VERSLAGEN EN TECHNISCHE GEGEVENS

Instituut voor Systematiek en Populatiebiologie (Zoölogisch Museum)

Universiteit van Amsterdam

No. 62

Behavioural ecology, distribution and conservation of the Javan Hawk-eagle *Spizaetus bartelsi* Stresemann, 1924

Resit Sözer & Vincent Nijman

May 1995

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Figures and lay-out by the authors, line drawing by Vincent Nijman.

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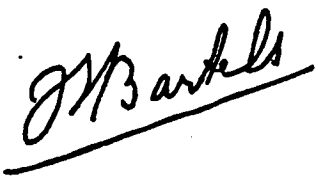
Foreword

Naarden, 7 December 1994

Het is moeilijk te zeggen wanneer ik *Spizaetus bartelsi* voor het eerst heb waargenomen en waar. Wij kenden hem al een tijd als *Spizaetus kelaarti* en pas later werd hij door Dr Stresemann naar mijn vader genoemd: *Spizaetus bartelsi*. Het laatst heb ik hem waargenomen in Meru Betiri in 1975, zowel volwassen als jeugdige exemplaren.
Het geeft mij veel voldoening dat ons werk, onderzoek naar de verschillende vogelsoorten op Java, wordt voortgezet door enthousiaste jonge biologen. Ik wens hen als laatst overgeblevene van de broeders Bartels een succesvol onderzoek toe in het belang van de vogels die snel zullen uitsterven als men doorgaat met ontbossing. Een grotere intensiteit van controle is nodig om stropen en klandestien kappen van oerbos tegen te gaan, wil er nog een beetje habitat overblijven voor de dieren in de laatste regenwouden niet alleen op Java en Sumatra, maar in alle overige werelddelen. Vooral de inheemse jeugd zou intensief ingelicht kunnen worden zodat door mentaliteits verandering de natuur een kans krijgt zich te herstellen.



Hans Bartels

"It is difficult to say when and where I first observed *Spizaetus bartelsi*. We knew it already as *Spizaetus kelaarti* and later it was called after my father by Dr Stresemann: *Spizaetus bartelsi*. I observed it for the last time in Meru Betiri in 1975, both adults and immatures.
It gives great satisfaction that our work, the research on various species of birds on Java, is being continued by enthusiastic young biologists. I wish them, as the last remaining of the Bartels brothers, a successful research into the importance of the birds which will soon be extinct if deforestation continues. More intensive guarding is needed to stop poaching and illegal logging of primary forest, if any habitat is to remain for the fauna in the last rainforests, not only on Java and Sumatra but also in other parts of the world. Especially the local youth should be intensively educated so that by change of mentality nature gets a chance to restore itself."

Preface

This report presents the results of our research which focuses on the biology of the Javan Hawk-eagle *Spizaetus bartelsi*. The research was part of our biology study at the University of Amsterdam to fulfil the requirements for the Degree of Master of Science (Drs). The project started in December 1993 and continued until January 1995. In total, seven months were spent in the field of which two weeks together with our counterparts Iwan Setiawan and Andi Prima Setiadi, of the Biology Department, Padjadjaran University, Bandung.

Preparations were mainly made in The Netherlands during the three months prior to our fieldwork. These preparations included the study of all the available literature on the avifauna of Java as well as study of the characteristics of the relevant birds in the collections of the Zoological Museum of the University of Amsterdam and the National Museum of Natural History at Leiden. The study of collected material was continued in Indonesia at the Museum Zoologi Bogoriense.

Javan Hawk-eagles were observed in all parts of Java, but our behavioural observations took mainly place at Gn Pangrango, West Java and at Gn Slamet, Central Java. (Gn is the abbreviation of *Gunung* which is Indonesian for mountain). Our study on the distribution was focused on the central part of Java, i.e. the province of Central Java, D. I. Yogyakarta and the western part of East Java.

The only two places where Javan Hawk-eagles were kept in captivity during our stay in Indonesia were the bird park of Taman Mini Indonesia Indah, Jakarta and Taman Safari Indonesia, Cisarua. These parks were also frequently visited in order to obtain a more complete picture of the moulting patterns as well as the behaviour of the species.

Initiator of the research was BirdLife International Indonesia Programme. The project was supported by the Indonesian Institute for Sciences (LIPI) and the Directorate General of Forest Protection and Nature Conservation (PHPA).

Parts of the results presented in this report have already been presented during seminars and can be found in handouts (Sözer & Nijman, 1994 a,b; Nijman, 1994; Sözer,1994).

"It's always less" (Rudyanto's Rule 13-7-1994).

Amsterdam, January 1995

Resit Sözer
Vincent Nijman

Acknowledgements

A number of people have advised us or assisted us by giving information or support . First of all we would like to thank our supervisors: Dr Jan Wattel, Paul Jepson and Drs Bas van Balen for their excellent guidance and patience. Secondly we would like to thank our counterparts from the Biology Department of Padjadjaran University, Bandung; Drs Iwan Setiawan and Drs Andy Prima Setiadi who joined us for fieldwork, who helped us in preparing seminars and with whom we had many thought-provoking discussions.

The following organisations and institutions co-operated and offered support to us during our research:
Indonesian Institute for Sciences (LIPI); BirdLife International Indonesia Programme; Institute of Systematics and Population Biology, University of Amsterdam; The Directorate General of Forest Protection and Nature Conservation (PHPA); Taman Safari Indonesia, Cisarua; Taman Mini Indonesia Indah, Depok; Museum Zoologi Bogoriense; National Museum of Natural History, Leiden; Research School for Biodiversity; Kutilang Birdclub, Yogyakarta; Symbiose Birdclub, Jakarta; Asian Wetland Bureau, Bogor; Kebun Binatang, Surabaya; Halmahera Expedition 1994, Bristol University; Expert Centre for Taxonomic Identification (ETI), Amsterdam.

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Pak Ashari, Pak Kamil Oesman, Pak Jansen, Pak Toni, M. Indrawan (Didi), Derek Holmes, Asep Adhikerna, Wahyu Widodo, Rona Dennis, Erik Meyaard, Jan Wind, Soenarto, Bas van Helvoort, Like & Leoni van Balen, Mark Linsley, Tulus Sibuea, K. J. Gurmaya, Hans Bartels, Herman Bruins, Helmut Albrecht, René Dekker, Annemarie van der Heijden, Henri Wijsman.
Jan Wattel, Steph Menken, Peter van Bree, Kees Hazevoet, Tineke Prins (Institute of Systematics and Population Biology, University of Amsterdam).

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PART A: GENERAL INTRODUCTION

1 Introduction

The Javan Hawk-eagle *Spizaetus bartelsi*, locally known as *Burung Elang Jawa*, was declared Indonesia's national bird and symbol of rare species by President Soeharto on the 10th of January 1993, because of its resemblance with *Burung Garuda*, Indonesia's mythological bird, and because of its rarity and uniqueness.

As its name implies, the Javan Hawk-eagle is restricted to the island of Java. It was previously thought to be confined to montane forest and to occur mainly in the best preserved forest areas. Although recently some surveys have been made (e.g. Meyburg et al., 1989, van Balen, 1991, van Balen & Meyburg, 1994), the species is still considered to be one of the world's least known raptors (van Balen et al., 1994). The knowledge we have today is largely derived from historical notes (e.g. Bartels, 1924, Hoogerwerf, 1949b), from specimens in museum collections and, to a lesser extent, from recent anecdotal records. Almost all basic data on the behavioural ecology of the Javan Hawk-eagle are lacking, the available knowledge being highly fragmented, and we are only just starting to get a better insight in the species' habitat preferences and habitat requirements. Although more research has to be done about the distribution and population status, the total population was recently estimated at less than 200 birds (van Balen & Meyburg, 1994). This low number, as well as the continuing habitat destruction and the probable recent increase in trade in the species, resulted in it being classed as endangered according to current IUCN threat categories (Collar et al., 1994).

1.1 RESEARCH AIMS

The aim of the present research was to contribute towards the establishment of criteria for a network of protected areas by the collection and interpretation of data concerning rare and vulnerable bird species in Central Java. The project was developed in conjunction with BirdLife International Indonesia Programme. We selected the Javan Hawk-eagle, one of the most endangered and least known raptors, as a typical representative of Java's unique biodiversity. By assessing the status of the Javan Hawk-eagle in the central part of the island as well as its altitudinal distribution and habitat preferences we have tried to achieve the first aim. This was complemented by ornithological surveys incorporating quantitative and qualitative components.

Because much about the status, the ecology and the distribution of the Javan Hawk-eagle is still insufficiently known, it is difficult to take appropriate measures for the conservation of this element of the Indonesian biodiversity. Our study of the species was aimed at two goals:

1. Study of the home range, habitat requirements and behaviour of the Javan Hawk-eagle
2. Study of the distribution of the Javan Hawk-eagle with special reference to the central part of the island.

This report is divided in four major parts. In the first part, a general introduction and abiotic and biotic data on of the island of Java are given. The recent geographic history, climate, and the occurrence of different forest types account for Java's rich biodiversity. A short description of the members of the genus *Spizaetus* is given as well as a more detailed description of the taxonomic history of the Javan Hawk-eagle. After the Javan Hawk-eagle's position in evolutionary history has been outlined the results of the research are presented.

In part two the geographical and altitudinal distribution of the Javan Hawk-eagle are discussed. The areas visited during the survey are described. Details are given of areas where Javan Hawk-eagles were encountered. In addition an updated population estimate is presented.

Part three focuses on the behavioural ecology of the Javan Hawk-eagle. Emphasis is laid on feeding behaviour, inter specific relations, reproductive behaviour and habitat preferences. Also a detailed description of the species is given with field characteristics and features relevant for its field identification.

Finally part four summarises the previous parts in order to determine the conservation status of the Javan Hawk-eagle. Threats are discussed and recommendations for its long-term survival are made.

1.2 JAVA'S BIODIVERSITY

Biodiversity encompasses the variety, variability and uniqueness of genes, species and ecosystems. With its wide range of natural habitats, rich plant and animal life and high numbers of endemics, Indonesia is one of the ten 'megabiodiversity' countries in the world. Together these countries account for 70% of all the world's biodiversity (McNeely et al., 1988 *in* Bibby et al., 1992). Bibby et al. (1992) mapped priority areas for global conservation by identifying areas with high numbers of restricted range species. Such areas are termed Endemic Bird Areas (EBA). There are 221 EBAs worldwide; with 24 Indonesia has more than other nation. Because of its richness in birds Indonesia has a great responsibility: of Indonesia's 1539 bird species 104 are classed as threatened (Collar et al., 1994).

Two of the Endemic Bird Areas are located on the island of Java. One of them in the lowlands (no. E 14, from 0 to 800m) and the other in the mountain forests (no. E 13, from 800 to 3000m). The latter is ranked in the highest priority group. Apart from being an important area for birds with 12% of the species being endemic, Java has 5% endemism in higher plants and 7% in mammals, and is quite distinctive from the other Sunda islands (Bappenas, 1993). About 28% of Javan landbirds are montane and amongst them are several endemic and rare birds. The status of their populations is still insufficiently known. Recently little intensive fieldwork concerning status and distribution of the endemic birds has been done, particularly in Central Java. One of the key species in Java's ecosystem is the rare and impressive Javan Hawk-eagle.

Because of the high human population density (800 people per km^2), pressure on the remaining highland forest on Java is very high. In Central Java this pressure is even higher, as this is the most deforested province, and no large areas are protected here. This is cause of great concern for the continued existence of the rare and endemic mountain flora and fauna. Protection is overdue, and in its absence delicate ecosystems will be seriously and irrevocably disturbed (Myers, 1989).

Several larger wildlife reserves have been established throughout Indonesia but few of them on Java. However Java has the largest number of reserves and receives most of the financial recources. Most of the reserves are rather small and lack adequate protection. Nowadays, the Indonesian authorities are realising that also in Java, and particularly in Central Java, some larger areas should have an effective protected status. Already in 1982 the FAO published a conservation plan for Java and Bali in which the most important areas are evaluated and several proposed protected areas indicated (MacKinnon et al., 1982). Some of these areas have not been surveyed and many of them lack plans for site protection and management.

The Indonesian government is also planning to establish an integrated protected area system including all major terrestrial habitats and covering *ca.* 10% of Indonesia's land area. Between 1977 and 1984 there was a rather high growth in areas legally gazetted as conservation areas but since 1984 almost no new areas have been gazetted (Bappenas, 1993). Also in Java one or more new national parks are planned in order to preserve Indonesia's unique wildlife. The PHPA/BirdLife Indonesia Programme is using birds to identify priority areas for gazettement. These organisations will advise the central government which areas are suitable as wildlife reserves. The presence of endemic species and especially those at the top of the food chain, such as the Javan Hawk-eagle, is an important indicator of high biological values (fauna as well as flora) of such an area.

1.3 GEOLOGY AND CLIMATE

Java is situated on the eastern border of the Sunda shelf. It has risen from the sea about 15-30 million years ago as a result of high tectonic and volcanic activity, so in geological terms the region is relatively young.

The Java Sea in the north is a shallow sea with depths less than 200m and is a part of the Sunda or Asiatic continental shelf. In the south the Sunda Trench runs down 7400m and marks the unstable zone where the Indo-Australian shelf shoves in northern direction under the Sunda shelf. As a result of this tectonic activity sedimentary marine deposits rose, forming the northern and southern parts of the island. In the south these belts are made up of limestone, marl and sandstone and in the north they form two limestone areas (van Steenis, 1972).

Between these hilly belts a backbone of volcanoes was formed. Java's volcanoes do not form a continuous mountain chain but are scattered along the island. In the west they lie close to each other with valleys and highlands in between: to the east they are more separated. Several peaks reach over 3000m with the Semeru in the east being the tallest with a hight of almost 3700m.

Between three million and 8000 years ago, during the Pleistocene, Java was connected to the Asiatic mainland several times. During the colder and drier interpluvial periods the sea level was repeatedly up to more than a hundred metres lower than nowadays and land now submerged by the Sunda and Java seas was exposed at the surface. During these times, Java, Sumatra and Borneo were a part of the Asian mainland and the Asiatic flora and fauna could freely colonise Java. Approximately 15000 years ago the island of Java was definitely isolated in its present shape. The intermitted connection to the mainland and the following isolations for different periods of time, profoundly influenced the present distribution of both flora and fauna and resulted in a high proportion of endemism. As a result of the drier conditions of the east -more or less similar to the climate during the interpluvials- several species which originated in Asia, still can be found in Java but do not occur in Sumatra or Borneo any longer (MacKinnon & Phillipps, 1993).

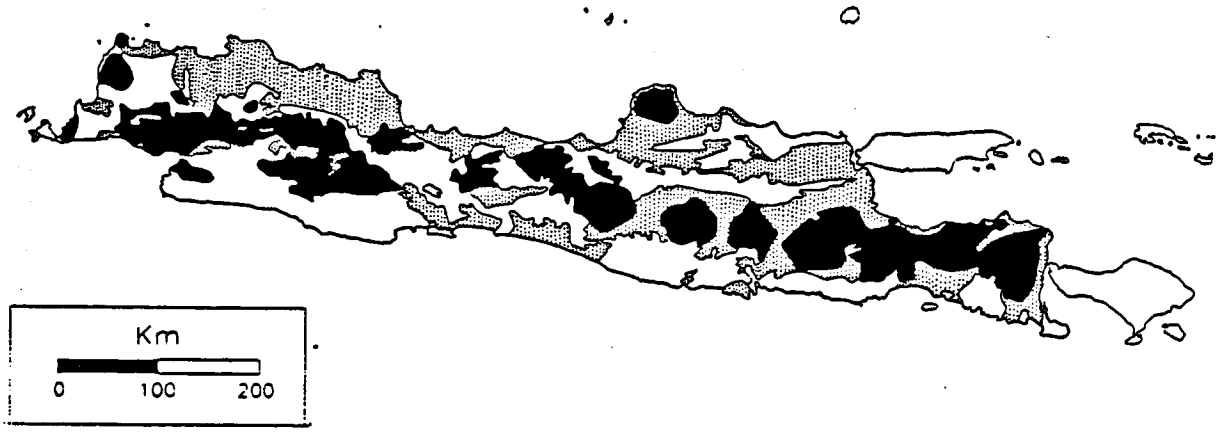


Fig. 1: Geology of the island of Java. Quarternary volcanoes and Tertiary basalts and andesites in black, Quarternary sediments in grey, and young and mid-Tertiary sediments in white (after Rutten, 1931).

The volcanic activities have resulted in fertile soils. New input of fresh mineral material occurs in the form of lava or ash. The ash from the volcanoes can spread very far and thus can enrich soils that are not typical volcanic (Mabberley, 1992). Volcanism is also a very disturbing force, not only owing to the deposition of ash or lava but also through the resulting landslides, fires and accompanied tidal waves. In Java several mountains never reach their climax vegetation because of these natural 'disasters'.

In general the climate in Java is hot and moist and does not change very much during the year. The length of day and night as well as temperature are rather constant. Daily temperature range in the lowlands is between 22°C and 34°C. However, in the mountain areas the climate shows more similarities with the temperate regions; the average temperature declines *ca.* 1°C with every 200m increase in altitude and above the 1500m frost can come in during the night (Holmes, 1991).

One of Java's striking features is its climatic contrast, with its impact on the vegetation, between the east and the west. The western half of the island is everwet with year-round rainfall and only a few drier months in June, July and August, and thus can support lush tropical rainforest. Here areas can be found with an annual

rainfall of 7000mm and more, and here more thunderstorm days are reported than anywhere else in the world. On the other hand, the eastern part and the northern coast have a far more pronounced dry season from May to October, the driest months being August and September (MacKinnon, 1990). The eastern part of Java is situated in the rain shadow of Australia and has similarities with the arid Lesser Sunda Islands. The easternmost tip of the island is also the driest part with less than 900mm annual rainfall. The dry season is most clearly marked in the east but also in the northern parts and has had a great effect on the vegetation and the wildlife. In the east deciduous monsoon forest can be found. Amidst the arid lowlands, the volcanoes on the eastern part form scattered wet islands as a result of stowage (rising air), even in the dry season the south-east wind brings rain onto the southern and south-eastern slopes (van Steenis, 1972). As a result of the high precipitation on these volcanoes lush rainforest can prevail.

Rather than looking at the annual rainfall, which can be evenly distributed over the year but can also be concentrated in a few very rainy months leaving the other parts of the year with scarcely any rain, it is biologically more interesting to measure the wetness of the climate by the number of rainy days during the four consecutive driest months of the year (van Steenis, 1972). The wettest vegetation types, i.e. the mixed lowland and hill rainforest and the montane everwet rainforest, only occur in those areas with at least 30 rainy days during the four consecutive driest months (van Steenis, 1965). The map in fig. 2 shows the distribution of the number of rainy days in Java in a simplified way. The wettest parts can be found in the west, the montane area between Gn Slamet and Gn Sundoro, and the southern slopes of the mountains in the east The driest areas with less than 10 rainy days during the four consecutive driest months are almost exclusively situated in the eastern half of the island.

Fig. 2: Climate types based on the number of rainy days during the four consecutive driest months of the year Areas with 0 to 10 rainy days during the four consecutive driest months are indicated in white, 10 to 30 rainy days in grey, and 30 days and more in black (after van Steenis, 1965).

1.4 NATURAL VEGETATION

Originally, Java was covered with tropical rainforest in the west and deciduous monsoon forest in the east; this as a result of the climatic gradient from everwet in the

west to a more seasonal drier climate in the east. The vegetation is not only effected by the climate, but also by Java's volcanic past. This had a disturbing and impoverishing effect on the islands floristic species richness. As a result, and because of its smaller size and partly seasonal climate, Java has a less extensive flora than the other Greater Sunda Islands with only 5% endemism against 11 and 33% on Sumatra and Borneo (Bappenas, 1993). Because of the continuing volcanic activity the vegetation on most of the mountains never reach their climax, but the succession is set back to one of the pioneer stages. Especially in the east large montane areas can be found covered in pioneer Cemara *Casuarina* forests. On those mountains where the volcanic activity is less, e.g. on Gn Gede Pangrango in the west, the vegetation has reached its climax and on the upper slopes a unique montane and alpine flora can be found.

The long-time volcanic activities have resulted in a very fertile soil and a high productivity. Even the ancient humans knew how to use these fertile soils and it is on such soils that the intensive agriculture with its high concentration of people is based (Mabberley, 1992). More than 60 percent of Java is cultivated and less than 10% remains under natural forest. Most of the natural forest can be found on the (upper) slopes of the mountains but also some areas in the lowlands are still covered with natural forest. Several vegetation types have totally disappeared however; viz. lowland forest in moist and seasonal areas and forest on limestone (MacKinnon et al., 1982).

A variety of different forest types can be distinguished, most of them have become rare but some of them still cover larger areas. The three major vegetation zones, for Java are: the lowland zone (between 0 and 1000m, with between 500 and 1000m the hill zone), the montane zone (1000 to 2400m, with between 1000 and 1500m the submontane zone) and the subalpine zone (above 2400m) (van Steenis, 1972). Forest are a source of genetic resources both floristic and faunetic. They are also very important for they protect the area from watersheds, prevent soil erosion, regulate water flow, actively modify climate and maintain and provide clean air and water.

By comparing fig. 3 with fig. 4 it becomes clear that the recent deforestation has not only resulted in the decrease of the forested area but also resulted in the fragmentation of the forest patches. The remaining forest is scattered on the island and the resulting patches form islands of forest themselves. Most of the forests occur on the slopes of volcanoes that run along the island. The larger forest blocks survive in the eastern and western part of the island. The central part has suffered the most from deforestation.

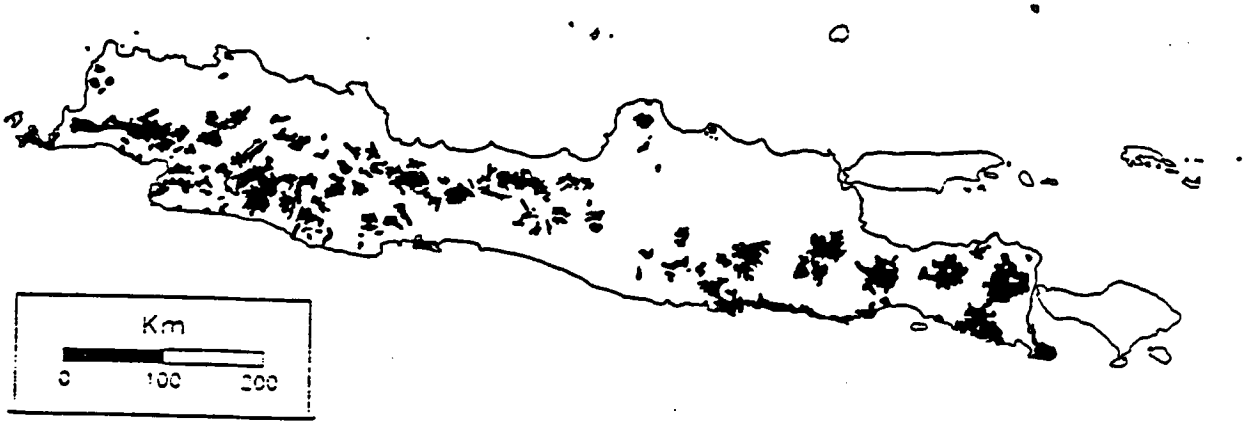


Fig. 3: Remaining natural forests on the island of Java, excluding mangrove forests (after van Steenis, 1965).

