about 22.7 % from total protected Indonesian mammals. Therefore, the continue of collection are still required. The DNAs collection from this study are very useful and beneficial to our living. They are protected, endangered and/or endemic; and considered as key species. It is clear that this collection is a great value.

Limited collection resulted from Phase I and II was caused by some problems which we encountered, and these are discussed below. The limited fund seems to be restricted our location for sampling. However, fund itself was not principal impediment that we faced. More serious one was limited samples (live animals) available at *ex-situ* conservation, since it is very difficult collecting DNA materials from the wild. Also lack of database information relating the origin and pedigree of the animals. Several samples were donated or confiscated animals with very limited information and it caused tracing their history became impossible. Coupled with these problems, for some reasons, we were not allowed to take blood. In fact, taking blood sometimes is not easy for small mammals.

Overcoming these obstacles listed above, it needs information of database on *ex-situ* conservation including species they have, status (endemic, endangered, protected, rared etc.); and can be accessed by people who need it. This information will bring us to be more effectively in preparing and collecting. The *ex-situ* conservation bodies (zoos, Safari Park, breeder, etc.) suggested us, we should synchronize our schedule for samples collection with their schedule for diseases/blood examination, and this will promote us in collecting blood. Also, training to be expertised in taking blood is urgently needed.

CONCLUSSION

An effort for establishment of DNA Bank on bird and mammalia faunae has been started at the Zoological Division, RD Center for Biology-LIPI, Indonesia. At the moment, approximately 6.5% endemic bird and 16% endemic mammal of total number in Indonesia are available. Our DNA collection has not yet represented all mammals or birds species live in Indonesia. Therefore, extension of the project under Pro Natura Fund should be considered, to continue our collecting effort in establishing DNA bank.

The collected DNA or material DNA samples can provide a useful reservoir data, especially promoting conservation for protected and endangered species.

Results observed from this initial effort may be useful for further genetic studies involving collaboration between Indonesia and Japanese institutions other institutions in the world.

REFERENCES

Andrew, P. 1992. *The Birds of Indonesia*. Kukila Checklist No.1. Indonesian ornithological Society, Jakarta.

Corbet, G.B. and Hill, J.E. 1992. *The Mammals of the Indomalayan Region: A Systematic Review.* Natural History Museum Publ., Oxford University Press.

Sambrook j., Fritsch E.F. and Maniatis T. 1989. *Molecular Cloning: a laboratory manual.* Second edition Cold Spring Harbor Laboratory Press.

Shannaz, J.P. Jepson and Rudyanto. 1995. *The threatened species in Indonesia.* Bird life International Indonesia Programme, Bogor.

Suyanto, A., M.Yoneda, I. Maryanto, Maharadatunkamsi and J. Sugarjito. 1998. *Check List of Indonesian Mammals.* LIPI, JICA and PHPA, Bogor.

第10期プロ・ナトゥーラ・ファンド助成成果報告書（2001）

要　旨

インドネシア産鳥類および哺乳類の遺伝子バンクの蓄積

スリ　スランダリ

鳥類の組織・血液・羽毛の標本は、インドネシア・サファリ公園、ジャカルタ鳥類取引センター、ヨギアカルタ動物園、スラバヤ動物園、バリ鳥類公園、TMII鳥類公園、マルガサツワ・ラグナン公園などで採取した。23科87種から合計363標本を集めた。

87種はインドネシア産鳥類のわずか6％に過ぎないが、40種が保護種、23種が固有種、22種が絶滅危惧種と、比較的緊急性の高い種から標本を採集するように努めた。

哺乳類の組織・血液・唾液・毛の標本は、インドネシア・サファリ公園、ヨギアカルタ動物園、スラバヤ動物園、ラグナン動物園、ギボン基金センターなどで採取した。合計33種から97標本を集めた。

33種はインドネシア哺乳類のわずか4.9％に過ぎないが、保護種に限ると22.7％に達している。

標本は96％エタノール液浸としてインドネシア科学院生物学研究センターの実験室に持ち込み、冷凍保存した。組織・血液・唾液標本からは標準プロトコール法で、また、羽毛や毛からはISOヘアー・キットを用いてDNAを抽出した。さらに、分光光度計を用いて、塩基濃度を測定したのち、DNAを超低温フリーザーに保存した。

以上のように、DNAバンクの立ち上げとして、本研究は予期以上の成果を挙げることができた。しかし、以下のような課題も残している。

1）今回DNA標本を採取できたのは、インドネシア産鳥類・哺乳類のわずか約5％程度の種からである。非常に緊急性を擁する絶滅危惧種を中心に、これからも標本採取に努めていく必要がある。

2）いくつかの小個体群に分かれて分布している種については、個体群別の標本採取を行う必要がある。

3）超低温フリーザーによるDNA保存はコストがかかるため、より安価な保存法の開発に努める必要がある。

4）標本の蓄積と同時に、DNAバンクのシステムやソフトの開発も進めていく必要がある。

以上の理由により、PRO NATURA FUNDのさらなる協力をお願いする次第である。

（推薦者：東　正剛　訳）

Appendix 1. Collected samples from a bird trader (Jakarta)

No.	Sample No.	Collection Date	Species	Family	DNA Concentration (μg/ml or ng/μl)	Distribution *)	Kind of sample	Collector **)	Status
1	H39	20.02.2000	*Tanygnatus sumatranus*	Psittacidae	Not measured yet	C	Blood	SS, DA,KM	Protected
2	H40	20.02.2000	*Tanygnatus sumatranus*	Psittacidae	Not measured yet	C	Blood	SS, DA, KM	Protected
3	H41	20.02.2000	*Chalcopsitta atra (atra)*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Endemic
4	H42	20.02.2000	*Chalcopsitta atra (atra)*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Endemic
5	H43	20.02.2000	*Trichoglossus h. djampeanus*	Psittacidae	Not measured yet	JCMTI	Blood	SS, DA, KM	-
6	H44	20.02.2000	*Trichoglossus h. djampeanus*	Psittacidae	Not measured yet	JCMTI	Blood	SS, DA, KM	-
7	H45	20.02.2000	*Chalcopsitta d. duivenbodei*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Protected
8	H46	20.02.2000	*Chalcopsitta d. duivenbodei*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Protected
9	H47	20.02.2000	*Trichoglossus h. haematodud*	Psittacidae	Not measured yet	JCMTI	Blood	SS, DA, KM	-
10	H48	20.02.2000	*Trichoglossus h. haematodus*	Psittacidae	Not measured yet	JCMTI	Blood	SS, DA, KM	-
11	H49	20.02.2000	*Pseudeos fuscata*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Protected
12	H50	20.02.2000	*Pseudeos fuscata*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Protected
13	H51	20.02.2000	*Charmosyna placentis placentis*	Psittacidae	Not measured yet	MI	Blood	SS, DA, KM	-
14	H52	20.02.2000	*Charmosyna placentis placentis*	Psittacidae	Not measured yet	MI	Blood	SS, DA, KM	-
15	H53	20.02.2000	*Psittaculirostris edwardsii*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Protected
16	H54	20.02.2000	*Psittaculirostris edwardsii*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Protected
17	H55	20.02.2000	*Psittaculirostris desmarestii*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Protected
18	H56	20.02.2000	*Psittaculirostris desmarestii*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	Protected
19	H57	20.02.2000	*Cyclopsitta diophthalma*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	-
20	H58	20.02.2000	*Cyclopsitta diophthalma*	Psittacidae	Not measured yet	I	Blood	SS, DA, KM	-
21	H59	20.02.2000	*Mino dumontii*	Sturnidae	Not measured yet	I	Blood	SS, DA, KM	-
22	H60	20.02.2000	*Mino dumontii*	Sturnidae	Not measured yet	I	Blood	SS, DA, KM	-
23	H61	20.02.2000	*Trichoglossus h. rubritorquis*	Psittacidae	Not measured yet	JCMTI	Blood	SS, DA, KM	-
24	H62	20.02.2000	*Trichoglossus h rubritorquis.*	Psittacidae	Not measured yet	JCMTI	Blood	SS, DA, KM	-

*) J for Java; C for Celebes; M for Mollucas; T for Indonesian Nusa Tenggara ; I for Irian Jaya
**) SS for Sri Sulandari; DA for Dwi Astuti; KM for Kundar Masno

Appendix 2. Collected samples from Indonesian Taman Safari Park (Cisarua- Bogor)

No.	Sample No.	Collection date	Species	Family	DNA Concentration (μg/ml)	Distribution *)	Kind of sample	Collector **)	Status
1	TSI 1	28.02.2000	*Cacatua s. citrinotristata*	Psittacidae	463.0	T(Sumba Is.)	Feather	SS.DA & AM	Endemic
2	TSI 8	28.02.2000	*Cacatua s. citrinotristata*	Psittacidae	2512.5	T(Sumba Is.)	Liver	SS.DA & AM	Endemic
3	TSI 3	28.02.2000	*Cacatua goffini*	Psittasidae	888.5	F T	Feather	SS.DA & AM	Endemic
4	TSI 7	28.02.2000	*Cacatua goffini*	Psittacidae	2900.75	F T	Liver	SS.DA & AM	Endemic
5	TSI 4	28.02.2000	*Cacatua s. sulphurea*	Psittacidae	136.25	JCT	Fether	SS.DA & AM	Endemic
6	TSI 5	28.02.2000	*Cacatua s. sulphurea*	Psittacidae	3113.0	JCT	Tissue	SS.DA & AM	Endemic
7	TSI 6	28.02.2000	*Paradisaea minor*	Paradisaeidae	3325.75		Liver	SS.DA & AM	
8	TSI 9	28.02.2000	*Eclectus roratus*	Psittacidae	6478.0	MTI	Feather , liver	SS.DA & AM	Protected
9	TSI 10	28.02.2000	*Goura victoria*	Psittacidae	103.0	I	Feather ,tissue	SS.DA & AM	Protected
10	TSI 11	28.02.2000	*Probosciger aterrimus.*	Psittacidae	209.0	I	Feather	SS.DA & AM	Protected
11	TSI 12	28.02.2000	*Probosciger aterrimus*	Psittacidae	Not measured	I	Feather	SS.DA & AM	Protected
12	TSI 13	28.02.2000	*Leucopsar rothschildi*	Sturnidae	Not measured		Feather	SS.DA & AM	Endemic; CITES app. I
13	TSI 14	28.02.2000	*Psittrichas fulgidus*	Psittacidae	Not measured	I	Feather	SS.DA & AM	CITESapp 2: near Threatened species
14	TSI 16	28.02.2000	*Eclectus roratus*	Psittacidae	134.75	MTI	Feather	SS.DA & AM	Protected
15	TSI 17	28.02.2000	*Eclectus roratus*	Psittacidae	110.25	MTI	Feather	SS.DA & AM	Protected
16	TSI 18	28.02.2000	*Paradisaea rubra*	Paradisaeidae	Not measured	I	Feather	SS.DA & AM	Protected
17	TSI 19	28.02.2000	*Seleucidis melanoleuca*	Paradisaeidae	Not measured	I	Feather	SS.DA & AM	Protected
18	TSI 24	28.02.2000	*Cacatua s. sulphurea*	Psittacidae	630.75	J C T	Feather	SS.DA & AM	Endemic
19	TSI 25	28.02.2000	*Cacatua s. sulphurea*	Psittacidae	Not measured	J C T	Feather	SS.DA & AM	Endemic
20	TSI 26	28.02.2000	*Cacatua moluccensis*	Psittacidae	Not measured	M	Feather	SS.DA & AM	Endemic

*) J for Java; C for Celebes; M for Mollucas; T for Indonesian Nusa Tenggara ; I for Irian Jaya
**) SS for Sri Sulandari; DA for Dwi Astuti; AM for Alwin Marahadikusuma

Appendix 3. Collected samples from Yogyakarta ZOO (Yogyakarta, Central Java)

No.	Sample No.	Collection date	Species	Family	DNA Concentration (µg/ml or ng/µl)	Distribution *)	Kind of sample	Collector **)	Status
1	KBY 1	07.03.2000	*Leptotilos javanicus*	Ciconiidae	Not measured	SKJ	Feather	SS,DA & AM	Protected, CITESapp. 1
2	KBY 2	07-.03.2000	*Cacatua moluccensis*	Psittacidae	171.5	M	Feather	SS,DA & AM	Endemic
3	KBY 3	07-.03.2000	*Anthracoceros albirostris*	Bucerotidae	Not measured	SKJ	Feather	SS,DA & AM	-
4	KBY 4	07-.03.2000	*Probosciger atterimus*	Psittacidae	Not measured	I	Feather	SS,DA & AM	Protected
5	KBY 5	07-.03.2000	*Cacatua alba*	Psittacidae	115.5	M	Feather	SS,DA & AM	Endemic
6	KBY 7	07-.03.2000	*Ardea cinera*	Ardeidae	Not measured	SJT	Feather	SS,DA & AM	-
7	KBY 8	07-.03.2000	*Anthracoceros malayanus*	Bucerotidae	402.0	SK	Blood	SS,DA & AM	-
8	KBY 9	08.03.2000	*Rhyticeros undulatus*	Bucerotidae	26.5	SKJ	Blood	SS,DA & AM	Protected
9	KBY 10	08.03.2000	*Argusianus argus*	Phasianidae	102.75	SK	Blood	SS,DA & AM	Protected
10	KBY 11	08.03.2000	*Lophura ignita rufa*	Phasianidae	266.0	SK	Blood	SS,DA & AM	Protected
11	KBY 12	08.03.2000	*Macrocepalon maleo*	Megapodiidae	119.0	C	Blood	SS,DA & AM	-
12	KBY 13	08.03.2000	*Spilornis cheela*	Accipitridae	145.5	SKJ	Blood	SS,DA & AM	Protected
13	KBY 14	08.03.2000	*Ardea cinera*	Ardeidae	15.5	SJT	Blood	SS,DA & AM	-
14	KBY 15	08.03.2000	*Ketupa ketupu*	Strigidae	172.5	SKJ	Blood	SS,DA & AM	-
15	KBY 16	08.03.2000	*Bubulcus ibis*	Ardeidae	100.75	SKJCMTI	Blood	SS,DA & AM	Protected
16	KBY 17	08.03.2000	*Haliastur indus*	Accipitridae	58.25	SKJCMI	Blood	SS,DA & AM	Protected
17	KBY 18	08.03.2000	*Ketupa ketupu*	Strigidae	70.25	SKJ	Blood	SS,DA & AM	-
18	KBY 19	08.03.2000	*Buceros rhinoceros*	Bucerotidae	Not measured	SKJ	Blood	SS,DA & AM	-
19	KBY 20	08.03.2000	*Ictynaetus malayensis*	Accipitridae	350.0	SKJ	Blood	SS,DA & AM	Protected
20	KBY 21	08.03.2000	*Leptotilos javanicus*	Ciconiidae	Not measured	S K J	Blood	SS,DA & AM	Protected, CITESapp. 1
21	KBY 22	08.03.2000	*Gallus gallus bankiva*	Phasianidae	977.0	SJ F	Blood	SS,DA & AM	-
22	KBY 23	08.03.2000	*Goura cristata*	Coulumbidae	789.5		Blood	SS,DA & AM	Protected

*) S for Sumatra; K for Kalimantan; J for Java; C for Celebes; M for Mollucas; T for Indonesian Nusa Tenggara ; I for Irian Jaya
**) SS for Sri Sulandari; DA for Dwi Astuti; AM for Alwin Marakarmah

Appendix 4. Collected bird samples from Surabaya ZOO (Surabaya, East Java)

No.	Sample No.	Species	Collection date	Family	Distribution *)	Kind of sample	Concentration of DNA (µg/ml)	Collector**)	Status
1	KBS 1	*Lorius lory lory*	08.03.2000	Psittacidae	I	Blood	281.75	SS,DA &AM	Endemic and protected
2	KBS 2	*Lorius lory lory*	08.03.2000	Psittacidae	I	Blood	334.5	SS,DA &AM	Endemic and protected
3	KBS 3	*Lorius garrulus garrulus*	08.03.2000	Psittacidae	M	Blood	1455.0	SS,DA &AM	Endemic; CITES app.2
4	KBS 6	*Lorius garrulus garrulus*	08.03.2000	Psittacidae	M	Blood	636.0	SS,DA &AM	Endemic, CITES app.2
5	KBS 4	*Trichoglossus h. weberi*	08.03.2000	Psittacidae	JCMTI	Blood	1417.0	SS,DA &AM	-
6	KBS 5	*Trichoglossus h. weberi*	08.03.2000	Psittacidae	JCMTI	Blood	393.0	SS,DA &AM	-
7	KBS 7	*Chalcopsitta atra atra*	08.03.2000	Psittacidae	F	Blood	95.75	SS,DA &AM	Endemic
8	KBS 8	*Chalcopsitta atra atra*	08.03.2000	Psittacidae	F	Blood	171.75	SS,DA &AM	Endemic
9	KBS 9	*Trichoglossus h. haematodus*	08.03.2000	Psittacidae	JCMTI	Blood	531.25	SS,DA &AM	-
10	KBS 10	*Trichoglossus h. haematodus*	08.03.2000	Psittacidae	JCMTI	Blood	502.75	SS,DA &AM	-
11	KBS 11	*Pseudeos fuscata*	08.03.2000	Psittacidae	I	Blood	196.5	SS,DA &AM	-
12	KBS 12	*Pseudeos fuscata*	08.03.2000	Psittacidae	I	Blood	232.50	SS,DA &AM	-
13	KBS 13	*Eos borneo*	08.03.2000	Psittacidae	M	Blood	284.25	SS,DA &AM	Endemic; CITES app.2
14	KBS 14	*Mivus migrans*	08.03.2000	Accipitridae	SCMTI	Blood	465.0	SS,DA &AM	Protected
15	KBS 15	*Spilornis cheela bido*	08.03.2000	Accipitridae	SKJ	Blood	63.25	SS,DA &AM	Protected
16	KBS 16	*Centropus bengalensis*	08.03.2000	Cuculidae	SKJCMT	Blood	185.50	SS,DA &AM	-
17	KBS 17	*Centropus bengalensis*	08.03.2000	Cuculdae	SKJCMT	Blood	155.50	SS,DA &AM	-
18	KBS 18	*Accipiter trivirgatus*	08.03.2000	Accipitridae	SKJ	Blood	225.75	SS,DA &AM	Protected
19	KBS 19	*Falco tinnunculus*	08.03.2000	Falconidae	S	Blood	218.5	SS,DA &AM	Protected
20	KBS 22	*Ictinaetus malayensis*	08.03.2000	Accipitridae	SKJCM	Blood	100.75	SS,DA &AM	Protected
21	KBS 23	*Strix seloputo*	08.03.2000	Strigidae	J	Blood	227.0	SS,DA &AM	
22	KBS 24	*Strix seloputo*	08.03.2000	Strigidae	J	Blood	45.25	SS,DA &AM	
25	KBS 25	*Otus lempiji*	08.03.2000	Strigidae	SKJ	Blood	not measured yet	SS,DA &AM	-
26	KBS 26	*Otus lempiji*	08.03.2000	Strigidae	SKJ	Blood	120.75	SS,DA &AM	-
27	KBS 27	*Corvus macrorhynchos*	08.03.2000	Corvidae	SKJT	Blood	16.25	SS,DA &AM	-
28	KBS 28	*Corvus enca*	08.03.2000	Corvidae	SKJCM	Blood	22.25	SS,DA &AM	-
29	KBS 29	*Corvus enca*	08.03.2000	Corvidae	SKJCM	Blood	33.25	SS,DA &AM	-
30	KBS 30	*Bubo sumatranus*	08.03.2000	Strigidae	SKJ	Blood	32.0	SS,DA &AM	-
31	KBS 31	*Ketupa ketupu*	08.03.2000	Strigidae	SKJ	Blood	78.75	SS,DA &AM	-

*) S for Sumatra; I for Irian Jaya; M for Moluccas , J for Java; C for Celebes; K for Kalimantan; T for Lesser Sunda ; F assumed to be exclusively feral
**) SS for Sri Sulandari, DA for Dwi Astuti ; AM for Alwin Marakarnah

Appendix 4. Continued

No.	Sample No.	Species	Collection date	Family	Distribution *)	Kind of sample	Concentration of DNA (µg/ml)	Collector**)	Status
32	KBS 32	*Ketupa ketupu*	08.03.2000	Strigidae	SKJ	Blood	204.25	SS,DA &AM	-
33	KBS 33	*Accipiter trivirgatus*	08.03.2000	Accipitridae	SKJ	Blood	not measured yet	SS,DA &AM	Protected
34	KBS 34	*Philemon buceroides*	08.03.2000	Meliphagidae	T	Blood	not measured yet	SS,DA &AM	Protected
35	KBS 35	*Philemon buceroides*	08.03.2000	Meliphagidae	T	Blood	not measured yet	SS,DA &AM	Protected
36	KBS 36	*Gallus gallus bankiva*	08.03.2000	Phasianidae	SJ	Blood	not measured yet	SS,DA &AM	-
37	KBS 37	*Gallus varius* (female)	08.03.2000	Phasianidae	J	Blood	not measured yet	SS,DA &AM	Endemic
38	KBS 38	*Gallus varius* (male)	08.03.2000	Phasianidae	J	Blood	not measured yet	SS,DA &AM	Endemic
39	KBS 39	*Irena puela* (female)	08.03.2000	Irenidae	SKJ	Blood	not measured yet	SS,DA &AM	-
40	KBS 40	*Irena puela* (male)	08.03.2000	Irenidae	SKJ	Blood	not measured yet	SS,DA &AM	-
41	KBS 41	*Cicinnurus regius* (male)	08.03.2000	Paradisaeidae	I	Blood	not measured yet	SS,DA &AM	Protected
42	KBS 42	*Cicinnurus regius* (female)	08.03.2000	Paradisaeidae	I	Blood	not measured yet	SS,DA &AM	Protected
43	KBS 43	*Pycnonotus jocosus*	08.03.2000	Pycnonotidae		Blood	not measured yet	SS,DA &AM	-
44	KBS 44	*Scissirostrum dubium*	08.03.2000			Blood	not measured yet	SS,DA &AM	-
45	KBS 45	*Scissirostrum dubium*	08.03.2000			Blood	not measured yet	SS,DA &AM	-
46	KBS 46	*Padda oryzivora*	08.03.2000	Ploceidae	J	Blood	not measured yet	SS,DA &AM	Endemic
47	KBS 47	*Padda oryzivora*	08.03.2000	Ploceidae	J	Blood	not measured yet	SS, DA &AM	Endemic
48	KBS 48	*Phaenicophaeus curvirostris*	08.03.2000	Cuculidae	SKJ	Blood	not measured yet	SS,DA &AM	-
49	KBS 49	*Geopelia striata*	08.03.2000	Columbidae	SKJFT	Blood	not measured yet	SS,DA &AM	-
50	KBS 50	*Geopelia striata*	08.03.2000	Columbidae	SKJFT	Blood	not measured yet	SS,DA &AM	-
51	KBS 51	*Garrulax leucolophus bicolor*	08.03.2000	Timaliidae	S	Blood	not measured yet	SS,DA &AM	Protected
52	KBS 52	*Garrulax leucolophus bicolor*	08.03.2000	Timaliidae	S	Blood	not measured yet	SS,DA &AM	Protected
53	KBS 53	*Dicrucus macrocercus*	08.03.2000	Dicruridae	J	Blood	not measured yet	SS,DA &AM	-
54	KBS 54	*Picus mentalis*	08.03.2000	Picidae	SKJ	Blood	not measured yet	SS,DA &AM	-
55	KBS 55	*Cacatua moluccencis*	09.03.2000	Psittacidae	M	Blood	292.0	SS,DA &AM	Endemic
56	KBS 56	*Probosciger atterimus*	09.03.2000	Psittacidae	I	Blood	not measured yet	SS,DA &AM	Protected
57	KBS 57	*Probosciger atterimus*	09.03.2000	Psittacidae	I	Blood	not measured yet	SS,DA &AM	Protected
58	KBS 58	*Cacatua goffini*	09.03.2000	Psittacidae	FT	Blood	677.5	SS,DA &AM	Endemic
59	KBS 59	*Cacatua goffini*	09.03.2000	Psittacidae	FT	Blood	339.0	SS,DA &AM	Endemic

*) I for Irian Jaya; M for Moluccas , J for Java; C for Celebes; K for Kalimantan; T for Lesser Sunda
**) SS for Sri Sulandari, DA for Dwi Astuti ; AM for Alwin Marakarmah

Appendix 4. Continued

No.	Sample No.	Species	Collection date	Family	Distribution *)	Kind of sample	Concentration of DNA (µg/ml)	Collector**)	Status
60	KBS 60	*Electus roratus* (male)	09.03.2000	Psittacidae	MTI	Blood	188.75	SS,DA &AM	-
61	KBS 61	*Electus roratus* (female)	09.03.2000	Psittacidae	MTI	Blood	729.25	SS,DA &AM	-
62	KBS 62	*Cacatua alba*	09.03.2000	Psittacidae	M	Blood	278.5	SS,DA &AM	Endemic
63	KBS 63	*Cacatua s. sulphurea*	09.03.2000	Psittacidae	JCT	Blood	478.75	SS,DA &AM	Endemic, Appendix I
64	KBS 64	*Cacatua s. sulphurea*	09.03.2000	Psittacidae	JCT	Blood	not measured yet	SS,DA &AM	Endemic, Appendix I
65	KBS 65	*Cacatua galerita*	09.03.2000	Psittacidae	FI	Blood	141.75	SS,DA &AM	Protected
66	KBS 66	*Cacatua galerita*	09.03.2000	Psittacidae	FI	Blood	318.25	SS,DA &AM	Protected
67	KBS 67	*Cacatua alba*	09.03.2000	Psittacidae	M	Blood	not measured yet	SS,DA &AM	Endemic, Appendix I
68	KBS 68	*Aceros subruficollis* (M)	09.03.2000			Blood	not measured yet	SS,DA &AM	Appendix I
69	KBS 69	*Aceros subruficollis* (F)	09.03.2000			Blood	not measured yet	SS,DA &AM	Appendix I
70	KBS 70	*Macrocephalon maleo*	09.03.2000	Megapodidae	C	Blood	not measured yet	SS,DA &AM	Endemic; Protected CITES appendix I
71	KBS 71	*Macrocephalon maleo*	09.03.2000	Megapodidae	C	Blood	not measured yet	SS,DA &AM	Endemic;Protected CITES appendix I
72	KBS 72	*Rhyticeros undulatus*	09.03.2000	Bucerotidae	SKJ	Blood	not measured yet	SS,DA &AM	Protected, Appendix 2
73	KBS 73	*Psitrichas fulgidus*	09.03.2000	Psittacidae	I	Blood	not measured yet	SS,DA &AM	Protected, Appendix 2
74	KBS 74	*Psitrichas fulgidus*	09.03.2000	Psittacidae	I	Blood	not measured yet	SS,DA &AM	Protected
75	KBS 75	*Haliastur indus*	09.03.2000	Accipitridae	SKJCMTI	Blood	not measured yet	SS,DA &AM	Protected
76	KBS 76	*Haliastur indus*	09.03.2000	Accipitridae	SKJCMTI	Blood	not measured yet	SS,DA &AM	Protected
77	KBS 77	*Pandion haliaetus*	09.03.2000	Accipitridae	SKJCMTI	Blood	not measured yet	SS,DA &AM	Protected
78	KBS 78	*Pandion haliaetus*	09.03.2000	Accipitridae	SKJCMTI	Blood	not measured yet	SS,DA &AM	Protected
79	KBS 79	*Haliaeetus leucogaster*	09.03.2000	Accipitridae	SKJCMTI	Blood	not measured yet	SS,DA &AM	Protected
80	KBS 80	*Haliaeetus leucogaster*	09.03.2000	Accipitridae	SKJCMTI	Blood	not measured yet	SS,DA &AM	-
81	KBS 81	*Oriolus chinensis*	09.03.2000	Oriolidae	SKJCT	Blood	not measured yet	SS,DA &AM	-
82	KBS 82	*Oriolus chinensis*	09.03.2000	Oriolidae	SKJCT	Blood	Not measured yet	SS,DA &AM	-
83	KBS 83	*Pavo munticus* (M)	09.03.2000	Phasianidae	J	Blood	not measured yet	SS,DA &AM	Protected, Appendix I
84	KBS 84	*Pavo munticus* (F)	09.03.2000	Phasianidae	J	Blood	not measured yet	SS,DA &AM	Protected, Appendix I

*) S for Sumatra; I for Irian Jaya; M for Moluccas , J for Java; C for Celebes; K for Kalimantan; T for Lesser Sunda ; F assumed to be exclusively feral
**) SS for Sri Sulandari, DA for Dwi Astuti ; AM for Alwin Marakarmah

Appendix 5. Collected bird samples from Bali Bird Park (Denpasar, Bali Island)

No.	Sample No.	Species	Collection date	Family	Distribu tion*)	Kind of sample	Concentration of DNA (µg ml)	Collector**)	Status
1	BBP 1	*Cacatua galerita*	13.03.2000	Psittacidae	FI	feather	185.5	SS,DA &AM	Protected,CITESapp.2
2	BBP 2	*Cacatua moluccensis*	13.03.2000	Psittacidae	M	feather	2407.0	SS,DA &AM	Endemic, CITESapp.2
3	BBP 3	*Cacatua s. citrinocristata* (M)	13.03.2000	Psittacidae	JCT	feather	1120.75	SS,DA &AM	Endemic, CITESapp 1
4	BBP 4	*Cacatua s. citrinocristata* (F)	13.03.2000	Psittacidae	JCT	Feather	707..0	SS,DA &AM	Endemic, CITESapp.1
5	BBP 5	*Alisterus amboinensis*	13.03.2000	Psittacidae	CMI	feather	not measured yet	SS,DA &AM	Endemic
6	BBP 6	*Cacatua alba*	13.03.2000	Psittacidae	M	feather	not measured yet	SS,DA &AM	Endemic, CITESapp.2
7	BBP 7	*Lorius garrulus flavopalliatus*	13.03.2000	Psittacidae	M	feather	not measured yet	SS,DA &AM	Endemic, CITESapp 2
8	BBP 8	*Cacatua s. sulphurea*	13.03.2000	Psittacidae	JCT	feather	not measured yet	SS,DA &AM	Endemik, CITESapp.2
9	BBP 9	*Psittrichas fulgidus*	13.03.2000	Psittacidae	I	feather	not measured yet	SS,DA &AM	Protected, CITESapp.2
10	BBP 10	*Leucopsar rotschildi*	13.03.2000	Sturnidae	J	feather	not measured yet	SS,DA &AM	Endemi, protected
11	BBP 11	*Probosciger atterimus*	13.03.2000	Psittacidae	I	feather	not measured yet	SS,DA &AM	Protected
12	BBP 12	*Goura victoria*	13.03.2000	Columbidae	I	feather	not measured yet	SS,DA &AM	Protected
13	BBP 13	*Goura schepmakeri*	13.03.2000	Columbidae	I	feather	not measured yet	SS,DA &AM	Protected
14	BBP 14	*Cacatua sanguena*	13.03.2000	Psittacidae	I	feather	115.5	SS,DA &AM	-
15	BBP 15	*Goura cristata*	13.03.2000	Columbidae	I	feather	not measured yet	SS,DA &AM	Endemic,Protected
16	BBP 16	*Sturnus melanopterus*	13.03.2000	Sturnidae	JT	feather	not measured yet	SS,DA &AM	Endemic, protected
17	BBP 17	*Casuarius unappendiculatus*	13.03.2000	Casuariidae	I	feather	not measured yet	SS,DA &AM	Protected
18	BBP 18	*Casuarius casuarius*	13.03.2000	Casuariidae	I	feather	not measured yet	SS,DA &AM	Protected

*) I for Irian Jaya; M for Moluccas , J for Java; C for Celebes, T for Lesser Sunda ; F species assumed to be exclusively feral
**) SS for Sri Sulandari, DA for Dwi Astuti ; AM for Alwin Marakarmah

Appendix 6. Collected samples from Taman Margasatwa Ragunan (Jakarta)

No	Sample No	Collection Date	Species	Family	DNA conc. (ug/ml)	Distribu tion*)	Kind of sample	Collector **)	Status
1	TMR1	27.07.2000	*Eclectus roratus*	Psittacidae	110.00	MTI	blood	SS,DW,KM	Protected.CI.2
2	TMR2	27.07.2000	*Haliastur indus*	Accipitridae	939.63	SKJCMI	blood	SS.DW,KM	Protected. CI.2
3	TMR3	27.07.2000	*Haliaeetus leucogaster*	Accipitridae	698.75	SKJCMI	blood	SS.DW,KM	Protected
4	TMR4	27.07.2000	*Spizaetus cirrhatus*	Accipitridae	113.38		blood	SS,DW,KM	Protected. CI.2
5	TMR5	27.07.2000	*Spizaetus cirrhatus*	Accipitridae	not measured		blood	SS,DW,KM	Protected,CI.2
6	TMR6	27.07.2000	*Haliastur indus*	Accipitridae	not measured	SKJCMI	blood	SS,DW,KM	Protected.CI 2
7	TMR7	27.07.2000	*Haliastur indus*	Accipitridae	not measured	SKJCMI	blood	SS,DW,KM	Protected.CI 2
8	TMR8	27.07.2000	*Haliastur indus*	Accipitridae	not measured	SKJCMI	blood	SS,DW,KM	Protected.CI 2
9	TMR9	27.07.2000	*Spilornis cheela palidus*	Accipitridae	627.63	SKJ	blood	SS.DW,KM	Protected. CI 2
10	TMR10	27.07.2000	*Spilornis cheela palidus*	Accipitridae	not measured	SKJ	blood	SS.DW,KM	Protected, CI.2
11	TMR11	27.07.2000	*Spilornis cheela palidus*	Accipitridae	585.88	SKJ	blood	SS.DW,KM	Protected, CI.2
12	TMR12	27.07.2000	*Spilornis cheela palidus*	Accipitridae	not measured	SKJ	blood	SS,DW,KM	Protected,CI.2
13	TMR13	27.07.2000	*Pavo muticus*	Phasianidae	not measured	J	blood	SS,DW,KM	Protected,CI.2
14	TMR14	27.07.2000	*Pavo muticus*	Phasianidae	not measured	J	blood	SS,DW,KM	Protected,CI.2
15	TMR15	27.07.2000	*Pavo muticus*	Phasianidae	not measured	J	blood	SS,DW,KM	Protected,CI.2
16	TMR16	27.07.2000	*Pavo muticus*	Phasianidae	not measured	J	blood	SS,DW,KM	Protected,CI.2
17	TMR17	27.07.2000	*Pavo muticus*	Phasianidae	not measured	J	blood	SS,DW,KM	Protected,CI 2
18	TMR18	27.07.2000	*Cacatua galerita*	Psittacidae	74.50	I	blood	SS,DW,KM	Protected
19	TMR19	27.07.2000	*Cacatua galerita*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected
20	TMR20	27.07.2000	*Eos bornea bornea*	Psittacidae	110.45	M	blood	SS,DW,KM	Endemic,CI.2
21	TMR21	27.07.2000	*Lorius lory*	Psittacidae	60.10	I	blood	SS,DW,KM	Protected,CI.2

*)S for Sumatra; K for Kalimantan; J for Java; C for Celebes; M for Mollucas; T for Indonesia Nusa Tenggara; I for Irian Jaya
**)SS for Sri Sulandari; DA for Dwi Astuti; KM for Kundar Masno
***)Protected by Indonesian Government (CI1:CITES appendix1; CI2:CITES appendix2)

Appendix 6. Continued

No	Sample No	Collection Date	Species	Family	DNA concentration	Distribution*)	Kind of spls	Collector **)	Status ***)
22	TMR22	27.07.2000	*Tanygnathus megalorynchos*	Psittacidae	160.35	CMTI	blood	SS,DW,KM	-
23	TMR23	27.07.2000	*Tanygnathus megalorynchos*	Psittacidae	not measured	CMTI	blood	SS,DW,KM	-
24	TMR24	27.07.2000	*Aprosmictus erythropterus*	Psittacidae	98.55	I	blood	SS,DW,KM	-
25	TMR25	27.07.2000	*Chalcopsitta duivenbodei*	Psittacidae	75.35	I	blood	SS,DW,KM	Protected
26	TMR26	27.07.2000	*Chalcopsitta duivenbodei*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected
27	TMR27	27.07.2000	*Chalcopsitta duivenbodei*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected
28	TMR28	27.07.2000	*Chalcopsitta duivenbodei*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected
29	TMR29	27.07.2000	*Chalcopsitta atra atra*	Psittacidae	75.35	I	blood	SS,DW,KM	Endemic
30	TMR30	27.07.2000	*Chalcopsitta atra atra*	Psittacidae	not measured	I	blood	SS,DW,KM	Endemic
31	TMR31	27.07.2000	*Chalcopsitta atra atra*	Psittacidae	not measured	I	blood	SS,DW,KM	Endemic
32	TMR32	27.07.2000	*Trichoglossus haematodus*	Psittacidae	35.1	JCMTI	blood	SS,DW,KM	-
33	TMR33	27.07.2000	*Trichoglossus haematodus*	Psittacidae	not measured	JCMTI	blood	SS,DW,KM	-
34	TMR34	27.07.2000	*Psittaculirostris desmarestii*	Psittacidae	100.05	I	blood	SS,DW,KM	Protected
35	TMR35	27.07.2000	*Psittaculirostris desmarestii*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected
36	TMR36	27.07.2000	*Eclectus roratus*	Psittacidae	not measured	MTI	blood	SS,DW,KM	Protected,CI.2
37	TMR37	27.07.2000	*Eclectus roratus*	Psittacidae	not measured	MTI	blood	SS,DW,KM	Protected,CI.2
38	TMR38	27.07.2000	*Eclectus roratus*	Psittacidae	not measured	MTI	blood	SS,DW,KM	Protected,CI.2
39	TMR39	27.07.2000	*Cacatua goffini*	Psittacidae	not measured	T	blood	SS,DW,KM	Endemic, CI 1
40	TMR40	27.07.2000	*Cacatua goffini*	Psittacidae	37.45	T	blood	SS,DW,KM	Endemic,CI 1
41	TMR41	27.07.2000	*Cacatua goffini*	Psittacidae	not measured	T	blood	SS,DW,KM	Endemic, CI 1
42	TMR42	01.08.2000	*Caloenas nicobarica*	Columbidae	not measured	C	blood	SS,DW,KM	Protected,CI 1
43	TMR43	01.08.2000	*Anthracoceros corverus*	Bucerotidae	not measured		blood	SS,DW,KM	Protected
44	TMR44	01.08.2000	*Anthracoceros corverus*	Bucerotidae	not measured		blood	SS,DW,KM	Protected
45	TMR45	01.08.2000	*Rhyticeros plicatus*	Bucerotidae	not measured	MI	blood	SS,DW,KM	Protected
46	TMR46	01.08.2000	*Rhyticeros plicatus*	Bucerotidae	not measured	MI	blood	SS,DW,KM	Protected
47	TMR47	01.08.2000	*Rhyticeros undulatus*	Bucerotidae	not measured	SKJ	blood	SS,DW,KM	Protected,CI.2
48	TMR48	01.08.2000	*Ictinaetus malayensis*	Accipitridae	1123.38	SKJCM	blood	SS,DW,KM	Protected

*S for Sumatra; K for Kalimantan; J for Java; C for Celebes; M for Mollucas; T for Indonesia Nusa Tenggara; I for Irian Jaya
**)SS for Sri Sulandari; DA for Dwi Astuti; KM for Kundar Masno
***)Protected by Indonesian Government (CI1:CITES appendix1; CI2:CITES appendix2)

Appendix 6. Continued

No	Sample No	Collection Date	Species	Family	DNA concentration	Distribution*)	Kind of sample	Collector **)	Status
49	TMR49	01.08.2000	*Ictinaetus malayensis*	Accipitridae	not measured		blood	SS,DW,KM	Protected
50	TMR50	01.08.2000	*Caloenas nicobarica*	Columbidae	not measured	C	blood	SS,DW,KM	Protected,CITES*app1*
51	TMR51	01.08.2000	*Caloenas nicobarica*	Columbidae	not measured	C	blood	SS,DW,KM	Protected,CITES*app1*
52	TMR52	01.08.2000	*Cacatua moluccensis*	Psittacidae	103.5	M	blood	SS,DW,KM	Endemic, Protected CI 1
53	TMR53	01.08.2000	*Cacatua moluccensis*	Psittacidae	not measured	M	blood	SS,DW,KM	Endemic,Protected CI 1
54	TMR54	01.08.2000	*Cacatua moluccensis*	Psittacidae	not measured	M	blood	SS,DW,KM	Endemic,Protected CI 1
55	TMR55	01.08.2000	*Cacatua moluccensis*	Psittacidae	not measured	M	blood	SS,DW,KM	Endemic,Protected CI 1
56	TMR56	01.08.2000	*Cacatua moluccensis*	Psittacidae	not measured	M	blood	SS,DW,KM	Endemic,Protected CI 1
57	TMR57	01.08.2000	*Cacatua alba*	Psittacidae	not measured	M	blood	SS,DW,KM	Endemic
58	TMR58	01.08.2000	*Cacatua alba*	Psittacidae	not measured	M	blood	SS,DW,KM	Endemic
59	TMR59	01.08.2000	*Cacatua alba*	Psittacidae	not measured	M	blood	SS,DW,KM	Endemic
60	TMR60	01.08.2000	*Cacatua sulphurea sulphurea*	Psittacidae	not measured	JCT	blood	SS,DW,KM	Endemic,Protected CI 1
61	TMR61	01.08.2000	*Probosciger aterrimus stenolophus*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected,CI 1
62	TMR62	01.08.2000	*Probosciger aterrimus stenolophus*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected,CI 1
63	TMR63	01.08.2000	*Probosciger aterrimus aterrimus*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected,CI 1
64	TMR64	01.08.2000	*Probosciger aterrimus aterrimus*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected,CI 1
65	TMR65	01.08.2000	*Probosciger aterrimus aterrimus*	Psittacidae	not measured	I	blood	SS,DW,KM	Protected,CI 1

*)S for Sumatra; K for Kalimantan; J for Java; C for Celebes; M for Mollucas; T for Indonesia Nusa Tenggara; I for Irian Jaya
**)SS for Sri Sulandari; DA for Dwi Astuti; KM for Kundar Masno
***)Protected by Indonesian Government (CI1:CITES appendix1; CI2:CITES appendix2)

Appendix 7. Collected samples from BIRD PARK at the Taman Mini Indonesia Indah

No	Sample No	Collection Date	Species	Family	DNA concentration	Distribution*)	Kind of sample	Collector**)	Status ***)
1	TMI 1	20.06.2000	*Cacatua goffini*	Psittacidae	not measured	T	blood	SS,DM,KM	Endemic, CI 1
2	TMI 2	20.06.2000	*Cacatua moluccensis*	Psittacidae	not measured	M	blood	SS,DM,KM	Endemic,CI 1
3	TMI 3	20.06.2000	*Cacatua sanguinea*	Psittacidae	not measured	I	blood	SS,DM,KM	-
4	TMI 4	20.06.2000	*Probosciger aterrimus*	Psittacidae	not measured	I	blood	SS,DM,KM	Protected, CI.1
5	TMI 5	20.06.2000	*Psittrichas fulgidus*	Psittacidae	not measured	I	blood	SS,DM,KM	Protected. CI.2
6	TMI 6	20.06.2000	*Lorius garrulus*	Psittacidae	not measured	M	blood	SS,DM,KM	Endemic
7	TMI 7	20.06.2000	*Lorius lorry*	Psittacidae	not measured	I	blood	SS,DM,KM	Protected,CI.2
8	TMI 8	20.06.2000	*Goura Victoria*	Columbidae	not measured	I	blood	SS,DM,KM	Protected, CI 2
9	TMI 9	20.06.2000	*Scissirotrum dubium*	Sturnidae	not measured	C	blood	SS,DM,KM	Endemic
10	TMI 10	20.06.2000	*Padda fuscata*	Ploceidae	not measured	T	blood	SS,DM,KM	Endemic
11	TMI 11	20.06.2000	*Spizaetus bartelsi*	Accipitridae	not measured	J	blood	SS,DM,KM	Endemic,Protected CI2
12	TMI 12	20.06.2000	*Paradisaea minor*	Paradisaeidae	not measured	I	blood	SS,DM,KM	Protected,CI.2
13	TMI 13	20.06.2000	*Paradisaea rubra*	Paradisaeidae	not measured	I	blood	SS,DM,KM	Protected, CI 2
14	TMI 14	20.06.2000	*Paradisaea rubra*	Paradisaeidae	not measured	I	blood	SS,DM,KM	Protected,CI 2
15	TMI 15	20.06.2000	*Cacatua alba*	Psittacidae	not measured	M	blood	SS,DM,KM	Endemic,CI.2
16	TMI 16	20.06.2000	*Cacatua alba*	Psittacidae	not measured	M	blood	SS,DM,KM	Endemic,CI.2
17	TMI 17	20.06.2000	*Goura cristata*	Columbidae	not measured	I	blood	SS,DM,KM	Protected, CI 2
18	TMI 18	20.06.2000	*Goura scheepmakeri*	Columbidae	not measured		blood	SS,DM,KM	Protected,CI 2
19	TMI 19	20.06.2000	*Leucopsar rothschildi*	Sturnidae	not measured	J	blood	SS,DM,KM	Endemic,protected CI 1
20	TMI 20	20.06.2000	*Leucopsar rothschildi*	Sturnidae	not measured	J	blood	SS,DM,KM	Endemic,Protected. CI 1
21	TMI 21	20.06.2000	*Sturnus melanopterus*	Sturnidae	not measured	J,T	blood	SS,DM,KM	Endemic,Protected
22	TMI 22	20.06.2000	*Casuarius casuarius*	Casuaridae	not measured	I	blood	SS,DM,KM	Protected
23	TMI 23	20.06.2000	*Casuarius unappendiculatus*	Casuaridae	not measured	I	blood	SS,DM,KM	Protected

*)J for Java; C for Celebes; M for Mollucas; T for Indonesia Nusa Tenggara; I for Irian Jaya

**)SS for Sri Sulandari; DA for Dwi Astuti; KM for Kundar Masno

***)Protected by Indonesian Government (CI1: CITES appendix1: CI2:CITES appendix2)

Appendix 8. Collected Blood Samples of *Psittacula alexandri* from captived bird at the zoological division, in Bogor-Indonesia