Fig. 4: Remaining natural forests on the island of Java, excluding mangrove forests (after Collins et al., 1991).

Although some of the areas covered by natural forest may seem relatively large, they themselves are also made up of several smaller forest areas with more or less disturbed areas in between. On the other hand, large areas are covered with plantations and production forest, and thus may provide a habitat for the less sensitive species or can be used as stepping stones. The question whether or not this is true remains open.

1.5 MOUNTAIN BIRDS OF JAVA

Being located in the extreme east of the Sundaic subregion Java and Bali are the most isolated of the remaining land masses and also furthest from the Asian mainland. Java is slightly less rich in bird species than Borneo and Sumatra but more distinct with some 27 endemic species still present and one (Javan Lapwing, *Holopterus macropterus*) recently extinct. The Javan avifauna is most closely related to that of Sumatra and shares 75% of its bird fauna with this island (MacKinnon & Phillipps, 1993). In Java 498 bird species have been recorded (Andrew, 1992) of which 368 are residents (MacKinnon, 1990).

Of the 27 endemics, 20 are confined to Java only, and another 7 are shared with Bali. Around 30 species, mostly species adapted to a drier climate, can be found in Java and in mainland south-east Asia, but do not occur in Sumatra or Borneo (MacKinnon & Phillipps, 1993). The composition of the resident bird species changes from west to east with more true Sundaic rainforest species in the west and more monsoon forest birds in the east.

The Javan mountains are an area of special interest as the avifauna here is less impoverished than in the lowlands: more than 80% of the endemics can be found in this habitat and almost half of them are exclusively montane.

Distribution studies on birds confined to the hill and montane forest have been mainly performed in the western and eastern parts of Java. The ornithological better known areas of West and East Java are separated by a wide gap in Central Java. MacKinnon (1990) states that the avifauna becomes poorer when travelling from west to east with 340 species resident in West Java, 316 in Central Java and 299 in East

Java. However as little intensive fieldwork has been done on the mountain birds, especially of the central part of Java the species richness in this province is probably higher in reality than previously estimated. This is probably not only valid for birds but also for other groups of plants and animals.

To protect species or habitat types, sufficient knowledge on the distribution is needed. It is therefore of the utmost importance for the long-term survival of all species, both floristic and faunistic, that the gap in the knowledge about Central Java is closed. By studying the Javan Hawk-eagle, one of the key species in the lowland and montain areas of Java (the two EBAs of Java), and by ensuring its long-term survival it is thought that many more species will benefit.

PLATE I ERRONEOUS DEPICTIONS OF THE JAVAN HAWK-EAGLE

1. Burton 1989.

[Chest and throat should be whitish with bold black dropmarks, crest longer and white-tipped]

2. Stamp of the Republic of Indonesia, 'Endangered species' 1993.

[Too many bands on the tail, banding on underparts too clear, chest and throat too speckled]

3. Brown & Amadon 1968; adult bird.

[Chest too much banding, crest lacking the two elongated white-tipped feathers]

4. BirdLife Int. Indonesia Programme calendar 1994, artist C. Rose.

[Crest lacking the white tips, underparts of body too white, striping on the talons should be horizontally, whitish margin on tail lacking, feathers on wings and back should be with beige margins]

5. Telephone book, Bogor, Sept. 1993-1994.

[Too many tail bands with yellow instead of greyish-beige, colour too green, lacking the light barrings on the underparts and white chest, crest too short and lacking the white tips]

6. Hoogerwerf 1949b; from left to right: immature, intermediate and adult bird.

[Immature's eye should be darkgrey or bright yellow, intermediate resembles adult but white throat and chest lacking, eye should be bright yellow, the adult resembles an intermediate bird, the eye should be yellow]

7. Bobo, Majalah Anak-anak No. 43 Tahun XX, Jakarta, Feb. 1993.

[Overall image too dark, throat and chest should be whitish, crest longer and with white tips]

8. MacKinnon 1990; adult bird.

[Resembles a subadult bird, legs too white]

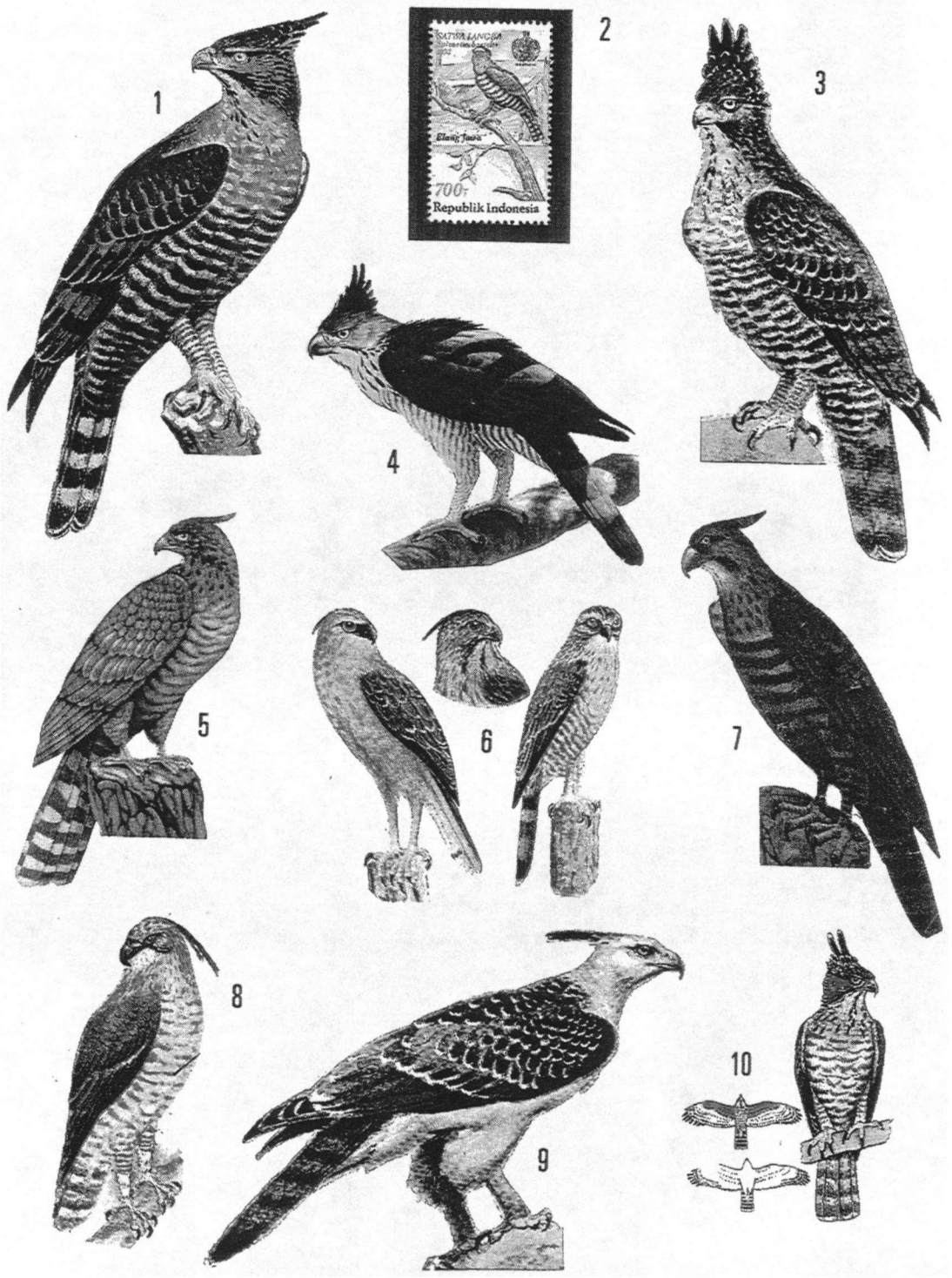
9. Brown & Amadon 1968; immature bird.

[No remarks]

10. MacKinnon & Phillipps 1993; adult bird and flight images of adult (top) and immature bird (bottom).

[adult lacking the whitish chest and throat, flight image (top) should not have white, flight image immature (bottom) should not be white]

PLATE I


1
2
SATRIA LANCIA
Elang Jawa
700
Republik Indonesia
3
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10

2 The genus *Spizaetus*

In this chapter an overview of the genus *Spizaetus* is given. Hawk-eagles of this genus are medium to large tropical raptors with broad wings and long tails, often crested. They are usually seen gliding on level wings or soaring with wings held in a shallow 'V'; hind margin of the wings appear 'pitched in' where it joins the body; tarsi are feathered (Lekagul & Round, 1991). Immatures are strikingly different from the adults and all species are known to have high-pitched screaming calls All species are residents (Brown et al., 1982).

A short description of the different taxa included in the genus follows and distribution of each species is shown. As not much is known about the biology of the Javan Hawk-eagle, we sometimes make comparisons with its congeners. Measurements of wing length, tail/wing-index and average tarsus/wing-index are after Wijsman 1963.

Suborder: Accipitres
Super-family: Accipitroidea
Family: Accipitridae
Genus: Spizaetus

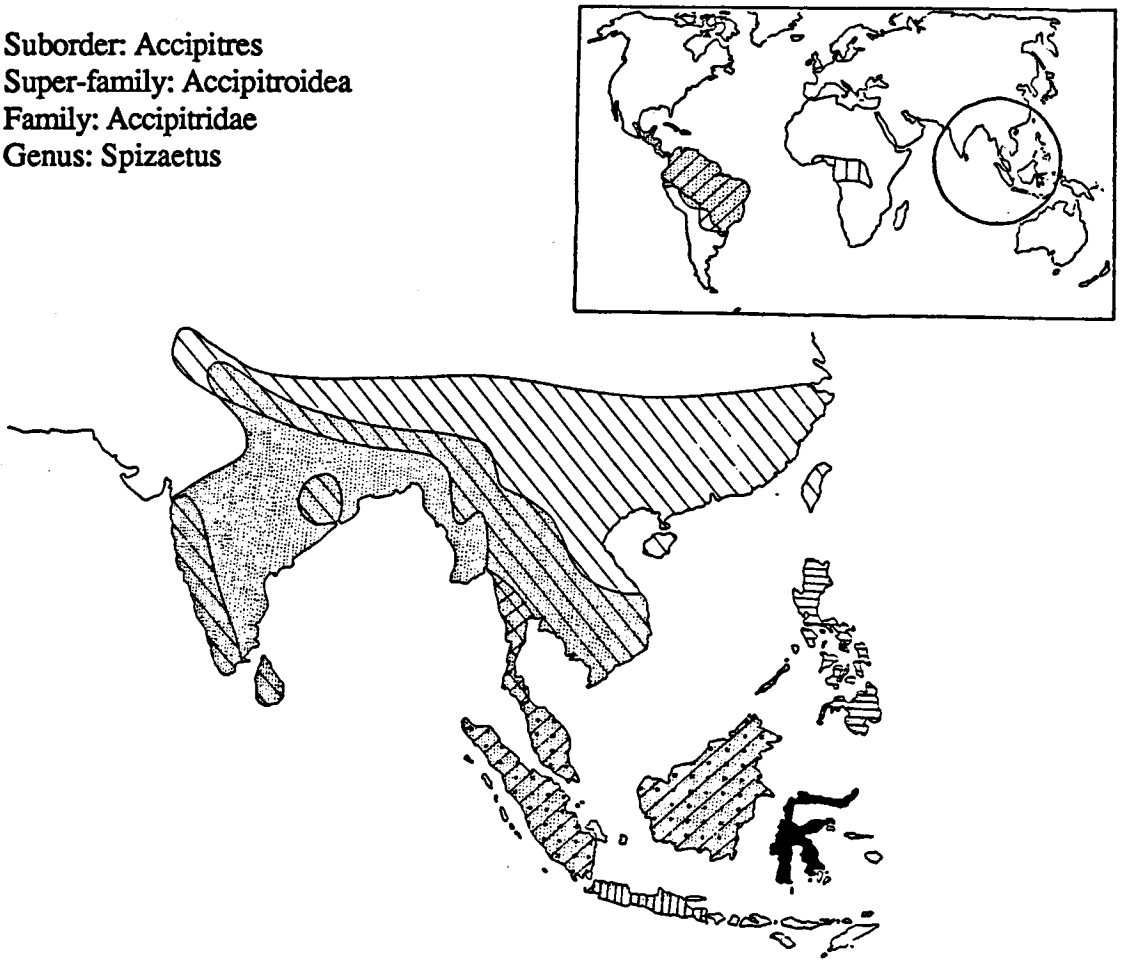


Fig. 5: Distribution of the genus *Spizaetus*.in the world (a) and in South-East Asia (b).
Map a: [⁘] = *S. ornatus*, [▽] = *S. tyrannus*, [▥] = *S africanus*. Map b: [⁘] = *S. cirrhatus*, [▨] = *S. nipalensis*, [▽] = *S. nanus*, [⁙] = *S. alboniger*, [■] = *S. lanceolatus*, [▤] = *S. philippensis*, [▥] = *S. bartelsi*

2.1 THE SOUTH-AMERICAN MEMBERS

2.1.1 Ornate Hawk-eagle *S.ornatus*

Short description: medium sized crested Hawk-eagle (58-67cm).
Adult plumage: wings and back blackish; upperside of the tail greyish-brown with four black bands; head and nape chestnut to reddish-brown, crown black; crest black; throat and chest pure white with a few black dropmarks on the lower parts, chestnut of neck extending to the sides of the chest; belly pure white with bold black bars; talons quite long, finely barred black and white and feathered to the base of the feet; cere yellow, iris orange, bill and claws black; feet yellow (after del Hoyo et al., 1994). Wing length 312-399mm, tail/wing-index 69-77 %, average tarsus/wing-index 24 %. Mean weight: female 1421 g. (n=4, range 950-1760 g.), male 1069 g. (n=3, range 841-1215 g.) (Dunning, 1994).
Immature plumage mostly white from below, back and wings dark brown; tail dark brown with four black bands; head and nape predominantly white, crest feathers black with white tips (after del Hoyo et al., 1994).

Voice: a high pitched screaming "wheeoo-whee pee pee" or "wheeoo whee peep" (Brown & Amadon, 1968).

Range: Central Mexico to northern Argentina (Madrid et al., 1991).

Distribution and status: not uncommon bird of tropical forests, up to 3000m (del Hoyo et al., 1994).

Habits: This Hawk-eagle hunts very low in dense forest, and specimens taken in mistnets were caught one or two metres above the ground (Olrog, 1985). Recorded prey comprises small mammals and birds (Lyon & Kuhnigk, 1985) and reptiles (Klein et al., 1988).

Note: two subspecies have been recognised (Stresemann & Amadon, 1979).

2.1.2 Black Hawk-eagle *S. tyrannus*

Short description: medium sized (58-71cm) crested Hawk-eagle.
Adult plumage: wings and back black; upperside of the tail grey with four black bands, end of tail with thin grey margin; head and nape black, short crowny crest mixed with white; chest and belly black, lower abdomen and thighs with fine white barrings; talons feathered to the feet, with fine white barrings; cere grey, iris orange-yellow, bill and claws black; feet orange-yellow (after Brown & Amadon, 1968). Wing length 367-455mm, tail/wing-index 72-88 %, average tarsus/wing-index 23 %. Weight 1025 (n=1) (Dunning, 1994)
Immature unique in the genus, having a white line from the forehead to over the eyes and a white throat; tail with more and finer bands; crown mixed with white and buff,

crest feathers white-tipped; chest streaked with black and brown; belly and abdomen blackish; iris orange brown, feet yellow (after Brown & Amadon, 1968).

Voice: this quite vocal species has a loud, ringing call "ker ker, ker ker, cu-weer" (Brown & Amadon, 1968) or "whit-whit-whit-wheeeeeeeer" (Burton, 1989).

Range: Central and South-America from central Mexico to eastern Peru, southern Brazil and north-eastern Argentina (del Hoyo et al., 1994).

Distribution and status: fairly common bird of the tropical forests in lowland and up to 3000m (del Hoyo et al., 1994).

Habits: Presumably hunts in forest canopy where birds, mammals and reptiles are taken (del Hoyo et al., 1994).

Note: two subspecies have been recognised (Stresemann & Amadon, 1979).

2.2 THE AFRICAN MEMBER

2.2.1 Cassin's Hawk-eagle *S. africanus*

Short description: small (50-61cm) though heavily built, crestless Hawk-eagle.
Adult plumage: wings and back dark brown; upperside of the tail brown with four black bands, underside paler; head and nape dark brown; chest white with bold black patches at the sides of the breast; belly and lower abdomen white; talons white with black markings on the outside of the thighs and feathered to the feet; cere pale yellow, iris pale yellow to brownish-cream, bill and claws black; feet pale yellow (after Brown & Amadon, 1968). Wing length 325-369mm, tail/wing-index 63-71 %. Mean weight: 1047 g. (n=3, range 938-1153 g.) (Dunning, 1994).
Immature much paler; head cinnamon-rufous, throat and crown streaked black; underparts rufous-buff, spotted on the chest; iris greyish-brown (after: Brown et al., 1982; Brown & Amadon, 1968).

Voice: a long and high pitched "weeeee-e" or "eeeeee-eh" lasting 1-2 seconds (Brown et al., 1982).

Range: Africa; from Togo east to Gabon, Cameroon, East-Zaire and West-Uganda (Brown et al., 1982).

Distribution and status: probably not uncommon bird of the dense tropical forests (Brown et al., 1982).

Habits: hunts for birds and small mammals probably in the forest canopy The finding of a juvenile at the nest site *ca.* six months after fledging suggests a prolonged post-fledging period (Brown et al., 1982).

Note: poorly known species. Monotypic (Stresemann & Amadon, 1979).

2.3 THE ASIAN MEMBERS

2.3.1 Changeable Hawk-eagle *S. cirrhatus*

Short description: large crestless or crested (different subspecies) Hawk-eagle (56-81cm).
Adult plumage (of *S. c. cirrhatus*, India): wings and back brown; upperside of tail brown with four dark brown bands, underside white with three brown bands; head brown with thin black horizontal streaks, nape brown; crest consists of six large and four smaller white-tipped blackish feathers; chest to lower abdomen white with dark brown vertical streaks; talon feathers buff, covering the base of the feet; cere greyish-greenish-brown, iris bright yellow, bill and claws black, feet yellow (after Naoroji, 1985; Brown & Amadon, 1968). Wing length 312-462mm, tail/wing-index 61-79 % (in 6 subspecies), average tarsus/wing-index 28 % (in 4 subspecies). Weight range 1360-1810 g. (Dunning, 1994).
Immature has unmarked, buffy white head and white underparts, on the flanks some light brown spots; iris grey (Henry, 1979).

Voice: a harsh and abruptly closed "Kleee-leek!" (own obs.), a ringing "kleee-klee-ek" or a rapid "ki-ki-ki-ki-ki-ki-ki-keeee" ending in a scream (Brown & Amadon, 1968), or a series of shrill whistles "kri-kri-kri-kri-kree-ah" (Lekagul & Round, 1991).

Range: India (including the Andaman Islands); Sri Lanka; Nepal to Burma; South-East Asia; Greater Sunda Islands, Sumbawa and Flores (Indonesia); Philippines (del Hoyo et al., 1994).

Distribution and status: widespread common to uncommon bird throughout its range, occurring in lowlands up to 1800m. Variable habitat preferences in different parts of its range have been reported (e.g. Bartels, 1924). The Sumatran and Javan races are known to inhabit the dense rainforests but also commonly frequent open country and cultivated land as e.g. rice paddies (Brown & Amadon, 1968). The species can be found in cultivated land as long as some patches of natural forest or plantation forest is present in the surroundings (Bartels, 1924) and can frequently be seen in the vicinity of villages. It is known to breed in forest edges (Kuroda, 1936) and even in cultivated land (Bartels, 1924).

Habits: hunts for smaller preys, usually birds (Hoogerwerf, 1949b), mainly game birds and poultry, and occasionally squirrels, rats, lizards and snakes (Bartels, 1931).

Note: besides its variable plumage and the occurrence of a black morph that is strikingly different from the pale one, six subspecies have been recognised (Stresemann & Amadon, 1979).

2.3.2 Mountain Hawk-eagle *S. nipalensis*

Short description: largest, crested Hawk-eagle of the genus (67-86cm)
Adult plumage: wings and back dark brown; upperside of the tail dark brown with 5 dark gray to black bands; head dark brown streaked with white, nape dark brown; long, white-tipped black crest; throat white with blackish mesial and moustachial stripes; chest light-rufous with black dropmarks; belly dark brown with white barrings that become smaller towards the abdomen; talons quite long and feathered to over the base of the feet, white barred dark brown; cere dark grey, iris yellow, bill and claws black; feet dull yellow (after Brown & Amadon, 1968). Wing length 402-535mm, tail/wing-index 64-74 % (in 3 subspecies). Weight male 2500 g., female 3500 g. (Dunning, 1994).
Immature largely white; underparts light cinnamon-brown; head and nape whitish, lightly streaked with black; feathers of wings and back with buff margins; more bands (dark brown) on the lighter-brown tail; iris grey (after Brown & Amadon, 1968).

Voice: the call consists of three shrill notes "tlueet-weet-weet" (Lekagul & Round, 1991) or during the breeding season a gurgling shout "awh-awhrr" (Henry, 1979).

Range: Asia; North and southernmost part of India, Sri Lanka, from Nepal east to South China, East China, Hainan, Taiwan, Thailand, Malaysia, Japan (del Hoyo et al., 1994).

Distribution and status: uncommon to rare bird (del Hoyo et al., 1994) of evergreen, deciduous and coniferous forests from lowland up to 3300m (Lekagul & Round, 1991; Brown & Amadon, 1968).

Habits: hunts for poultry, mammals and reptiles at clearings on the forest floor, by taking up a post of vantage on a high branch and stooping down if prey is in sight (Henry, 1979) or while flying.(Morimoto & Iida, 1992).

Note: as three subspecies have been recognised (Stresemann & Amadon, 1979) and the species has a wide distribution, the above short description is not valid for all birds, e. g. crestless *S. nipalensis* ssp. have been described and plumages may vary.