No	Sample No	Collection Date	Species	Family	DNA concentration	Distribu*) tion//origin place	Collector**)	Status
1	Pa 3-Pa8	11.05.2000	*Psittacula alexandri*	Psittacidae	not measured	SKJ /Jonggol	KM	-
2	Pa9-Pa22	11.05.2000	*Psittacula alexandri*	Psittacidae	not measured	SKJ/Cepu	KM	-
3	Pa23-Pa28	11.05.2000	*Psittacula alexandri*	Psittacidae	not measured	SKJ/Blora	KM	-
4	Pa29-Pa38	11.05.2000	*Psittacula alexandri*	Psittacidae	not measured	SKJ/Yogyakarta	KM	-
5	Pa39-Pa45	11.05.2000	*Psittacula alexandri*	Psittacidae	not measured	SKJ/ Central Java	KM	-
6	Pa46-Pa56	11.05.2000	*Psittacula alexandri*	Psittacidae	not measured	SKJ/Ngawi	KM	-
7	Pa66-Pa72	11.09.2000	*Psittacula alexandri*	Psittacidae	not measured	SKJBawean	KM	-

*)S for Sumatra; K for Kalimantan; J for Java;

**)KM Kundar Masno

Note: Before birds kept in captivity, origin place of the birds were from Jonggol, Cepu, Blora, Yogyakarta, Ngawi and Bawean

Appendix 9.Collected Parrots Blood Samples (Psittacidae family) from Bird Trader (Jakarta)

No	Spl No	Collection Date	Species	DNA conc. (ng/ul)	Distribution*)	Kind of sample	Collector **)	Status
1	H1	August1999	*Alisterus chloropterus*	21.25	I	Blood	SS,DW,KM	Protected
2	H2	August1999	*Alisterus chloropterus*	86.25	I	Blood	SS,DW,KM	Protected
3	H3	August1999	*Alisterus chloropterus*	168.50	I	Blood	SS,DW,KM	Protected
4	H4	August1999	*Alisterus chloropterus*	388.75	I	Blood	SS,DW,KM	Protected
5	H5	August1999	*Alisterus chloropterus*	188.75	I	Blood	SS,DW,KM	Protected
6	H6	August1999	*Alisterus chloropterus*	266.25	I	Blood	SS,DW,KM	Protected
7	H7	August1999	*Alisterus chloropterus*	881.75	I	Blood	SS,DW,KM	Protected
8	H8	August1999	*Alisterus chloropterus*	733.25	I	Blood	SS,DW,KM	Protected
9	H9	August1999	*Trichoglossus haematodus coeruleiceps*	158.75	JCMTI	Blood	SS,DW,KM	-
10	H10	August1999	*Trichoglossus haematodus coeruleiceps*	447.75	JCMTI	Blood	SS,DW,KM	-
11	H11	August1999	*Chalcopsitta scintilata*	172.00	I	Blood	SS,DW,KM	Protected
12	H12	August1999	*Chalcopsitta scintilata*	1564.75	I	Blood	SS,DW,KM	Protected

*)S for Sumatra; K for Kalimantan; J for Java; C for Celebes; M for Mollucas; T for Indonesia Nusa Tenggara; I for Irian Jaya

**)SS for Sri Sulandari; DA for Dwi Astuti; KM for Kundar Masno

Appendix 9. Continued

No	Sample No	Collection Date	Species	DNA conc. (ng/µl)	Distribution*)	Kind of sample	Collector **)	Status***)
13	H13	August1999	*Chalcopsitta scintilata*	1233.50	I	Blood	SS,DW,KM	Protected
14	H14	August1999	*Chalcopsitta scintilata*	719.25	I	Blood	SS,DW,KM	Protected
15	H15	August1999	*Eos bornea*	301.25	M	Blood	SS,DW,KM	Endemic
16	H16	August1999	*Eos bornea*	482.00	M	Blood	SS,DW,KM	Endemic
17	H17	August1999	*Pseudeos fuscata*	1077.00	I	Blood	SS,DW,KM	Protected
18	H18	August1999	*Pseudeos fuscata*	2318.75	I	Blood	SS,DW,KM	Protected
19	H19	August1999	*Pseudeos fuscata*	395.50	I	Blood	SS,DW,KM	Protected
20	H20	August1999	*Trichoglossus haematodus haematodus*	213.75	JCMTI	Blood	SS,DW,KM	-
21	H21	August1999	*Trichoglossus haematodus haematodus*	920.50	JCMTI	Blood	SS,DW,KM	-
22	H22	August1999	*Chalcopsitta duivenbodei*	386.50	I	Blood	SS,DW,KM	Protected,CI2
23	H23	August1999	*Chalcopsitta duivenbodei*	204.25	I	Blood	SS,DW,KM	Protected,CI2
24	H24	August1999	*Chalcopsitta duivenbodei*	334.25	I	Blood	SS,DW,KM	Protected,CI2
25	H25	August1999	*Aprosmictus erythropterus*	132.50	I	Blood	SS,DW,KM	-
26	H26	August1999	*Aprosmictus erythropterus*	235.25	I	Bood	SS,DW,KM	-
27	H27	August1999	*Psittaculirostris edwardsii*	414.25	I	Blood	SS,DW,KM	Protected,CI2
28	H28	August1999	*Psittaculirostris edwardsii*	214.00	I	Blood	SS,DW,KM	Protected,CI2
29	H29	August1999	*Cyclopsitta diopthalma*	112.25		Blood	SS,DW,KM	-
30	H30	August1999	*Cyclopsitta diopthalma*	826.50		Blood	SS,DW,KM	-
31	H31	August1999	*Psittaculirostris desmarestii*	361.75	I	Blood	SS,DW,KM	Protected,CI2
32	H32	August1999	*Psittaculirostris desmarestii*	321.00	I	Blood	SS,DW,KM	Protected,CI2
33	H33	August1999	*Charmosyna placentis*	262.25	M,I	Blood	SS,DW,KM	-
34	H34	August1999	*Charmosyna placentis*	62.75	M,I	Blood	SS,DW,KM	-
35	H35	August1999	*Cacatua alba*	101.25	M	Blood	SS,DW,KM	Endemic
36	H36	August1999	*Cacatua alba*	694.75	M	Blood	SS,DW,KM	Endemic
37	H37	August1999	*Cacatua alba*	453.00	M	Blood	SS,DW,KM	Endemic
38	H38	August1999	*Cacatua alba*	244.00	M	Blood	SS,DW,KM	Endemic

*)S for Sumatra; K for Kalimantan; J for Java; C for Celebes; M for Mollucas; T for Indonesia Nusa Tenggara; I for Irian Jaya

**)SS for Sri Sulandari; DA for Dwi Astuti; KM for Kundar Masno

***)Protected by Government of Indonesia (CI2: CITES appendix 2)

Bird Migration Links Between Kamchatka and Japan
— Essential Data for Conservation III —

Yuri Gerasimov [1], Nickolay Gerasimov [1], Kiyoaki Ozaki [2], Vsevolod Voropanov [3]

Summary

The main works included migration studies, studies of breeding biology of birds, preparation of poster about banding and marking birds on East Asian-Australian Flyway and second issue of the collection articles book 「The biology and Conservation of the Birds of Kamchatka」. During spring migration studies on Khallaktyrskiy Beach more than 315,000 waterfowl were counted, including 124,959 Anatidae; 107,696 Auks; 53,429 Gulls; 16,427 Cormorants; 9,236 Loons and others. During banding work (July-September) in total 2,344 birds of 45 species were ringed, including 1,538 birds of 43 species during Russian - Japanese expedition in August. In total more than 220 nests of 32 species of birds were found during breeding biology studies in May-July. All nests were described, standard measurements and photos of them were made when it was possible. Investigation about breeding ecology (songs activity, making nest, laying eggs, incubating period, hatching time and so on) and behavior were conducted. Transects counts of nesting birds were conducted in different areas and different types of habitats.

Destination of the projects

Destination of the Projects is getting essential biological information including banding data for conservation efforts for birds of Kamchatka which migrate to or through Japan.

Projects works had three main directions:

1. Migration studies (April-May; August-September).
2. Studies of breeding biology of passerine birds (May - July 2000).
3. Preparation of publication of poster 〈For what band birds?〉 and monographs 〈The biology and Conservation of the Birds of Kamchatka, Issue 2〉.

Site of the project

Kamchatka Peninsula, mainly central part.

---

[1] Kamchatka Institute of Ecology Far-East Branch Russia Academy of Sciences
[2] Bird Migration Research Center, Yamashina Institute for Ornithology
[3] Kamchatka Hunting Management Service

Introduction

Kamchatka Peninsula has still remained almost non-development area with wild nature. Many peoples believe that unique nature of Kamchatka must be keeping non-development for the future. At present local government is at the crossroads. They have 2 main possibilities for future economic development of the Province. First way is development of mining industry, gas and oil exploring and extracting industry, timber-cutting industry and so on. Another way is use nature without development - mainly for different kind of tourism. One of the main tasks for ornithologists in Kamchatka is to show people national and international importance of Kamchatka for migratory birds through the publications and posters. To elucidate migration links between Kamchatka and Japan and other countries is extremely needed.

The project was focused on researches, which promote nature conservation via national and international recognition Kamchatka as important area for migratory birds: banding research, visible migration studies, breeding biology studies.

Materials and methods

Some field trips to Central Kamchatka and southwest coast of peninsula conducted to different part of peninsula during April - September 2000. The main investigated areas are showed in the Table 1.

Table 1. Time, areas and main purposes of field trips in 2000.

	Date	Area	Main purpose
1.	22 April – 29 May	Hallaktirskiy Beach	Observation of northward migration
2.	31 May – 5 June	Central Kamchatka Area	Breeding biology studies
3.	7-8 June	Khlamovitskiy Reserve	Breeding biology studies
4.	12-21 June	Central Kamchatka Area	Counting and breeding biology studies.
5.	25-27 June	Pravaya Kamchatka River	Breeding biology studies
6.	28 June – 3 July	Khlamovitskiy Reserve	Breeding biology studies
7.	6-7 July	Tolmachevskoe Lake	Counting and breeding biology studies
8.	14-17 July	Makovetskoe Lake	Counting, banding and breeding biology studies
9.	6-8 August	Bolshoe Lake	Southward migration studies
10.	14 - 25 August	Bystraya River	Banding expedition
11.	11-13 September	Plotnikova River	Banding passerine birds

The main methods of migration studies were:

1. Visible migration studies:
2. Passerine banding use of mistnets.

Direct count of flying and feeding birds was a main method during visible migration studies. Additionally all other materials were collected.

Spring count of migrating waterfowl was carried out on Khallaktyrskiy Beach (ocean coast near Petropavlovsk-Kamchatsky) during 3-13 hours daily. The additional calculations were made for estimation of number of migrated birds. Total observation time was 202 hours.

Three-days observation of wader southward migration was conducted on Bolshoe Lake.

Passerine banding work were carried out in three points of Kamchatka:

a) Avacha River near Elizovo Town (South-eastern Kamchatka 53° 09'N; 158° 24'E). Banding work was conducted in July - September 2000 by Nick Gerasimov (collaborator of this project) with assistants other peoples. Six nets were used.

b) Upper part of Bystraya River (Central Kamchatka Valley 53° 50'N; 157° 42'E). Banding work was conducted 15-26 August by special banding expedition including 7 Japanese banders 43 nets were used.

c) Plotnikova River (53° 00'N; 157° 20'E). Banding work was conducted 11-13 September. Twelve nets were used.

The main methods of breeding biology investigations were:

* Transect counts of birds for estimation of breeding density of birds in the different types of habitats: fixed width of count transect 100-500 m were used; total extend of counts was 75.5 km;
* Searching of nests of passerine birds; all nests were described, standard measurements and photos of them were made when it was possible; 220 nests of 31 species (excluding colonial species) were found.
* Studies of timing of breeding of passerine birds (sings songs activity, making nest, laying eggs, incubating period, hatching time and so on);
* Studies of behavior of birds during breeding period.

Results

Migration studies

a) Visible migration studies

Waterfowl spring migration studies were conducted from 22 April to 19 May on Khallaktyrskiy beach. In total about 316 thousand waterfowls were counted, including 9,236 Loons, 1,662 Grebes, 16,427 Cormorants, 124,959 Anatidae, 53,429 Gulls, 1,572 Terns, 362 Skuas, 107,696 Auks, 57 Shearwaters and 183 Waders (Appendix 1).

From 6 to 8 August 2000 observation of southward migration of waders on Bolshoe Lake (52°30'N, 156° 30'E) was conducted. This Lake is included in the list of IBA and potential Ramsar Sites.

b) Banding use mistnets

During July - September 2000 in total 2,344 birds of 45 species were banded in Kamchatka Peninsula including 2,211 passerine birds of 31 species and (table 2).

From 15 until 26 August special international Japanese - Russian banding expedition was conducted in Central Kamchatka on the bank of Bystraya River. This place was chosen in 1997 and this year was a fours banding year for this point. In 2000 in total 2,003 birds of 42 species were caught on Bystraya River, 1,538 of them were banded (465 Willow Tits were not banded) (table 2).

Table 2. Number of banded birds on Kamchatka in 2000.

Species	Number of banded birds in 2000			
	Bystraya River	Avacha River	Plotnikova R.	Total
Motacilla flava	3			3
Motacilla cinerea	18	24		42
Motacilla alba	9	27		36
Anthus hodgsoni	83	53	2	138
Anthus rubescens		1		1
Lanius cristatus	2			2
Prunella montanella	1			1
Erithacus sibilans	55	1		56
Erithacus calliope	8	118	2	128
Erithacus svecicus	2			2
Tarsiger cyanurus	6	2		8
Turdus obscurus	28	1	26	55
Locustella ochotensis	102	33		135
Locustella lanceolata	2	1	1	4
Phylloscopus fuscatus	24		30	54
Phylloscopus borealis	148	59		148
Ficedula parva	322	199		521
Muscicapa sibirica	8	1		9
Muscicapa griseisticta	71	4		75
Parus montanus	not banded (465)	not banded (>500)	not banded (26)	not banded (>1000)
Parus ater	35			35
Sitta europaea	86	not banded (>200)	3	89
Emberiza rustica	120	76	10	206
Emberiza aureola	24	2		26
Emberiza variabilis	5	13		18
Emberiza schoeniclus	143	4	2	149
Fringilla montifringilla	5	1		6
Carduelis sinica	17	4	1	22
Acanthis flammea	5			5
Carpodacus erythrinus	150	11		161
Pyrrhula pyrrhula	7			7
Coccothraustes coccothraustes	4	6		10
Total Passerine	**1,493**	**641**	**77**	**2,211**
Anser fabalis				64
Anas crecca	3			3
Falco subbuteo	1			1
Falco rusticolus		10		10
Calidris ruficollis	1			1
Tringa brevipes	1			1
Tringa hypoleucos	4			4
Larus ridibundus		1		1
Cuculus canorus	1			1
Cuculus saturatus	1			1
Aegolius funereus	5			5
Dendrocopos major	1			1
Dendrocopos minor	23	9	4	36
Picoides tridactylus	4			4
Total Non passerine	**45**	**20**	**4**	**133**
Total	**1,538**	**661**	**81**	**2,344**
Species	**42**	**25**	**10**	**45**

We have compared quantity of the caught birds of various species in 1998, 1999 and 2000 for comparison of intensity of migration of birds in different time. We consider such comparison correct, as the duration of a banding and quantity of used mistnets was approximately identical during three years. Approximately the same number of birds was banded but the percentage ratio between different species has appeared various (Table 3: Fig. 1).

Table 3. Comparison of banding data on Bystraya River in 1998, 1999 and 2000.

No	Species	Banded in 1998 (5-16 Sep)		Banded in 1999 (26 Aug – 4 Sep)		Banded in 2000 (15-26 Aug)	
		Number	%	Number	%	Number	%
1.	Yellow Wagtail	-	-	3	0.2	3	0.2
2.	Gray Wagtail	6	0.4	4	0.3	18	1.2
3.	White Wagtail	21	1.4	2	0.1	9	0.6
4.	Indian Tree Pipit	159	10.7	131	9.6	83	5.4
5.	Pechora Pipit	7	0.5	2	0.1	-	-
6.	Water Pipit	55	3.7	1	0.1	-	-
7.	Brown Shrike	-	-	-	-	2	0.1
8.	Siberian Accentor	-	-	-	-	1	0.1
9.	Siberian Rubythroat	37	2.5	41	3.0	8	0.5
10.	Swinhoe's Red-Tailed Robin	-	-	16	1.2	55	3.6
11.	Siberian Bluechat	17	1.1	9	0.7	2	0.1
12.	Bluethroat	1	0.1	4	0.3	-	-
13.	Gray-headed Thrush	56	3.8	18	1.3	28	1.8
14.	Wood Nuthatch	-	-	7	0.5	-	-
15.	Middendorff's Grasshopper Warbler	10	0.7	49	3.6	102	6.6
16.	Lanceolated Grasshopper Warbler	2	0.1	6	0.4	2	0.1
17.	Arctic Warbler	100	6.7	185	13.6	148	9.6
18.	Dusky Warbler	3	0.2	16	1.8	24	1.6
19.	Red-breasted Flycatcher	7	0.5	107	7.9	322	20.9
20.	Sooty Flycatcher	-	-	-	-	8	0.5
21.	Gray-spotted Flycatcher	4	0.3	22	1.6	71	4.6
22.	Rustic Bunting	801	53.7	490	36.1	120	7.8
23.	Yellow-breasted Bunting	2	0.1	33	2.4	24	1.6
24.	Gray Bunting	9	0.6	21	1.6	5	0.3
25.	Reed Bunting	129	8.7	153	11.3	143	9.3
26.	Oriental Greenfinch	2	0.1	2	0.1	17	1.1
27.	Common Redpoll	-	-	1	0.1	5	0.3
28.	Brambling	42	2.8	6	0.4	5	0.3
29.	Scarlet Finch	4	0.3	47	3.5	150	9.8
30.	Bullfinch	-	-	1	0.1	7	0.5
31.	Hawfinch	-	-	-	-	4	0.3
32.	Nutcraker	-	-	3	0.2	-	-
33.	Grate Sported Woodpecker	1	0.1	1	0.1	1	0.1
34.	Lesser Sported Woodpecker	6	0.4	22	1.6	23	1.5
35.	Three-toed Woodpecker	-	-	-	-	4	0.3
36.	Common Cuckoo	-	-	2	0.1	1	0.1
37.	Oriental Cuckoo	1	0.1	-	-	1	0.1
38.	Boreal Owl	1	0.1	4	0.3	5	0.3
39.	Common Sandpiper	1	0.1	1	0.1	4	0.3
40.	Gray-tailed Tattler	2	0.1	2	0.1	1	0.1
41.	Red-necked Stint	-	-	-	-	1	0.1
42.	Hobby	-	-	-	-	1	0.1
43.	Sparrow Hawk	2	0.1	1	0.1	-	-
44.	Green-winged Teal	-	-	-	-	3	0.2
	Total	1,491	100	1,359	100	1,538	100

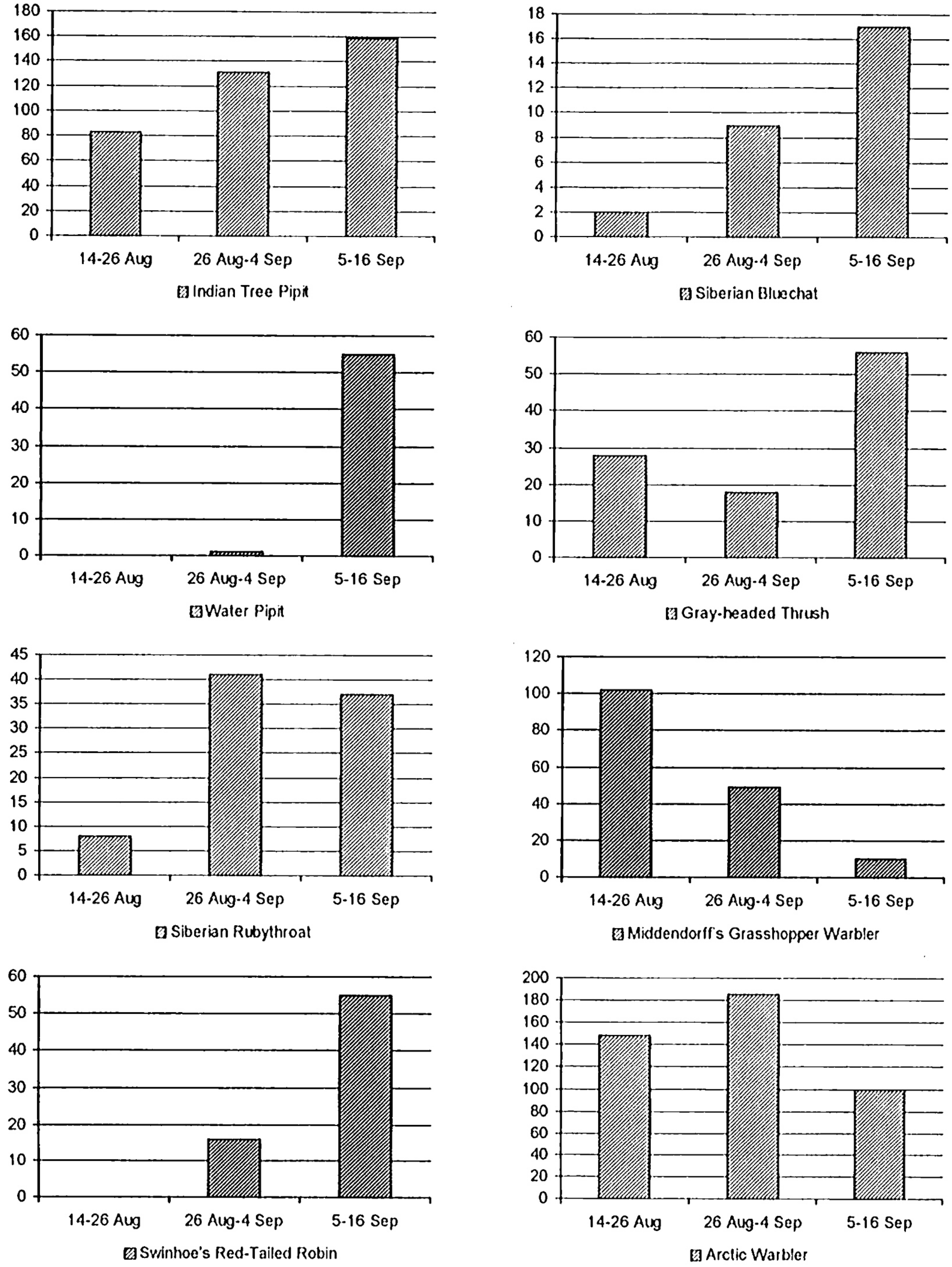


Fig. 1. Comparison of banding data on Bystraya River in 1998 (5-16 Sep.), 1999 (26 Aug - 4 Sep.) and 2000 (14-26 Aug).

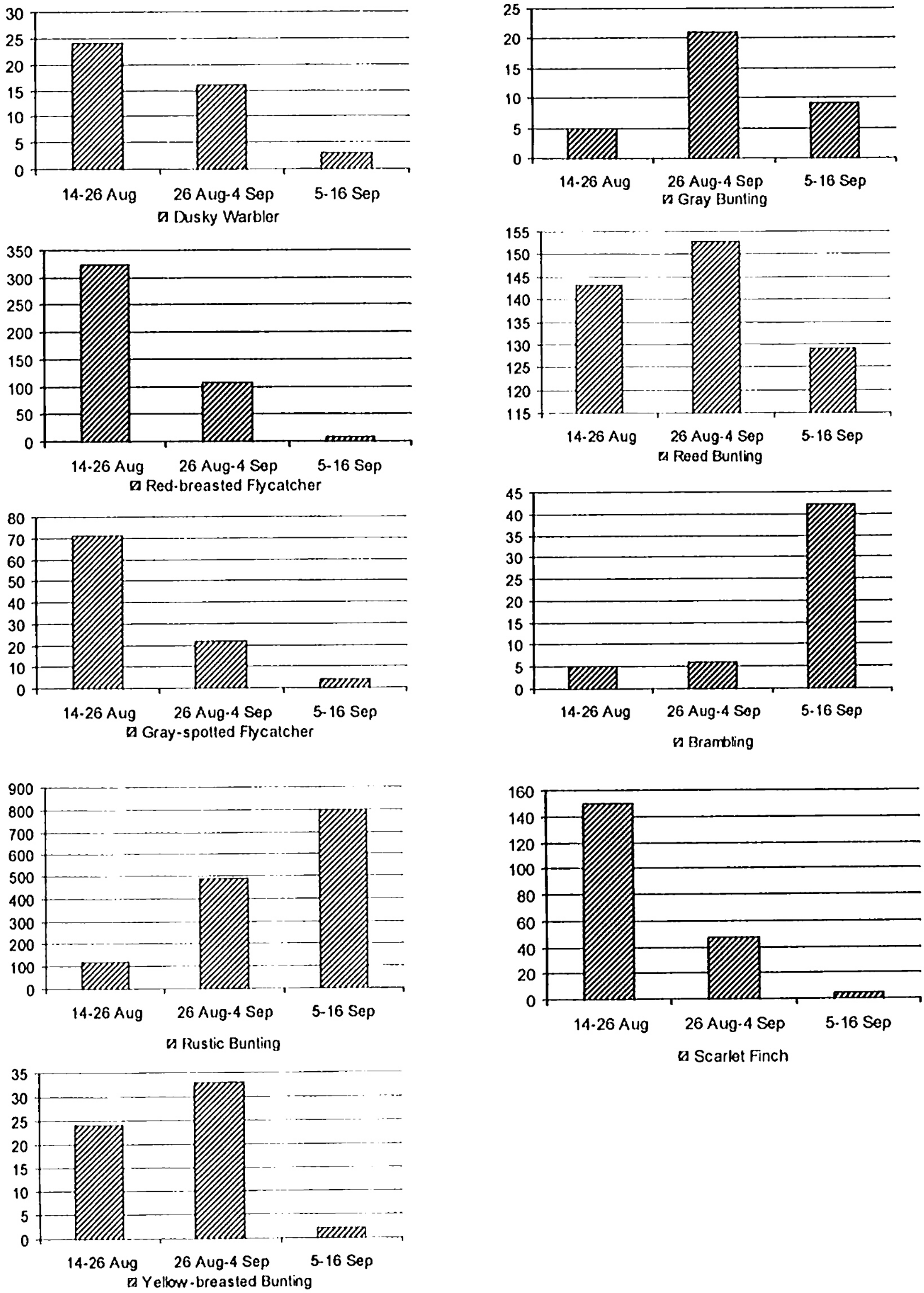


Fig. 1. Continued

In 1998-2000, in total 11 foreign recoveries of birds banded in Kamchatka and 6 recoveries of birds banded abroad were received. All recovered birds belong to Reed Bunting (Table 4).

Table 4. Foreign recoveries of Passerine birds, which were received during 1998-2000.

Banded				Recovered	
Species	**Ring No**	**Place**	**Date**	**Place**	**Date**
Recoveries of birds from foreign countries					
Emberiza schoeniclus	XD823477	Elizovo Town, Kamchatka, Russia	18.06.1993	Nanaemachi, Hokkaido, Japan	19.10.1998
Emberiza schoeniclus	XS-32831	Bystraya River, Kamchatka, Russia	16.08.1998	Sagata, Niigata-city, Niigata Pref. Japan	01.11.1998
Emberiza schoeniclus	XS-32978	Bystraya River, Kamchatka, Russia	11.09.1998	Mamejima,Nagano, Nagano Pref. Japan	13.11.1998
Emberiza schoeniclus	XS-33745	Bystraya River, Kamchatka, Russia	29.08.1999	Watarase,Fujioka town,Shimotsuga-gun Tochigi Pref. Japan	20.11.1999
Emberiza schoeniclus	XS-33220	Bystraya River, Kamchatka, Russia	15.09.1998	Mitsukaido,Ibaraki Pref. Japan	22.11.1998
Emberiza schoeniclus	XS-33320	Bystraya River, Kamchatka, Russia	27.08.1999	Shinkaisakunishi,Kounan ku,Ube-shi,Yamaguchi Pref. Japan	26.12. 1999
Emberiza schoeniclus	XS-37070	Bystraya River, Kamchatka, Russia	01.09.1999	Abukuma River, Terashima, Iwanuma-shi,Miyagi Pref. Japan	22.11.1999
Emberiza schoeniclus	XS-37075	Bystraya River, Kamchatka, Russia	01.09.1999	Ukishima,Numazu, Shizuoka Pref. Japan	16.11.1999
Emberiza schoeniclus	XS-33402	Bystraya River, Kamchatka, Russia	27.08.1999	Lake Kabukuri, Tajiri-machi,Tooda-gun, Miyagi Pref. Japan	17.10.2000
Emberiza schoeniclus	XS-35838	Bystraya River, Kamchatka, Russia	21.08.2000	Lake Sagata, Niigata-shi, Niigata Pref. Japan	21.10.2000
Emberiza schoeniclus	XS-34246	Bystraya River, Kamchatka, Russia	07.09.1997	Kitashinden,Netosita,Abikos-shi,Chiba Pref. Japan	03.11.2000
Recoveries of birds banded abroad					
Emberiza schoeniclus	2F-89140	Sanuki,Ryuugasaki, Ibaraki Pref. Japan	28.10.1997	Bystraya River, Kamchatka, Russia	10.09.1998
Emberiza schoeniclus	2K-38604	Kabukurinuma, Miyagi Pref. Japan	25.10.1996	Bystraya River, Kamchatka, Russia	14.09.1998
Emberiza schoeniclus	2M-55295	Yonago City, Tottori Pref. Japan	04.11.1998	Bystraya River, Kamchatka, Russia	29.08.1999
Emberiza schoeniclus	2L-98342	Nishio City, Aichi Pref. Japan	30.11.1998	Bystraya River, Kamchatka, Russia	31.08.1999
Emberiza schoeniclus	2L-34646	Taziri-cho, Miyagi Pref. Japan	25.10.1997	Bystraya River, Kamchatka, Russia	01.09.1999
Emberiza schoeniclus	2K-09274	Yonago City, Tottori Pref. Japan	09.11.1997	Elizovo Town, Kamchatka, Russia	02.06.2000

Studies of distribution, breeding density and breeding biology

During breeding biology researches we investigated birds, which inhabited Central Kamchatka . Main studied areas were:

1. Khlamovitsky Reserve. We studied this area 23, 29 May, 6, 28, 30 June, 2-3 July.
2. Pravaya Kamchatka River. We studied this area 31 May-1 June, 4-5, 12-13, 25-27 June. Except breeding biology studies, 11.2 km length count of breeding birds has conducted. Based of materials of this and last years researches, articles "Birds of Pravaya Kamchatka River" has prepared.
3. Middle part of Kamchatka River. We studied this area 1-4 June, 14-21 June. More than 100 nests were found, 35.8 km length count of breeding birds was conducted in all main habitats. Based of materials of this and 1998 years researches, articles "Nesting birds of Kamchatka River" has prepared.
4. Tolmachevskoe Lake and Pravaya Opala River. We studied this area 6-7 July. 12.6 km length count of breeding birds has conducted.
5. Makovetskoe Lake. We studied this area 14-17 July. 15.9 km length count of breeding birds has conducted.

Additionally we investigated some areas near Petropavlovsk-Kamchatsky. In total more than 220 nests of 31 species (additionally more than 100 last year nests) were found (not including colonial species, *Corvus corone* and *Pica pica*) measured and described during breeding season of 2000.

Publishing activity

Poster about banding of birds was prepared and printed (3,000 copies) in Moscow. It was prepared with the help of the ornithologists from the Russian Banding Center, Moscow State University and Geese and Swans Study Group of Eastern Europe and Northern Asia. Poster is dispatched in Far East and Eastern Siberia regions of Russia. The main purpose of preparation of it is to involve a public in work on protection and banding of birds. Poster contains the information on the main projects on a banding of birds, which are carried out on East Asian-Australian Flyway. It also contains the special request to all people to send the information on the banded and marked birds in the Russian Banding Center.

Second Book 〈The biology and Conservation of the Birds of Kamchatka, Issue 2〉 has published in Moscow. It includes 16 articles about current studies of birds of Kamchatka (Appendix). All ornithologists currently working on Kamchatka (Gerasimov N. N., Gerasimov Yu. N., Artukhin Yu. B., Vyatkin P. S. and Lobkov E.G.) and other researches which studied birds of Kamchatka in last years have represent them materials for this issue. Special reference to support of "Pro Natura Fund" is contained in two papers of this book. Book was distributed for Russian ornithologists and also for ornithologists from Japan, USA, China, Taiwan, India, Shri-Lanka, Indonesia, Australia, Malaysia and Grate Britain. The information about this book included in "Oriental Birding List" and we continue to receive the requests for sending of this book to different countries.

List of articles prepared in this year, which base of materials, which were collected during carry out of the project:

Spring waterfowl migration on South-Eastern Kamchatka.
Birds of Pravaya Kamchatka River
Nesting birds of Kamchatka River

Acknowledgments

We wish to extend special thanks to all peoples who worked with us during carrying-out of this project. Ornithologist-photographer Eduard V. Malinovskiy was a participant of our expedition to Central Kamchatka and helped us with breeding biology studies. Researcher of Kamchatka Institute of Ecology Vladimir V. Savenkov and German ornithologist Falk Huttmann took part in expedition to Bolshoe Lake. Sergey Ignatyev, Kozlova Lida and Japanese ornithologists Yoshihiro Kurahashi, Norio Fukai, Jun Ueda Toshihiro Shimizu, Kiyoshi Iso and Takahito Yamamoto were the participants of banding expedition on Bystraya River.

第10期プロ・ナトゥーラ・ファンド助成成果報告書（2001）

要　旨

カムチャツカ半島と日本の間の鳥類の渡り解明 III

ユーリ ゲラシモフ・ニコライ ゲラシモフ・尾崎清明・ブセボド ボロパノフ

日本とカムチャツカの間を行き来する渡り鳥に関して、渡りや繁殖生態の研究を実施するとともに、その結果をまとめた「カムチャツカ鳥類の生態と保護－II」を出版した。また、標識調査の普及啓蒙のためにポスターを作成し、カムチャツカを含むロシアの極東地域の関係機関に送付した。

カラキティルスキー海岸の春期の渡り調査では、31万5千羽以上の水鳥をカウントした（内訳はカモ科124,959、ウミスズメ科107,696、カモメ科53,429、ウ科16,427、アビ科9,236など）。標識調査では7月から9月の間に、合計45種2,344羽が放鳥された。このうち1,538羽は8月に行われたロシアと日本との共同調査での成果である。

5月から7月の繁殖調査中に、32種220巣を発見し、それら全てに関して記載・測定をするとともに、可能なものでは写真記録も行った。繁殖生態に関しては、囀り・造巣・産卵・抱卵期間・孵化時期などの調査を実施した。繁殖鳥のセンサスをさまざまなタイプの環境でおこなった。

なお、プロ・ナトゥーラの助成によって出版した書籍とポスターは下記のものである。

The Biology and Conservation of the Birds of Kamchatka, II（カムチャツカ鳥類の生態と保護－II）. 2000. Kamchatka Institute of Ecology. Moscow.128pp.
内容：カムチャツカにおける渡り鳥の生息状況や保護に関する論文16編からなっている。このうち助成を受けた研究者自身のものが10編含まれている。

For what band birds?（鳥の足環はなんのため？）ポスター
内容：カムチャツカを含むロシア極東地域と日本を渡る鳥類の標識回収記録を呼びかける普及啓蒙用のポスター。

（推薦者：尾崎　清明 訳）

Appendix 1.

Table Counted number of waterfowl species migrated along sea coast near Petropavlovsk-Kamchatsky in spring 2000.

Species	Counted	
Gavia sp.	9,236	Loons 9,236
Podiceps grisegena	1,451	
Podiceps auritus	211	Grebes 1,662
Phalacrocorax sp.	16,427	Cormorants 16,427
Branta bernicla (B. nigricans)	12	
Anser fabalis	6	
Anas platyrhynchos	136	
Anas acuta	11,003	
Anas penelope	4,091	
Anas crecca	4,491	
Anas clypeata	37	
Anas falcata	28	
Bucephala clangula	317	
Mergus merganser	174	
Mergus serrator	3,950	
Mergus albellus	29	
Aythya marila	4,176	
Clangula hyemalis	53,624	
Melanitta fusca (M. deglandi)	30,390	
Melanitta nigra (M. americana)	10,381	
Histrionicus histrionicus	1,533	
Polysticta stelleri	91	
Somatteria mollissima	490	Anatidae 124,959
Larus hyperboreus	566	
Larus schistisagus	17,985	
Larus argentatus	254	
Larus glaucescens	7	
Larus canus	8,438	
Larus ridibundus	24,058	Gulls 53,429
Larus tridactylus (Rissa trydactylus)	2,121	
Sterna hyrundo	1,538	
Sterna sp.	34	Terns 1,572
Stercorarius longicaudus	54	
Stercorarius parasiticus	32	
Stercorarius sp.	276	Skuas 362
Uria aalge + Uria lomvia	12,901	
Cepphus columba	1,043	
Alcidae sp. (small size)	81,303	
Lunda cirrhata	11,948	
Fratercula corniculata	501	Auks 107,696
Fulmarus glacialis	57	Sherwaters 57
Charadrius mongolus	17	
Pluvialis dominica (P. fulva)	6	
Calidris ruficolis	10	
Calidris alpina	103	
Arenaria interpres	5	
Tringa brevipes	3	
Numenius madagascariensis	33	
Phalaropus lobatus	6	Waders 183
Total	**315,583**	

Figure. Number of migrated waterfowl species along Khallaktyrsky Beach (South-eastern Kamchatka) in April – May 2000

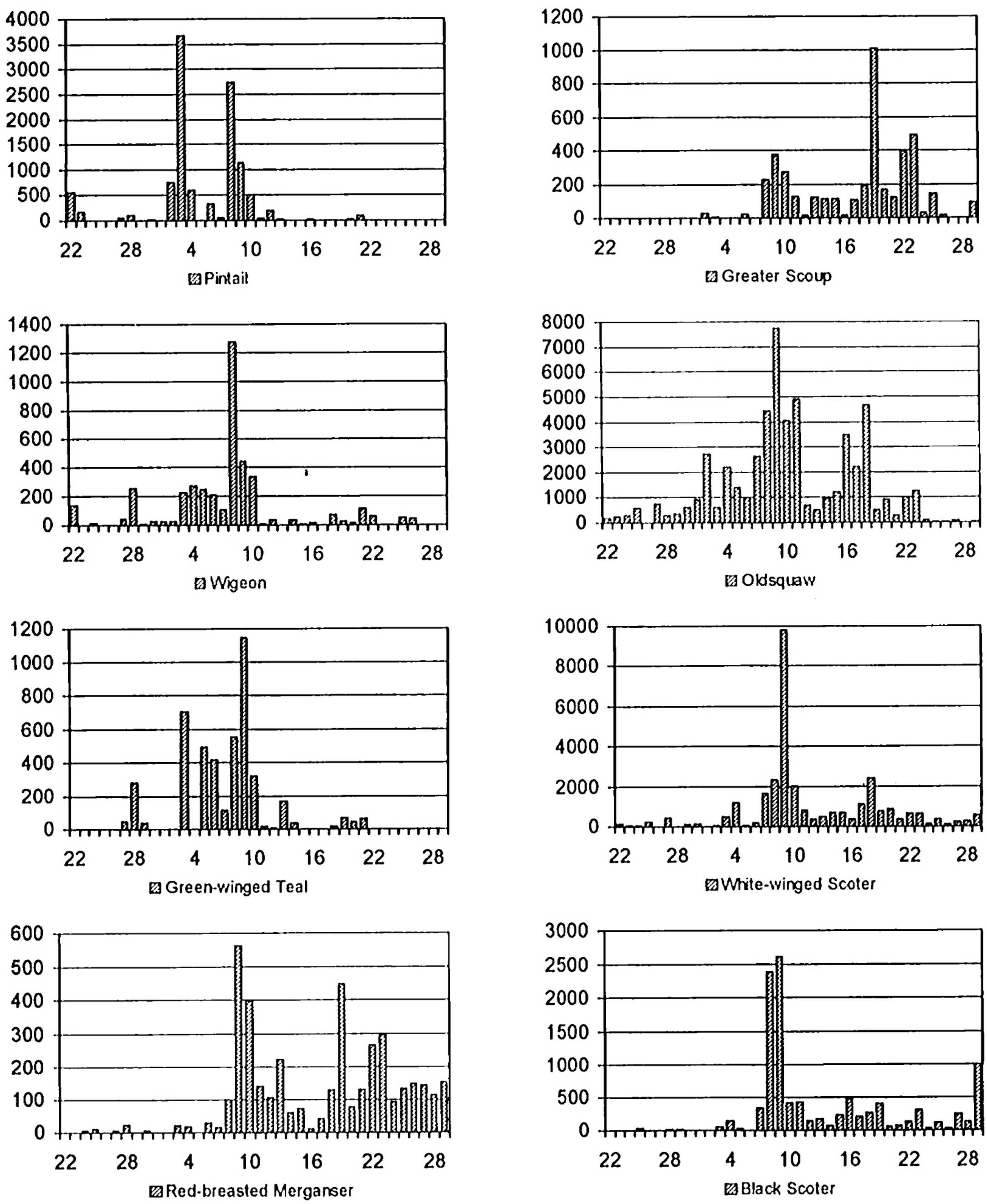


Figure. Continued

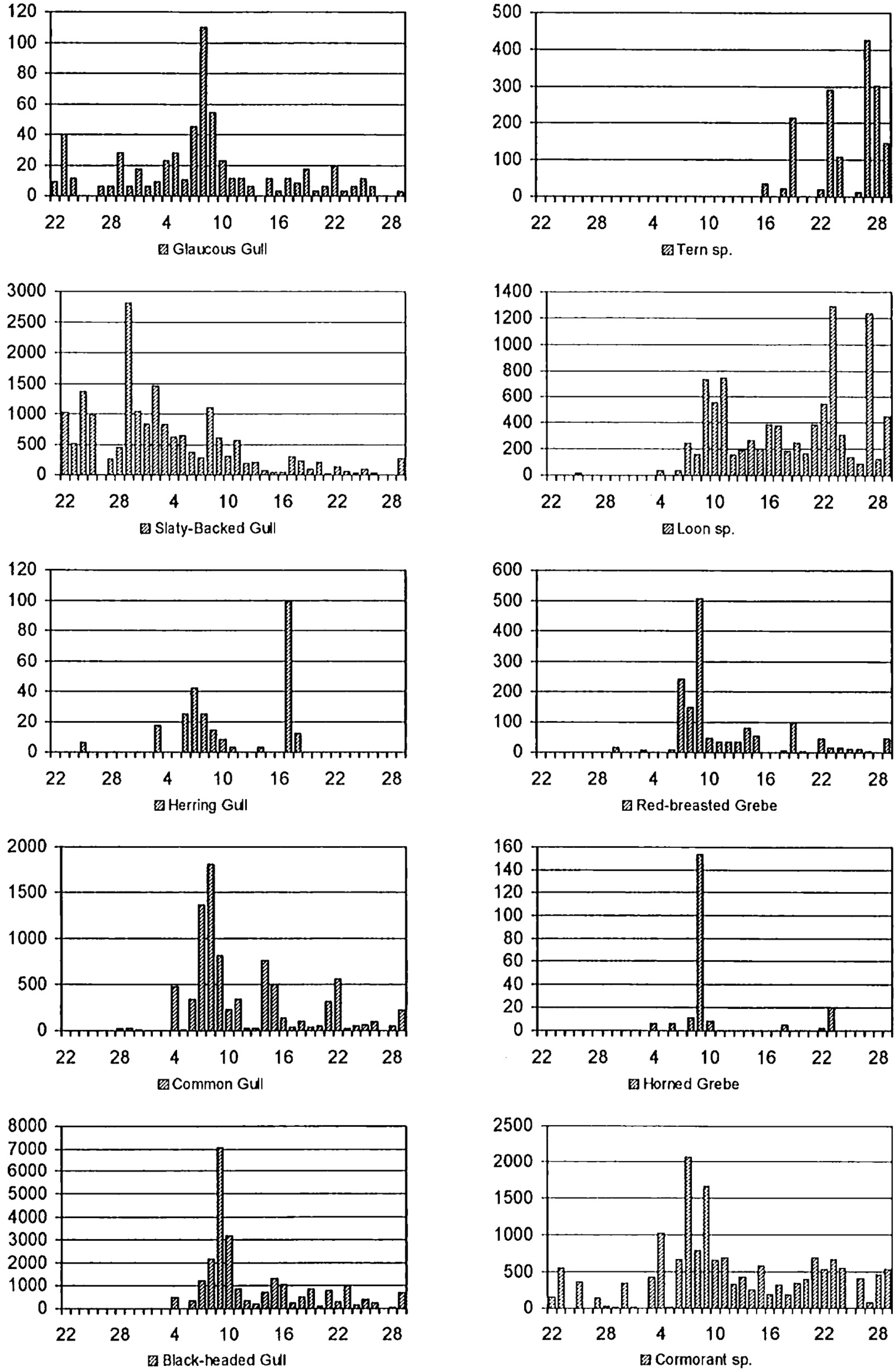
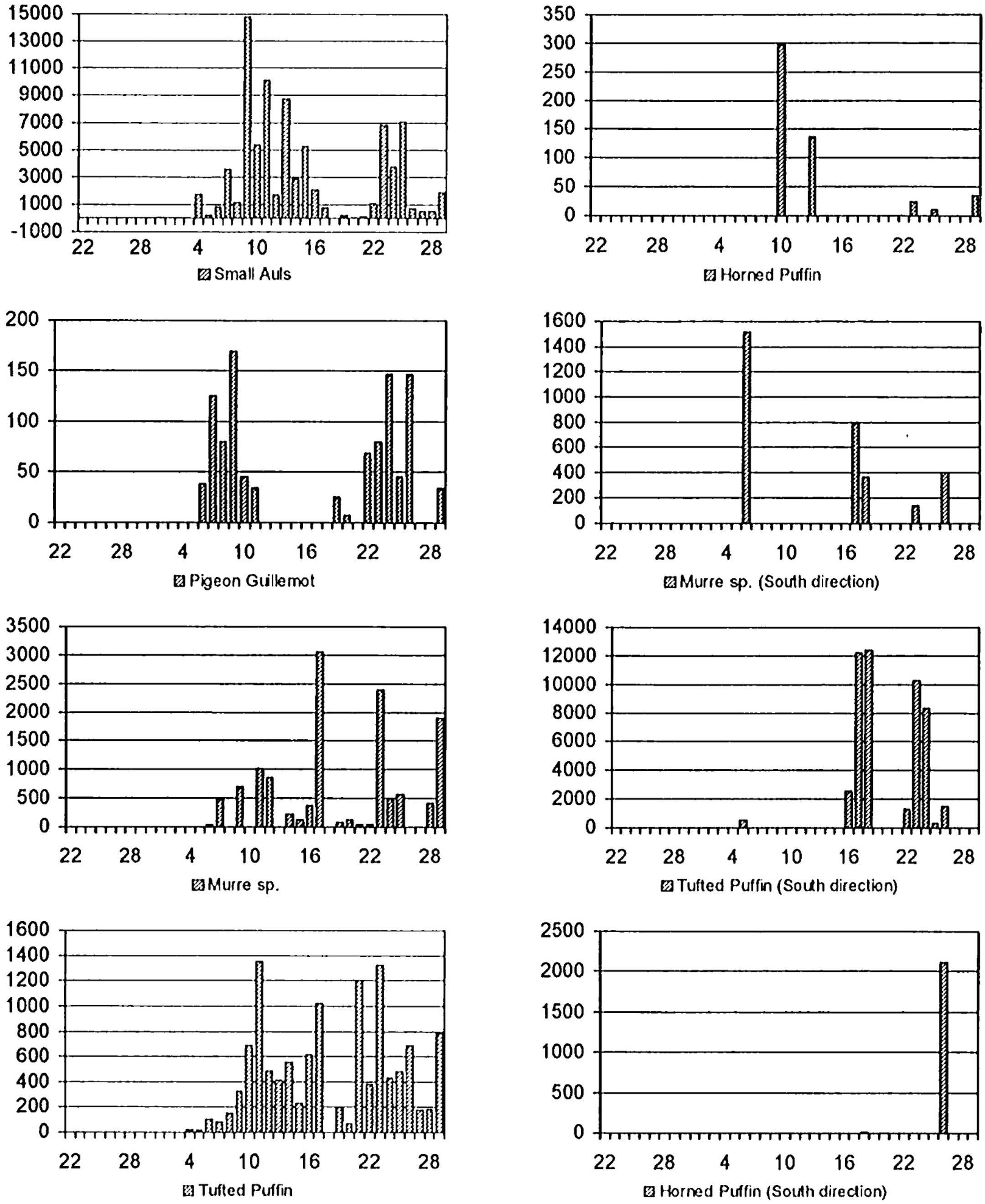


Figure. Continued



Appendix 2.