2.3.3 Wallace's Hawk-eagle *S. nanus*

Short description: smallest, crested Hawk-eagle of the genus (43-58cm)
Adult plumage: wings and back dark brown; upperside of the tail greyish-brown with three black bands, underside more contrastingly barred than upperside; head and nape dark brown, crown streaked brighter brown, long crest consisting of four buff-tipped black feathers; mesial stripe blackish, moustachial stripes consisting of dark brown streaks; upper chest and sides of the head with ill-defined buffy brown collar, lower chest whitish, covered with blackish dropmarks; belly and lower abdomen whitish with dark brown bars; talons buffy with fine dark brown barrings; cere grey, iris yellow, bill and claws black, feet yellow (after Hoogerwerf, 1946; Brown & Amadon, 1968).

Wing length 280-346mm, tail/wing-index 71-79 % (in 2 subspecies), average tarsus/wing-index 26 %.
Immatures' head and underparts whitish, washed and streaked buff brown to brown; back and wings paler than adult, with buffy margins; tail with reduced bars (Brown & Amadon, 1968).

Voice: a shrill "yik-yee" (Lekagul & Round, 1991).

Range: South Malaysia, South Thailand and Indonesia; Sumatra (including Nias island) and Borneo (MacKinnon & Phillipps, 1993).

Distribution and status: rare bird of the lowland evergreen forests (del Hoyo et al., 1994).

Habits: probably feeds on small prey such as birds, reptiles and small mammals (del Hoyo et al., 1994).

Note: the Javan Hawk-eagle described by van Heurn & van Heurn (1926) which was obtained from Sumatra is, to be judged from its total length of 53cm and the photograph, likely to be a member of *S. nanus*. Two subspecies have been recognised (Stresemann & Amadon, 1979).

2.3.4 Blyth's Hawk-eagle *S. alboniger*

Short description: medium sized (51-58cm) crested, black and white Hawk-eagle. Adult plumage: wings and back black; upperside of the tail pale grey with two black bands widely apart, underside paler; head and nape black; crest long, consisting of two white-tipped black feathers; throat and chest pure white, mesial stripe black, bold black dropmarks; belly and lower abdomen pure white barred black; talons quite long, white with black barrings, feathers covering the base of the feet; cere grey, iris light yellow, bill and claws black, feet yellow (after Brown & Amadon, 1968). Wing length 322-366mm, tail/wing-index 67-72 %, average tarsus/wing-index 27 %.

Voice: variable shrill whistles like "kee-kew-kew" or kreee-krit" (Lekagul and Round, 1991) or "yhu yhu yip-yip-yip" (King et al.,1976).

Range: South Burma (del Hoyo et al., 1994), Peninsular Thailand and Malaysia, Sumatra and Borneo (King et al.,1976).

Distribution and status: uncommon to fairly common bird of evergreen hill and mountain forests from lowland up to 1700m (Lekagul and Round, 1991).

Habits: hunts in the forest canopy where it preys upon mammals, birds and reptiles (del Hoyo et al., 1994).

Note: monotypic species (Stresemann & Amadon, 1979).

2.3.5 Sulawesi Hawk-eagle *S. lanceolatus*

Short description: medium sized Hawk-eagle, 56-64cm, without pronounced crest. Adult plumage: wings and back dark brown; upperside of the tail dark brown with four black bands, underside beige with three black bands and a beige margin at the end; head and nape very dark brown; moustachial and mesial stripes dark brown to black on beige throat; chest rufous to cinnamon brown with very thick black dropmarks; belly and lower abdomen rufous brown with white barrings; talons quite long, white with fine dark brown barrings and feathers covering the base of the light yellow feet (after Brown & Amadon, 1968) The colour of bill and claws are not known, but is probably similar to that of the other species. Wing length 335-402mm, tail/wing-index 69-74 %, average tarsus/wing-index 23 %.
Immature plumage: head white with brownish streaks; underparts white (after Brown & Amadon, 1968).

Voice: first year birds were heard to produce a fast repeated "kee-kee-kee" (42-50 times per 10-11 seconds; van Balen, 1991).

Range: Sulawesi (Indonesia) and the off-lying islands of Muna, Butung, Banggai and Sula (del Hoyo et al., 1994).

Distribution and status: lowland and mountain forest from 250 to over 1500m (White & Bruce, 1986). Found not to be uncommon by Meyburg and van Balen (1994).

Habits: tends to hunt in the forest canopy as well as in clearings in the forest, nest recorded in August in a large tree at an altitude of 1600m (Burton, 1989).

Note: monotypic species (Stresemann & Amadon, 1979).

2.3.6 Philippine Hawk-eagle *S. philippensis*

Short description: medium sized crested Hawk-eagle (64-69cm).
Adult plumage: wings and back dark brown; upperside of the tail pale brown with five dark brown bands; head and nape dark brown with pale brown edges; long black crest consisting of four feathers; throat and chest rufous with dark brown dropmarks; belly darker brown, unmarked; thighs and legs dark brown finely barred with whitish, feathers covering the base of the feet; cere dark grey, iris bright yellow, bill and claws black, feet light yellow (after Brown & Amadon, 1968). Wing length 350mm, tail/wing-index 70 %. Weight female 1168 (n=1) (Dunning, 1994).
Immature birds can be easily distinguished by their pale head and white underparts (after Brown & Amadon, 1968).

Voice: not known.

Range: endemic to the Philippines (Dickinson et al., 1991).

Distribution and status: uncommon bird of lowland and mid-montane forests (Dickinson et al., 1991).

Habits: not known.

Note: very poorly known species. Monotypic (Stresemann & Amadon, 1979).

2.3.7 Javan Hawk-eagle *S. bartelsi*

Short description: medium sized (60-*ca.* 70cm) Hawk-eagle with a long crest. Adult plumage: wings and back dark brown, upperside of tail dark brown with three visible black bands, white margin at the tip, underside grey with three dark brown bands and grey margin at the end; head and nape chestnut brown; thin white-tipped crest up to 12cm, mesial stripe and moustachial stripes black; chest whitish with bold black dropmarks; belly, lower abdomen and legs whitish, barred dark brown; talons quite long with feathers covering the base of the feet; cere grey; iris bright yellow; bill and claws black; feet light yellow. Wing length 349-358mm, tail/wing-index 69 %. Immature plumage: without mesial and moustachial stripes and barrings; chest, belly, lower abdomen and legs cinnamon brown; tail with reduced bands; iris dark grey. Intermediate plumages occur between first and *ca.* sixth year.

Voice: single or repeated high pitched "ee-eeew" or "eew-eee" which gradually fades; less common calls are: "ee-ee-eeew", just "eeew", "klee-eeew", "glee-eck!" or a fast repeated "klü-klü-klü".

Range: endemic to Java, Indonesia.

Distribution and status: endangered resident in the primary lowland and montane forests of Java, recorded from sea level up to 3000m.

Habits: inhabits the best preserved forest areas; hunts mainly in the forest canopy where it preys on reptiles and small to medium-sized mammals; breeding recorded in large Rasamala trees; can be seen circling during the morning when usually vocal.

Note: Monotypic species (Stresemann & Amadon, 1979).

3 Taxonomy and identification

3.1 TAXONOMIC HISTORY AND SYSTEMATIC POSITION

Already in the year 1820 the first specimen of *Spizaetus bartelsi* was collected by Kuhl and van Hasselt, and it was erroneously identified as *Spizaetus cirrhatus*. Three years later Kuhl and van Hasselt collected another specimen. Both specimens were sent to the collection of the National Museum of Natural History, Leiden, The Netherlands, one erroneously being filed as *cirrhatus*. A third specimen was collected by Bernstein in West Java (year of collection not known), and was also misidentified as *Spizaetus cirrhatus limnaetus*. This bird was also presented to the Leiden Museum (Stresemann, 1924). In 1898 a fourth specimen was collected by Prillwitz at Gn Gede, West Java. This immature female was also identified as *S. c. limnaetus* (Amadon, 1953).

Finsch (1908) noticed that a bird sent to him by M. Bartels Sr., who collected this specimen in 1907 in West Java, was quite different from *S. cirrhatus limnaetus*, known to occur on the island of Java. He was convinced that it concerned another species and Finsch was the first to describe a crested form of *Spizaetus* other than *S. cirrhatus limnaetus*. He concluded that this bird (currently known to be a specimen of *S. bartelsi*) must have been a straggler of *S. nipalensis kelaarti* from Sri Lanka.

Stresemann (1924) made a revision of the races of the species *S. nipalensis* and *S. cirrhatus* and found that the size of the bird mentioned by Finsch was intermediate between that of *S. n. kelaarti* and *S. n. alboniger*. Therefore he described it as a new subspecies of *S. nipalensis* and named it after its collector: *Spizaetus nipalensis bartelsi; "Ich benenne diese ausgezeichnete Form zu Ehren ihres Wiederentdeckers, der sich im Verein mit seinen Söhnen so erfolgreich um die Erforschung ihrer Lebensweise bemüht hat".*

Some years later Stresemann (1938) realised that many of his earlier named subspecies of *S. nipalensis* had been isolated from each other for a long period of time and had evolved into separate species. He also found that *S. nanus* could be devided into separate subspecies and that the bird handled by Finsch was one of these. He therefore renamed *S. nipalensis bartelsi* as *S. nanus bartelsi.*

Hoogerwerf (1946) took measurements of the six Javan specimens present at the Museum Zoologi Bogoriense, collected in Java, that were renamed by Stresemann as *S. nanus bartelsi.* He found that these birds of the genus *Spizaetus* were far too large to belong to the species *S. nanus*. He stated that the measurements of wings, tail, middle toe and the wing-tail-index were even larger than those of *S. alboniger* and that it was therefore more likely that they were closer related to *S. alboniger* than to the much smaller *S. nanus*. Hoogerwerf said that it was likely that the Java-birds mentioned above belonged to the *S. nipalensis* "Formenkreis", but because there was insufficient study material in Bogor and a lack of literature, he found it premature to make any pertinent statements about their systematic position.

Amadon (1953), who was sent three eagles of the genus *Spizaetus* from Borneo for identification, got interested in this taxonomically difficult group of *Spizaetus* and tried to answer some of the questions left open by Stresemann and Hoogerwerf. He made a review of the whole group of Asiatic *Spizaetus* species and came to the conclusion that

the crested birds from the island of Java were separated from the range of *S. nipalensis* by *S. alboniger* which occurs on the island of Sumatra, and therefore did not find it justified to recognise them as a race of *S. nipalensis*. He found that the *bartelsi* birds - although having more similarities with *S. nipalensis* than with any of the other species- should be considered a full species, forming a super species together with *alboniger, lanceolatus,* and *philippensis* and *S. nipalensis.*

Although today the Javan Hawk-eagle is generally considered to be a separate species, its systematic position remains unresolved.

For instance, Brown & Amadon (1968) stated that; "*S. bartelsi* may be closer to *S. nanus* than to *S. nipalensis*". This weakened Amadon's (1953) previous statement that *bartelsi* forms, together with *alboniger, lanceolatus* and *philippensis,* a super species with *S. nipalensis,* without involving *S. nanus*. However Amadon, in 1979, stated again that *bartelsi* and perhaps *lanceolatus, philippensis* and *alboniger* form a super species together with *nipalensis* (Stresemann & Amadon, 1979).

H. Bartels (pers. comm.) thinks that the Javan Hawk-eagle is not a separate species, but a subspecies of *S. alboniger.* He refers to the similarity in vocalisations of immature birds of these taxa as well as their secretive way of life in a similar kind of habitat, i.e. lowland forests.

Van Balen (1991) reported to have heard calls of *S. alboniger* in Malaysia which he found much like those of *S. bartelsi.* He confirms Bartels' statement that both birds have the same habitat preferences. About relationship with *lanceolatus* he says: "In contrast, calls of *S. lanceolatus* in Sulawesi ... appeared to differ completely from those of *S. bartelsi*".

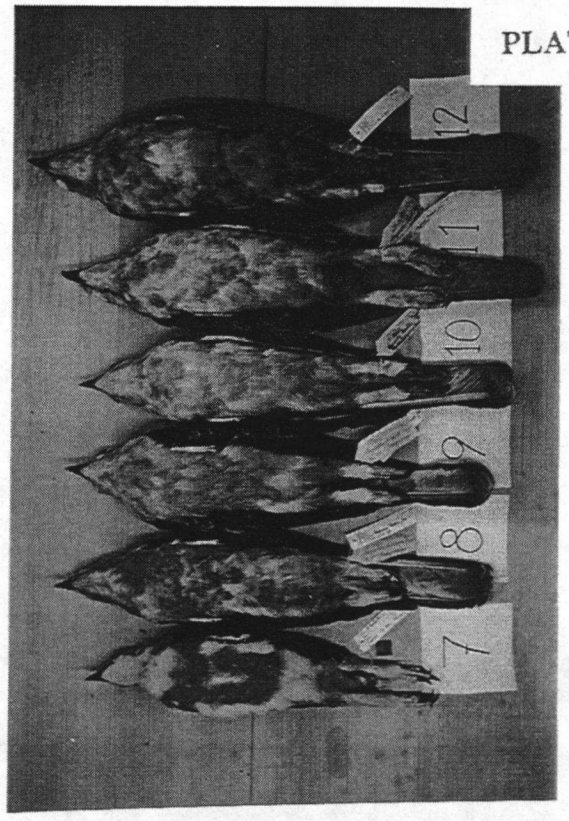
These contradicting statements about classification which are often based on few data only, make a sound phylogenetic analysis of the evolutionary relationships of *bartelsi* all the more interesting. As we have not done any studies on these relationships we cannot give a solution to this problem, but we do have the strong impression that in the past most of the classifications were more based on authority of the researchers rather than on the characteristics of the different species.

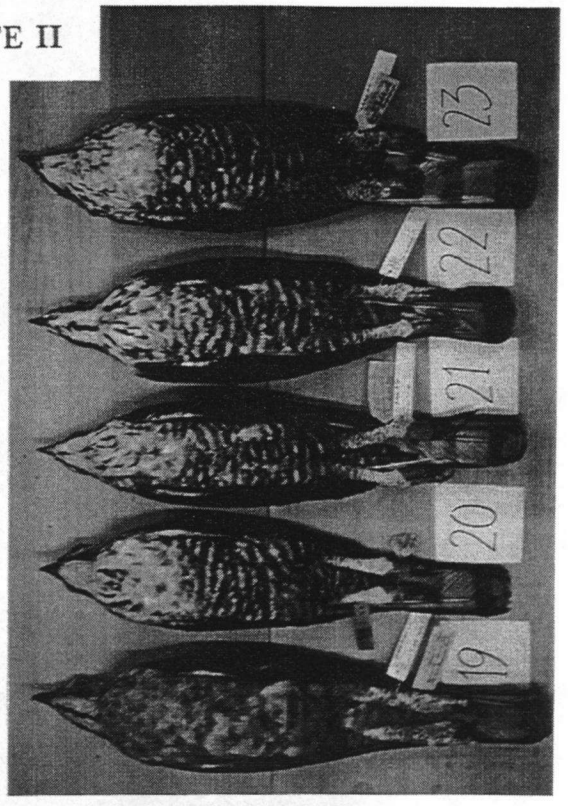
PLATE II MUSEUM SPECIMENS OF JAVAN HAWK-EAGLE

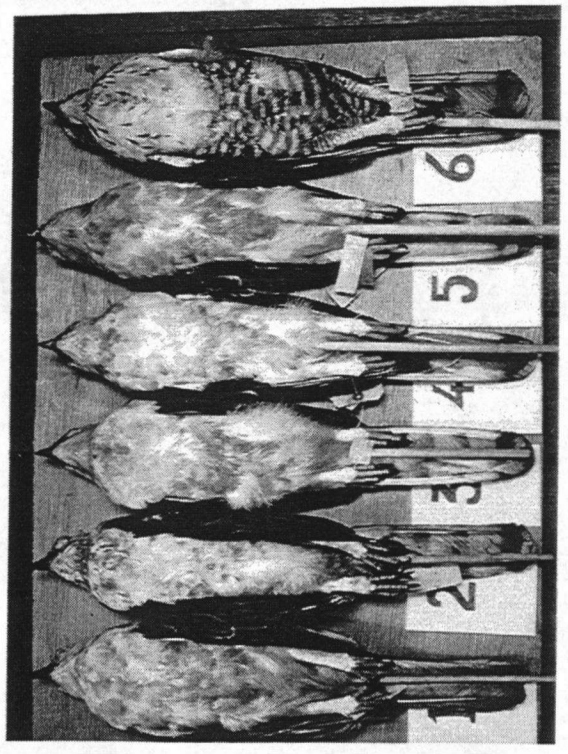
No. 1-6: Museum Zoologi Bogoriense, Bogor, Indonesia, No. 7-23: National Museum of Natural History, Leiden, The Netherlands (photos: V. Nijman).

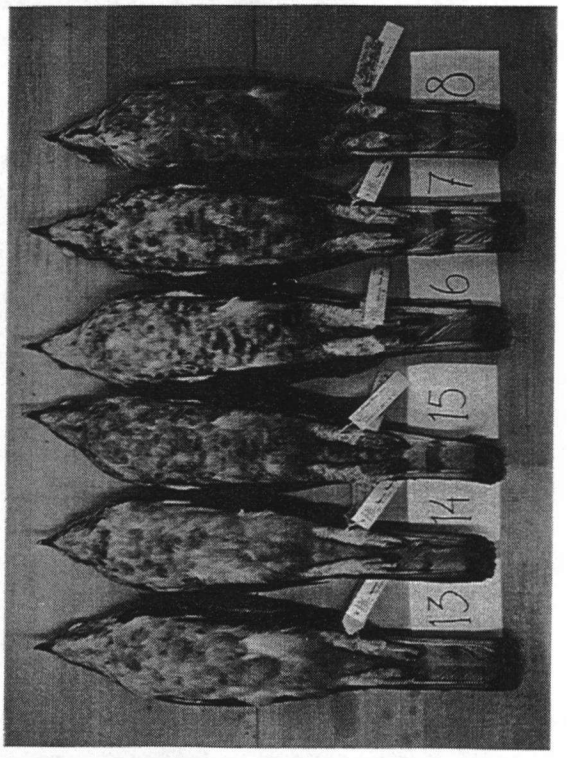
Approximate ages: 1. first year bird; 2. third year bird; 3. second year bird; 4. second year bird; 5. second year bird; 6. ≥ sixth year bird; 7. chick; 8. third year bird; 9. first year bird; 10. first year bird; 11. third year bird; 12. fourth year bird; 13. third year bird; 14. third year bird; 15. fourth year bird; 16. fifth year bird; 17. fifth year bird; 18. fifth year bird; 19. fifth year bird; 20. ≥ sixth year bird; 21. ≥ sixth year bird; 22. ≥ sixth year bird; 23. ≥ sixth year bird.

PLATE II









3.2 FIELD IDENTIFICATION

The field identification of the Javan Hawk-eagle is difficult due to the variability of its plumage during the different stages of the birds life until it reaches maturity, and because of lack of a good descriptions or illustrations in field guides. In 1924, Bartels already drew attention to the different immature plumages of the bird but descriptions were never published.

Until now descriptions in standard works on raptors are rather poor or even wrong. Most of the illustrations show juveniles or immatures. Even if a juvenile and an adult are depicted, the adult is at its best subadults (see plate I). In addition more than once several important field characteristics are not shown, probably because most of the illustrations are largely based on older depictions and museum skins and not on actual field observations. We have rarely seen flight images and those we have seen were rather poor and not characteristic and once again mainly based on juvenile birds.

As an aside it may be stated that most of the Javan Hawk-eagles that are stored in the different museums are juveniles or immatures and even the type specimen of the Javan Hawk-eagle, stored in the National Museum of Natural History at Leiden, the Netherlands, is an immature bird, probably in its first or second year plumage.

The Javan Hawk-eagle is a distinctive raptor. Although recently more ornithological research has been carried out on Java, we have the impression that still only a few people are able to identify the species. Features useful for the identification of the species, a more accurate description of the several plumages and flight image are given and, in order to minimise confusion with other raptors that could be held for Javan Hawk-eagles, we also give some differences with those species. Similarity of the Javan Hawk-eagle with its congeners that do not occur on Java is not discussed here as this is not of importance for field identification.

It should be borne in mind that the identification of the Javan Hawk-eagle requires that a wide range of features is considered in combination.

3.2.1 Appearance in flight

As tropical forest raptors are difficult to spot whilst in the forest most observations will be made from vantage points outside or above the forest, or from viewpoints over the canopy on hill sides. Javan Hawk-eagles are known to soar above the canopy during the morning. Usually they stay close, 5 to 25m, to the canopy. Occasionally this gives an opportunity for seeing the bird in flight for a short period. Later in the morning, when the sun warms up the area and thermal is available the Javan Hawk-eagle regularly starts thermal soaring and great heights can be reached. When soaring the flight is very stable and the bird can be seen for several minutes without noticeably making wing movements. During soaring the wings are held in a slight V-shape. Soaring gives the best opportunity for seeing the banding pattern.