Table. Number of banded birds in Kamchatka, Russia (1966-1999)

Group of birds	1960s	1970s	1980s	1990s	Total
Swans	-	-	8	-	8
Geese	-	-	603	755	1,456
Ducks	7	-	1	-	9
Gulls	106	1,605	8,788	480	10,980
Waders	3	-	52	27	90
Auks	7	-	-	-	7
Cormorants	13	-	-	-	13
Falcons and Hawks	-	-	1	3	15
Owls	-	-	-	4	9
Woodpeckers	-	1	5	16	85
Cuckoos	-	-	-	1	5
Passerine	73	177	1,236	5,516	10,860
Total	**209**	**1,793**	**10,694**	**6,802**	**23,505**

Appendix 3.

Table 1. Breeding density of birds of main types of habitat in Pravaya Kamchatka River area.

(pairs /square km)

Species	Birch forest from *Betula Ermanii*	Birch forest from *Betula kamtschatica*	Flood-lands forest
Motacilla flava	-	3.1	-
Motacilla cinerea	-	-	7.7
Motacilla alba	-	-	3.8
Anthus hodgsoni	16.7	34.4	-
Erithacus sibilans	7.4	-	11.5
Turdus obscurus	3.7	6.3	19.2
Locustella lanceolata	7.4	25	3.8
Phylloscopus borealis	3.7	3.1	11.5
Ficedula parva	1.9	9.4	34.6
Muscicapa sibirica	-	3.1	-
Muscicapa griseisticta	42.6	15.6	23.1
Parus montanus	14.8	6.3	11.5
Sitta europaea	-	-	7.7
Emberiza rustica	5.6	6.3	42.3
Emberiza aureola	-	6.3	-
Carduelis sinica	11.1	1.6	7.7
Acanthis flammea	9.3	3.1	30.8
Fringilla montifringilla	20.4	3.1	34.6
Carpodacus erythrinus	7.4	37.5	23.1
Pyrrhula pyrrhula	1.9	-	-
Coccothraustes coccothraustes	-	3.1	-
Corvus corax	0.2	-	-
Dendrocopos major	1.9	-	3.8
Dendrocopos minor	-	-	3.8
Cuculus canorus	-	-	1.9
Cuculus saturatus	0.5	-	
Tringa hypoleucos	-	-	3.8
Buteo lagopus	-	-	1
Falco subbuteo	-	-	1.9
Bucephala clangula	-	-	3.8
Anas crecca	-	-	0.5
Mergus serrator	-	-	0.5
Total	**156.5**	**167.3**	**293.9**

Table 2. Breeding density of birds of main types of habitat in Kamchatka River Valley.

(pairs /square km)

Species	Combined forest No.1	Combined forest No.2	Forest from *Picea ajanensis*	Open bushes	Combined forest No.3	Flood-lands forest
Motacilla flava	-	1.0	-	-	-	-
Motacilla alba	-	-	-	-	0.6	-
Anthus hodgsoni	-	-	-	-	16.2	-
Bombycilla garrulus	-	-	-	-	0.6	7.1
Tarsiger cyanurus	0.7	-	-	-	-	-
Turdus obscurus	11.8	21.4	9.7	7.7	12.3	50.0
Locustella ochotensis	-	-	-	-	-	-
Locustella lanceolata	5.3	7.1	-	15.4	5.2	7.1
Phylloscopus borealis	2.6	7.1	-	-	3.2	-
Ficedula parva	11.8	7.1	-	-	5.8	14.3
Muscicapa sibirica		10.0	-	-	13.0	7.1
Muscicapa griseisticta	13.2	5.7	12.9	-	5.2	-
Parus montanus	23.7	31.4	25.8	-	26.0	14.3
Parus ater	5.3	5.7	9.7	-	3.9	-
Aegithalos caudatus	1.3	2.9	-	-	3.2	7.1
Sitta europaea	9.2	11.4	9.6	-	13.6	7.1
Emberiza rustica	42.1	60.0	12.9	53.8	7.8	50.0
Emberiza aureola	2.6	5.7	-	15.4	-	-
Emberiza schoeniclus	1.3	-	-	-	-	-
Carduelis sinica	2.6	2.9	6.5	-	0.6	-
Carduelis spinus	1.3	1.4	3.2	-	0.6	-
Acanthis flammea	6.6	5.7	9.7	-	3.2	14.3
Fringilla montifringilla	26.3	47.1	12.9	-	50	78.6
Carpodacus erythrinus	38.2	50	12.9	76.9	24	35.8
Pyrrhula pyrrhula	1.3	5.7	9.7	-	5.2	7.1
Coccothraustes coccothraustes	19.7	15.7	9.7	30.8	3.9	21.4
Nucifraga caryocatactes	-	0.7	1.6	-	-	-
Corvus corone	0.7	1.4	-	-	-	-
Corvus corax	0.1	0.3	-	-	-	-
Dendrocopos major	6.6	12.9	3.2	-	13.0	14.2
Dendrocopos minor	1.3	7.1		-	0.6	7.1
Picoides tridactylus	1.3	1.4	3.2	-	3.2	
Cuculus canorus	0.7	0.7		-		
Cuculus saturatus	0.3	2.9	3.2	-	2.6	7.1
Tringa nebularia	-	-	-	-	-	7.1
Surnia ulula	1.3	-	-	-	-	-
Aegolius funereus	-	-	-	-	0.6	-
Pandion haliaetus	-	-	-	-	0.2	-
Buteo lagopus	0.3	0.7	-	-	-	-
Accipiter gentilis	-	-	-	-	0.3	-
Falco subbuteo	1.3	1.4	-	-	-	-
Bucephala clangula	1.3	-	-	-	0.6	-
Anas crecca	-	-	-	-	0.3	-
Total	**242.1**	**334.5**	**156.4**	**200.0**	**225.5**	**356.8**

Table 3. Breeding density of birds of main types of habitat near Tolmachevskoe Lake.

(pairs /square km)

Species	Mountain bushes	Dry mountain tundra	Flood lends of Pravaya Opala River
Alauda arvensis	3.8	10.4	
Motacilla flava	38.5	20.8	65.2
Motacilla cinerea	1.9		
Antus hodgsoni	23.1		
Anthus spinoletta	3.8	13.0	21.7
Erithacus calliope	23.1		4.3
Erithacus svecicus	3.8		4.3
Locustella ochotensis	11.5		26.1
Phylloscopus fuscatus	3.8		13.0
Phylloscopus borealis	34.6		
Emberiza rustica	3.8		
Calcarius lapponicus	7.7	28.6	17.4
Carduelis sinica	26.9		
Acanthis flammea	19.2		8.7
Nucifraga caryocatactes	1.0		
Corvus corone			
Corvus corax			
Cuculus canorus	3.8		
Lagopus lagopus	3.8	1.3	
Tringa glareola			8.7
Calidris subminuta			4.3
Gallinago gallinago			4.3
Larus canus			8.7
Buteo lagopus			
Falco subbuteo			
Anas crecca			4.3
Melanitta deglandi			
Total	**214.1**	**74.1**	**191.0**

Table 4. Breeding density of birds in swampy tundra around Makovetskoe Lake.

(pairs /square km)

Species	Density
Cavia stellata	0.6
Gavia arctica	1.0
Podiceps grisegena	0.2
Anas platyrhynchos	0.4
Aythya marila	0.2
Melanitta nigra	1.0
Mergus serrator	0.4
Larus schistisagus	3.6
Larus canus	3.1
Larus ridibundus	0.1
Sterna hirundo	0.4
Sterna paradisaea	0.2
Calidris subminuta	1.3
Calidris alpina	0.6
Linosa limosa	0.6
Numenius madagascariensis	0.2
Gallinago gallinago	0.6
Phalaropus lobatus	1.3
Lagopus lagopus	2.5
Motacilla flava	1.3
Anthus gustavi	9.4
Locustella ochotensis	1.3
Calcarius lapponicus	27.0
Total	57.3

Appendix 4.

List of articles of the collecting articles book «The Biology and conservation of the birds of Kamchatka. Issue 2». Moscow 2000. 128 pp.

Gerasimov N. N., Gerasimov Yu. N., Vyatkin P. S. Important bird areas of Kamchatka.
Vyatkin P. S. Nest cadastre of colonial seabirds of the coasts of Koryak Highland and Eastern Kamchatka.
Dyakonov P. N. Birds of Kamchatka River Valley.
Artukhin Yu. B. On the breeding biology of the birds of Kamchatka.
Gerasimov Yu. N. Materials on biology of birds of the Icha River.
Gerasimov Yu. N., Ozaki K. Nasting birds of Anava River (Western Kamchatka).
Gerasimov Yu. N., Gerasimov N. N., Artukhin Yu. B., Macina A. I. Nasting birds of game refuge "Khlamovitskiy".
Ladygin A. V. Birds wintering on the Kamchatka's salmon spawning grounds: ecological strategies for existence.
Gerasimov Yu. N., Kalyagina E. E. The spring migration of gulls on the south-west of Kamchatka.
Gerasimov Yu. N. Observation of spring migration of birds on Kharchinskoe Lake (the Central Kamchatka).
Gerasimov Yu. N., Gerasimov N. N. Spring migration of Great Knot *Calidris tenuirostris* on Kamchatka.
Gerasimov Yu. N., Gerasimov N. N. Spring migration of Dunlin *Calidris alpina* on Kamchatka.
Artukhin Yu. B. Status of the Cassin's Auklet *Ptychoramphus aleuticus* in the Russian Far East.
Gerasimov N. N., Gerasimov Yu. N. Pacific Brent Goose *Branta bernicla nigricans* in Kamchatka.
Gerasimov N. N. Kuril Mountain Finch *Leucosticte arctoa brunneonucha* (Brandt, 1984) in Kamchatka.
Artukhin Yu. B., Burkanov V. N., Zaochny A. N., Nikulin V. S. Mortality of seabirds in the Japanese driftnet salmon fishery in the Bering Sea, 1993-1999.

INSECT FAUNA AND THEIR CONSERVATION IN TROPICAL NEPAL

Keshab Shrestha[1], Bhaiya Khanal[1], and Pusp K. Shrestha[1]

Summary

Tropical region is much disturbed part in Nepal mostly due to over population pressure and rapid deforestation. Though Nepal is regarded rich in floral and faunal wealth, study of such resources is much neglected in outer Himalaya region. Thus a study was designed to explore the insect fauna and their relation to forest habitat in outer foothill of Koshi in the east, Parsa in the center and Karnali in the west of Nepal. The study comprises following five objectives, (i) to make survey of insect in Koshi, Parsa and Karnali (Kailali) regions of Nepal with their status in nature, (ii) to survey plants associated with insects of Koshi, Parsa and Karnali regions of Nepal (iii) to prepare maps of survey areas (iv) to emphasize importance areas for conservation and management, and (v) to recommend proper conservation measures A total of 102, 116, 124 species of butterflies and 71, 93 and 91 species of other insects were reported from Koshi, Parsa and Karnali areas. A total of 538 species of plants, of which three new to Nepal, are reported from the studied areas. Five new reports of insects containing one hemiptera and four coleoptera were collected from Karnali region.

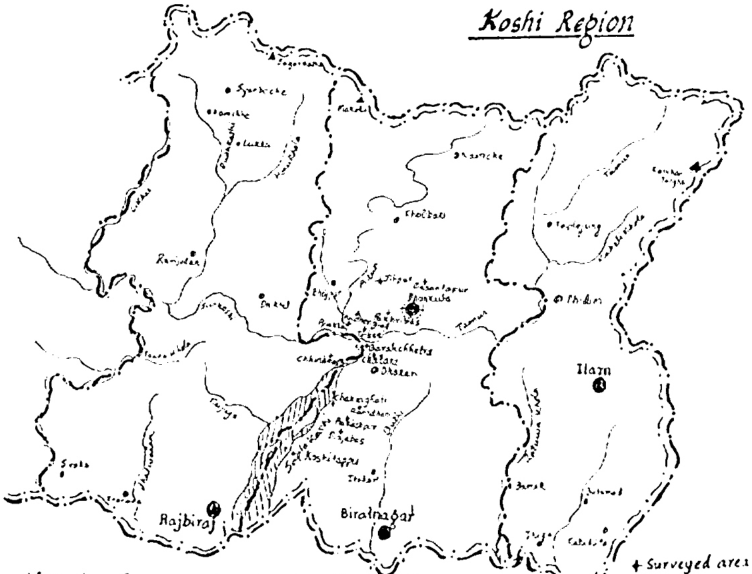
Lebadea martha, a nympalid butterfly was collected for the first time from central Nepal in Parsa as its former report comes only from eastern Nepal. Concerning the management and conservation aspects, Koshi Tappu Wildlife Reserve of Koshi needs special attention to bring firmness in the conservation efforts. Artificial water sources need to be constructed in different potential sites of Parsa Wildlife Reserve. This help to accommodate many water loving insects and butterflies. Forests along the belt of Karnali river and its tributaries need protection. Stlict rules and regulation or the development of community forest have been felt in this region. This help to shelter rich diversity of insects and butterflies.

Background

Tropical parts of Nepal is the most populated region in Nepal. Migration of people from hill and India is uncontrolled. Most forest areas are under pressure and cleaned to make shelter for them. Forests are randomly utilized for timber, fuel, fodder, medicine etc. Due to these the good habitat for insect is declining and a point may arise when insect population will be decrease and extinct before their recording. Less attention has been paid to enumerate insect fauna and their food plants in Nepal and outer foothill is not exception. It is seriously felt that a detail study on insect fauna of the tropical region has been carried out. Vegetation is the essential aspect of insect for their existence in nature.

In the present study three region has been selected as representative areas. Two areas on Koshi(Map 1.) and one Karnali (Map 3.) have the biggest river systems in Nepal. Parsa (Map 2.) in the central Nepal has also Rapti river. Thus these rivers arising from the Himalaya has much impact in the composition of flora and fauna in these regions of Nepal.

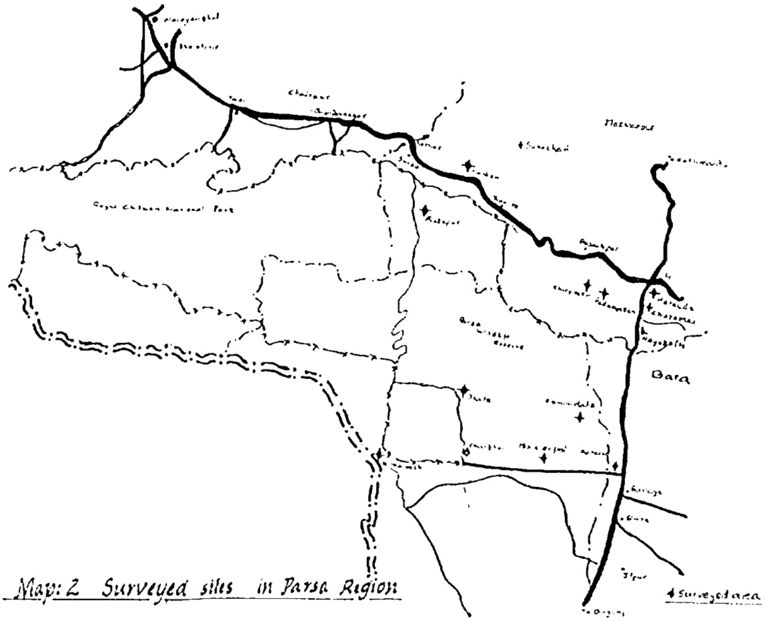
1) Natural History Museum, Tribhuvan University, Kathmandu, Nepal



Map: 1 Surveyed sites in Koshi Region

Koshi area lies in east Nepal under the eastern development region of Koshi zone. Arun and Barun originating from northern side merge out with five other rivers to make the united river called Koshi river. This belt is densely forested providing preferable habitats for many flora and fauna including the plentiful of insects. The southen part of Koshi region continue to the flat land of Indian territory. The northern part continue to the mountainous and Himalayan regions across the other district of Himalayan border in the northern Nepal. The eastern part goes into Mechi zone, which is border line to the west Bengal of India. Koshi region encompasses five political districts of which Sankhuwasabha district makes borderline to China. Sunsari and Morang are the other districts of Koshi. Koshi Tappu Wildlife Reserve is the well known protected wetland area of Nepal lying in Sunsari district bordering Morang on the south, Jhapa in the east, Mahotari and Bhojpur on the west and Dhankuta in the north. Insect diversity is very rich in this part. Most of the flora and fauna existing in this reserve are of the kinds preferring wetland habitat. Our study in Koshi focused along the belt of Koshi river including rivulets merging to Koshi finally and comprises tropical and subtropical climate.

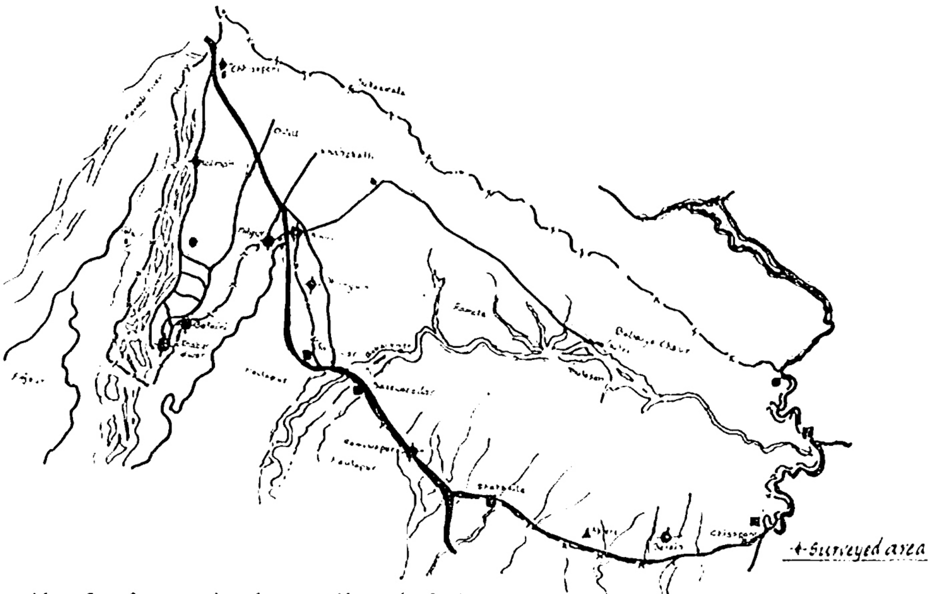
The forest in this region are, (i) evergreen tropical and (ii) mixed deciduous types. The former types includes forest around riverbelt and in bhawar areas. Main forest components are *Dalbergia sissou, Acacia catechu, Bombax ceiba, Adina cordlfolia* and *Albizia chinensis, Trewia nudiflora, Mallotus philippenesis, Syzigium cumini etc.* Koshi Tappu Wildlife Reserve has three biological habitat which includes grassland 80.0%, wetland 12.9% and forest 6.3%. Commonly observed grassland vegetation along the river bank of this reserve included *Saccharaum-Phragmites* type. The other type includes *Saccharaum, Typha, Imperata* and *Cymbopogan*. The common plant species are *Lantana camera, Eupatorium odorata, Ipomoea conea, Zizyphus mauritiana* and *Clerodendron viscosum*. The wetland plant dominant in this part are *Chara sp., Hydrilla sp., Verticillata sp., Eichhornia crassipes, Nymphaea nouchali, Nelumbo nucifera and Typha elephantine.*



Map: 2 Surveyed sites in Parsa Region

In the central Nepal, this study was carried out in Parsa region which is 200km south of Kathmandu. Most of the area of Parsa region is dominated by densely wooded areas showing very good diversity of various floras ranging from small herbs to big trees of different status. The warm climatic condition and varied flora has led to shelter plentiful species of insects ranging from very commnon to significant conservation point of views. Uniform altitudinal level of 300m except at Chainpur 1,500m has accommodated the insects of different habitat types including those of riverine forests, shaded areas, open areas, grasslands, dense forest etc. Rapti river crosses this region. The recent mountain formation, the Churia or Siwalik range runs through the forests of this Parsa region. Southern side of this region is bordered to Birganj, the gate way to Nepal. Once the area was well known for its excellent forest conditions and the unique fauna existing here. This region consist of Churia on the north, mid bhawar area and southern alluvial flat land. Most of the part of this newly formed mountain is covered with good vegetation. Bhawar is specialized in having sand, pebbles and stones and is formed by the river courses coming out from the Siwalik moutain system. This area is not suited for agriculture. Important trees found in this part are *Shorea robusta, Dalbergia sissoo, Acacia catechu* etc. Below the bhawar area is the continuation of alluvial flatland which goes to the Indian border to the south. Parsa region is influenced by tropical climate. Regarding the forest condition, about 20% of the land of this part have very good forest coverage. On the basis of climatic condition, three main types of forest exist here. These are new riverine forest, old riverine forest and bhawar or Churia forest.

New riverine forest is developed due to the deposition of fertile soil brought by river courses in different areas of this region. Warm climate and good rain has led to grow dense forest in such areas. Old riverine forest occurring in this part is little elevated from the river courses. Flood during monsoon times does not affect this forest hardwood evergreen forest is found in this part. *Shorea robusta* in the dominant forest of area. In addition to this, *Bombax ceiba, Albizia sp., Adina cordifolia, Terminalia alata, Dalbergia latifolia,* *Teminalia chebula, T. bellirica* are also common. Besides the rich diversity of insects, this area is also rich in other fauna and birds. Among interesting mammals found in this part are elephant, tiger, bear, leopard, wild cat, jackle, fox, blue bull, swamp deer, spotted deer, gaur bison, porcupine, wild boar, four horned antepole and hares. Prominent reptiles of this part are king cobra, cobra, python and crocodile. Sometimes these fauna migrate to nearby district of Chitwan, which provides very good and diverse habitat for many wildanimals. Interesting birds observed here are jungal fowl, pheasants, longtailed magpie, drongos, swallows, serpent eagle lapwings, warblers, robin dayal, doves, wild pigeons etc. Important butterflies reported here are *Athyma* sp., *Neptis* sp. and *Papilio* sp. Important beetles are *callistus sp., Saprinus sp., Pseudoides sp., Sisyphus sp., Drepanocerus sp.* and many more.



Map:3 Surveyed sites in Karnali Region

Karnali river borderes Kailali district in the west and Bardia district in the east. Karnali river has many diversification in the border side of Bardia National Park and composed many small river islands. This area offer many factors for the richness of insect diversity. In Kailali district Ghoda Ghodi lake (150m) provide varied habitats preferred by many insect species. This is an IUCN protected lake accommodating mixed forest around and is still least disturbed area. Geographically, the northern part adds its altitude and continues to many mountainous districts up to the higher elevation of Jumla district of Midwest Nepal. This brings total changes in the vegetation and the sheltering insect species and other fauna existing here depend upon such vegetation. Climatic condition in very cool in such areas. The southern part of Karnali region continue to the Great Indian plain making least differences in the elevation. Summer is very hot and vegetation pattern is almost similar with the characteristics to survive in warm and humid conditions. Due to the presence of good vegetation and weather, southern belt of Karnali region represents good insect diversity as compared to the northern belt.

Royal Bardia National Park encompassed by Karnali region is well protected and maintained for unique flora and fauna characteristic to subtropical climatic zones. This park covers an area of 968 sq.km, which also includes the newly formed mountain system of Siwalik or Churia ranges. Due to the presence of multifarious plant species, the insect fauna present here are numerous and interesting, and keeps significances as previous works on insects are lacking from this part. The Karnali river, which originates from the northern Himalaya and Tibet, after reaching Chicapani makes tributaries in three places viz. Sati, Rajapur and Mohana rivers of this region. Many parts of Karnali regions are still beyond our exploration due to the increasing activities of terrorist. The main concern of Karnali region is the increasing deforestation rates. Hill and mountainous peoples started to migrate to Karnali's fertile areas when Government opened its settlement program after clearing the existing luxurious forests of this part. Besides this, many peoples migrate here, cleared up the forests for their requirements to extend their agricultural practices and to established their own business. So deforestation rate is very extensive in these areas. Royal Bardia National Park, now has made its extension keeping in view to conserve rare and endangered flora and fauna occurring here. Many unique and interesting mammals like one horned Rhinoceros, Bengal Tiger, Blackbuck, Asiatic Elephant etc are found in the forest of Karnali region. Interesting reptiles like Crocodiles, Gharial, King Cobra, and many other species exist here. This region is the paradise for bird and insect enthusiasts. Very rare mammals like river Dolphins are numerous in this part. Insect diversity shown by this study is remarkable along the belt of the riverine forest of Karnali.

Studied Areas:

a) In Koshi, Itahari, Koshi Tappu Wildlife Reserve, Prakashpur, Rajabash, Chakraghati, Ramdhuni, Chatara, Kusaha, Rajabas, Chhinamasta, Barahchhetra, Tribeni, Simle, Lamibagar, Piula, Lunibagar, Anderighat, Pakhribaas, Dhankuta and Basantapur.

b) In Parsa, Adhavar (Parsa Wildlife Reserve), Niumalbasti, Pattlaiya, Amlekhganj, Hetauda, Bhaise, Bhimphedi, Manahari, Chainpur, Lothar, Sunachari, Churia, Pratapur, Machan, Teen Piple and Birganj.

c) In Karnali, Tikapur, Khargwar, Satti, Rajapur, Kothiaghat, Mohana, Lamki, Ghoda Ghodi Lake, Chisapani, Kachali, Bhrigaon, Thakurdwara, Lalmati, Sitakund, Katachhi and Chhatiwan.

Methedology:

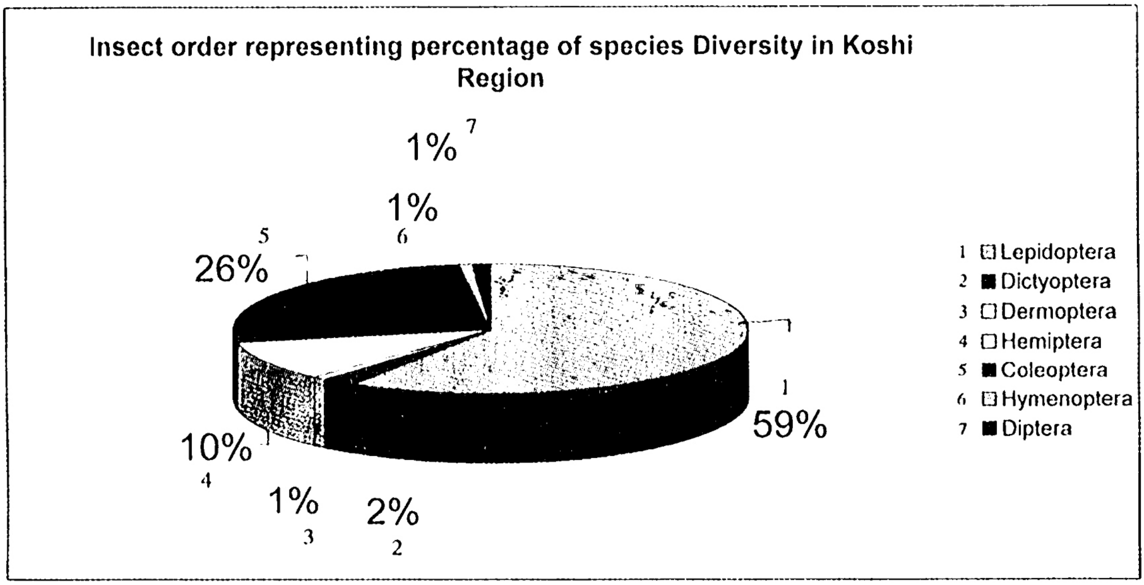
Above mentioned places were visited two times in a year in different seasons. Butterflies and insects were collected by sweeping the insect net. Waternet was used to collect aquatic insects. Beating and sweeping method was followed for those insects sheltered in shrubs and tree-branches. Light trap was also used to collect night insects. Insects inhabiting in dung, excretory matters were taken directly by forcep and killed them in killing bottle. Food plants of most of the insects were identified in the field. Some of the insects were identified by tallying with the specimens preserved at the Natural History Museum, T.U and Entomology Section (NARC), Kathmandu. Literatures consulted for the identifications were as follows:Anada, *et al.* (1978), Andrew (1935), Arrow (1917, 1925, 1931, 1939), Distant (1902, 1904,1906,1908), Fletcher (1914), Fowlwe (1912), Habu (1967), Jacoby (1908), Kapoor *et al.* (1978), Kirby (1914), Kimoto (1972, 1973, 1979, 1981, 1982), Kimoto and Takizawa (1981), Lynerberg (1976), Numata (1983), Shrestha (1980,1982,1999), and Tetsue and Shinji (1999). For identification of plants species, seeds, flowering and vegetative parts were collected, and identified in the field and in the Natural History Museum using the literatures of Maheshwari (1966), Shrestha and Corvinus (2000), Shrestha (1984), Polunin and Stainton (1984) and Stainton (1988). Butterflies were identified with the help of Smith (1989), Khanal and Smith (1997). Insects and plants are deposited in the Natural History Museum.

Result and discussions

a) Koshi region

In Koshi region a total of 173species of Insects and 297 plants has been reported. The most common and prevalent butterflies species occurring in this part include *Euploea core, Eurema hecabe, Catopsilia pyranthe* and *Castalius rosimon*. Rare species recorded are *Delias pasithoe, Ypthima kashimira, Rapala rectivitta, Leptosia nina, Nacaduva kurava* etc. The total species reported in this region comes to be 15% of the total species (645 species) found in Nepal. Most of the species occurring in this part belong to tropical climatic types and are said to be oriental species. In the hilly region of Koshi species such as *Cethosia bibles, Libythea myrrha, Papilio mennon and Loxura atymnus, Pieris brassicae,* white butterflies which was not observed in Koshi Tappu Wildlife Reserve are numerous in Pakhribas and Arun river side. *Axias pyrene*, an oriental species was very common along the belt of Arun and Koshi river. This butterfly shows sexual dimorphism. It has two generations in a year. Common among the commonest species observed in our study is *Eurema hecabe*. This species was found attracted to leguminous plants occurring in wild and cultivated both. *Castalius rosimon*, a small lycaenid, was very abundant in Koshi tappu in August, but it was very scare during Januay in the same year. This provided us a very good conclusion that the winter season checkered the growth of leguminous plants in this part which in summer had luxurious growth thus increasing the population of *Castalius rosimon*.

During summer time

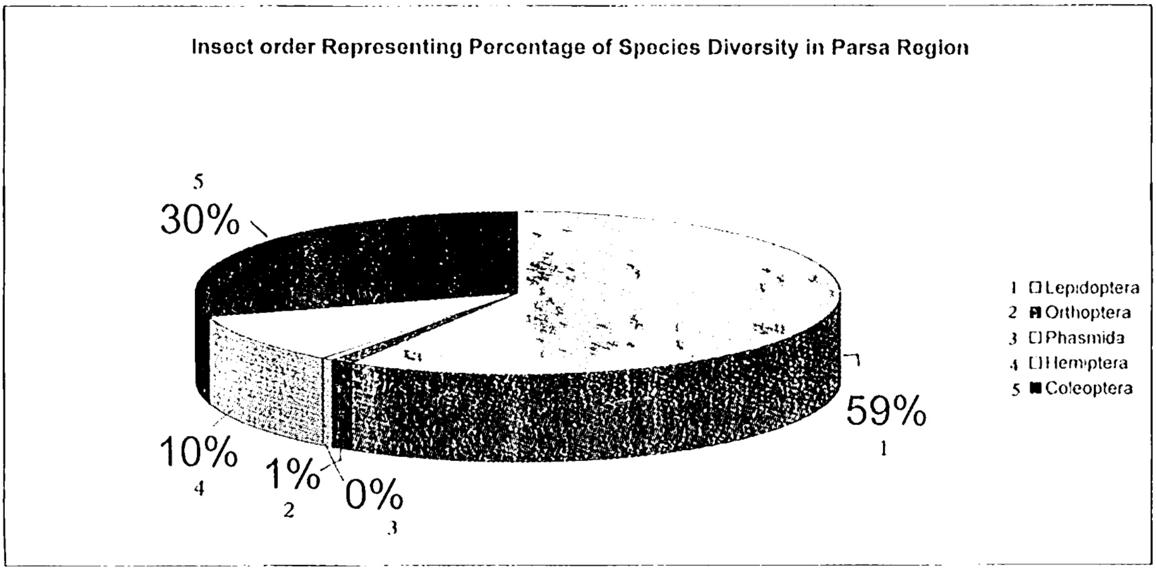


Insect diversity was found to be high in hilly and mountainous regions as it is the transitional and meeting zones for both the oriental and Himalayan species. Most of the species observed here are the derivatives of eastern Himalayan elements. Eastern part of Koshi region, close to Dhankuta is Sankhuwasabha district and is found to be the best region for insect diversity in Nepal. About 90% of the insect species occurring here are the east Himalayan species. More than 15 species of butterflies occurring here are not recorded in other parts of Nepal but are found in the east Himalayan range of Myanmar, Sikkim and Assam State of India. Endemic and endangered species of insects (except one) were not observed in Koshi region in the present study. *Saprinus subcoerulus* is the only endemic coleopteran insect collected at Koshi region. Beetle species, *Cicindela fabrici, Lanka brunnea* and *Selina westermani* are the rare species reported in Koshi. Likewise a beetle, *Onitis castaneus* was collected from the dung of wild water buffalo. Among the other rare species of insect reported in Koshi region are the Hemipterons *Antestia anchora* feeding upon *Eupatorium* plant, *Graptotethus trisignatus* and Coleopteron like *Dactylispa daipa, Onthophagus rectocornis, O. cervus* on cattle grazing sites where dungs were deposited, also provided very good diversity of Coleopteron species. Likewise forested areas at Koshi Tappu also provided very good diversity of forest insects. From the present study it has been found that the season for insect in lower basin of Koshi region was found from March onward till the start of November. Maximum diversity was found in July/August. December to the end of February represents very low diversity due to the cold climate and poor floral growth. It is very interesting to note that even in the month of January, the forest of Charata (Sunsari, 500m) provides very good diversity of insect species. In January, 42 species of butterflies and 1 5 species of other insects were recorded from this area. In Chatara the richness of insect fauna is claimed due to the evergreen mixed forest and good source of water. Due to these factors butterfly diversity is rich even during the extreme cold months of the year. Warm, humid and good vegetation in this area influence the richness of the insect diversity as well. Koshi regions receive heavy rainfall in the monsoon time. This has left direct effect upon the insects occurring here. Insects here are more brighter and darker compare to the insects of west Nepal. The main butterfly season in northern mountainous parts of Koshi region starts generally from may onward till the end of October, peak time is July/August of the year. October to June represents dry season forms with less prominent colours and spots. The only new report on insects made during our study in Koshi region is *Onitis crassus* and *Onitic castaneus*, dung beetle reported close to forested area of Chatara.

A total of 63 species of insects (Coleoptera, Hemiptera, Hymenoptera and Dictyoptera) besides butterflies were reported. Majority of them are Coleopterons. Most of these insects were recorded from warm, humid and forested lower basin of Koshi region. Huge wet land areas of Koshi Tappu provided some water beetles as well. 66 species of insect under 67 genera 5 orders and 44 food plants were reported. Rare species of insects include Hemipterons are *Fitha arden, Placosternum taurus, Antestia anchora, Belostoma indicum, Cosmocarta inclusa*, Coleopterons includes *Selina westermani, Dicranonus circumdatus* (Carabidae), *Lank brunnea, Morphosplaera montivaga, Leptispa nigra, Aphrodium cribricolle, Lophosternus indicus, Aceraus grandis* etc. Ecologically they are mostly forest species and are distributed largely on the wooded mountains and valley, south of the crestline of the Great Himalaya and to a very small extent in the east and central Himalaya and gradually disappear at the western end of the Himalaya at the Sutlej defile.

b) Parsa region

Parsa region in the central Nepal was explored twice in a year in the month of February and September. A total of 116 butterflies categorized under 10 families were recorded. About 70% of these recorded species are oriental. *Pieris brassicae, Eurema hecabe* and *Lampides boeticus* recorded in the lowland of Parsa region also exist in higher Himalayas up to an altitude of 450m (Smith 1989). These are the cosmopolitan species occurring in all the altitudinal levels of lowland, mid hills and Himalayan region. Besides their distributional pattern, *Lampides boeticus* is an oligophagus species which feed on cultivated crops and forest plants as well. Rare species *Neptis procris, Rapala* sp., *Hestina nama, Ypthima newara, Pachiliopta aristolochae* and *Jamides bochus* are seen only in some parts of Parsa. *Lebadea Martha* is the first report made from Parsa region as its former report comes only from eastern Nepal (Smith 1989). Widely observed common species in this region are *Catopsilia pyranthe, Zizeeria maha, Precis orithya, Melanitis leda* etc. Species like *Colias fieldii, Nymphalis canace* and *Orsotrioena medus* are very common species. *Colias fieldii* is a paleartic species occurring up to an altitude of 3500m, is very scare these days. This species was observed only at Teen Piple near Lothar. *Colia arate* is its allied species and was very common few years before. In Brindaban, 28 species of butterflies were recorded of which *Precis almana, Euploea core* and *Ypthima* sp. And *Papilio demoleus* were abundant and was seen attracted to the citrus plant. *Kallima inochus*, a dry leaf butterfly in fresh form was observed here attracted to citrus plant. Likewise, *Symbrenthia* sp., *Catopsilia pomana, Cyrestis thyodamus* and *Precis atlites* were also seen around citrus trees. During the month of February, *Papilio polytes* and *Vanessa indica* were quite fresh forms. The forest of this part has been opened for settlement for landless people thus destroying a vast area of mixed trees for human settlements. The dominant vegetation here are *Shorea robusta, Pinus roxburghii, Schima wallichii, Bombax ceiba, Dalbergia sissoo* and *Acacia catechu.*



Adhavar is the headquater of Parsa Wildlife Reserve and is one of the potential site for insects. Different places in this reserves were visited. This reserve is very dry except Kaminidaha. So water loving and aquatic insects are almost lacking in the reserved. *Shorea robusta, Terminalia alata, Semicarpus nacardium, Syzygium cumini* and *Aegle marmelos* are the dominant species of plant of this part. *Curetis bulis* and *Pachiliopta aristolochae* are the only rare butterflies recorded in this area. *Aglais cahmirensis* was the common species attracted to *Urtica* plant. Common species like *Papilio demoleus* and *Melanitis leda* were seen attracted to citrus and bamboo plant respectively. Besides butterflies all other insects of this part are of common status except *Abulfeda punctatus* (Hemiptera), *Leptispa samikirna* (Coleoptera) and *Chalaenius hemifer* (Coleoptera), Hemipterons like *Lohita grandis, Iphita limbata, Physopelta bivittata* and *Chlaenius hemifer* are the rare coleopteron insects existing in this part. Beetles like *Monochilus sexmaculata, Coccinella septopunctata* and *Hister benghalensis* are the most common species found in this part. *Aglais cashmirensis, Hypolymmanas bolina* and *Venessa indica* were seen attracted to plant like *Tridax procumbens, Justicia* sp. and *Urtica dioca*. 26 insect species under 2 orders (Hemiptera and Coleoptera) exist here. *Abulfeda punctata* (Hemiptera) and *Physorrhynchus tuburculatus* (Hemiptera) are rare bug species occurring in this part. Rare beetles like *Dactylispa daipa* was found feeding upon *Dalbergia sissoo* and *Polygonum* sp. Tiny dung beetle, *Onthophagus rectocornis* was found feeding upon cowdung and dog faeces. Most of the insect occurring in this part are dependent on agricultural crop, grasses and dungs.

Padam Pokhary and Churia (430m) are the next sited of our study program. The main vegetation of this area include *Terminalia alata, Shorea robusta, Ficus semicordata, Daubanga grandiflora* etc. Orchids like *Vanda sp., Dendrobium sp., Pholida articulata* are also common on the tree trunks. These area represent 23 butterflies species categorized under 5 families (Papilionidae, Pieridae, Nymphalidae, Lycaenidae and Danaidae). Rare species of this part are *Moduza procris* and *Arophala* sp. Most common species existing in this part are *Eurema hecabe* feeding upon leguminous plant, *Neptis hylas, Pieris brassicae, Precis iphita, Danaus chryssipus* etc. Among other insects 13 species of two orders (Hemiptera and Coleoptera were found here. *Callistus lunatus*, is the only rare carabid beetle reported here. Common hemipterons existing here are *Eusacocoris rosaceus* and *Dysdercus cingulatus*. Aquatic common bug *Ptiomere laticaudata* also exist here. Common beetles found here are *Monolepta signata* feeding upon *Polygonum* plant and *Apiona gangeticum* feeding upon *Rubus ellipticus* plant. Likewise *Clerodendron viscosum* and *Mazus rugosa* are the host plant of *Coccinela septopunctata*.

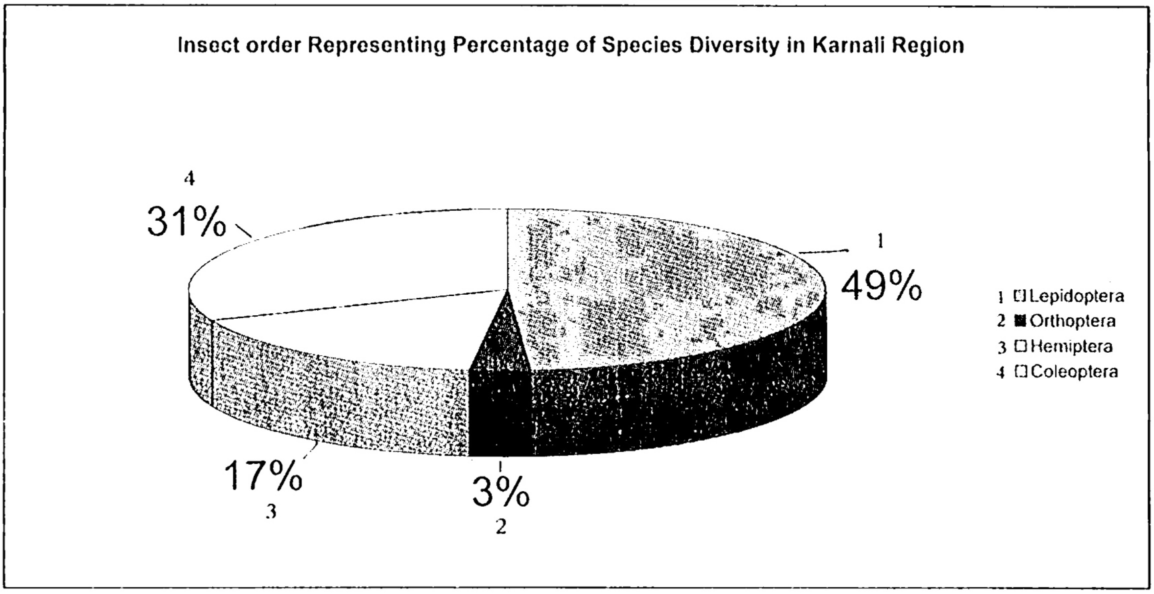
Limenitis procris, a nymphalid butterfly is the new addition made at Bhimphedi. *Catopsilia pyranthe, Precis almana, Pieris brassicae* and *Eurema hecabe* all of common status found here. *Ypthima kashmira* was the rare species. In February the most common species observed were *Catopsilia pomana, Papilio polytes, Euploea core, Danaus genutia, Papilio demoleus, Graphius sarpedon* and *Cupha erymanthes. Eurema hecabe* and *Eurema laeta* are also found of which the later is rarer than the former. These species rely on leguminous plant for their food. This area has 29 species of insects including Orthoptera, Hemiptera and Coleoptera. This area provide good habitas for Hemipterons like *Erthesino fullo, Leptocoriza acuta* and *Lohita grandis* of which the food plants are *Trewia nudiflora* and *Mallotus philippensis*. In Lalimati the most common beetle species recorded are *Coccinella septopunctata, Gonocephalum civicum, Aspidomorpha sanetae-crucis* and *Aspidomorpha milaris*. Of which the food plant of *Aspidomorpha santae-crucis* and *Aspidomorpha milaris* is *Ipomoea cornea*. All these species were also reported from Koshi and Karnali as well. *Onitis subopacus* is common species reported from this part. This species occurs in all the sites of Koshi and Karnali region of our study program. Its habitat was found to be interesting in all the three places. In Koshi region it was reported from buffalo's dung while in Adhavar (Parsa) and Karnali region these were collected from wild elephant and cow's dung respectively. Pratappur is the next potential site and was revisited in September. A total of 31 species of butterflies were recorded from here. *Pachiliopta aristolochae* and *Ypthima* sp were the rare species recorded here.