Flying adults show a distinctive wing pattern when seen from below. From above the bird seems much darker but even than the banding pattern can be seen. This pattern and the hazelnut brown colours of the adult 's underparts is usually seen only on birds coming near and under good light conditions. The tail is rather long and so is the head; the overall picture is that of a rather slender bird. Mostly the tail is held straight but occasionally it is spread out, in both positions the banding pattern can be seen very

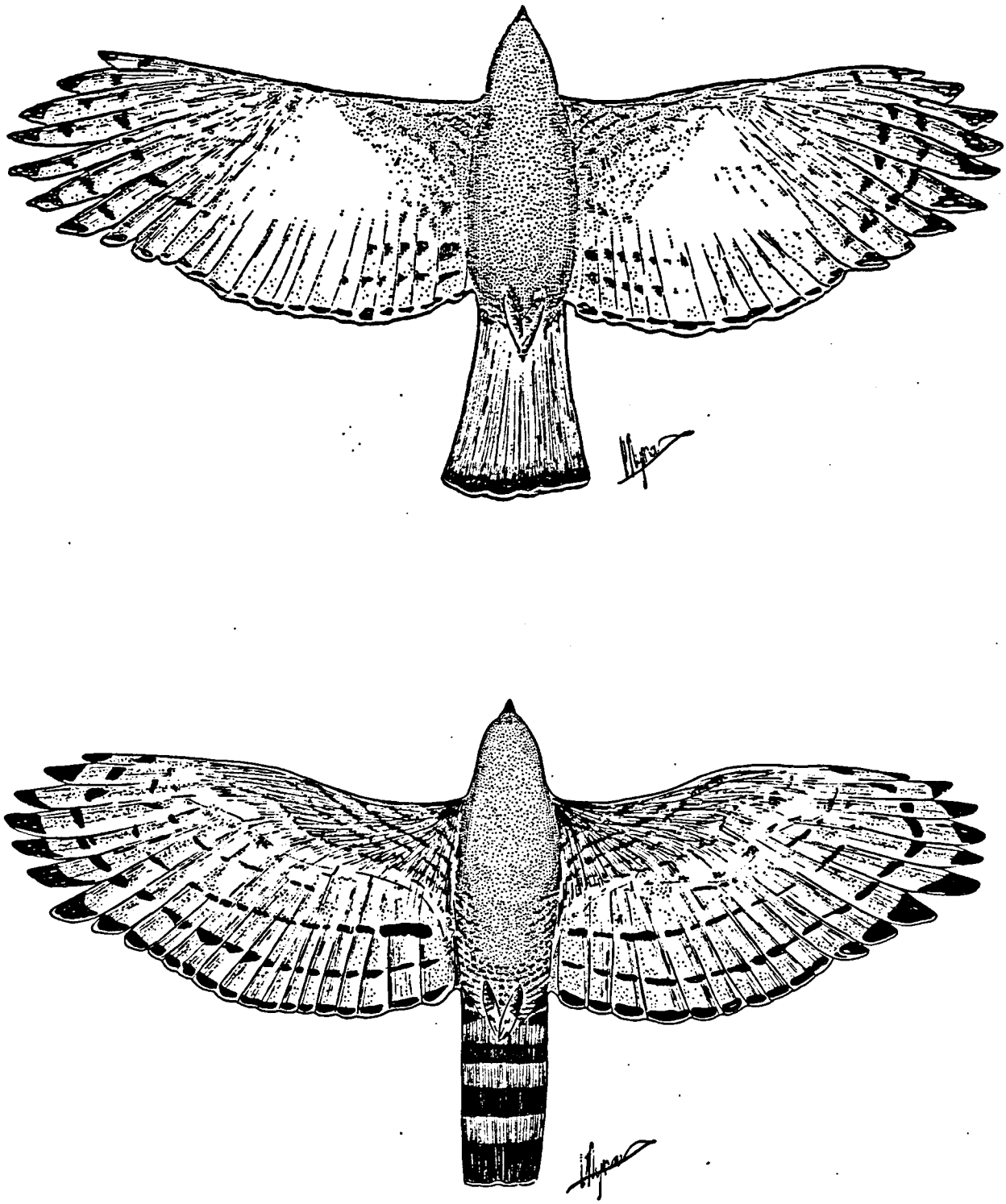


fig. 6: Javan Hawk-eagles from below. A: juvenile in its first year plumage; the underparts are cinnamon brown as well as the underwing coverts, the primaries and underparts of the tail are greyish-beige, B: bird in intermediate plumage; bands on the underside of the tail are present and the banding pattern on the undersides of the wings is more pronounced, barring on the belly and flanks is visible.

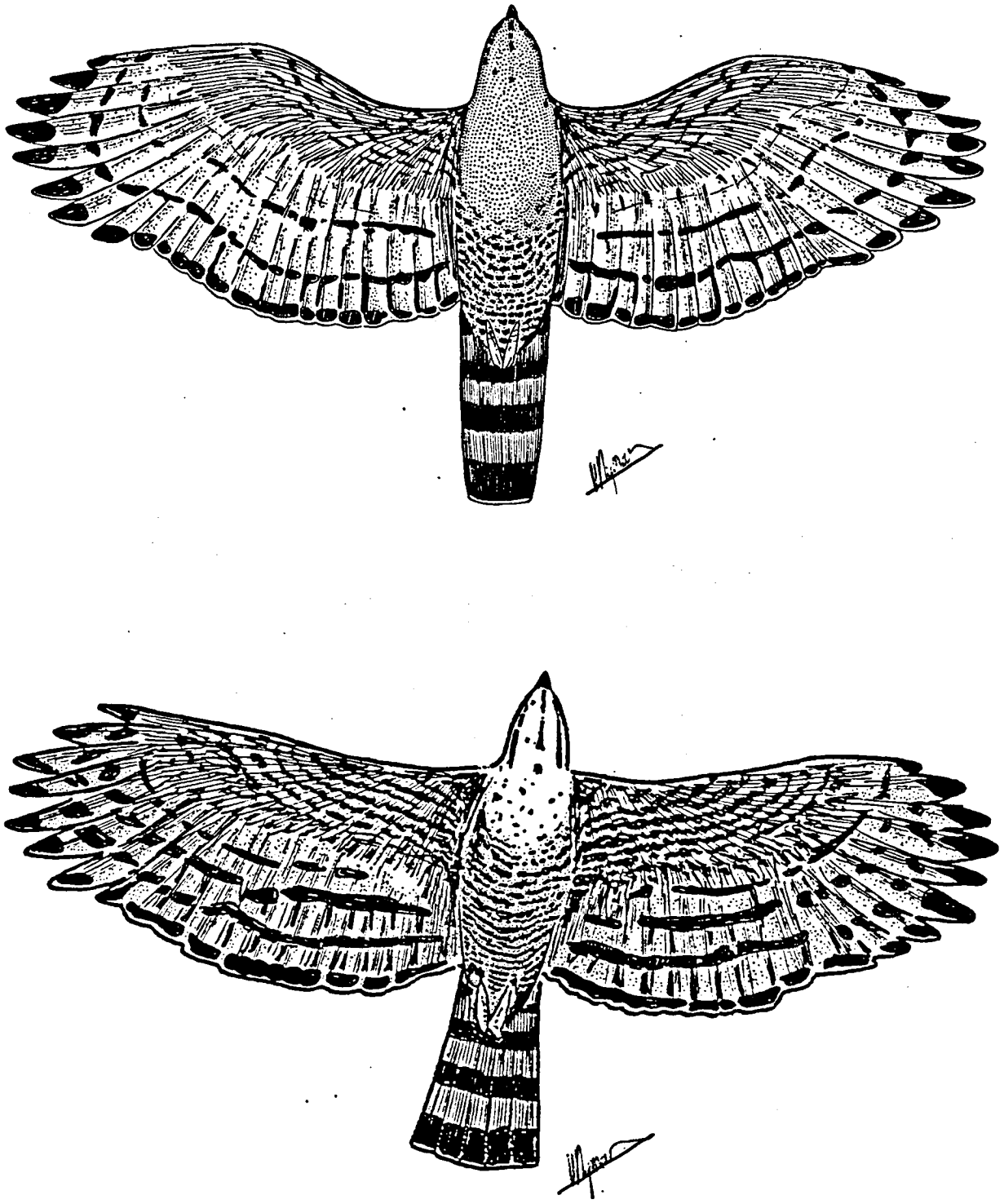


Fig.7: A: bird in intermediate plumage; striping pattern is fully developed, moustachial and mesial stripes start to develop, B; adult bird; chest has changed into white, mesial and moustachial stripes are clearly present.

clearly. Immatures show a less pronounced banding pattern and in first year juveniles it is almost absent: the wings appear white with grey-beige primaries and cinnamon brown underwing coverts, the white in between is triangular shaped, with the tip at the carpal joint.

One of the most characteristic features of the Javan Hawk-eagle is the light-chestnut-coloured head which always contrasts with the much darker body and wings. In flight the crest is seldom seen.

Flying juveniles appear mostly chestnut below with the same but less pronounced wing pattern. From above the juveniles are coloured much lighter than the adults. When flying the wing beat is very regular and rather fast.

The overall appearance of a Changeable Hawk-eagle is that of a more robust bird. Black-eagles are easily recognised by their greater wingspan and more obvious fingering, immatures can be quite pale and when shortly seen may cause confusion. Crested Serpent-eagles are smaller, while soaring the wings are held forwards: the tips are held in one line with the head and the white band on the underparts of the wing is clearly visible.

3.2.2 Appearance in rest

Javan Hawk-eagles can quite frequently be seen perching on a large dominant tree or even on the edge of the forest. The bird perches occasionally in small trees near the ground but usually stays high up in the trees. When perching the crest is very often raised.

The Javan Hawk-eagle is a medium to large sized, slender built eagle with a total length of 60 to 70cm. Females are bigger and more robust than males but the overall appearance remains slender. In adults the head is chestnut-brown, the nape yellow-brown, appearing golden in sunshine. The crown consists of dark brown or even black feathers with thin beige margins and the area around the eyes appears very dark with pronounced eyebrows. The iris is bright yellow and the bill is dark grey to black with a grey cere. The crest usually consists of two to four very long - up to 12cm - white tipped black feathers. When fan shaped, the crests consists of two long feathers in the centre, flanked by two somewhat shorter feathers and even shorter feathers on the sides, gradually forming the crown.

The throat is almost pure white, bordered at the side of the cheeks with dark brown to black moustachial stripes and a very dark brown mesial stripe in the centre.

Back and upperwings are dark brown with beige margins to the feathers and the tips of the primaries are black. The upperside of the tail is dark brown with four black bands and a thin white line at the tip. The underside of the tail is greyish-beige with also four darker brown bands and a white margin.

The underparts are whitish-beige coloured, the belly barred very dark brown, the chest is almost white but with bold dark brown or black dropmarks. The talons are quite long, with feathers covering the base of the feet. The legs are whitish with thin dark brown bars. Feet are light yellow with black claws.

In fledgelings and first year juveniles, the head and crown are cinnamon brown. The iris is blueish-grey, instead of darkbrown described by van Balen et al. (1994). The area around the eye is also cinnamon brown. The crest is black with white tips. The upperparts are less dark brown than in adults, the underparts are cinnamon brown and the mesial and moustachial stripes are not yet developed. The underside of the tail is greyish-beige with only the outer dark brown band present.

In second year juveniles the iris has turned yellow and the crown is gradually turning darker. Bands on the tail are present. In the following years the bars on the underparts gradually develop, beginning near the legs and the flanks. Moustachial stripes appear, as does the mesial stripe, although in some cases the adult birds do not seem to develop a mesial stripe at all (see plate II). When the barring and the striping has completed the chest turns lighter to almost pure white and the dropmarks appear. The fully adult plumage is probably reached in five to six years.

Although the long crest is a characteristic feature of the Javan Hawk-eagle it should be noted that several other long-crested raptors occur on Java e.g. Black Baza (*Aviceda leuphotes*), Rufous-bellied Eagle (*Hieraatus kienerii*) and Oriental Honey-buzzerd (*Pernis ptilorhynchus*).

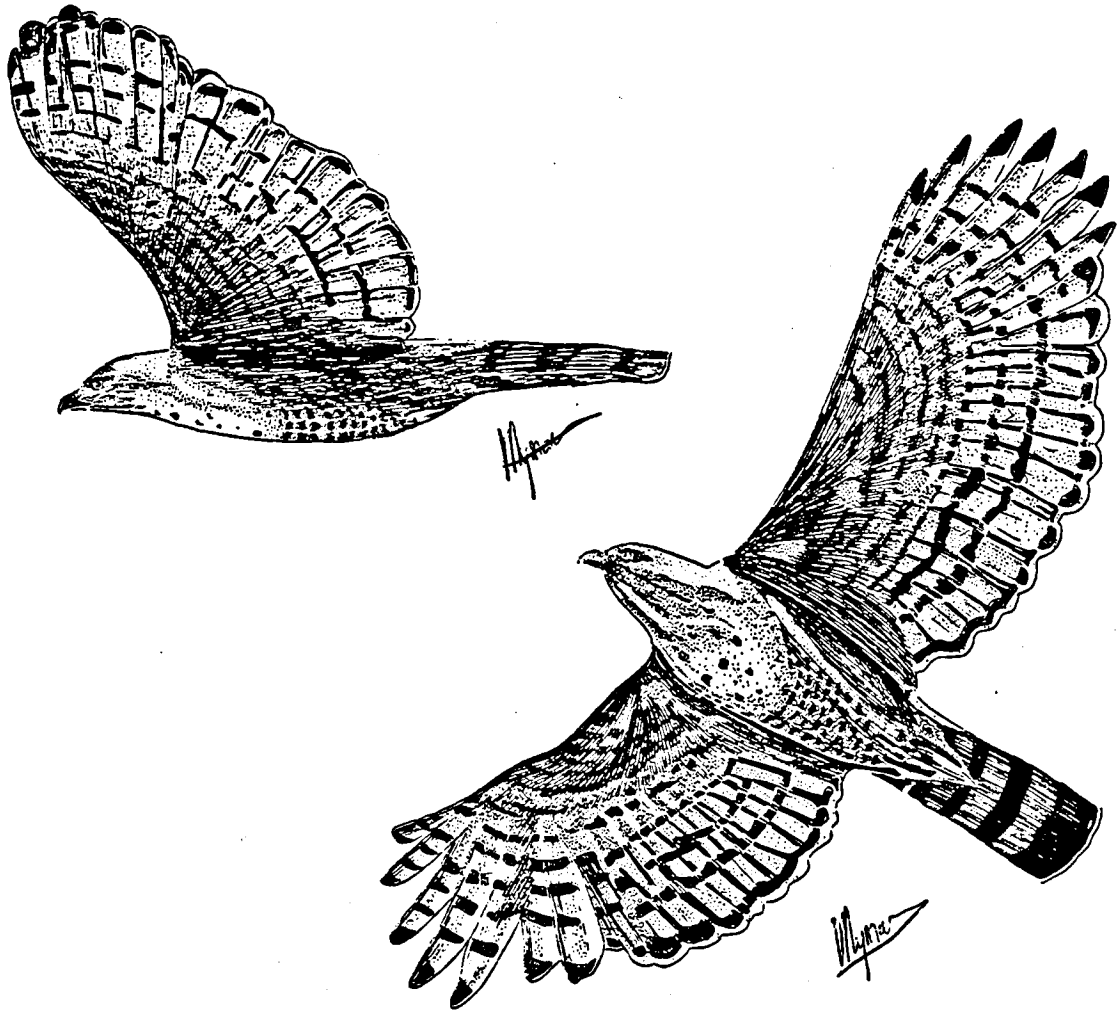


Fig. 8: Adult Javan Hawk-eagles in active flight, note that this posture is thus not comparable with the image of a soaring Crested Serpent-eagle.

3.2.3 Vocalisations

Identification by call is essential in rainforest where birds are very difficult to see. Sometimes visual contact does not give enough information for a positive identification. The call of the Javan Hawk-eagle is characteristic and and useful for identification. For the Javan Hawk-eagle vocal communication is of prime importance because of the dense cover in the habitat it lives in. Especially during courtship Javan Hawk-eagles are very vocal and can be heard from afar. Soaring birds can often been heard whilst producing a single or repeated disyllabic call "ee-eeew" or "eew-eee", however there is no consequent number of which this call is repeated (see fig. 9).

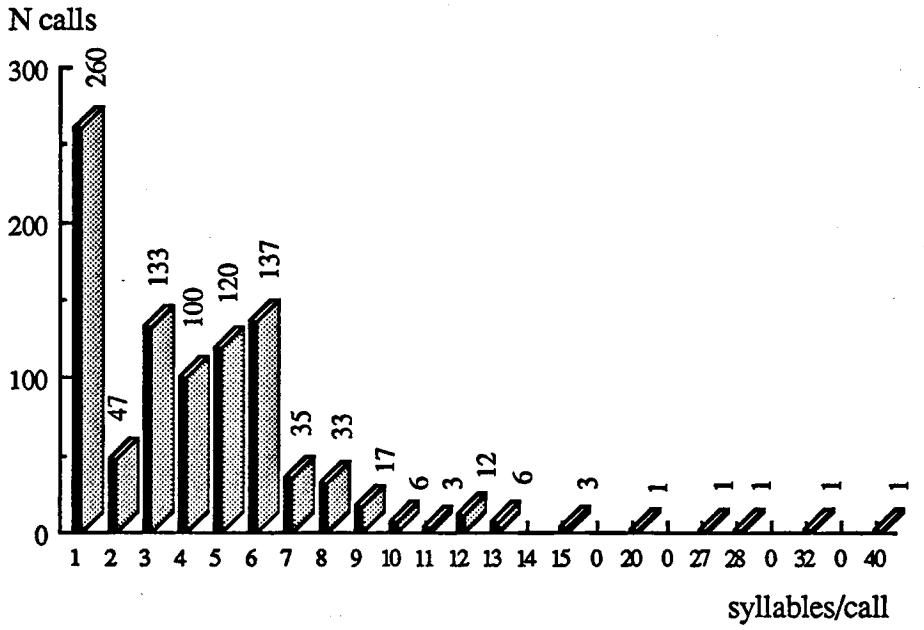
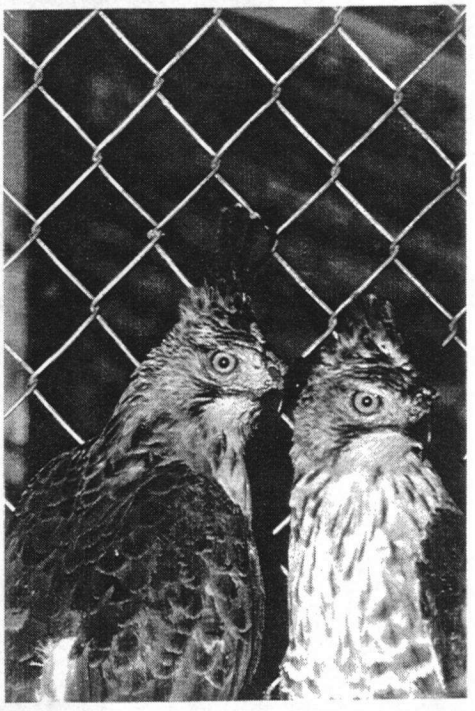


Fig. 9: Frequency distribution of number of disyllabic calls uttered in a row by 8 individual birds (total 7590 syllables)

PLATE III CAPTIVE JAVAN HAWK-EAGLES OF DIFFERENT AGES
Top left: Juvenile *ca.* 11 weeks old. Bojong Galing 18-5-'94 (photo: V. Nijman). Bottom left: Juvenile *ca.* 14 weeks. Taman Safari, Cisarua 30-5-'94 (photo: A. van der Heijden). Top right: Immature *ca.* 4 years. Taman Mini Indonesia Indah, Depok 2-4-'94 (photo: Martôn Tuinbeek). Bottom right: Two adults. Taman Safari, Cisarua. December 1994 (photo: B. van Balen).

PLATE III



These main calls, produced by both male and female, were recorded most often and could be heard over a very large distance. This call (duration *ca.* 0.96-1.1 sec.) consists of two syllables (see fig. 13 b), the latter being longer than the first, and have a rather high-pitched tone (between *ca.* 3.8-5.4 kHz). The first syllable has a duration of between 0.29-0.37 sec. and has a frequency between 3.8-4.1 kHz. The second syllable is longer in duration between 0.65-0.78 sec., the beginning shows a frequency modulation between 3.8-5.4 kHz and the last part has a frequency between 3.7-4.1 kHz. Occasionally this call consists of three syllables, "ee-ee-eeew" or even only one: "eeew". We also heard this same call but with a more harsh beginning: "Klee-eeew klee-eeew". The interval between two calls is between 1.3-1.6 sec.
During observations on a nest we several times heard one of the birds uttering a very often repeated, very high pitched sound with very short intervals: "klü-klü-klü-klü".
The chick was heard producing a soft screaming call for the first time at the age of 6 weeks, (we were situated at a distance of more than 300m!) while the female was also present at the nest. Probably the same call was heard in a 9 week-old chick, in the Taman Safari zoo, and tape recordings were made (see fig. 13 a). This begging call consisted of fast repeated notes with a duration of 0.26-0.38 sec. with intervals of 0.20-0.25 sec. The notes show a frequency modulation between 3.8-9.0 kHz.

Shortly after a copulation, whilst being attacked by an Ashy Drongo (*Dicrurus leucophaeus*) the male gave a very loud call:" Glee-eck!". Later this call was heard again, this time given by the female while breeding.
The calls of *S. cirrhatus* (fig. 13 c) which sound like "Kleee-leek!" resemble those of the Javan Hawk-eagle but are lower in tone (frequency between 3.7-4.1 kHz), of shorter duration and are abruptly closed whilst that of the Javan Hawk-eagle fades slowly. The call of the Black Eagle (*Ictinaetus malayensis*) is different in many respects. Again the tone is lower and consist of several slowly repeated "kee"'s.

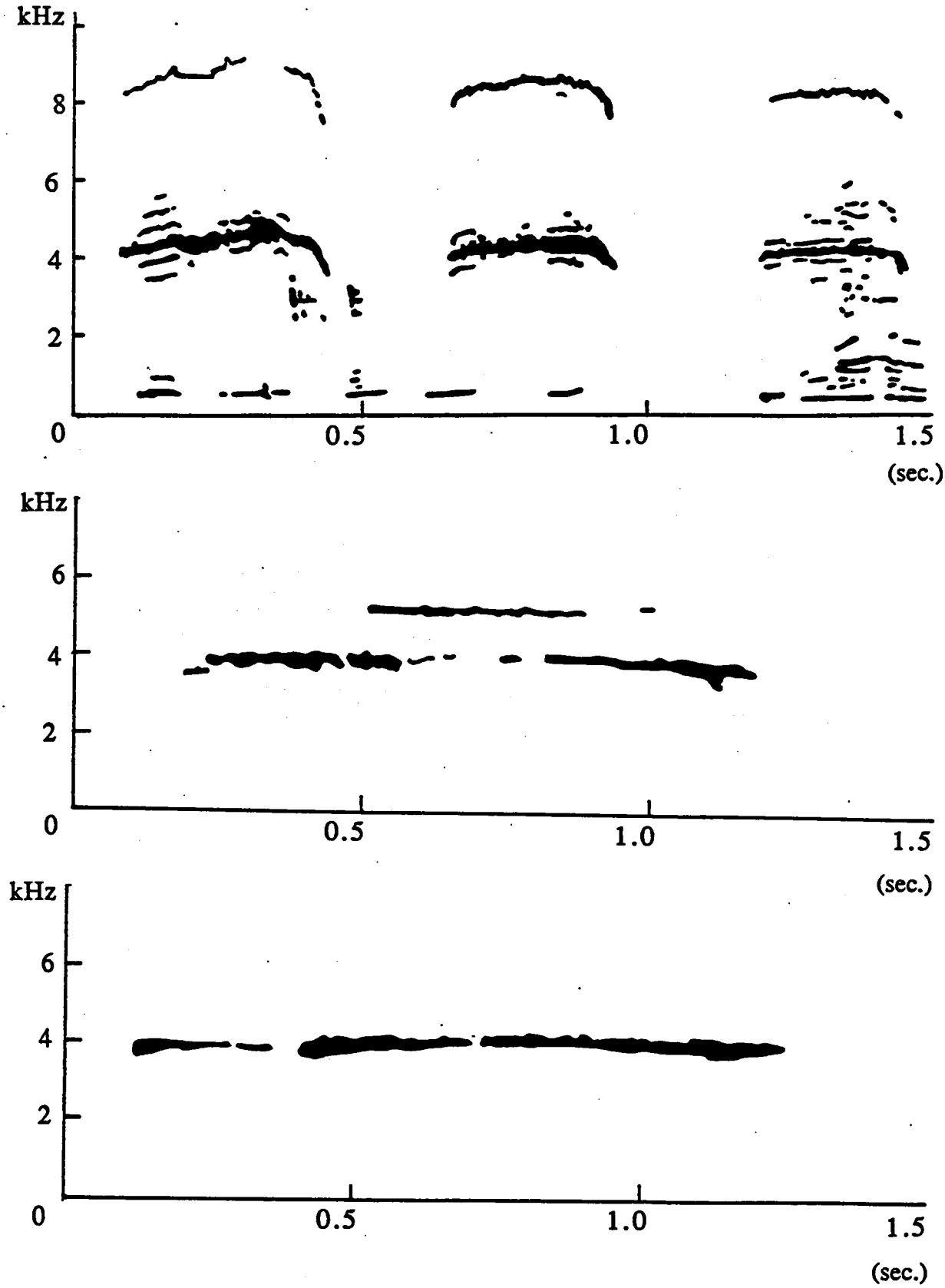


Fig. 10: Sonagrams of a) *Spizaetus bartelsi* chick, b) *Spizaetus bartelsi* adult and c) *Spizaetus cirrhatus* adult.

PART B: DISTRIBUTION

4 Introduction

The Javan Hawk-eagle (*Spizaetus bartelsi*) is endemic to the island of Java and mainly confined to the montane forests. It is recorded up to 3000 metres in the western part of the island but can also be found at sea level, especially in the east. Previously it was thought to be restricted to the mountain forests of western Java but recently it has become clear that a fairly high proportion of the population exists in the eastern part of the island. Surveys by Meyburg et al. (1989), van Balen (1990), van Balen & Meyburg(1994) show a disjunct distribution of the species with a wide gap in the central part of Java. Between the easternmost known locality in West Java and the westernmost locality in the east is a gap of more than 500km. In 1990 a juvenile Javan Hawk-eagle was reported from the southern slopes of Gn Slamet (van Balen & Meyburg, 1994). Although the presence of a juvenile Javan Hawk-eagle on this mountain gives no certainty about the existence of a population - juveniles tend to disperse beyond their breeding range - the sighting gave an impulse for a comprehensive study in this ornithologically little known province of Jawa Tengah.

Most of the remaining 10 % of the island's natural forest is found in the eastern and western parts of Java. However some patches of primary forest are present still on the mountains of Central Java. These patches might turn out to be vital for the long-term survival of the species as they would provide a stepping stone between the two remaining subpopulations.

5 Material and methods

After a thorough study of the available literature it became clear that the methods most used for observing tropical rainforest raptors are largely based on encountering these birds by chance. We therefore had to develop some strategies to increase the chance of contacts. These strategies were constantly altered and improved. After several encounters with the Javan Hawk-eagle we found it easier to establish new contacts and when in a new area we could even quite accurately predict its presence or absence. Surveying large areas in relatively short time spans was more than compensated by the exclusive attention for only one species. When a certain area seemed suitable habitat but no Javan Hawk-eagle was sighted, the area or a neighbouring area was given more attention, or visited again.

5.1 SELECTION AND LOCATION OF THE STUDY SITES

In order to obtain a more complete picture of the distribution of the Javan Hawk-eagle we visited as many seemingly suitable areas in the central part of Java as possible, as well as some in the west in the period March-September 1994.

By comparing land use maps (e.g. RePPProT; Land Resources Department/Bina programme, 1990), maps of forest distribution (e.g. Collins et al., 1989), historical vegetation maps (e.g. van Steenis, 1965), rainfall maps (van Steenis, 1965; 1972) with already proposed conservation areas (MacKinnon, 1982) we tried to find the potentially suitable areas for tropical forest raptors. While in Central Java we frequently spoke with local inhabitants in order to select the most suitable survey areas. We visited the areas at least once and some more often. The areas selected were: Ujung Kulon, Gn Tangkuban Prahu, (West Java), Gn Segara, Gn Slamet, Gn Besar, Gn Prahu, Gn Bismo, Gn Butak, Gn Sundoro, Gn Sumbing, Gn Merapi, Gn Muria, (Central Java), Gn Lawu, Gn Jokolanangan and Gn Wilis-Liman, (East Java). Geographical names of mountains, areas and villages are taken from maps of the firm Pradika, Jakarta and sometimes local names are used.

5.2. BIRD OBSERVATION TECHNIQUES

Tropical forest raptors are notoriously difficult to observe. According to Thiollay (1985a), rainforest birds of prey, as a group, are extremely secretive and difficult to study and on average, during a full day spent walking slowly inside a primary forest one can expect to see only one raptor for more than a few seconds. Identification of the birds of which only a glimpse is seen is only possible for an experienced observer, thoroughly acquainted with the calls of the birds. It is urgently needed to survey the status and distribution of endemic raptors, known to occur in species-rich but little surveyed areas (Thiollay, 1994).

According to Thiollay & Meyburg (1988) it is not possible to give a reliable relative frequency of forest raptors within an acceptable period of time. Instead of trying to calculate the relative number of Javan Hawk-eagles we tried to obtain the absolute number. We also tried to get insight in the species geographical as well as its altitudinal distribution. As the total number of Javan Hawk-eagles is not known and as it is not known on which part of the island they occur and in what numbers we tried to assemble as many records as possible in the central part of the island. At the same time we spent as much time as possible in the vicinity of an individual once contact was established in order to observe its behaviour.

Observing from viewpoints over the canopy on hill sides or from vantage points outside the forest was the main technique for scoring observations. During midday the area was surveyed for suitable vantage points and these locations were visited during the early morning until noon the next days.

At high altitudes it was possible to get an overview of the area and we were able to decide if the area as a whole was suitable for tropical rainforest raptors.

At all times the observers were close enough to contact each other audibly. When observing a raptor with the appearance of a Javan Hawk-eagle the other(s) was (were) contacted so that almost all observations were made by at least two persons.

5.2.1 Recordings

Each contact was recorded as a sighting, a call, a series of calls or a combination of these. For each Javan Hawk-eagle seen we recorded:

1) time and duration of observation
2) exact location (coordinates)
3) habitat type
4) weather conditions
5) altitude of the observer and approximate altitude of the bird
6) approximate distance to the observer
7) activity type, such as thermal soaring, gliding, perching or miscellaneous behaviour
8) when vocal a description of the call and number of times the bird was calling
9) a short description of the plumage and striping pattern
10) whether the bird was recogniziable as a juvenile, an immature or an adult
11) additional notes

For observation binoculars were used, the altitude was determined by using a Casio watch with altimeter and coordinates were determined with a Motorola 1992 version 1.3 Traxar GP-system.

Identification by call is essential in rainforest where it is very difficult to see raptors. Sometimes visual contact is not possible or does not give enough information for a positive identification. By observing a nest of Javan Hawk-eagles, on Gn Pangrango, during which we had more than 80 hours of contact with the adult birds and by studying sound recordings of calls of Javan Hawk-eagles in West and East Java (van Balen, 1985) we familiarised ourselves with the different types of calls. We also studied the calls of several other forest raptors such as the Changeable Hawk-eagle *Spizaetus cirrhatus*, the Crested Serpent-eagle *Spilornis cheela*, the Black Eagle *Ictinaetus malayensis* and the Crested Goshawk *Accipiter trivirgatus* as we tried to exclude errors of identification by call.

We found the call of the Javan Hawk-eagle both very characteristic and much different from other raptors. When familiar with the calls of the Javan Hawk-eagle it is not possible to mistake them with those of other birds of prey in the area.

We recorded features of the habitat in all the areas which we visited. When we had contact with a Javan Hawk-eagle we described the area in more detail. The area was assigned to one of the following categories: (disturbed) primary forest including edges, (disturbed) secondary forest with small clearings, monoculture forest such as teak or pine forest with patches of secondary forest, or cultivated land. Although this categorisation is subjective it gives an overall view of the habitat preference of the Javan Hawk-eagle.

5.2.2 Roadside observations

Roadside counts are a common method when studying birds of prey (e.g. Meyburg & van Balen, 1994, Meyburg & Thiollay, 1988, Newton, 1979). The most efficient way to collect data about the presence of Javan Hawk-eagles was travelling as much as possible on the back of pick-up trucks, small trucks, motorbikes or hanging outside buses. When in forested area the roads were most of the time very bad so that low speed was maintained and when possible we asked the driver to slow down. By doing this both authors could concentrate entirely on the lookout for raptors and many birds

of prey were recorded in this way. Stops were made at suitable vantage points or when a bird of prey was seen which resembled a Javan Hawk-eagle in appearance.

5.2.3 Additional methods

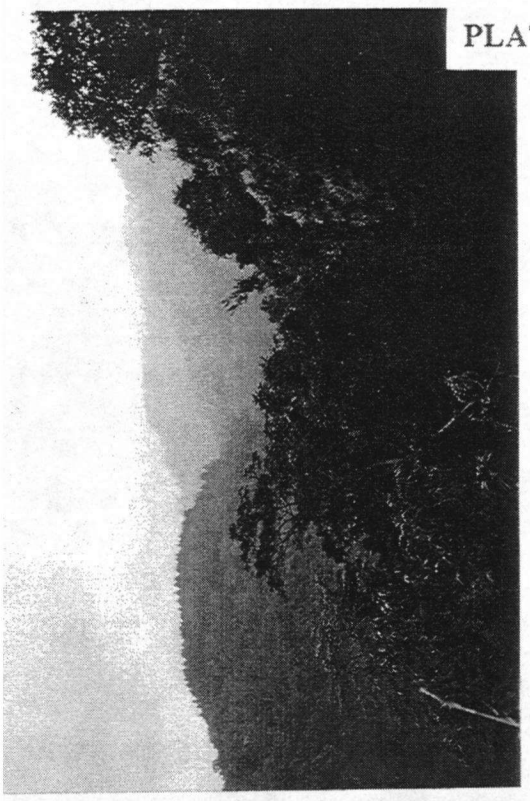
In order to acquire more information we discussed the distribution and status of birds with local people. They were interviewed in Bahasa Indonesia or, especially the elder, in Dutch. The interviewing was done in a subtle way in order to obtain more information about the presence or absence of Javan Hawk-eagles. By asking questions about more common bird species we could find out whether the person really knew the area and the birds in it, or was only willing to please. When knowledgeable we first informed about raptors in general and finally about the presence of Javan Hawk-eagles or *Elang Jawa*. As a lot of people on Java consider every eagle as *Elang Jawa*, we first showed them pictures of the more common Black Eagle and then pictures of other raptors. During the discussion we used pictures of field guides (MacKinnon, 1990 and MacKinnon & Phillipps, 1993), drawings made by the authors, and photos.

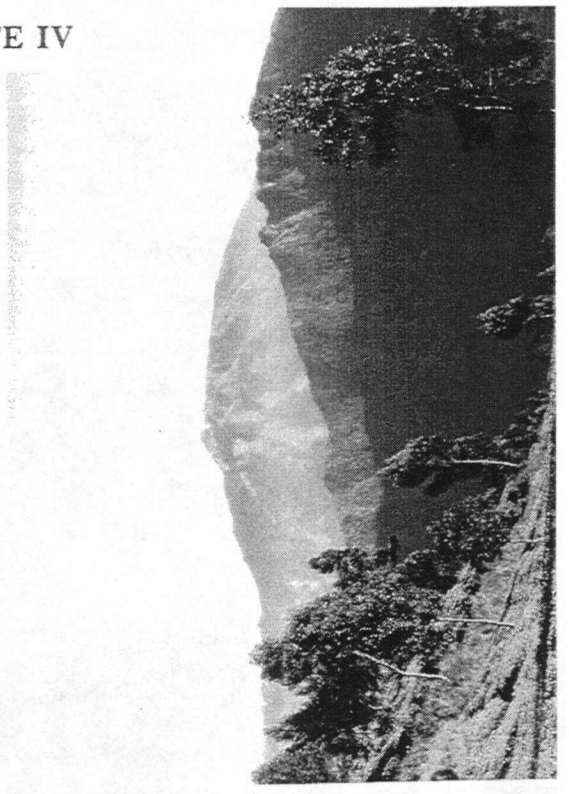
Although interviewing local people is not a very reliable method it turned out to be very useful in some cases.

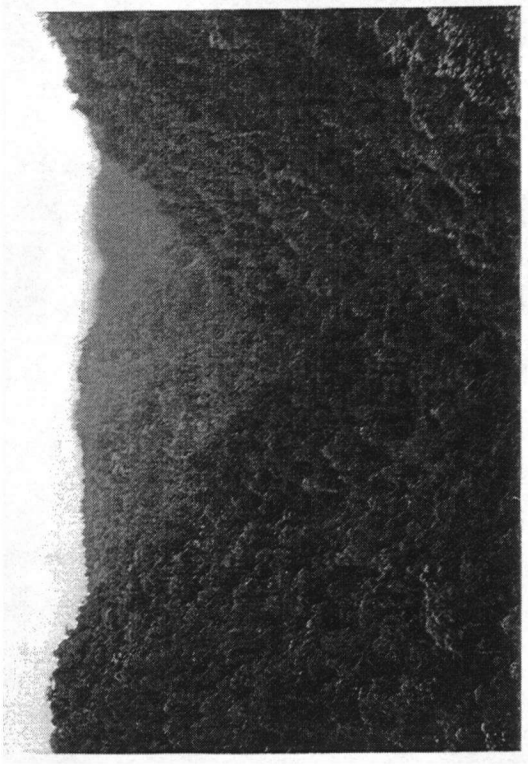
PLATE IV AREAS SURVEYED DURING THE RESEARCH

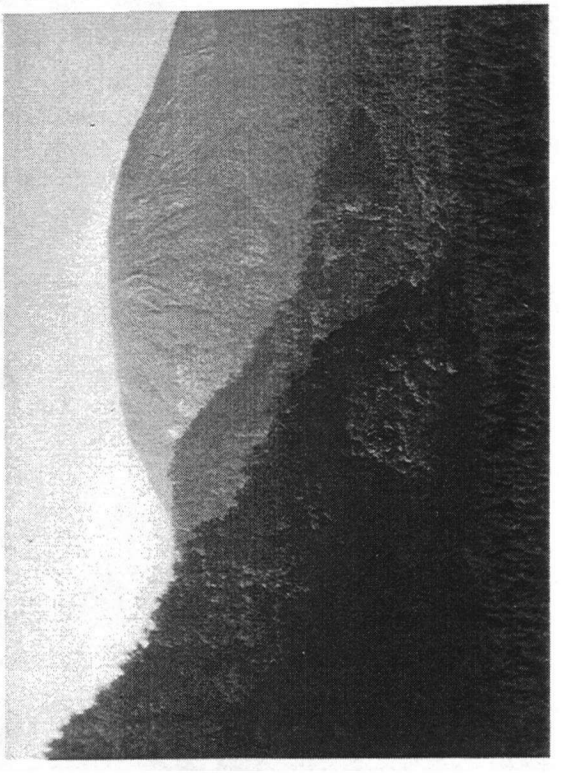
Page bottom left: western slopes of Gn Pangrango, West Java (photo: V. Nijman). Page top left: southwestern slopes of Gn Segara, Central Java (photo: V. Nijman). Page bottom right: northwestern slopes of Gn Slamet, Central Java (photo: V. Nijman). Page top right: southern slopes of Gn Butak and Gn Prahu (background) taken from Gn Sundoro, Central Java (photo: V. Nijman).

PLATE IV









6 Results

6.1 DISTRIBUTION IN WEST JAVA

The vast majority of recent records originate from a rather small area around Bogor: Gn Gede-Pangrango, the Puncak Pass and Gn Salak. One of the larger populations can be found in the Gn Halimun national park, west of Gn Salak, but the remoteness of the area may account for the few records from this area. The area south of Bandung is historically known for the presence of the species and in the 1920s and 1930s Javan Hawk-eagles were observed on Gn Patuha by E. Bartels, and collected at several other sites in this area. Other records in this area include those by van Balen (Gn Papandayan: Meyburg et al., 1989) and by T. Sibuea (Gn Tilu: pers. comm.).

6.1.1 Ujung Kulon national park

- coordinates: (105°20'-105°35'E, 6°45'S)
- kabupaten: Pandeglang
- elevation range: 0-623m
- forested area: *ca*: 12,500ha

This is one of the largest remaining areas of natural forest in Java (105.20-105.35 E, 6,45 S) and consists of more than 76,000ha. In 1980 this area was the first to be declared a national park (Taman Nasional) in Indonesia. The area is covered with coastal forest, mangroves, and lowland rainforest. The elevation ranges from sea level to 623m (Gn Honje in the eastern part of the park). The area has a very high conservation value and is botanical very rich. The only Indonesian population of Javan Rhinoceros (*Rhinoceros sondaicus*) occurs in the western part of Ujung Kulon and consist of approximately 50 animals. The only other 'population' of this species is thought to be present in Vietnam, but here only a few individuals are left.

Other interesting mammals that do occur in this area include Leopards (*Panthera pardus*), Banteng (*Bos javanicus*), Rusa deer (*Cervus timorensis*), Grizzled Leaf Monkey (*Presbytis comata*), Javan Gibbon (*Hylobates moloch*). Also for reptiles the area is of primary importance as it is one of the few remaining areas where the Saltwater Crocodile (*Crocodilus porosus*) as well as the Green Turtle (*Chelonia mydas*) can be seen.

Noteworthy birds reported from this area include Rhinoceros Hornbills (*Buceros rhinoceros*), Javan Peafowl (*Pavo muticus*) and Lesser Adjudant (*Leptoptilos javanicus*). Although the area has been thoroughly surveyed for birds, the Javan Hawk-eagle has never been observed in this area before (e.g. van Balen, 1990).

Around noon, on 21 June 1994, after a 2.45h hike south-eastwards from the village of Taman Jaya along the north coast of Ujung Kulon, the sound of a non-identified bird of prey, coming from the forest, was heard. At that moment we were wading through the second river, just before the trail going to the south-coast (narrowest point of Ujung Kulon peninsula). After a few minutes a very dark coloured medium sized raptor was seen for about 5 seconds, circling over the canopy of the *ca.* 15m high trees along the coast . Just after this bird disappeared another raptor was seen coming from the same

direction, circling above the canopy. This bird could be clearly seen with binoculars for about 30 to 40 sec. The shape and size of the flying bird, together with the striped underside, the dark brown colour of the upper parts, the chestnut brown coloured head and the long crest left no doubt about the identity of this bird; a Javan Hawk-eagle. The bird disappeared into the same direction where it came from.

According to Hans Bartels (pers. comm.) the Javan Hawk-eagle is much less dependent on the montane forests than is currently is thought. The reason for the absence in the lowlands is the absence of good lowland forest on Java. When the lowland forest disappeared the Javan Hawk-eagle had to move to the montane forests as this was the only habitat left for the bird. The absence of Javan Hawk-eagles in Ujung Kulon, one of the largest lowland forest on Java, was in contradiction with this view.
This new record is interesting and may prove of value for the continued existence of the species. The Ujung Kulon National Park is a large and relatively safe area. The presence of the Javan Hawk-eagle makes the area even more valuable. Only a few decades ago the forests on the eastern part of Ujung Kulon almost formed a continuum with those on the Gn Halimun area (see fig 3) and the latter is now known for its relatively high numbers of Javan Hawk-eagles.

6.1.2 Gede-Pangrango national park

- coordinates: (106°51'-107°02'E, 6°41'-6°51'S)
- kabupaten: Bogor, Cianjur, Sukabumi
- elevation range: 500-3019m
- forested area: *ca*: 17,500ha

This park with the size of 15,196ha is situated in West Java on the slopes of the two mountains Gn Gede (2958m) and Gn Pangrango (3019m) and has an elevation range between 500 and 3019m (106.51-107.02 E, 6.41-6.51 S). The botanical gardens of Cibodas are included in the Gede-Pangrango national park. The park consists of everwet rainforest with an annual rainfall of 3000-4200mm.

The vegetation consists of lower montane and montane forest and at the higher altitudes alpine moss forest can be found. Typical plant species comprise: Javan Edelweiss (*Anaphalis javanica*), 'Puspa' tree (*Schima walichii*), Rasamala tree (*Altingia excelsa*) and 208 of the 592 wild Orchid species of Java.

Interesting mammal species include Leopard (*Panthera pardus*), Javan Gibbon (*Hylobates moloch*), Grizzled Leaf Monkey (*Presbytis comata*), Javan Wild Dog (*Cuon alpinus javanicus*) and Barking Deer (*Muntiacus muntjak*). Less than 150 years ago the area was still the domain of the Javan Rhino (*Rhinoceros sondaicus*): in 1854 Junghuhn reports that two of these animals were seen near a creek on the upper slopes of Gn Pangrango. Most of the Javan endemic and several other rare bird species can still be found here. They include all three endemic Barbets (*Megalaima*), Chestnut-bellied Partridge (*Arborophila javanica*), Javan Scops-owl (*Otus angelinae*) and Blue Tailed Trogon (*Harpactes reinwardtii*). Most of the recent sightings of Javan Hawk-eagles come from this area.

Threats to the area are wood cutting, hunting and poaching, rural encroachment, improvement of the infrastructure.

6.1.2.1 Gn Pangrango

On the north west-slope of Gn Pangrango we observed a breeding pair of Javan Hawk-eagles during the period 25 March until 16 June. Our observations were mostly made from a small ridge which was situated at 1085 m. A major part of our knowledge derives from the intensive observation of this pair and their young. After the 16th of June the chick, which was not mature enough to fledge had disappeared from the nest and although we visited the area several times afterwards we did not see any Javan Hawk-eagle in this area anymore.

6.1.2.2 Cibodas

The characteristic call of the Javan Hawk-eagle was heard in the early morning of the 28th of April at an altitude of 1410m near a tree in which a pair of Javan Hawk-eagles had raised a young two years before. Intensive searching could not reveal the presence of the bird nor the presence of a nest in the former nest tree.

A more detailed description of the area is given by van Balen et al. (in press)

6.1.2.3 Cisarua

Apart from several Javan Hawk-eagles kept in captivity in Taman Safari this area is also inhabited by wild Javan Hawk-eagles. We observed a Javan Hawk-eagle flying above this zoo on the 16th of June in close assembly with several Changeable Hawk-eagles. The last birds were seen regularly in the surroundings of the cages where the birds of prey were kept. The question whether the Javan Hawk-eagle was attracted by the calls of the captive juveniles remains open.