The most common species sighted here are *Catopsilia pyranthe, Goneptery rhamni, Precis almana, P. lemonias, P.atlites, Eurema hecabe* etc. In Nirmal Basti (Parsa), a rare butterfly *Nymphalis canace* was found in the *Smilax* plant. Other insects also showed a good diversity in September. Good growth of vegetation and warm weather also influenced to flourish. Among the common insects recorded in this season are *Coccinella septopunctata, Brumus saturalis, Gonocephalus civicum, Philopona birmanica* etc. These are all Coleopteron insects which also exist in Karnali and Koshi region. *Chlaenius hemifor* is the only rare species recorded from this part. Among the hemipterons, *Erthesina fullo, Leptocoriza zcuta, Lohita grandis* and *Iphita limbata* (food plant-*Trewia nudiflora*) are common species. Insect species showed increasing from 29 to 43 in Parsa in September than in February.

c) Karnali region

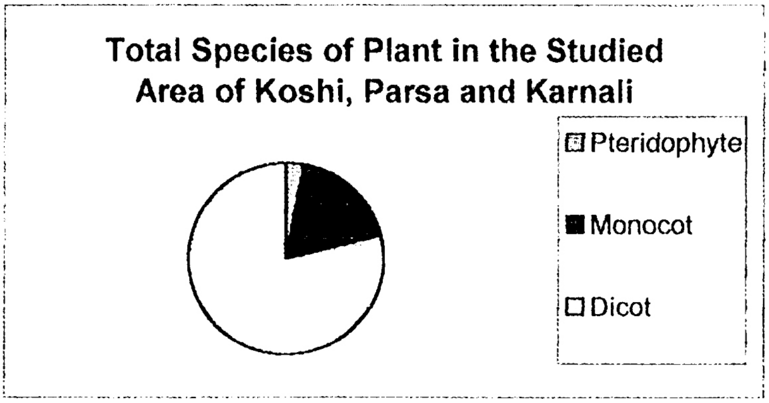
Karnali region was explored from every corner along the belt of Karnali river and its side tributaries which goes up to the Mohara river of Indian Uttar Pradesh states. This region provided varied habitats for diversified butterfly species ranging from the small lycaenids to the big papilos. During the first phase study of Karnali region in mid summer time before the monsoon revealed the existence of species of butterfly categorized under different families. Among the rare species observed there during this time includes *Ypthima kashmia, Symphaedra nais, Graphium euros, Elymnias hypermnistra* and *Curetis bulis.* This region is almost with the uniformity in altitudinal level and has forest of different types like mixed forest, deciduos forest, evergreen forest and riverine forest. Both the old and new riverine forest exist in the part. Many forested area are also run, by the local communities maintain in excellent condition. Common butterflies existing in these forest are *Precis almana, Danaus chryssipus, D. genutia, Papilio demoleus, Catopsilia sp., Eurema hecabe, Gonepteryl rhamni, Pantoporia hordonia, Zizeeria maha etc.* No endemic and protacted species were seen existing in this region during first phase program.

Bardia encompasses one of the largest National Park of midwest Nepal. This National Park has played a vital role to protect many valuable insect species in wild. Chispani is one of the potential site for many insect species. Situated on the bank of Karnali river, Chisapani still maintains good forested areas. Vegetation like *Dalbergia sisoo, Shorea robusta, Cassia fistula* and many types of grasses are dominant in this part. Butterflies like *Eurema hecade* and *Cepora nerissa* were found abundantly in this part. Good diversity of insects were observed at Lalmati area of Royal Bardia National Park. A total of 26 species of butterflies were recorded from the well managed forest of Chisapani and Lalmati areas. Next potential site for insect in Karnali region is the Sati Karnali area. Very good forest run by the locals exist here. Our study revealed the existence of 23 species of butterflies in this community forest covering an area of 139 hectors. Rare species of butterflies observed here are *Ypthima kashmira* and *Athyma* sp. One of the most potential site for our study program was found in Ghodaghodi lake of Kailai District, Midwest Nepal. This is a protected lake by IUCN and has very good forested areas around. About 15 species of butterflies were found in this part during our first phase program held in the month of May. In Lalimati forest, lycaenid butterfly *Castalium rosimon* was also observed. This species is the most common species in Koshi region. *Castalius rosimon* is not so common in Lalimati area like in Koshi region.Rare species of butterfly reported in Lalimati forest is *Symphaedra nais,* a red nymphalid and is categorized rare under the national status.



Karnali region is a vast and represent many potential sites for many insect species. Total insect species besides butterflies, reported from this region includes 69 species under 59 genera. This includes Orthoptera 5 species (5genera), Hemiptera 2 species (2 genera) and Coleoptera 44 species (34 genera). Among the reported insects during the first phase program, *Captosomus siamicum, Tesseratoma javanica, Homoeocerus signatus, Mononyx turgidulus* and *Otinotus oneratus* were rare Hemipterons, not found in Koshi and Parsa regions. Rare Coleopteron insects reported in our first phase program are *Neocollyris attenuata, Cicindela octonotata, Scapterus sulcatus, Cryptocephalus dodecastigma, Gymnopleurus gemmatus, G. dejeani, Onthophagus bonasus* and *O. pactolus. Onthophagus pactolus* is confined to Bardia region and is found to be new to Nepal. Other new report includes *Scarabaeus sanctus, Phalops oliivaceus, Gymnopleurus gemmatus, Onitis singhalensis* (Coleoptera) and *Captosoma siamicum* (Hemiptera). Almost all insects collected are the forest species. Due to well protected forest conditions, this part is very rich in forest insect diversity. Riverine forest of this area also provides good habitat for many insect species. Reported insects from this site includes *Cicindela octonotata, Scapterus sulcatus* and *Gymnopleurus gemmatus*, all are Coleopterons. *Belostoma indicum* (Hemiptera, Giantwater bug), *Orectochilus metallicus* (Coleoptera) and *Micronecta heliploides* (Hemiptera, boatmanbug) are the only insect species collected from aquatic habitats. So various habitat types were visited during the first phase program in Karnali region. Most common species of this area is *Lohita grandis, Iphta limbat* and *Physopelta schlanbusch* (Hemiptera). *Physopolta schlanbuschi* is the most common species, found abundantly in riverine wooded land and riverine grass land of this areas.

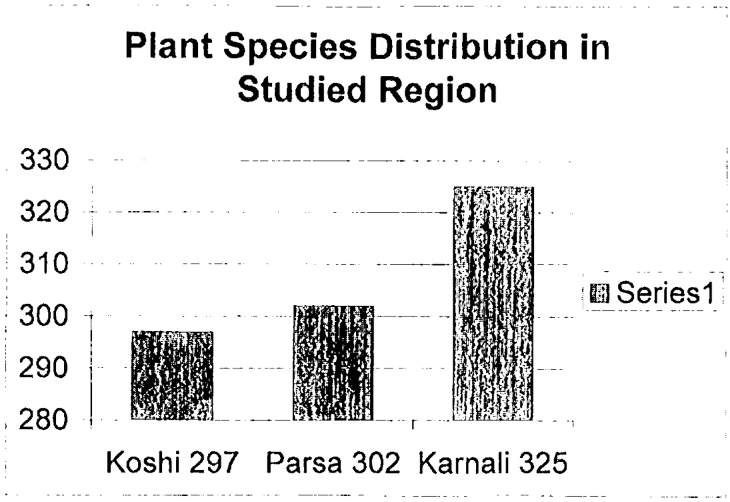
In November the region was still warm enough to accommodate different insect species of various status. One Euthalia species, *Castalias caleta, Elymnias hypermnestra* (female), *Yphthima kashmira* and *Papilio epycides* were the rare species. Among the common species common in the November month are *Eurema hecaba, Precis atlites, P. iphita, Melanitis leda, Pieris brassicae, Catopsilia pyrathe, Danaus genutia* and *D. chryssipus.* Rajapur and Kothiaghat area were very poor for butterlies and other insects. Very poor vegetation and high human settlement exist in these area. Forest along the riverbank is almost nil, mustard and sugarcane cultivation cah be observd in some parts. In Sati Karnali a total 20 species of butterflies was reported in November which is fewer than in May. Three butterflies, namely *Mycalesis perseus*, *Ypthima* sp. and *Elymnias hypermnestra* are the new addition to previous collection. Plentiful of Nemeobiid butterflies, *Ariadne merione* were seen attracted toward castor plants. Among the most common species observed in this forest are *Eurema hecabe, Castalius rosimon, Zizeeria maha* and *Neptis hylas*. Shade loving species like *Mycalesis perseus* and *Melanitis leda* were also found in this part. 22 species with 21 genera have been reported including Coleoptera (13 genera, 14 species) and Hemiptera (8 genera and 8 species). Among the rare insects are *Fitha ardens* (Hemiptera), *Cydnocoris crocatus* (Hemiptera), *Vesbius perpurens* (Hemiptera) and *Belostoma indicum* (Hemiptera). The most common species include *Lohita grandis, Physopelta schlanbuschi, Nephottettix apicalis, N. bipuactata, Coccinela septopunctata, Aspidomorpha sanctar-crucis, A. milaris* and *Gymnopleurus cyaneus*. 44 species food plants of insects are reported from this area. The most common insect species include *Acrida turitta, Chrotogonus trachypterus* and *Poecilocerus pictus* (Orthoptera) recorded from the flooded land of Karnali river. *Poecilocerus pictus* was found feeding on *Calotropis gigantea* along with other insects. *Schleichera oleosa, Lalki Bathania* (local name), *Calotropis gigantean, Buddleja asiatica, Acacia catechu, Dalbergia sissoo, Trewia nudiflora, Mallotus philippensis, Perilla frutescens* and *Callicarpa microphylla* are the important food plants of insects of this area. 1 6 species of dung beetles are reported from the forest of this region. Among them 4 species are new to Nepal.



Pteridophyta	16
Monocot	97
Dicot	422

Conservation of insect fauna is one of the essential task specially in the country like Nepal where impact on forest is increasing in an alarming rate. In what rate the insect rate are facing attenuating is not known but diversity of insects are decreasing and are becoming scare in the nature. In Koshi region 20 species of insects are found to be rare including one endemic and one new to Nepal. But except Koshi Tappu all other region are loosing forest die to lack of conservation knowledge. Even Koshi Tappu area need strict conservation measures as invasion and disturbances are increasing in alarming rate. This area need extension of conservation area extending to the Churia range in Chatara and Patnale where butterflies and insect diversity is very rich. A total of 302 species of flora are recoded from the studied area with two species new to Nepal.

Insect diversity is comparatively higher in Parsa area than Koshi and Karnali. About 75% of the studies area fall under the protected area. Rest part facing enchroachment form the new comers in the area from the hill and the peripherial localities. A total of 116 species of butterflies and 85 species of insects of which one is found to be endemic and 20 species are rare carrying urgent conservation requirement. *Sapribus subcoerulus* is the endemic beetle found in Parsa. This part has loose and porous soil condition so the rain-water does not get accumulated here. This makes this place devoid of water sources which ultimately leave impact to the existence of many insect species. 305 species of plants have been recorded in the surveyed area. Construction of artificial ponds and lakes are required in the reserve. Those ponds be constructed in different areas of the forest where the habitats are good for the insects. Anti poaching patrolling should be increased and illegal cutting of the forest trees should strictly controlled here as well.



Karnali region has also shown very good diversity of insect as well. 78 species of butterflies and 81 species of insects are reported and categorized under different status. Here 25 species are under rare and 5 new species have been reported to Nepal. Study here was mostly confined to the forested areas in National Park and community forests. Ghoda Ghodi lake though protected by IUCN still need effective conservation method. Areas in Karnali has potential to attract tourists also if those protected areas are well studied and implemented strict conservation measures. The main problem concerning the conservation management in this area is the lack of boundary wall. In many place guard system is lacking as well. Other areas of our study sites do not keep so much significance for the insect diversity except in the protected areas due to the human interferences.

Acknowledgement

This study was supported by Pro Natura Fund to the first author. Our sincere thanks are due to Prof. Dr. M. Ohsawa of Chiba University and Dr. T. Nakaike of Natural History Museum and Institute, Chiba, Japan for their kind support and encouragement. Thanks are also due to Dr. T. Maskey, Director General of department of National Park and Wildlife Conservation (HMG/N), Prof. Dr. Krishna Manadhar, then dean of Institute of Science and technology, TU, Wardens of Koshi Tappu Wildlife Reserve, Parsa Wildlife Reserve and Royal Bardia National Park, Chairman of Satti Community Forest and the staffs of Natural History Museum for their cooperation during the work.

REFERENCES

Amand, R. K., Y. K. Mall and K. B. Shah, 1978. Meloid Beetle (Col: Meloidae) of Nepal. J.Nat. Hist. Mus. 2: 1-4.

Andrew, H. E., 1935. The fauna of British-India, Coleoptera: Carabidae vol. II . Taylor and Francis, London.

Arrow, G. J., 1917. The fauna of British-India, Lamellicomia, part II (Rutelinae). Taylor and Francis, London.

Arrow, G. J., 1925. The fauna of British-India, Coleoptera: Lamellicomia. Taylor and Francis,London.

Arrow, G. J., 1931. The fauna of British-India, Coleoptera- Lamellicomia, part III (Coprinae).Taylor and Francis, London.

Arrow, G. J., 1933. The fauna of British-India, Coleoptera: Lamellicomia (Lucanidae and Passalidae), vol. IV . Taylor and Francis, London.

Distant, W. L., 1902. The fauna of British-India. Rhynchota, vol. II (Theteroptera). Taylor and Francis, London.

Distant, W. L., 1904. The fauna of British-India. Rhynchita, vol. I (Theteroptera). Taylor and Francis, London.

Distant, W. L., 1906. The fauna of British-India. Rhynchita, vol. III (Theteroptera-Homoptera). Taylor and Francis, London.

Distant, W. L., 1908. The fauna of British-India. Rhynchita, vol. IV (Homoptera andAppendis). Taylor and Francis, London.

Fletcher, T. B., 1914. Some Indian insects and other animals of importance. Suporitendent Government Press, India.

Fowler, W. W., 1912. The fauna of British-India, Coleoptera- General introduction and Cicindelidae and Paussidae. Taylor and Francis, London.

Habu, Aa., 1967. The fauna of Japonica. Carabidae : Trunetipennis group (Insect Coleoptera). Biogeographical Society of Japan.

Jacoby, M. 1908. Fauna of British-India. Chrysomelidae. vol.1. Taylor and Francis, London.

Kapoor, V. C., Y. K. Mall and P. J. Shah, 1978. On collection of Earwigs (Dermonptera) from Nepal. J. Nat. Hist. Mus. 2: 57-66.

Khanal, B., and C. Smith, 1997. Butterflies of Kathmandu Valley. Tec Press Book Service, Bangkok.

Kirby, W. F., 1914. The fauna of British-India, Orthoptera, vol. I . Acrididae. Taylor and Francis, London.

Kimoto, S., 1972. Chrysomelid beetles of Nepal, Collected in Hokkaido Univ., Scientific expedition of Nepal Himalaya 1968, part 1. Kontyu 40 (4) : 215-223.

Kimoto, S., 1973. Chrysomelid beetles of Nepal, collected by Hokkaido Univ., Scientific expedition of Nepal Himalaya 1968, part 2, Kontyu 41 (2) : 170-180.

Kimoto, S., 1979. The Galerucinae (Col : Chrysomelidae) of Nepal, Bhutan and Northern Territories of India. The Nat. Hist. Mus. In Entomologica Gasilian 4.

Kimoto, S., 1981. The Cassidinae of Nepal, Bhutan and Northern Territories of India. Nat. Hist. Mus. Basel, (Col. Chrysomelidae). Ent. Rev. Jap. 36 (1) : 56-62.

Kimoto, S., 1982. The Galerucinae of Nepal, Bhutan and Northern Territories of India. Nat. Hist. Mus, Basel, (Col. Chrysomelidae). Ent. Rev. Jap. 37 (1) : 7-24.

Kimoto, S., and H. Takizawa, 1981. Chrysomolidae beetle of Nepal, collected by Hokkaido Univ. Scientific expedition of Nepal, 1968 and 1975, part II . (Col.). Ent. Rev. Jap.35 (2) : 51-65.

Lyneberg, L., 1976. Beetles in color. Blandford Press, London.

Matheshwari, J. K. C., 1966. Illustrations of the flora of Delhi. Council of Sci. & Ind. Research, New Delhi.

Numata, M. (ed.), 1983. Biota and Ecology of Eastern Nepal. Chiba University, Chiba.

Polunin O., and A. Stainton, 1984. Flowers of the Himalaya. Oxford University Press, Orford.

Shrestha, K., and G. Corvinus, 2000. The Nepal Siwaliks : their environmental and palaeonotological importance. NHM, Tribhuvan University, Kathmandu.

Shrestha, P. K., 1980. Some Chrysomelid beetles of Nepal. J. Nat. His. Mus. 4 (3) : 91-112.

Shrestha, P. K., 1982. Beetles of Gokarn Forest. J. Nat. His. Mus. 6 (3).

Shrestha, P. K., 1999. Some Coleopteron insect from Dolakha District, Central Nepal. J. Hist. Mus. vol. 18.

Smith, C., 1989. Butterflies of Nepal. Tecpress Book Service, Bangkok.

Stainton, A., 1988. Flowers of the Himalaya, a supplement. Oxford University Press, Oxford.

Tetsue, M., and N. Shinji, 1999. The Lucanid Beetles of the World. Shizawa Printing Co. Ltd., Tokyo.

DISTRIBUTION AND POPULATION OF SULAWESI HAWK – EAGLE (*Spizaetus lanceolatus*) IN SOUTH AND CENTRAL SULAWESI

Wahyu Raharjaningtrah [1]

SUMMARY

The research aimed to gather information on distributions, populations, and status of Sulawesi Hawk-eagle *Spizaetus lanceolatus*.

The research was carried out at 36 sites in Sulawesi. Although the habitat of Sulawesi Hawk-eagle ranges 0-800m asl., the species concentrated between 600-800m, suggesting the decrease of lowland forest. Population is estimated as 254-306 pairs in South and Central Sulawesi.

The species was more frequently seen in lowland forest than other forest types. The species was less encountered in the open forest of less than 25% coverage. In the forest of more than 50% coverage, it was difficult to detect the bird due to dense leaves.

Plantations are recorded in the northern part of South Sulawesi and Tolitoli of Central Sulawesi. The forest degradation due to land conversion, hunting and logging, are detected in Central Sulawesi. The situation is getting worse because of the recent chaos.

Local people consider raptors as injurious, but mostly ignore. Poaching for trade, based on interviewing people and visiting bird market, was not detected.

The community awareness to conserve eagles, in particular Sulawesi Hawk-eagle, has been made through dissemination of posters in whole Sulawesi.

INTRODUCTION

Sulawesi Hawk-eagle has a near-threatened status, on appendix II CITES and protected by Indonesian law and endemic to Sulawesi (Shanaz *et al.*, 1995; WCMC, 1998). Conservation effort on Sulawesi Hawk-eagle are importantly needed before it really be extinct. Efforts to enhance the awareness of people to conserve this hawk-eagle applied as entry point to save the remaining forest as their habitat. Forest conservation is greatly of important to the life of not only biodiversity moreover to all local communities at Sulawesi. The information about Sulawesi Hawk-eagle is limited and poorly known. The research about Sulawesi Hawk-eagle is becoming very important especially the bird is one of endemic bird that very susceptible to be extinct because their high dependence to the forest.

The aim of the programme is to improve understanding of genus *Spizaetus* in Indonesia. The objectives of the project are to identify of status, distribution and population of Sulawesi Hawk-eagle, to describe habitat and its disturbances, and to increase the community awareness to conserve the Hawk-eagle.

The expected results of the programmes were knowledge and information of status, distribution and

---

1). Yayasan Pribumi Alam Lestari, Bandung

population of Sulawesi Hawk-eagle, knowledge of disturbances forcing the Sulawesi Hawk-eagle. Comparing information of the Indonesian endemic Hawk-eagle, establishing the Hawk-eagle networking with local NGO's and scientists, and recommendation of Sulawesi Hawk-eagle conservation action and follow up researches. Forest vegetations (trees with DBH ≧ 4.5 cm) in 46, 0.16 ha plots of six forest types; dry dipterocarp.

METHOD

Method usually used to observe the tropical forest raptor is according to the opportunity on encounter species of bird. Survey on wide area which limited time for seeking a secretive bird is needing a necessary specially attention to a smaller area to convince the effective observation (Bibby *et al.*, 2000). On experience with observation on the Javan Hawk-eagle as similar genera to Sulawesi Hawk-eagle, we use observation method focused on the forested area. However, Sulawesi Hawk-eagle has already known distributed from sea level to 3,000m (Coates *et al.*, 1997), moreover we visit several areas which has variety of habitat type and elevation to get approaching specific habitat of this species.

Selection and survey locations

Field study was conducted in South and Central Sulawesi provinces. Survey in South Sulawesi was beginning on February to middle April 2000 at seven selected conservation areas. Survey in Central Sulawesi was visited five selected conservation area was made on March and August to September 2000.

Data Record

During field observation, *look-down method*, to observe on a hill taking the opportunity to monitor the top of canopy or from the suitable in the edge forests or open areas is the best way to detect raptor occurrence (Thiollay, 1996). Searching and determining on vantage point is made on the first day observation, followed by daylight observation on the next day. Observing on the higher elevation taking the advantage on the possibility of seeing wider point of view is priority given.

RESULT AND DISCUSSION

General Setting

South Sulawesi comprises of 24 districts and the most developing than other province at the Sulawesi Island. In addition, human population are increasing and most of the inhabitants are farmers both of rice and other industrial agriculture such as cocoas, coffees, and spices. The high value of cocoas on recent years was stimulating forest encroachment for extensive plantation.

Central Sulawesi Province has diversity land habitat type that spread out from coast to mountain in 2,500m asl. Mountain rainforest (upper and lower Montane) and lowland rainforest are in along Tokalekaju Mountains and Ogoamas Mountains. This forest type dominates most of area in Lore-Lindu National Park. Morowali Nature Reserve has most completely vegetation type, from mangrove forest until *hutan lumut* (moisy forest) at 2,200m asl.

Distributional of Sulawesi Hawk-eagle

The Sulawesi Hawk-eagle found on 36 observational sites of 55 observational points. In South Sulawesi, 29 observational points on 13 locations and 11 observational points were the Sulawesi Hawk-eagle found. In Central Sulawesi is more record of observational point, 26 observational points of seven locations and the Sulawesi Hawk-eagle found on 25 observational points. (see Table 1).

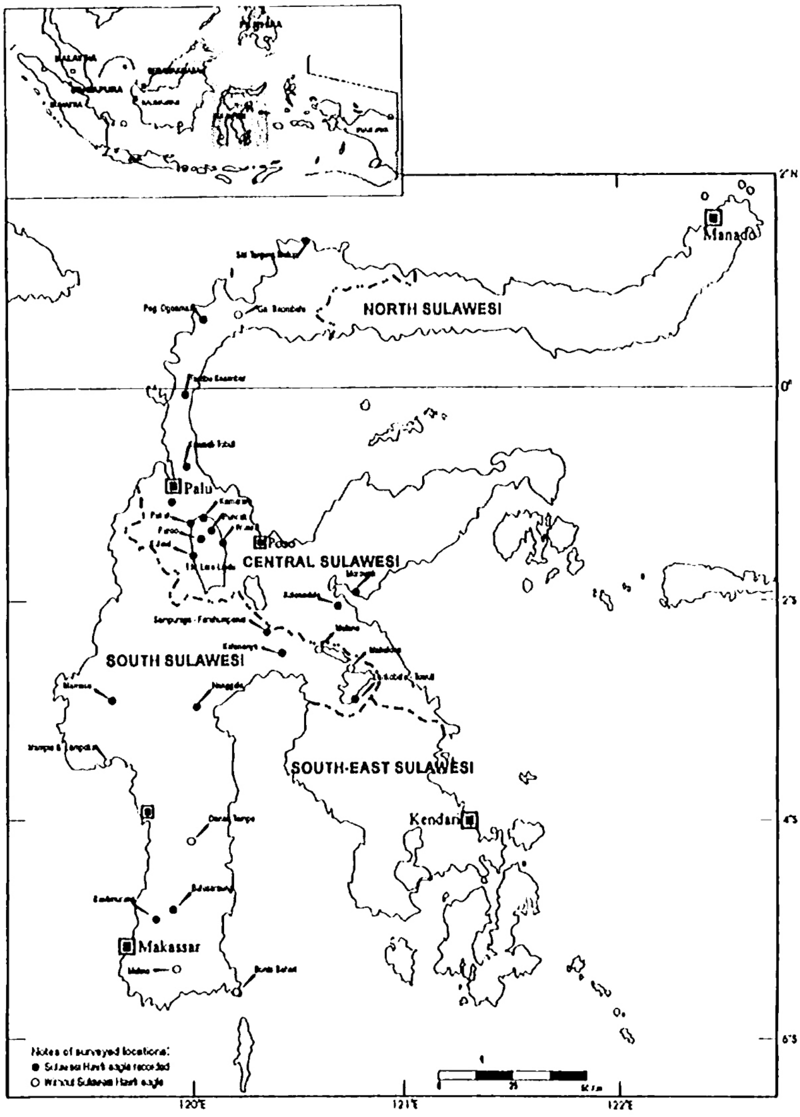


Figure 1. Map of survey location and locality record of Sulawesi Hawk-eagle.