6.1.3 Gn Tangkuban Prahu

- coordinates: (107°35'-E, 6°45'S)
- kabupaten: Bandung
- elevation range: 1500-2076m
- size: *ca*: 1660 ha

This well-known volcano (2076m) north of Bandung, is very important for its water catchment capacity. It is also an important touristic area. 1660 ha has been set aside as a nature reserve and 370ha are used as a recreation park (MacKinnon et al., 1982). The forest descends below 1500m and reaches over 2000m. The area is aesthetically as well as botanically interesting. Typical plant species are: Javan Edelweiss (*Anaphalis javanica*), Rhododendron (*Rhododendron javanicum*) and *Vaccinium* spp. On this mountain the Javan Gibbon (*Hylobates moloch*) still occurs (1992, own obs.).
The type specimen of the Javan Hawk-eagle is a juvenile collected in 1907 by Max Bartels Sr. on Gn Melatti, west of Gn Tangkuban Prahu. In April 1994 a short visit to Gn Tangkuban Prahu did not reveal the presence of Javan Hawk-eagles on this mountain. The area south of Bandung is thought to hold one of the larger populations of Javan Hawk-eagles and is historically known for its presence.

6.2 DISTRIBUTION IN CENTRAL JAVA

The central part of Java is climatically the transition zone from the wet west and the dry east and does show several interesting patterns in local flora and fauna. Several species widely distributed in the Asiatic mainland reach their eastern border of their range in this area. Maybe as a result of this and the peculiar climatic and geographical conditions on Central Java a relatively high number of endemic taxa are found in this province.

The only observation of a Javan Hawk-eagle made in this province was a juvenile photographed by R. Seitre on the south slope of Gn Slamet in 1990 (van Balen & Meyburg, 1994). In the period of our survey M. Linsley (pers. comm.) found Javan Hawk-eagles on Gn Slamet and Gn Ungaran.

6.2.1 Gn Segara

- coordinates: (*ca.* 108°35'-108°48'E, 7°08'-7°07'S)
- kabupaten: Brebes
- elevation range: 300-1351m
- forested area: *ca*: 22,500ha

In the westernmost part of Central Java, near the boundary with West Java, a lowland and hill rainforest area can be found where one of the taller mountains is locally known as Gn Segara. Gn Segara lies north-east of the *ca.* 13.000ha proposed nature reserve Pegunungan Pembarisan (MacKinnon et al., 1982). According to maps in Collins et al. (1991), the forest of Pembarisan continues until Gn Segara. The current status is protected forest owned by Perum Perhutani, the governmental commercial forestry company. The area consist of moderately disturbed lowland to montane rainforest with an elevation range of 300-1351m, and the soils are of non-volcanic origin. Already in 1982 Pembarisan was ranked as one of the most valuable remaining forest in Central Java because of the presence of rare endemic flora and fauna (MacKinnon et al. 1982). Typical animals for the area are Short-tailed Magpie (*Cissa thalassina*), Green Junglefowl (*Gallus varius*), Red Junglefowl (*G. gallus*), Lesser Mouse Deer (*Tragulus javensis*), Stinkbadger (*Mydaus javensis*), Barking Deer (*Muntiacus muntjak*) and Javan Leafmonkey (*Trachypithecus auratus*). The area is threatened by rural encroachment, wood cutting and hunting activities (own obs.). The presence of Javan Hawk-eagles and the first observations of Javan Gibbon (*Hylobates moloch*) in this area (Nijman & Sözer, in press a) show that the proposed nature reserve should be extended to also include Gn Segara.

On the 22th of July at 9.30 hrs we heard the call of a Javan Hawk-eagle. The authors were standing on a ridge at an altitude of 595m and the calling was heard coming from the south-south-east side of Gn Segara. The bird was heard calling 20 times. At 10.52 hrs, the same morning another Javan Hawk-eagle was heard, this time coming from a spot 4 to 5km to the south. We were standing on the same ridge this time at an altitude of 470m. During the rest of the morning both birds were heard calling from both sides of the valley.

As the forests in the area were still in good condition the area may be very valuable. It is one of the last remaining lowland forests on Java and it forms a link between the populations of Javan Hawk-eagles on the western part of the island and Gn Slamet.

6.2.2 Karanganyar

Along the main road between Tegal and Purwokerto, *ca.* 15km east of Gn Segara and west of Gn Slamet on the 24th of June at 14.57 hrs two Javan Hawk-eagles were seen performing display flights above a small hill covered with teak plantations. The surroundings consisted of cultivated land and from the top of the small hill no larger areas of natural forest could be seen: in the direction of Gn Slamet some small patches of natural forest were seen but in the direction of Gn Segara the view consisted of large areas of teak. The birds were seen and heard for more than ten minutes after which they disappeared in the direction of Gn Slamet.

6.2.3 Gn Slamet

- coordinates: (109°15'E, 7°15'S)
- kabupaten: Banyumas, Brebes, Tegal, Pembalang, Purbalingga
- elevation range: 700-3418m
- forested area: *ca*: 20,000ha

This cone-shaped volcano with an altitude of 3418m is Java's second tallest mountain and is a very distinctive feature in the Central Javan landscape. The mountain is believed to be sacred and is paid great respect by local people. The southern slopes of Gn Slamet are one of the wettest areas in the world with an annual rainfall of more than 8000mm.

Large parts of the mountain are still well forested and especially on the southern and eastern slopes the forest descends below 700m. Of the higher altitudes, above 1000m, 15000ha is proposed as a nature reserve (MacKinnon et al., 1982). As recently as 1847 the traces and skeletons of the Javan Rhinoceros were regularly seen (Junghuhn, 1854). Nowadays the area still is the home of a subspecies of the Grizzled Leaf Monkey (*Presbytis comata fredericae*) and the Javan Gibbon (*Hylobates moloch pongoalsoni*), both endemic to Central Java.

6.2.3.1 Pancuran 7

Pancuran 7 is a small recreation spot with hot water spring on the south slope of Gn Slamet near Batu Raden. As stated before, a couple of Javan Hawk-eagles were observed from April to September. Most of the observations were made near the hot springs at altitudes between 650 and 750m. We also observed Javan Hawk-eagles on a ridge a few kilometres to the north at an altitude of 970m.

6.2.3.2 Pekandangan

In the end of June we visited the north-west slope of Gn Slamet near the village of Pekandangan. Here we observed Javan Hawk-eagles on different occasions between 1310 and 2200m. On the 23th of June, at an altitude of 1310m, a Javan Hawk-eagle was seen gliding from a natural forested ridge over a pine (*Pinus spec.*) plantation to another ridge which was also covered with natural forest. The next day we observed a

Javan Hawk-eagle a few km north of the spot of the day before, at altitudes between *ca.* 1500m and *ca.* 1700m and later that day the same bird was observed while it was flying towards an altitude of 2200m. The area consisted of montane forest still in suitable condition.

The population on Gn Slamet is probably one of the larger of Central Java and therefore the conservation of the area is a top priority for the long-term survival of this and a great many other species.

6.2.4 Dieng mountains

- coordinates: (109°37'-109°55'E, 7°05'-7°10'S)
- kabupaten: Pekalongan, Batang, Temanggung, Wonosobo, Banjarnegara
- elevation range: 250-2565m
- forested area: *ca*: 27,500ha

The mountains on the north and north-east side of the Dieng plateau are still covered with natural forest. The area stretches between Gn Besar (1579m) in the west and Gn Prahu (2565m) in the east and probably forms a continuous block of rainforest of *ca.* 27,500ha. On Gn Prahu 25,000ha above 1000m are proposed as a game reserve (MacKinnon et al., 1982). The forest descends to below 250m in the north-east corner, south of Gn Besar and to below 1500m on the eastern slopes of Gn Prahu. The plateau is easily reached from the southern side but the mountain massif is poorly accessible from the north, due to steep and densely forested slopes.

Although recently the area has not been biologically surveyed, it is thought to be of primary importance for the survival of the Central Javan forms of different species including Javan Gibbons and Grizzled Leaf Monkeys (see Nijman & Sözer, in press a). Besides these unique subspecies the area supports several other interesting animals such as Leopards, Javan Leaf Monkeys, Woolly-necked Storks (*Ciconia episcopus*), Pink-headed Fruitdoves (*Ptilinopus porphyreus*), Wreathed Hornbills (*Rhyticeros undulatus*) and Javan Hawk-eagles.

The Dieng mountains as a whole have magnificent scenic features with impressive mountain summits in the east and a more park-like landscape in the west with a variety of natural forests from lowland to montane. Although the area is somewhat disturbed it is an excellent example of Central Javan forest ecosystems.

6.2.4.1 Gn Besar

On the 27th of August on the foot of Gn Besar we visited a recreation area (tempat wisata): Linggo asri. The area consisted of undisturbed lowland forest, beginning at an altitude of approximately 250m. The area consisted of several valleys and small mountains, and in the beginning of the park there were rice fields and grasslands. When entering the area we observed a couple of Woolly-necked Storks (*Ciconia episcopus*) which were soaring at a distance of *ca.* 200m. During the morning these two birds were seen regularly. At 11.02hrs these two birds were seen flying again, at a distance of several kilometres, but this time they were joined by a third bird. The three birds were flying from the south to the north-east. After *ca.* 30 seconds two of the birds flew more to the west and the third bird was flying straight towards the observers. At

11.04hrs this bird was identified as being an adult Javan Hawk-eagle. It flew at a distance of approximately 30-40m above one of the observers who were situated at 620m. At this time the head of the bird was clearly visible. The front of the bird's head was rather dark, and the rest was chestnut brown. When at closest range the bird turned its head and the crest and the eye were shown. The bird flew off in north-eastern direction. A few moments later the two Woolly-necked Storks had returned to the area and one of them attacked the Javan Hawk-eagle, while the other flew at only a few metres distance. While being attacked the Javan Hawk-eagle held its wings closer to its body and flew very fast in the direction of the top of a small forested mountain and dove down into the canopy. At 11.07hrs the bird was out of sight. According to local farmers and rattan collectors Javan Hawk-eagles were seen regularly in this area.

6.2.4.2 Gn Prahu

As Gn Prahu is in the middle of Central Java it is of the highest priority for the study on the distribution of Javan Hawk-eagles. We entered the area several times from different directions. The first time was at the 5th and 6th of April, when we visited the village of Bawang on the northern side of the mountain. From this village we explored the area into southern direction but no suitable forest was found. As we observed several montane bird species, we came to the conclusion that the area should be visited again. On the 4th and 5th of May we entered the forest via Dieng on the southern slope of Gn Prahu. This time we found the area suitable; the northern and eastern side of the mountain were completely forested and two Black Eagles were seen performing display flights, but no Javan Hawk-eagles were seen.

The eastern side of the mountain was visited on the 26th of August. At an altitude of 1775m at 9.12h we observed a Javan Hawk-eagle soaring above two valleys and three ridges, on one of which we were standing. The bird was clearly visible and was observed at a distance of less than 70m. As the bird was fully striped and dark coloured we identified this bird as a adult Javan Hawk-eagle. After *ca.* 10 sec. the bird disappeared to the east. During this period of time the bird was not vocal. At 9.17h we heard the characteristic call of the bird. Two minutes later the bird was seen again, this time soaring above the eastern slope of Gn Prahu at a distance of approximately 500m. After 40 seconds the bird disappeared out of sight.

6.2.5 Gn Sundoro, Gn Bismo, Gn Butak

- coordinates: (110°00'E, 7°17'S, 109°55'E, 7°14'S,109°58'E, 7°15'S,)
- kabupaten:
- elevation range: 2000-3136m
- size: <*ca*: 5,000ha

In July 1994 Gn Sundoro (3135m), Gn Bismo (2365m) and Gn Butak (2136m) were visited. The latter two are smaller mountains north and north-east of Sundoro, on the south side of the Dieng plateau. The area consists mainly of cultivated land, with wide areas of tobacco and cabbage on the lower slopes and with tea plantations up to 2200m. The water on Gn Sundoro, was polluted by pesticides and the only forest left were small patches of production forest, mainly consisting of *Pinus* spec. No Javan Hawk-

eagles were seen or heard and it seems very unlikely that the area could support even a small population of this species.

The total lack of suitable habitat for Javan Hawk-eagles in this formerly rich montane avifauna, shows the importance of adequate protection of those areas which still support populations of Javan Hawk-eagles. Just as van Balen & Meyburg (1994) we observed some (sub)montane species such as Black Eagles, which are probably relicts of the former forested habitats. We also observed a Spotted Kestrel (*Falco moluccensis*) which is known to prefer more open country.

6.2.6 Gn Sumbing

- coordinates: (110°04'E, 7°22'S)
- kabupaten: Wonosobo, Temanggung and Magelang
- elevation range: 500-3371m
- size: *ca*: 10,000ha

This high volcano (3371m) is the southern most volcano of the line Gn Prahu, Gn Sundoro, Gn Sumbing and is an characteristic land mark in the Central Javan landscape. *C.* 10,000ha between 500 and 3371m are a proposed nature reserve (MacKinnon et al., 1982). The last remaining forest on this mountain may survive on some of the lower slopes in the south and on the upper slopes but most of the area has been brought under cultivation with large areas of tobacco, corn and pine plantations. The upper slopes are heavily disturbed and no forest large enough to support tropical rainforest raptors could be found during a short visit in early July to the eastern, northern, and western parts of this mountain.

6.2.7 Gn Merapi

- coordinates: (110°26'E, 7°32'S)
- kabupaten: Sleman, Magelang and Sukoharjo
- elevation range: 1000-2911m
- size: *ca*: 5,000ha

This well known volcano, north of Yogyakarta, is probably the most active volcano in Java. The south side of Gn Merapi consists of relatively good primary forest belt from *ca.* 1000m to *ca.* 2000m. The western slope is covered with the outflow of lava from the crater, so there is no forest on this side and forest, although less, can also be found on the northern slopes. In the area prone to erosion and landslides these forests are important for hydrological protection and water catchment. Gn Merapi is very attractive for recreational purposes; for hill climbers there are several routes leading to the top, there are waterfalls and several caves.

On the 9th of June 1994 while on the top of Gn Turgo, a small peak on the south slope of Gn Merapi and north-west of the village Kaliurang, the call of a Javan Hawk-eagle was heard. The bird was located in a small valley north of Gn Turgo and the southern slope of Gn Merapi. After the call, which consisted of two syllables "eew-eeek" repeated several times, was heard, intensive searching began. However because of the

dense cover the bird was not seen. The fourth day in the forest, on the 12th of June, was spent on Gn Plawangan another small mountain also on the southern slope of Gn Merapi, where the total area could be overseen. At 10.20hrs the call of the Javan Hawk-eagle was heard again coming from the western side of the mountain. In the valley between Gn Turgo and Gn Plawangan a Javan Hawk-eagle was seen. The bird was an adult and flew very stable. The wings were held in a V-shape. After *ca.* 30 seconds the bird disappeared into the canopy and was not seen again.

The forest between the two mountains Turgo and Merapi consists of relatively good primary forest. The top of Gn Turgo is regularly visited by tourists; there is a good overview over the forest and at night one can see lava floating on the western slope of Gn Merapi. Only a few people visit the area north of Turgo; the forest here is undisturbed and seems a perfect habitat for Javan Hawk-eagles. From above the treeline at *ca.* 2300m the southern slope of the mountain could be overlooked. Although the forest directly north of Kaliurang is a recreation forest and consists of less suitable habitat the southern slope of Gn Merapi is densely covered with forest and seems little disturbed. Very recently though (22-11-1994) Gn Merapi has erupted on the south side and the recent state of the forest is not yet known.

6.2.8 Gn Muria

- coordinates: (110°52'E, 6°37'S)
- kabupaten: Jepara, Kudus and Pati
- elevation range: 600-1602m
- size: *ca*: 12,000ha

This dormant volcano on the north coast of Java has got several forested peaks. The highest of these reaches more than 1600m and there are many very steep ridges. As it is one of the few remaining volcanic forests outside the wet climatic zone it is thought to be of high conservation value (MacKinnon et al., 1982). In the 16th century Gn Muria was separated from Java by the sea and the city of Kudus in the south, now 25km inland had a harbour (Oey, 1991).

On the 26th and the 27th of August, the southern slopes were surveyed. The area seemed quite suitable with forest descending below *ca.* 800m, and especially the lower part in the centre between the forested peaks seemed promising, but no Javan Hawk-eagles were observed.

6.3 Distribution in East Java

In 1975 H. Bartels found Javan Hawk-eagles to be present in Meru Betiri. The species was historically known from three localities in East Java: a specimen collected on Gn Arjuno early this century is stored in the American Museum of Natural History and Kooiman (1941) reports the species to be present both at the Yang and Ijen highlands. Recent sightings were made by van Balen in Lebakharjo, Ijen, Kalibaru, Alas Purwo (van Balen & Meyburg, 1994) and Gn Kawi-Arjuno (B. van Balen, pers. comm.).

6.3.1 Gn Lawu, Gn Jokolanangan

- coordinates: (111°10'-111°11' E, 7°40'-7°41' S)
- kabupaten: Karanganyar, Wonogiri and Magetan
- elevation range: 1000-3262m
- size: *ca*: 20,000ha

Gn Lawu (3265m) is a well known volcano on the provincial boundary between Central and East Java. Gn Jokalanangan, a few kilometres to the south, with its 2298m is smaller and much less known. The upper slopes of these volcanoes remain forested. Van Balen (1990) surveyed the eastern slopes of Gn Lawu but no Javan Hawk-eagles were found. Further surveys on the rest of the mountain were believed necessary.

We extensively surveyed the southern slopes of Gn Lawu and the northern slope of Gn Jokolanangan and we could also not reveal the presence of Javan Hawk-eagles. Although the upper slopes of the two mountains were still well forested on these sides no forest below 1000m was present and a survey on the western and northern slopes of Gn Lawu is recommended.

6.3.2 Gn Wilis-Liman

- coordinates: (*ca.* 111°46'-111°48'E, 7°48'-7°50'S)
- kabupaten: Madiun, Nganjuk, Kediri, Tuban, Trenggalek, Ponogro
- elevation range: 600-2563m
- size: *ca*: 45,000ha

These twin volcanoes remain to be covered with an extensive block of continuous rainforest from hill to montane. In the area, 45,000ha is proposed as a game reserve (MacKinnon et al., 1982). The Gn Wilis-Liman complex is very valuable as it represents a rather undisturbed mountain ecosystem. The upper slopes are covered with *Casuarina* forests (van Steenis, 1965) and the area is still the domain of the Leopard and other unique Javan wildlife. Noteworthy bird species include Changeable Hawk-eagle, Chestnut-bellied Partridge and Wreathed Hornbill (*Rhyticeros undulatus*),

During a two days' survey on the southern slopes of Gn Wilis, in an area which seemed to be a perfect habitat for Javan Hawk-eagles, with dense forest and steep slopes, we heard the call of the species. We were situated on a ridge with an excellent view over two valleys and three ridges at an altitude of 1140m, approximately 10km north of the village of Sendang.

As this complex is situated on the western part of the East Java province it forms a link between the populations of this province and the population in Central Java.

6.4 OVERALL DISTRIBUTION

The forest patches where Javan Hawk-eagles were present, described in the previous section, combined with previous records give an overall distribution as presented in table 2.

Table 1: Distribution of the Javan Hawk-eagle listed from west to east.

location	habitat type	climate	presence	reference
Ujung Kulon	Hw, Lw	2-(3)	+	1
Gn Halimun	Mw, Hw	3	+	2
Gn Salak	Mw	3	+	2
Gn Pangrango	Mw, Hw	3	+	1, 2
Gn Gede	Mw, Hw	3	+	1, 2
Gn Tankuban Perahu	Mw,	3	-	1
Gn Halu	Mw, Hw	3	+	6
Gn Papandayan	Mw	3	+	2
Gn Segara	Mw, Hw, Lw	3	+	2
Karananyar			+	1
Gn Slamet	Mw, Hw	3	+	1, 3, 5
Gn Besar	Hw, Lw	3	+	1
Gn Prahu	Mw	3	+	1
Gn Bismo	Mw	3	-	1
Gn Butak	Mw	3	-	1
Gn Sundoro	Mw	3	-	1, 4
Gn Sumbing	Mw, Hw, Hm	3	-	1
Gn Ungaran	Mw	2	+	5
Gn Merapi	Mw	2	+	1
Gn Muria	Mm, Hm	2	-	1
Gn Lawu	Mw	2	-	1, 4
Gn Wilis Liman	Mw, Mm, Hw, Hm	(2)-3	+	1
Gn Kawi-Arjuno	Mw, Mm, Hw, Hm, Lm	2-(3)	+	3
Lebakharjo	Lw	3	+	4
Yang plateau	Mw, Mm	3	+	2
Meru Betiri	Mm, Hm, Lm	2	+	2, 3
Kalibaru		3	+	4
Ijen	Mw, Mm, Hm, Lm	3	+	2
Alas Purwo	Ld	2	+	4

Forest types are indicated by altitude and humidity: M (montane forest), H (hill forest) L (lowland), w (wet), m (moist) and d (dry). So Mw is wet montane forest and Hm is moist hill forest (after MacKinnon et al., 1982).
Climate types from dry to wet; 1: 0-10 rainy days during the four driest months, 2: 10-30 rainy days and 3: 30-120 rainy days see also fig.2
References; 1 = this study, 2 = Meyburg et al., 1989, 3 = van Balen and Meyburg, 1994, 4 = van Balen, 1990, 5 = M. Linsley, pers. comm., 6 = T. Sibuea, pers. comm.

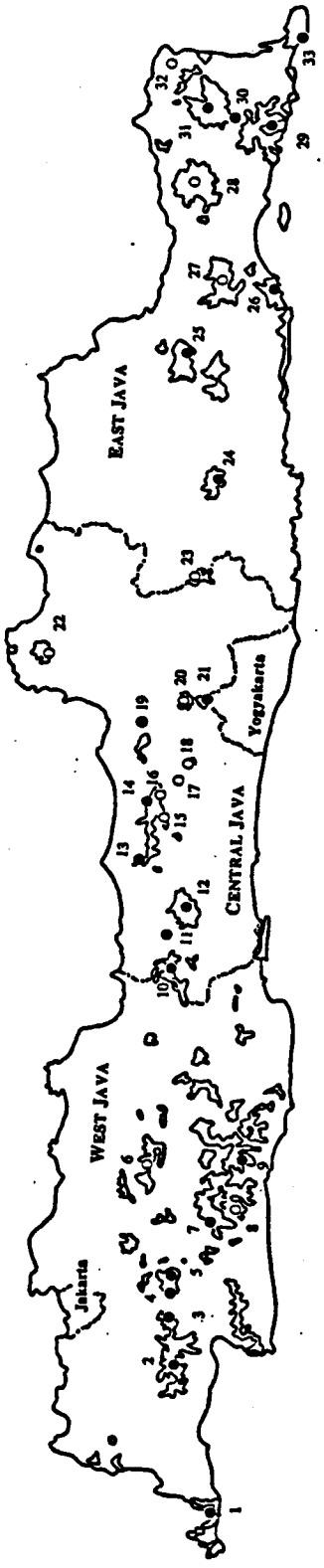


Fig. 11: Distribution of the Javan Hawk-eagle.
o = present, ● = not found to be present during this study, or known from historical data only.
For references see table 1.

6.5 ALTITUDINAL DISTRIBUTION

Each time we encountered a Javan Hawk-eagle the altitude at which we were present or where the bird was present was noted. These results are presented in fig. 13 and it can be seen that we found Javan Hawk-eagles to be present at all altitudes between sea level (in Ujung Kulon) and 2200m (Gn Slamet). Although no equal period of time is spent at the different altitudes -we have spent more time at the higher altitudes partly because of the small amount of lowland forest left on Java- the results give an image of the altitudinal preferences of the species. It is clear that the Javan Hawk-eagle is not dependent on the montane forests although all the areas visited had some montane characters i.e. hills or slopes were always present.

The Javan Hawk-eagle has long time been considered to be an exclusive montane or slope dependent species. The Bartelses (Bartels, 1924) only observed the bird at the higher altitudes (above 1000m) and noted the presence of an alleged Javan Hawk-eagle at 3019m, gliding over the top of Gn Pangrango. Kuroda (1936) reports it to be a 'mountain living species' but with a given altitudinal distribution between 300 and 1200m he also includes the lowland zone. Also Thiollay (1985a) states the Javan Hawk-eagle to be living mostly in mountain forests. According to Brown & Amadon (1968) the species is restricted to the wooded hills of West Java. The species was recorded in East Java by H. Bartels (pers. comm.; see also Meyburg et al., 1989) where he observed it in Meru Betiri at lower altitudes. After surveys by van Balen (1990) it became evident that the species also occurs at lower altitudes in Lebakharjo and Alas Purwo, where the species was recorded at sea level. MacKinnon & Phillipps (1993) state that most of the records are from the mountains in West Java up to 3000m but also at sea level in Meru Betiri. Van Balen & Meyburg (1994) consider the bird to be dependent on the lowland and hill rainforests.

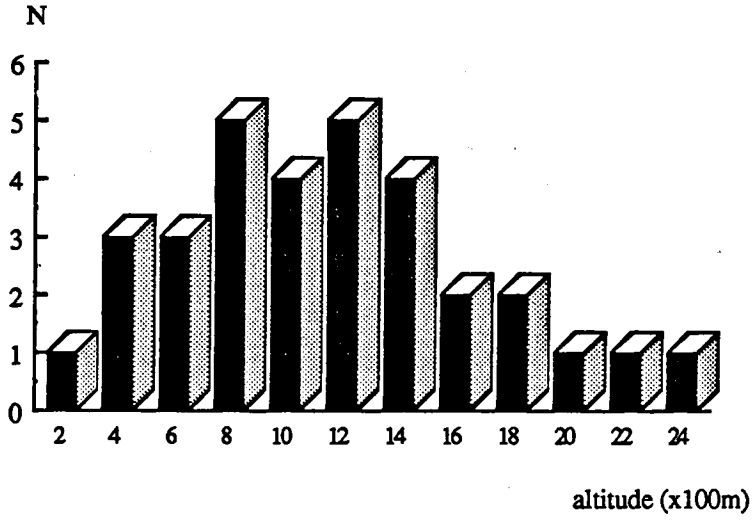


Fig. 12: Altitudinal distribution of Javan Hawk-eagles. Number of individuals observed in altitudinal categories from 0 to 200m, 200 to 400m etc. One bird may be represented in more than one category.

6.6 ESTIMATED POPULATION SIZE

As it is impossible to count all the individuals of the population of Javan Hawk-eagles, population numbers must be estimated. This must be done by extrapolation based on the geographic area inhabited and the density of the population expressed in number of established pairs per area.

By comparing different landuse maps and conservation plans (e.g. MacKinnon et al., 1982; RePPProT, 1990 and Collins et al., 1989) we tried to measure the forest patches inhabited by Javan Hawk-eagles as accurately as possible. However the most recent available maps were based on satellite imagery from the mid 1980's so recent habitat loss is not included. This may result in an overestimate of the size of some areas. Three localities which are known to be only partly suitable or only partly cover suitable habitats for Javan Hawk-eagles (see habitat requirements in part B) are indicated.

Forest patches which are likely to support Javan Hawk-eagles, but of which no (recent) information is available, were measured separately. Adjoining forest patches or forest patches with continuous vegetation cover in between, i.e. if no major gaps in the forest cover were observed in the field or on vegetation maps, were treated as one area. The fifteen locations which are known to support Javan Hawk-eagles as well as the four areas where the species might occur, are listed in table 3. The total inhabited surface in the fifteen localities amounts to some 3600km^2.

The density of Javan Hawk-eagles based on the home range of a breeding pair has been estimated (see 9.2: home range). As the home range sizes will not be adjoined but on a local scale show a patchy distribution even in pristine forest (see Thiollay, 1989 for *S ornatus* and *S. tyrannus*) an established pair will need more space than the observed home range size. For the calculations of population numbers a conservative estimate of one breeding pair for every 30-40km^2 was used.

The density of the Javan Hawk-eagle population will not be constant in all areas, but is subjected to variation from place to place. To obtain a higher level of accuracy, not subject to geographical variations or to variations within the forest, estimates of population density in each forest as well as in the different distinct habitat types, is needed. As no information on this is available we have used the home range size of a pair of Javan Hawk-eagles to calculate the numbers of pairs.

Our calculations reveal that 81 to 108 pairs of Javan Hawk-eagles may be present throughout Java. These pairs represent 162 to 216 individuals; the total number of Javan Hawk-eagles is obviously higher. A part of the Javan Hawk-eagle population consists of immature birds, but as no information is available on the demography, no statements can be made on the total population size.

Table 2: Approximate size of Javan Hawk-eagle habitat, with observations from 1975 until 1994, and estimated number of pairs of Javan Hawk-eagles thought to be present.

location	status[a]	size (in km^2)	alt. range[b]	estimated no. of pairs
present				
Ujung Kulon/Gn Honje*	TN	125	0-623	2-3
Gn Halimun/Gn Salak	TN, hl	500	*400*-2211	12-16
Gn Gede-Pangrango	TN	175	*500*-3019	4-5
Gn Papandayan/Gn Halu	ca, hw ?	200	*700*-2622	5-6
Gn Segara/Pembarisan	hl, [ca]	225	*300*-1351	5-7
Gn Slamet	[ca]	200	*700*-3418	5-6
Gn Besar/Gn Prahu	hl, [sm]	275	*250*-2565	6-9
Gn Ungaran	[ca]	75	*1000*-2050	1-2
Gn Merapi	hl [hw]	50	*950*-2911	1
Gn Wilis/Liman	[sm]	300	*600*-2563	7-10
Gn Kawi/Arjuno	[ca]	400	*300*-2886	10-13
Lebakharjo	[ca]	160	0-*250*	4-5
Meru Betiri	TN	500	0-1223	12-16
Ijen/Baluran*	[sm] [ca]TN	150	0-3332	3-4
Alas Purwo*	TN	225	0-360	4-5
			total	**81-108**
possibly present				
South of Bandung	various	400	*300*-2821	10-13
Gn Merbabu	[hw]	100	*1000*-3142	2-3
Gn Tengger/Bromo	TN	350	*800*-3676	8-11
Gn Iyang	sm	140	*1600*-3088	3-4
			total	23-31

The current status of the forest is indicated: national park - taman nasional (TN), nature reserve -cagar alam (ca), wildlife sanctuary - suaka margasatwa (sm), recreation forest - hutan wisata (hw) and unprotected forest - hutan lindung (hl). Localities with known less optimal habitats are indicated [*].
[a] : [ ] means proposed, [b] : italic numbers represents approximate altitudes

Table 3: Number of pairs of Javan Hawk-eagles present in the three Javan provinces.

province	probable	possible
West Java	23-30	33-43
Central Java	18-25	20-28
East Java	40-53	51-68

In table 3 the numbers of pairs of Javan Hawk-eagles is indicated for each province. The larger populations survive in the western and eastern provinces and these provinces might contain more areas with suitable Javan Hawk-eagle habitat.
For several reasons no widely accepted methods for quantifying population densities of raptors are available (Robinson & Wilcove, 1989). For estimating the population size we therefore used the methods already used in previous population size estimates of Javan Hawk-eagles (Meyburg et al., 1989, van Balen & Meyburg, 1994) so that comparison will be possible.

Despite the various assumptions and the absence of a reliable quantitative method for the practical determination of the population density, the results are presented here as it is believed that these rough estimates are the best currently possible. Meyburg et al. (1989) estimated the population size at 50 to 60 pairs, van Balen & Meyburg (1994) re-evaluated this number and estimated the population size to be 52 to 61 pairs with possible 15 to 20 additional ones in the surroundings of Bandung, in areas not yet surveyed. However the previous estimate was made with data gathered in the period 1990-1992 and did not include the most recent records.

If data on those areas not yet surveyed become available and more is known about the densities of Javan Hawk-eagles in the different habitats and areas, the calculations can be adjusted. However, it is unlikely that a greater precision will change our conclusions or recommendations.

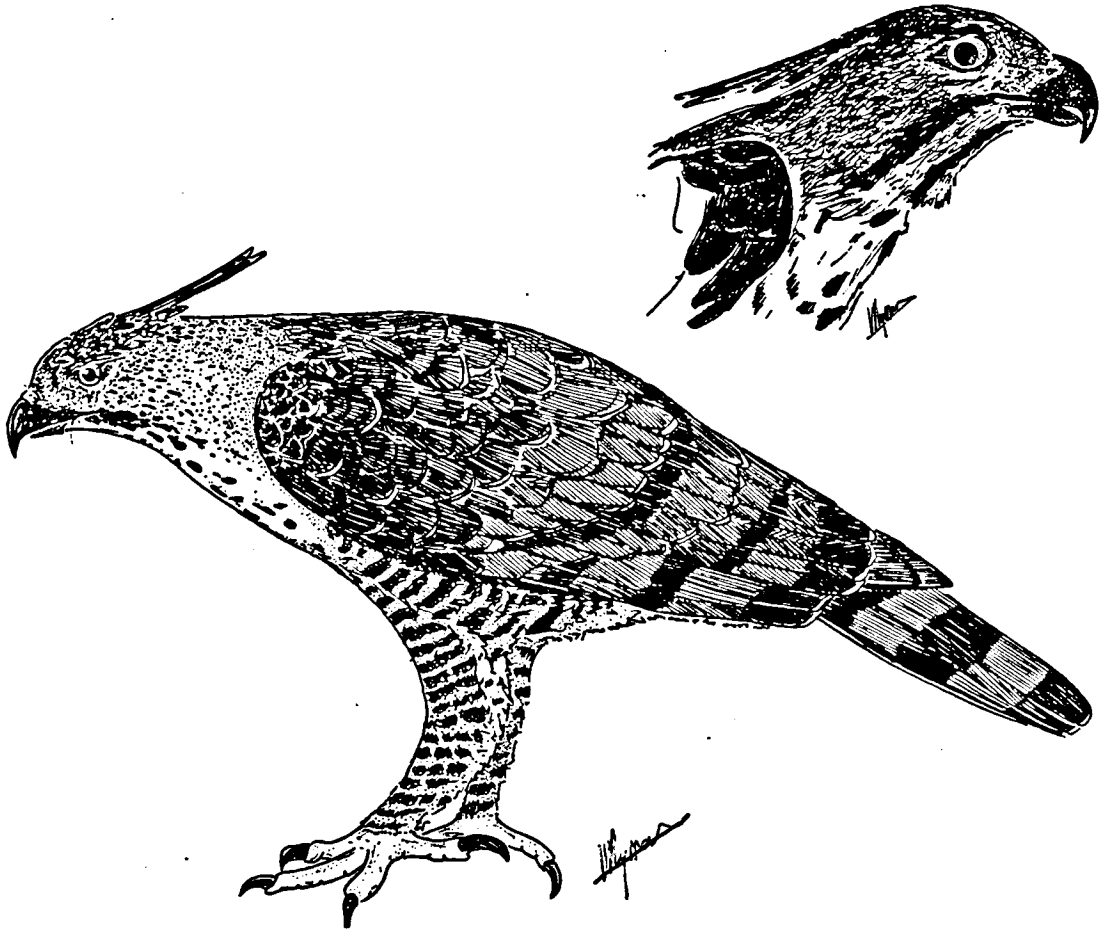


Fig. 13: Head study of an adult Javan Hawk-eagle and a perching immature Javan Hawk-eagle

PART C: BEHAVIOURAL ECOLOGY

7 Introduction

Previous studies of the ecology of a species took little account of the behaviour of the organism. Increasingly it has been realised that, just as the knowledge of genetics is important for an understanding of ecology, so is the knowledge of behaviour. In order to survive and to reproduce, an individual needs to do many things. Some of these are simple bodily functions, such as ingestion and excretion, but around these functions is a pattern of activity, such as food searching, resource defence, mate localisation and parental care, which can be described as behaviour (Chapman & Reiss, 1992).

Behavioural ecology investigates the relationship between the behaviour of organisms and their ecology. For example, in the case of the Javan Hawk-eagle, if we want to understand the way its feeding behaviour helps it to survive and reproduce, we need to know much about its ecology. Almost all of the basic information is lacking, the knowledge we have today is highly fragmentary.

We have studied several problems that the species faces and these include: feeding, interspecific interactions, reproduction and habitat choice.

8 Material and methods

8.1 LOCATION AND DESCRIPTION OF THE STUDY SITES

In order to obtain data on the behavioural ecology of the Javan Hawk-eagle we studied a breeding pair on the western slopes of Gn Pangrango, in the period March-June and a non breeding pair, together with their second year young on the southern slopes of Gn Slamet in the period April-September.

8.1.1 Gn Pangrango

The Pangrango pair inhabited several valleys near the boundaries of the Gn Gede-Pangrango national park. The observations were made at an elevation of 1085m from a small path that wound along a slope opposite to the slope where the Javan Hawk-eagles had build their nest. The nest was situated in a huge emergent Rasamala tree (*Altingia excelsa*) which was halfway the slope; the distance between the observation site and the nest was goniometrically calculated at 330m. The area consisted of submontane forest with steep slopes.

8.1.2 Gn Slamet

The Slamet pair was observed on the southern slopes of Gn Slamet, at a recreation spot, Pancuran 7, at 750m, and from a ridge at 970m altitude. The forest above the observation point was still in good condition and the area at lower altitudes consisted of Damar (*Agathis loranthifolia*) plantations and other cultivated land.

8.2 Bird Observation techniques

Observing from viewpoints over the canopy on hill sides or from vantage points outside the forest was the main technique for scoring observations. On Gn Pangrango observations were made from a small trail, leading to a waterfall. This trail gave an excellent view over the valley that was inhabited by the breeding pair. When the female was incubating one of the authors kept observing her through a telescope while the other would walk along the trail on the look-out for the male. When the female left the nest, e.g. when the male brought food, both authors observed the birds along the trail. The telescope was left in place so the juvenile could be observed also. At all times the observers were close enough to contact each other audibly. When one of us observed a Javan Hawk-eagle the other was warned.

8.2.1 Recordings

Each contact was recorded as a sighting, a call, a series of calls or a combination of these. For each Javan Hawk-eagle contact we recorded:

1) time and duration of observation
2) exact location (coordinates)
3) activity type, such as
   a) thermal soaring, characterised by soaring in circles on the thermal updrafts
   b) soaring, a stationary flight in which the birds control their position with minor wing beats and tail movements
   c) flying, an active flapping flight
   d) gliding, a straight, level flight with the wings outstretched without flapping
   e) perching
   f) miscellaneous behaviour
4) during the breeding period we also recorded
   a) incubation
   b) rearranging the nest
   c) egg rolling
   d) feeding
   e) preening
   f) standing on the nest
   g) other behaviour
5) interspecific behaviour i.e. reaction to the behaviour of other animals (here we recorded the other species involved)
6) when vocal a description of the call and number of times the bird was vocal
7) additional notes

When possible we tried to take photographs and to make sound recordings.

For observation a telescope (Vixen Zoom, 20 to 60 times) and binoculars (Colorado, 8 x 40 and Noblesse, 12 x 50) were used, photographs were taken with a Minolta SRT 101 camera with a Tokina 500mm lens and Panagor auto-tele-converter and a Practica B 200 camera with an Olympus 500mm lens, sound recordings were made with a Fortron portable mini cassette recorder.

9 Results

9.1 HABITAT REQUIREMENTS

During our study most of the Javan Hawk-eagles were observed in primary forest. This primary forest was often disturbed, either by human influence or by nature e.g. as a result of hurricanes or landslides. A common feature of all the areas in which Javan Hawk-eagles were observed was the ruggedness of the terrain. In most areas steep slopes were present. The different habitat types where we observed the species are listed in table 4. Most of the time we observed soaring birds and they were quite often observed while above different habitat types.

Table 4: The different habitat types wherein Javan Hawk-eagles were observed.

location	habitat
Ujung Kulon	primary forest
Gn Gede-Pangrango	(disturbed) primary forest/ secondary forest/ cultivated land near primary forest/ cultivated land
Gn Segara	primary forest/ (disturbed) primary forest near cultivated land/ secondary forest
Karanganyar	teak plantation/ cultivated land
Gn Slamet	(disturbed)primary forest/ secondary forest/ cultivated land near primary forest/ Pinus plantation near primary forest
Dieng mountains	(disturbed) primary forest/ cultivated land near primary forest
Gn Merapi	primary forest/ primary forest near secondary forest
Gn Wilis-Liman	primary forest

Occasionally Javan Hawk-eagles were observed in less typical habitat like teak (*Tectona grandis*) plantations, pine forest and in the vicinity of human settlements. Except for the two birds performing display flights near Karanganyar the (disturbed) primary forest was always at very close range and quite often the Javan Hawk-eagles observed in less typical habitat came from or disappeared into or in the direction of the primary forest.

In figure 14 the number of observations are presented on a gradient from undisturbed to disturbed habitats. No equal time was spent in these four habitat types, so this figure presents only a rough picture, but it is clear that most of the observations were made in the primary forest, and also quite a few birds have been observed above cultivated land. However, as stated before, forest was almost always in the vicinity of these cultivated areas. The birds flying or soaring above these areas, were spotted easier than those above other habitat types and this may cause an over-representation of birds in habitat type IV.

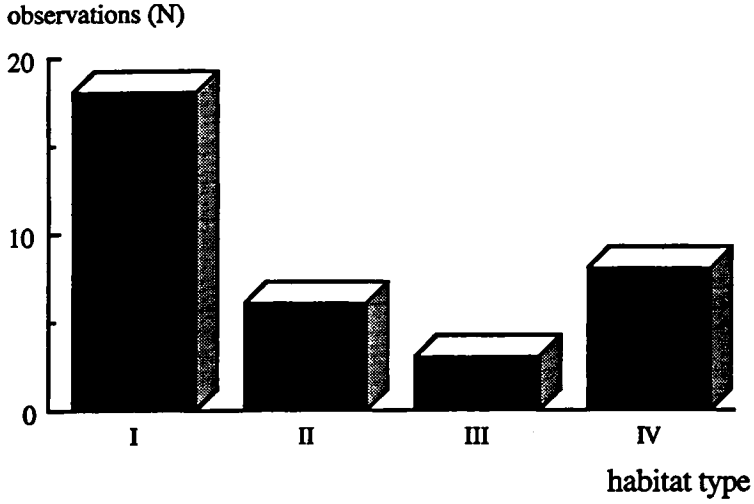


Fig. 14 Number of observations of Javan Hawk-eagle on a gradient from primary forest to cultivated land. I = (disturbed) primary forest, II = secondary forest with small clearings, III = plantations with patches of secondary forest, IV = cultivated land

Kuroda (1936) stated that the species breeds in the wooded hills of West Java. According to Brown & Amadon (1968) the species is restricted to the wooded hills of West Java. Bartels (1924, 1936) knew the species from the virgin forest where it breeds and gathers its food and also Delsman (1926) found the species to be present in the virgin forests of Gn Gede. Van Balen & Meyburg (1994) consider the bird to be dependent on the lowland and hill rainforests. Juveniles are the ones most often seen above cultivated land and these are the ones the ornithologists most often collected.

The optimal habitat of an adult couple of Javan Hawk-eagles is undisturbed primary forest; the incidental observations of Javan Hawk-eagles in degraded forests do not lead to the conclusion that the species can survive in these habitats for any longer period of time.

When comparing the climate types, based on the number of rainy days during the driest part of the year (fig. 2) with the overall distribution of the Javan Hawk-eagle (fig. 12) it becomes clear that the Javan Hawk-eagle is almost exclusively confined to areas with the least pronounced dry period i.e. with more than 30 rainy days in the driest consecutive 122 days. In fig. 15, the areas where Javan Hawk-eagles are present are listed from west to east, and it becomes clear that records originating from areas with a more pronounced dry season are found more in the east than in the west. Javan Hawk-eagles are dependent on certain vegetation types viz. the mixed lowland and hill rainforest and the montane everwet rainforests. These wet vegetation types can only be found in areas with more than 30 rainy days during the four driest months (van Steenis, 1965). Some records come from areas with slightly less rainfall, e.g. Ujung Kulon and Meru Betiri and only one, namely the sighting of two birds by K. D. Bishop (Robson, 1988) in Baluran, is in an area that falls in the driest category. Although this record was withdrawn, more unconfirmed sighting originate from this area. It is however likely that if Javan Hawk-eagles were seen in this area, they came from the adjoining Ijen plateau.

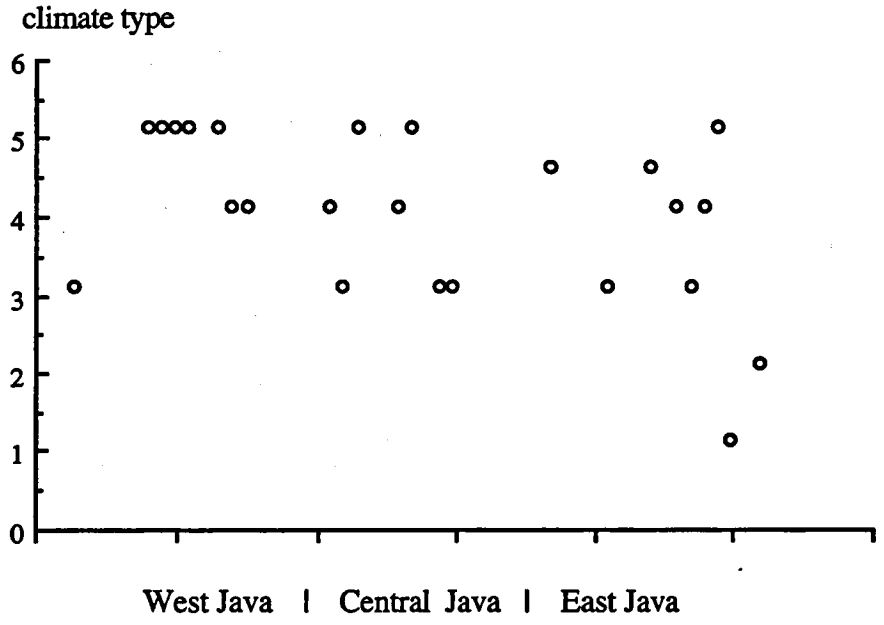


Fig. 15: Climate type of areas where Javan Hawk-eagles are present in an west to east sequence expressed in number of rainy days during the driest consecutive months of the year. 1) 0-10; 2) 10-20; 3) 20-30; 4) 30-40; 5) 40-122.