In South Sulawesi province, the Sulawesi Hawk-eagle is less recorded on lowland area, especially deforested habitat of lowland forest to agricultural and fishpond in this area. To more northern area of this island, this species is more present recorded especially at Tana Toraja regency and Polewali-Mamasa, to northern Luwu and Mamuju until into boundary area of Central Sulawesi. In Central Sulawesi, this species widely and distributed on every forested area. Meyburg and van Balen (1994) indicated this species found not uncommon. Therefore, distribution of this species is not limit to main island of Sulawesi but was record on satellite islands. A present record, widely distributed of this species but not commonly to be seen in Buton island (Baltzer, 1998) record on Banggai Island (Indrawan. *et al.* 1997), and sometime to be seen at forest in Togean Island (Indrawan press. com) and not recorded in Sangihe Talaud Islands (Stones *et al.* 1997).

Table 1. Locality Record of Sulawesi Hawk-eagle.

Location	Status	Op	Total number	Composition	Elevation (m asl)	Vegetation Type
Bulusaraung	NR	Reatoa atas	1	1 im	900	LM
Bulusaraung	NR/PA	Bontosiri	2	1 im, 1 a	600	LM
Bantimurung	NR/RP	Airterjun gua batu	1	1 a	180	LS
Gn Mambuliling	PA	Pebadongan	2	1 im, 1 a	1510	UM
Nanggala I	PA	Kebun kopi Tarcojaya	2	2 a	1085	LM
Nanggala I	PA	Wayrede	1	1 a	1230	UM
Fahumpenai	NR	Sampuraga	1	1 a	1265	UM
Fahumpenai	NR	Salonoa	3	1 im, 2 a	535	LF
Fahumpenai	NR	Laroeha	1	1 a	400	LF
Danau Towuti	RP	Lengkobale	1	1 a	300	LF
Air terjun Wera	RP	Balumpewa	2	2 a	150	LF
Lore Lindu	NP	Tongoa	1	1 a	745	LM
Lore Lindu	NP	Kamarora	1	1 a	800	LM
Lore Lindu	NP	Lambara	1	1 a	420	MO
Lore Lindu	NP	Wuasa	2	1 im, 1 a	1200	UM
Lore Lindu	NP	Dodolo	1	1 a	1400	UM
Lore Lindu	NP	Tomado, Danau Lindu	2	1 im, 1 a	900	LM
Lore Lindu	NP	DusunIII Pakuli	2	2 a	140	LF
Lore Lindu	NP	Dusun II Pakuli	1	1 a	400	LF
Lore Lindu	NP	Simoro	2	2 a	315	LF
Lore Lindu	NP	Kulawi	2	1 im, 1 a	625	LF
Lore Lindu	NP	Sidaunta	1	1 a	1020	LM
Lore Lindu	NP	Puroo	1	1 a	990	LM
Lore Lindu	NP	PunNRk-Batu Salome	2	2 a	1080	UM
Lore Lindu	NP	Sedoa	2	2 a	1120	UM
Morowali	NR	Morowali	1	1 a	50	CF
Morowali	NR	Kayupoli	1	1 a	90	LF
Morowali	NR	Kolonedale	3	2 a, 1im	40	LF
Kawaeli	PA	Kawaeli-Tobuli	3	2 a, 1im	450	LF
Kawaeli	PA	Kawaeli-Tobuli b	2	2 a	720	LF
Tambu- Kasimbar	PA	Tambu	2	2 a	210	LF
Tambu- Kasimbar	PA	Ranang	1	1 a	75	LF
Tjg Matop	SM	Pinjan	4	4 a	200	CF
Tjg Matop	SM	Binontoa	2	2 a	420	CF
Gn. Sojol	NR	NR Gn. Sojol	1	1 a	350	LF

Note: a = adult; im= immature;.op=observational point
CF = coast forest; LF = lowland Forest 0 - 700m, LM = Lower Montane Forest 700 – 1200m;
UM = Upper Montane Forest 1200 – 2100m; LS = Limestone Forest; MO = Monsoon Forest

Altitudinal Distribution

Sulawesi Hawk-eagle is distributed on elevation of 0 - 3,000 m (Coates *et al.*, 1996), but poorly known about elevation area more needed and like to this species. We was surveyed from coast to elevation of 1,800m at Mambuliling Mount and we have result that this species was record on these elevation. Lower elevation of locality record of this species is on 50m at Morowali and the upper elevation of locality record is on 1,510m at Pebandongan, Mambuliling Mount. As result of all number of elevation record, indicated to high number of elevation record on extended of 600-800 m, where most of lowland and hills forest remaining (Fig. 2).

We has no same duration of observation time in each location (extend of sample 5-14 hour), but as result, estimated to high dependence of this species to forest. When the lowland forest is more distoyed, this species will flying up to more widely of hills forest. Moreover, based on record of each elevation locality, Sulawesi Hawk-eagle is more frequently record to be seen on 0-200m (ET=0.59), and then 600-800m (ET=0.50), while on 1,000-1,800m is rare to be seen (ET= 0.32-0.14). Cause of these all, indicated to lowland forest on good condition is has wider supporting to life of this species.

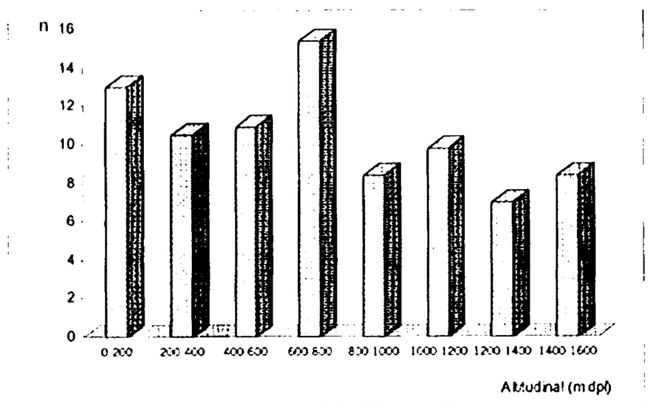


Figure 2. Sulawesi hawk-eagle distribution according individual numbers (n=62) which found on the some altitudinal sites. One individual could be recorded in some site of altitudinal category.

Estimate of Population

The homerange of a number of diurnal raptor species of *Spizaetus* genera is known. A breeding pair of *S. nipalensis* at Mt. Suzuka, central part island of Japan, has territory on 22.8 - 28.8 km^2(Yamazaki, 1990) and homerange of this species at southern part was estimated on 13.65 km^2(Morimoto and Iida, 1992). A breeding pair of *S. bartelsi* in Java, is estimated has a home range on minimum 12 km^2/pair (Sozer and Nijman, 1995), or 20 - 30 km^2(Thiollay & Meyburg ,1988). *S. ornatus* in South America has estimated homerange of male on 12-21 km^2 and 8 km^2 of female (Madrid *et al.*, 1991) (see Table 2).

Table 2. Size of Home range of Genera of Spizaetus.

Species	Region	Body size (cm)	Home range (Km2/pair)
S. nipalensis	Asia	67 – 86	22.8-28.8; 13.65
S. baretelsi	Asia (Jawa)	60 – 70	12; 20-30
S. ornatus	South America	58 – 67	12-21/male, 8/female
S. lanceolatus	Asia (Sulawesi)	56 – 64	-

After Sozer & Nijman (1995)

Assuming all habitat is suitable for Sulawesi hawk-eagle, the number of population of surveyed area is between 254 - 306 pairs (Table 3). Sixty to seventy pairs are estimated occupying the surveyed area of South Sulawesi Province and 194 - 235 pairs located at surveyed area at Central Sulawesi. Thiollay (pers. comm.) based on his counting, estimated 200 number of pairs is accupying the surveyed area at Central Sulawesi.

Table 3. Estimation a Number of Pair of Sulawesi Hawk-eagle at Locality Survey.

location	Status	Size (km²)	Altitude	Estimation number of pair
Bulusaraung	NR	80	500 – 1800m	4 – 6
Bantimurung	NR/RP	10	100 – 750 m	1 – 2
Mambuliling mount	PA	50	700 – 200 m	4 – 5
Nanggala	PA	50	600 – 1800 m	4 – 5
Feruhumpenai	NR	900	250 – 1678 m	45 – 50
Towuti Lake	RP	45	295 – 600 m	2 – 3
Wera waterfall	RP	2,5	150 – 800 m	1 – 2
Lore Lindu	NP	2290	140 – 2610 m	92 – 110
Morowali	NR	2250	0 – 2630 m	90 – 105
Kawaeli	PA	60	400 - 750 m	3 – 5
Tambu- Kasimbar	PA	50	75 - 350 m	2 – 4
Matop cape	WS	16.12	0-420m	3 – 5
Sojol mount	NR	50	500 - 450 m	3 – 4
			Total	**254 – 306**

Note: NR-= Nature Reserve; RP= Recreation Park; PF= Protected Forest; NP= National Park; WS= Wildlife Sactuary

Habitat

The Sulawesi Hawk-eagle was recorded at coastal forest, lowland forest, lower montane forest, upper montane forest, limestone forest and monsoon forest, but no presence sign at mangrove forest, savanna, marshes, monoculture forest and cultivation area. (see appendix 2). Based on encounter rate of forest vegetation type, this species is most frequently seen in lowland forest (ET=0.114) and rare to be seen in limestone forest and monsoon forest (ET=0.005) (Table 4).

Table 4. Record of Sulawesi Hawk-eagle based on vegetation type.

VEGETATION TYPE	Number of Individual		Number of individual / 220 hour	Classification of density
	South	Central		
Coastal forest	0	7	0,032	Common
Lowland forest	4	21	0,114	Frequent
Lower montane forest	6	6	0.055	Common
Upper montane forest	4	7	0,050	Common
Limestone forest	1	0	0,005	Rare
Monsoon forest	0	1	0,005	Rare

Classification of value: 0,001 – 0,009 = rare; 0,01 – 0,099 = common; > 0,1 = frequent

In four categories of percentage of forest covering, Sulawesi Hawk-eagle is frequently seen in forest with covering area percentage of 25-50% (F2; ET= 0.101) and rare to be seen in open forest with covering area of 5-25% (F1; ET=0.016). In addition, F3 with forest covering 50-75% and F4 with 75-100% forest covering are both similar on encounter rate (see Table 5). The high encounter rate in F2 is due to the wider observational area and with only 25-50% covering area percentage offering the higher opportunity to find Sulawesi Hawk-eagle than F4 (75-100%) and F3 (50-75%). Thiollay & Rakhman (2000, *in prep.*) describing that Sulawesi Hawk-eagle is highly confined to the primary forest, and the secretive habit has been causing the difficulties on detecting the species on high vegetation cover.

Table 5. Encounter rate value based on the stratification of forest cover.

Category % Forest Cover	CF	Lf	Lm	Um	Ls	Mo	Number of Individual / 188 hour	Classification of density
	VEGETATION TYPE							
F1 (05-25%)		3					0,016	Rare
F2 (25-50%)		12	5	2			0,101	Often
F3 (50-75%)		7	3	5	1	1	0,090	Common
F4 (75-100%)	7	2	4	4			0,090	Common

Note: remarks of vegetation type (see table 4); result category: 0,01 – 0,05 = Rare; 0,06 – 0,09 = Common; > 0,1 = Often

Threaths

Thiollay (1994) has been indicating that most currently identificable threats to raptors in tropical forest belt are related to the habitat destruction. Other classical threats including poaching, trade or pesticide are of local occurrence and most oftenly little significance. Three different threats are involved under general of habitat loss including deforestation, disturbance and habitat fragmentation. Deforestation is the conversion of forest to various open habitat including monoculture plantation. Disturbance is secondarisation of forest cover, resulting in an important change of the vegetation structure and in improveshed plant and animal communities. Habitat fragmentation is tracts leading to mosaic of forest patches and open area.

Even though almost status of all visited area are conservation area (Nature Reserve, Recreation Park, WildLife Sanctuary and National Park) but still the management and law enforcement to protect those areas is less, as many evidences are able to be identified. We noted the various different threats to Sulawesi Hawk-eagle in almost all of visited locations. Generally, more than one variety of threat in each location with different scale has been identified. Enhancing plantation tend to be a deforestation type is mostly noted at South Sulawesi, and forest disturbance including hunting, logging, collecting rattan and enchroachement is mostly happened in Central Sulawesi. (Table 6).

Table 6. A variety of threat to Sulawesi Hawk-eagle.

Kind of Threat	Number of Case * South Sulawesi	Number of Case * Central Sulawesi	Total
Cultivation	8	4	12
Enhancement of mining area	1	0	1
Illegal hunting	3	21	24
Illegal logging	10	12	22
Rattan collection	0	13	13
Forest encroachment	2	12	14
Road building	0	1	1
Fire	2	0	2

Note = * more than one variaty of threat in each location

Conservation

Local people consider all raptors are injurious because of the habit of stealing of chicken, but mostly people ignore. Beside that, poaching for trade, based on both interviewing people and visiting bird market at Todopuli, Makassar (Nurwatha & Rahman, 2000). Only one record of eagle hunting for diet was noted in

Reatoa. Even though the poaching is less, people is always revealed on the rareness of the eagle in neighborhood comparing to last ten years ago.

Contrary to the Javan Hawk-eagle in Java Island, poaching and illegal trade is now become one of important threat to this species beside habitat destruction. Javanesse has a long history of keeping wildlife in cage especially bird. In a large scale, a being popular bird song contests have been triggering a massive hunting which will be affecting the population in wild. The culture and bird contest are to be afraid of being affecting Sulawesi people in where Javanesse intruding Sulawesi through transmigration program which basically Sulawesi does not have any culture of captive. A program to enhance public awareness to safeguard the Sulawesi's biodiversity in where they living is highly required.

In Central Sulawesi, Sulawesi Hawk-eagle is seemingly having a healthy population in a wide area and is apparently able to survive on a level of deforestation and fragmentation in certain habitat. Of course, the species could not be surviving in a totally high threats. Habitat loss in lowland mostly occurred in area of South Sulawesi has been pushing the species to refuge to the upper habitat in hills and montane forest, it is probably that the forests in mountain area would be a last refuge for this species. The island of Java with its Javan Hawk-eagle is an example to explain that habitat loss in lowland has been forced the species to be an estranged species (Meyburg, 1986), from the habitat to be concentrated in the remained montane forest.

Raptor is often to be a sensitive bio-indicator of environmental changes or habitat quality, unfortunately, the important role of raptor, particularly in Sulawesi, is less studied or even frequently ignored. We will probably lose the opportunity to study their life when most of diurnal raptor species, especially endemic species, is extinct. To gain a general conservation strategy based on the role of the eagle, on the first phase is by conserve this species. Thiollay (1994) explained that raptor, like other vertebrate predators, are playing an important role in several respects for general conservation strategy. First, they play the role of "umbrella species" because of their large home range. Second, they are "flag-ship species" (species symbol in a broader conservation management), species arousing public interest and supporting wider conservation programmes. Third, raptor is often sensitive bio-indicator of environment changes or habitat quality, far beyond their well-known sensitivity to chronic food-chain contamination. At last, the key biological role of predators in primary rain forest begins to be appreciated.

CONCLUSION

The Sulawesi Hawk-eagle was found in 36 observational sites, including 11 observational points in South Sulawesi i.e. Bulusaraung, Bantimurung, Mambuliling, Nanggala, Faruhumpenai and Towuti, and 25 observational points in Central Sulawesi i.e. Wera Waterfall, Lore Lindu, Morowali, Kawaeli, the Protected Forest between Tambu-Kasimbar, Tanjung Matop and Mt Sojol.

Bantimurung is only the southern distribution record of this species in Sulawesi Island, and visiting north area of the island, the species is become commoner especially from Tana Toraja regency and Polewali-Mamasa, to northern Luwu and Mamuju until into boundary area of Central Sulawesi. In Central Sulawesi, the species is widely distributed on every forested area, and not an uncommon species.

Sulawesi Hawk-eagle is distributed on elevation of 0 - 3,000 m, the lower elevation of locality record of this species is on 50m at Morowali and the upper elevation of locality record is on 1,510m at Pebandongan, Mt. Mambuliling. The species is mostly found at altitude of 0-800m asl, in which the lowland and hill forest still remains. However, the species is more concentrated in elevation of 600-800 m as a consequences of decreasing of lowland forest.

In order to counting the population number, the density of breeding pair of Sulawesi Hawk-eagle has estimated on extend of 15 - 25 km^2. Population number of pair of Sulawesi Hawk-eagle at all locality surveyed are between 254 - 306 pairs, 60 - 71 pairs are estimated located on surveyed area at South Sulawesi Province and 194 - 235 pairs located at surveyed area at Central Sulawesi.

The Sulawesi Hawk-eagle recorded in coastal forest, lowland forest, lower montane forest, upper montane forest, limestone forest and monsoon forest. This species was not found in Mangrove forest, savanna, marshes, monoculture forest and agricultural area. Based on encounter rate in forest vegetation type, Sulawesi Hawk-eagle is mostly seen in lowland forest and rarest in limestone forest and monsoon forest. Sulawesi Hawk-eagle is often to be seen in forest with cover area of F2 (25-50%) and rare to be seen in open forest with cover area of F1 (5-25%) In addition, F3 with forest cover 50-75% and F4 with 75-100% forest cover are compressing to the same level.

Plantation as a deforestation type is mostly recorded at northern of South Sulawesi and Toli-toli in Central Sulawesi, and forest disturbance including hunting, logging, collecting rattan and cultivation is mostly occurred in Central Sulawesi.

Local people consider all raptors are injurious because of the habit of stealing of chicken, but mostly people ignore and during observation time, no eagle in trade was recorded.

FUTURE STUDY

The study of Sulawesi Hawk-eagle will be covering all Sulawesi regions, including satellite islands. The sites to be surveyed are other part South-east Sulawesi, North Sulawesi Province and eastern continental of Central Sulawesi (Morowali area), in addition, the satellite island of Muna where is very little information about Sulawesi Hawk-eagle known.

REFERENCE

Bibby, C. Jones, M. dan Marsden s. 2000. *Teknik-teknik Ekspedisi Lapangan Survey Burung* (Terjemahan). BirdLife International Indonesia Programme, Bogor.

Coates, B. J., Bishop, K.D., Gardner D. 1997, *A Guide To The Bird of Walacea*, Dove Publications Pty, Australia.

Indrwawan, M., Y. Masala and L. Pesik. 1997. Recend Bird Observations from Banggai Island. *Kukila* 9: 61-70.

Madrid, J.A., Madrid, H.D., Funes, S.H., Lopez, J., Botzoc, R. & Ramos, A. 1991. Reproductive Biology and Behavior of the Ornate Hawk-eagle In Tikal National Park. Pp. 93-113 in D.F. Whutacre, W.A. Burnham & J.P. Jenny (eds) *Progress Report 2, 1991, Maya Project*. The Peregrine Fund, Boiso, Idaho.

Meyburg, B.-U. 1986. Threatened and near-threatened diurnal birds of prey of the world. *Birds of Prey Bull.* 3: 1-12.

Morimoto, S & Iida, T. 1992 (Ecology and Preservation of Hodgson's Hawk-eagle.) *Strix* 11:59-90. (berbahasa Jepang dengan abstrak Inggris).

Nurwatha, P.F & Rahman, Z. 2000. *Distribusi Elang Sulawesi di Provinsi Sulawesi Selatan. Yayasan Pribumi Alam Lestrai*, Bandung (unpublished).

Shanaz, J., P. Jepson dan Rudyanto. 1995. *Burung-burung terancam Punah di Indonesia*. PHPA/BirdLife International IP. Bogor.

Sozer, R & V. Nijman. 1995. *Behaviural Ecology, Distribution and Conservation of The Javan Hawk-eagle spizaetus bartelsi, 1924,* (thesis). Institute of Systematic and Population Biology. University of Amsterdam. Netherlands.

Thiolay, J.-M. 1994. A World Review of Tropical Forest Raptors Curren trends, Research Objerctives and Conservation Strategy. Pp. 231-240. On Meyburg, B. U & D Chencellor eds, *1994 Raptor Conservation Today* WWGBP/ The Pica Press.

Thiollay, J.-M. & Mayburg, B.-U. 1988. Forest Fragmentation and the Conservation of Forest Raptor: A Survey on the Island of Java. *Biol. Conserv.* 44:229-250.

WCMC. 1998. *Checklist of CITES Species: A reference to the appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora.*

Yamazaki, T. 1990. The Ecology of Japanese Mountain Hawk Eagle. RRF draft.

要　旨

スラウェシ島に生息する希少鳥類 セレベスクマタカ（*Spizaetus lanceolatus*）の 個体数、分布、生息状況の現状に関する調査

ワーユ ラハルジャニントゥラ

低地熱帯林の減少により絶滅が心配されるセレベスクマタカについて、同種の世界で唯一の生息地であるスラウェシ島における個体数、分布、生息状況の現状を調査した。

調査は南スラウェシと中央スラウェシの全36地点で行われた。セレベスクマタカの生息域は海抜0mから800mにかけての地域であるが、今回同種が実際に確認された地点は海抜600mから800mの間が多く、下方から進む開発によって生息地が狭められていることが示唆された。調査の結果から、セレベスクマタカの現存数は南と中央を合わせて254－306番と推測される。

今回セレベスクマタカが確認された地点の主な植生は低地熱帯林であり、マングローブ林やサバンナ、湿地帯、松林、耕作地帯などでは観察されなかった。同種がもっともよく目視されたのは植生被覆率25％以上の林であり、被覆率が25％を切ると確認数はぐっと減少した。一方で、被覆率が50％を超えると目視が難しくなり、この場合も確認数は減少した。

地元住民からの聞き取り調査や現地の見分調査の結果、スラウェシ島の森林はプランテーションに代表される土地開発や木材伐採、狩猟など多岐の理由から劣化・減少していることが明らかになった。特に近年、政治不安や経済危機を反映して森林資源の搾取が苛烈になっており、セレベスクマタカの生息地を脅かしている。

地元の住民は、家禽を襲うこともあるワシタカ類を全般的に嫌っているようであるが、積極的に駆除しようとすることはあまりなく、また売買のための捕獲等もとくに行っていないようである。鳥類の取引市場も調査したが、セレベスクマタカが売られていた形跡はなかった。

本事業では、調査と並行して、ポスターの配布を通じたセレベスクマタカの保護に関する普及・啓発活動も実施した。

（推薦者：乾 由布子 訳）