9.2 HOME RANGE

The density of Javan Hawk-eagles was estimated by comparing data presented in literature with our field observations. The most accurate estimate is that based on the home range of a breeding pair.

The Pangrango breeding pair presented a unique opportunity to determine the home range of a male Javan Hawk-eagle. During a three-month period we projected all the places where we had observed the male on a topographical map and measured the total area. The visiable home range was 12km^2. Because of the inaccessibility of the area we were not able to observe the total home range. Also, male Ornate Hawk-eagles have smaller home range sizes than females (Madrid et al., 1991) and we assume that this is valid for the Javan Hawk-eagle too. This leads to the 12km^2 being an absolute minimum.

On Gn Slamet we observed a non-breeding pair on the southern slopes. On different occasions, Javan Hawk-eagles were observed in two different localities along the northern slopes. In the same period, a Javan Hawk-eagle was observed by M. Linsley (pers. comm.) on the eastern slopes. On a local scale, home ranges show a patchy distribution and will not be adjoined even in pristine virgin forests (c.f. *S ornatus* and *S. tyrannus* Thiollay, 1989). An established pair will thus require a larger area than the observed home range. As we surveyed only half the total area on this mountain, of which *ca.* 200 km^2 is covered with natural forest our rough estimate is

that 6 pairs of Javan Hawk-eagles are present . Each pair has on average about 33 km^2 at its disposal. All estimates of home range sizes are two-dimensional, increase of area due to slopes is not included.

In 1988 Thiollay and Meyburg estimated that the home range size of a breeding pair of the Javan Hawk-eagle comprised between 20 and 30 km^2. This estimate was based on their long experience with other raptor species and on observations of territorial pairs of Javan Hawk-eagles performing display flights.

Ornate Hawk-eagles are known to have home ranges between 13 and 21km^2 for females and 8km^2 for males (Madrid et al., 1991). Breeding pairs of Mountain Hawk-eagles in the Suzuka mountains in central Japan had territories between 22.8 and 28.8km^2 (Yamazaki, 1990). In the south home ranges had been estimated to be 13.65km^2 (Morimoto and Iida, 1992).

Without doubt the density of the Javan Hawk-eagle population in Java is not constant, but subjected to interlocal variation. It will not only be influenced by variation in habitat quality such as variation in climate, soil, topographic relief and vegetation, but also by variation in hunting and capturing pressure and other forms of human disturbance. In less optimal habitat the home range may be much larger. Meyburg et al. (1989) estimated about 4-5 breeding pairs of Javan Hawk-eagle in Alas Purwo national park, with 620 km^2 within its boundaries, resulting in an average of 124-155 km^2 per pair. Some areas are only partially suitable. Ijen covers only partially suitable habitat (van Balen & Meyburg, 1994) like the nearby situated Baluran national park. This latter is probably only suitable during the wet season, because of its extreme conditions during the dry season. The Javan Hawk-eagle seen in Ujung Kulon national park may have belonged to a population inhabiting only the eastern part near Gn Honje. The other parts of Ujung Kulon are not suitable and the bird has never been observed here in spite of the high search intensity (van Balen, 1991).

9.3 Hunting and feeding behaviour

We observed the Pangrango male bringing a snake and three medium sized mammals to the female and the chick. Once we observed the female feeding the chick for about 22 minutes parts of a mammal which was lying at the nest. The male usually announced his arrival by loud vocalisations after which the female came from the nest and started to follow the male to take over the prey. On these occasions the male repeatedly flew away when the female approached and did not hand over the prey before she had followed him several times. After he finally gave the prey to the female she started feeding on it for an average of 13.15 minutes while he flew to the nest.

The diet of the Javan Hawk-eagle is still little known. Bartels (1924) reports that a chicken (*Gallus* spec.) and a large fruitbat (*Cynopterus* spec.) were found inside the stomach of collected specimens and that the feathers were smudged with the secretions of a Stinkbadger (*Mydaus javensis*). A Javan Hawk-eagle was seen catching and feeding on a squirrel by Mark Linsley (pers. comm.) and lizards have been reported to be part of its diet (van Balen, 1991).

It is remarkable that, except for the *Gallus* spec. which might be a domestic chicken, no birds were ever recorded to be part of the bird's diet.

On several occasions we saw Javan Hawk-eagles hunting close to the forest canopy; after manoeuvring very stably above the canopy in a slow soaring flight, the birds stooped straight into the foliage in an effort to catch prey with their talons.

Hunting behaviour has been described differently by Bartels (1931). He recorded still hunting. When searching for prey the Javan Hawk-eagle perched in small trees and on tree trunks. During this waiting for prey the crest is erected. When not searching for food the Javan Hawk-eagle could be found high up in the trees. The hunting method described by Bartels accords with Brown & Amadon (1968) who state that raptors living inside the forest in general hunts from perches within the forest.

9.4 BREEDING BIOLOGY

Nests of Javan Hawk-eagles are very difficult to locate not only because of the birds' rarity but also because the nest is very well hidden. Only four nests of this species have ever been observed. We were fortunate to be able to study the species at the nest in submontane forest in Gede-Pangrango national park. Observations were made on the north-west slope of Gn Pangrango, from a ridge opposite to the slope where the nest was situated. Prior to the discovery of the nest, Javan Hawk-eagles were regularly seen in this area and copulation has been observed (van Balen, pers. comm.).

Observations of the post-fledging period of an adult pair and their second year offspring were made on Gn Slamet. The adult birds could not only be distinguished by size differences but also by difference in colour- and moulting patterns. The pair of Javan Hawk eagles in Gn Pangrango differed in size and in age; the male was in subadult plumage while the female was fully adult.

Further observations revealed that the birds are very vocal, also during the breeding season. The birds did not seem very disturbed by human presence near the nest site so observations had probably no significant effect on their behaviour.

9.4.1 Observations during the pre-incubation period

On the 25th of March at 9.00hrs we observed a Javan Hawk-eagle in a valley on the western slopes of Gn Pangrango. The bird, which later turned out to be the female, was perched on the nesting tree. When it flew away and started soaring over the canopy it was attacked by two Black Drongos (*Dicrurus macrocercus*). After it flew around for a while it perched in a tree on the east side of the valley. At 9.28hrs the male was seen soaring over the canopy and after a few minutes it came down and perched in a tree. The birds were observed for a period of 1.11 hours in which the birds spent 14.05 minutes flying and soaring, 56.54 minutes perching, and 9.10 minutes preening. No calls were heard during these observations which later turned out to be a few days prior to the beginning of the incubation period.

The pair consisted of a male not yet in its adult plumage and an adult female. Most large raptors have several subadult plumages before acquiring the definite adult

plumage. According to Newton (1979) raptors are rarely found breeding in subadult plumage. So, it maybe inferred that larger species begin breeding at a greater age than small ones which is also born out by ringing studies. Individual raptors may begin breeding before their plumage is fully adult, when conditions are especially good, either in favorable years or areas or when depleted populations have left territories vacant. For instance after severe persecution of the Imperial Eagle (*Aquila heliaca*) in Spain in the end of the 19th century several female birds in subadult plumage mated with adult males and produced eggs (Valverde, 1960). Whether the conditions at Gn Pangrango are favorable or whether the population of Javan Hawk-eagles is depleted or at a very low density is not known.

9.4.2 Observations during the incubation period

After the observations on the 25th of March we decided to spend more time in this valley. We visited the area from 29 to 31 March, from 21 to 24 April, from 8 to 11 May, on the 13th of May, on the 15th of May and on the 6th, 24th and 26th of June. Due to the rain, incoming fog from the mountains, or the sun coming up above the ridge, it was not possible to observe the birds during the entire day. During the twelve days we visited, we observed the birds for over 82 hours. Observations took place between 6.00 and 18.00 hrs.

On the 30th of March at 9.46hrs the nest was discovered in a trifurcation of the main trunk of a huge Rasamala tree (*Altingia excelsa*). The tree had an etimated hight of 30-35m, and the nest was situated at roughly half way up The female incubated the major part of the day, with periods off the nest ranging from 4.30 minutes to 3.41 hours with an average of 32.30 minutes. During the sixteen days of observation the female left the nest 17 times.

During incubation breaks the female was usually feeding on prey which was brought by the male. He visited the nest for eight times and sometimes incubated.

The male was seen to come in the vicinity of the nest many times. In four cases he was seen to bring prey and on the other occasions he was soaring over the canopy, flying from tree to tree or perching in a tree near the nest.

9.4.2.1 Courtship display

In large raptors such as the Javan Hawk-eagle display flight can be very spectacular. Courtship displays are chiefly performed during but also often outside the breeding season and can be done by one or both of the birds, usually in flight but sometimes while perching.

The displays performed by a single bird may be termed advertisement displays and in its simplest form consists of perching in a tree and calling at intervals. An elaboration of perched display is soaring and calling by a single bird during which it may soar above the breeding ground or fly in a straight line, calling at intervals (Brown & Amadon, 1968). This has been observed on Gn Segara where two birds in one valley were alternatively calling. The birds were both present in the same valley, but the distance between the birds was several kilometres. The calling could be heard over a large distance. Even the constant calling which has been observed prior to copulation is a form of advertisement display (see 6.5.2.2: copulation).

More obvious courtship behaviour has been observed on Gn Slamet and consisted of several aerial displays in which single birds dove straight down from a high altitude.

In the period March-September observations on mutual display were made at several locations. The displays consisted of calling, soaring, perching and undulating flights combined with talon grasping. These obvious display flights were observed in both a breeding pair as well as in several non-breeding pairs. During the incubation period we observed courtship display after the female had eaten a prey brought by the male. For example, on one occasion ,when the female was perched in a tree, the male approached her. Male and female both started flying, sometimes the male was followed by the female, sometimes the other way round. The birds made undulating flights and approached one another during flight. At one moment the male flew high up into the air and dived down towards the female. When the birds met, one of them turned on its back (we think the female) and talon grasping occurred. After this the female returned to the nest and the male left the valley. These display flights lasted for *ca.* five minutes.

On the 2nd of May we observed another display flight of two Javan Hawk-eagles near the hot water springs at Pancuran 7 on the south slope of Gn Slamet. Both male and female were gaining height through thermal soaring above a ridge, during which both birds were vocal. After a while, soaring changed into flying without any notable pattern. The distance between the birds changed from approximately 50-100m into 20-30m. At one time the female which was flying above the male, dived down towards him and approached him up to ten metres. These flight lasted four minutes during which even more calls were uttered. Then the birds flew in separate directions and disappeared behind the ridge for 30 seconds. When the birds were seen again they were flying close above the canopy on top of the ridge, while making undulating flights and approaching each other very closely. While the female was constantly vocal the male gained height and dived down towards the female. The female turned on her back while flying and talon grasping between the two birds was seen. The birds were still flying closely together and talon grasping took place for a second time. One minute later the birds were lost out of sight.

A third location where display flights were observed was near the village of Karanganyar, west of Gn Slamet. In June a pair of Javan Hawk-eagles was seen above a teak plantation and rice paddies. The birds were very vocal and thermal soaring, undulating flights and talon grasping was observed.

Many eagles appear to be vocal during courtship display above the forest. they can be heard from afar which probably helps them to maintain large territories with minimum energy costs or to find mates in species which have a patchy distribution (Thiollay, 1985b). Display flights were observed in both a breeding pair and in non-breeding pairs. This may be a way for maintaining the pair bond, as breeding displays of other *Spizaetus* species, e.g. *S. nipalensis* are known to continue until the late nesting period (Yamazaki, 1990; Morimoto & Iida, 1992).

9.4.2.2 Copulation

At the 22nd of April at 7.20 hrs, while still in our camp at 400m from our main observation point, near the nest on Gn Pangrango we heard calling of the Javan Hawk-eagles. A few minutes later we saw the female sitting at the nest while the male was heard in the vicinity. At 9.10hrs the female went off the nest and started to follow the

male who carried a small mammal. The next one hour and a half, after it had started to rain heavily, the male and female stayed closely together (50 to 60 metres) flying from one tree to another. At 10.41hrs the female entered the nest. The next two hours the male and the female were constantly calling and during this period of time 956 calls were counted. The female flew back to the nest after having fed on the prey which the male had brought earlier. At that time the male was constantly calling from different trees close to the nest tree and finally perched about 60m from the nest. At 11.30hrs the female flew to a leafless tree 60m north-east, where she started preening. After nine minutes she left this tree and flew to a tree 10m from the nest tree. The male flew to the leafless tree and perched in the lower part of the tree. The female flew to the same tree and perched on a branch one metre below the male. The male in his turn jumped down and mounted the female. He was seen squat down and pressing his abdomen against that of the female. During this mounting he balanced by spreading his wings. This obvious copulation lasted for only 4 seconds after which the male perched on its previous branch. A few moments later the female returned to the nest and started incubating again, 40 seconds later the male also flew away and started soaring above the valley for 5 minutes after which he disappeared behind the ridge in southern direction.

Copulation has only been reported twice in Javan Hawk-eagles, observed in the same pair; once on the 13th of February 1994 by two BirdLife International Indonesia Programme officers (*in litt.*) and once on the 22nd of April 1994 during the incubation period as described above.

According to Newton (1979) copulations of raptors in general occur over a longer period and much more often in the pre-nesting period then might be thought to be necessary for fertilising eggs and thus may be important as pair-bonding behaviour. Another explanation for frequent copulation during the pre-incubation period might be the occurrence of sperm competition between males although no pertinent information is available. in that case copulations during other periods of the breeding season can be explained in terms of pair-bonding. As the egg was already laid this copulation had no use for fertilising an egg. Apparently, this behaviour is a function of ensuring the pair-bond between the male and the female.

9.4.2.3 Nest tree preference

The nest found earlier was situated in a large distinctive Rasamala tree, and was exposed on the north-west slope of a very steep ridge. We estimated the height of the tree at 30-35 m. In the valley below a small river was running from the mountains.

Data on three nests of the Javan Hawk-eagle (Bartels, 1924; van Balen et al., 1994; own obs.) reveal that the Rasamala tree *Altingia excelsa* is a preferred nesting tree, probably because of its height, branchless stem and protecting canopy. Data of other species of nesting trees are not yet known. Rasamala exclusively grows in the western part of Java as far eastward as the mountains near Garut. Together with *Podocarpus imbricatus* and *Podocarpus neriifolius* these are the characteristic emergent trees on West Java, but on Gn Slamet, for example, only the latter two are present. All three species can grow very tall and can be present at lower altitudes, Rasamala up to 60m and mostly found between 600 and 1700m, *Podocarpus imbricatus* up to 40m in height and present between 1000 and 2600m, and *Podocarpus neriifolius* up to 50m in height,

and can be found between 700 and 2900m (van Steenis, 1972). It is likely that eastwards of the range of the Rasamala tree the latter species are used as nesting trees.

All three are excellent timber trees and thus most forests at the lower altitudes have been depleted of these species. Production forests of Rasamala has been established in some parts of Java.

9.4.2.4 Nest maintenance

The nest of the Javan Hawk-eagle consisted of large dry sticks and green twigs and was situated in a trifurcation of the main trunk. During breeding fresh green limbs are frequently brought to the nest. For 22 times we observed the female rearranging nest material. Most of the times she was manipulating sticks and fresh limbs while incubating the egg. Sometimes she was standing while rearranging the nest, twice she stood on the edge of the nest, the other times she was inside the nest.

On the 24th of April the female flew from the nest at 9.35hrs and visited three nearby trees after which she returned to the nest tree a few metres below the nest. She plucked a green twig, the size of herself, after which she entered the nest and started arranging it into the nest. The nest rearrangements usually took less then one minute but occasionally the female was occupied for up to five minutes. For four times, after this date, the female was seen bringing twigs with green leaves varying in size from one third- to more than her body length, on three occasions she was actually seen plucking the twig. Only once the bird carried the twig in her talons, the other times it carried twigs in her beak.

In a total of eight visits to the nest, the male manipulated nest material six times. When he was standing on the nest or incubating the egg he was pulling sticks at the nest and rearranging nest material at the nest surface. On most occasions he shortly visited the nest while the female was eating prey, he had given her.

In total the male manipulated twigs and sticks for 3.38 minutes during his visits to the nest.

The nest described by van Balen et al. (in press) consisted of dry branches and leaves, was *ca.* 40 to 45cm wide and 35cm high and was constructed on a large branch of a 35 to 40m high Rasamala tree. Bartels (1924) described a nest which was situated on a branch in or near a large moss vegetation lump covered with epiphytes, high up in a emergent tree. H. Bartels (pers. comm.) described a nest which he found on Gn Pangrango as rather large. It was was situated at an height of 40m on a branch of a Rasamala tree (photographs published in Rozendaal, 1981).

9.4.2.5 Incubation

Observations on the incubation period started the 30th of March at which time the female already bred for one or two days. Incubation is mainly done by the female, during this period she occasionally came off the nest for feeding, perching in nearby trees, soaring and flying. During the 61.17 hrs of observation she left the nest for a total period of 9.01 hrs but because it is very likely that during the time we could not observe, the female did not leave the nest (rain, dense fog, night) we find it justified to state that she left the nest for 9.01 hrs during the whole of the 10 observation days in the incubation period. The female spent a total of 2.57 hrs preening, 2.57 hrs flying and soaring, 53 minutes feeding and 6.03 hrs perching in nearby trees. The female

stayed always in the vicinity of the nest, only once she flew away 500m when she was following the male to obtain prey. During incubation a total of 3441 calls were uttered by the male and female.

On eight occasions the male visited the nest, with a total period of 81.05 minutes, and incubated for four times with an average of 7.30 minutes. One time both male and female were on the nest at the same time.

During the incubation period egg rolling occurred and was also mainly done by the female; the male only rolled the egg twice during his short incubation spells. The female was seen rolling the egg for 23 times during incubation. Egg turning was achieved by rising of the parent, peering at the egg, and sweeping the bill gently between the egg and the belly.

In the first period of incubation (day 1 until day 41) the egg was rolled for 25 times during 44.14 observation hours, evenly divided over 8 days (average of 0.56 per hour). During the last 5 incubation days (day 42 until day 47) the egg was not rolled at all during the 17.03 hours of observation divided over 3 days. As the chick has to assume a certain position in the egg before it can start to work its way out, it is thought that this is the functional explanation for the absence of egg rolling in the last stage of incubation. Turning is especially important in the first half of the incubation period to prevent membranes from sticking together prematurely.

9.4.3 Observations during the post-hatching period

On the 15th of May, at 8.16hrs, the female which was on the nest at that time, showed an unusual behaviour. She seemed quite nervous as she kept on screaming, standing up in the nest, looking inside it and sitting down again for seven times with short intervals. She did not make any moves similar to egg rolling but repeatedly stood up and watched underneath her, turned her body a little, sat down again and so fort. Every once in a while, in between the periods of the above behaviour she did some nest rearranging but only for a few seconds. At this time we believe the chick to have hatched.

On the 6th of June RS together with B. van Balen returned to the nest for some more observations. At 7.26hrs the female was observed on the nest. After about two hours she left the nest and 25 minutes thereafter she returned carrying prey, a small mammal the size of a large rat, and flew directly to the nest. At this moment the three-week old chick could be clearly seen for the first time; it had the size of a feral pigeon and was completely covered with white downy feathers, only the area around the eyes towards the bill and the bill itself were dark grey to black in colour. The female started tearing small pieces from the prey and feeding these to her young. At the beginning she spent a lot of time working on the prey, but somewhat later, probably when its intestines had been opened, feeding intervals became smaller and constant feeding during the subsequent 22 minutes was observed. At 10.20hrs she sat down again and did some nest rearranging (25 seconds)

On the 24th of June the site was visited again. Observations started at 8.45hrs but due to the fact that we were facing into the sun no birds could be seen in the nest until 9.09hrs. At this time a moving white stripe which turned out to be the chick's back could be seen in the nest. At 9.11hrs the head of the now 5.5 week old chick was clearly visible, the female was not seen at the nest. Seven minutes later the female arrived and perched on a branch close to the nest where she started preening and

continuously calling for the next 11 minutes. At 9.44hrs the young became active; it started looking around and preening its whole body with clumsy shaky movements for about six minutes during which the major part of its body was visible: the odd, square shape of its head induced by the beginning of a small crest at the back, its white body already approximately 30cm long, its blackish mask and a black line bordering its small wings which is formed by the short black tips of the appearing primaries .

After a short period of rest (*ca.* three minutes) it started looking around and preening again. At 10.02hrs the chick stood upright in the nest (at which time only the feet were concealed behind the edge of the nest), stretched its legs, turned its back towards the observers, lifted its vent up while bending forwards, walked a little backwards until it stood on the edge of the nest, lifted its vent even higher while balancing with short spread wings and defaecated towards the observers. After having finished, it stepped forward into the nest, shook its round fluffy tail, turned its body back in the old position and sat down very deep in the nest. From 10.10hrs on its body could only be seen as a thin white stripe sticking out. No nest rearranging was done by the chick during the 20.50 hours of accurate observation.

On the 26th of June the authors paid another visit to the nest together with some interested birdwatchers. Observations started at 8.15hrs, the female was at the nest and the chick was about six weeks old. At 8.35hrs the female started calling and during the next three minutes the chick also uttered soft though very high pitched begging screams. After the female flew from the nest at 8.38hrs the chick was alone on the nest until observations were stopped at 12.31hrs. During the period in between the chick was quite active; now and then preening its chest, belly and neck (3.45 minutes), trying to walk a little (6.45 minutes) or just standing up (14.30 minutes), manipulating sticks in the nest three times (7.25 minutes), resting (1.58 hours) and occasionally calling. Because the adult birds also had to be observed, the chick was not watched when it showed no such activities; the female was always in the immediate vicinity (< 50m distance from the nest) and the male also visited the area.

Unfortunately the next two visits on the 13th and 19th of July were the last ones as they revealed that the young was no longer present at the nest and also the parents were not seen anymore. During 5.5 observation hours no activity of Javan Hawk-eagles was seen at or near the nest, or even in the valley. In January 1995, Javan Hawk-eagles were seen here again (P. Jepson, pers. comm.). It is possible the young died or fell out of the nest but it is not unlikely that it was robbed from the nest as once in a while new wild-caught birds turn up in zoos and birdmarkets.

In the post-hatching period a total of 25.06 observation hours were made; nest rearranging by the female added up to a total of only 25 seconds and no fresh limbs were brought to the nest. Furthermore the female spent 5.56 minutes preening, 61.23 minutes flying and soaring, 22 minutes feeding the chick and herself, 13.29 hours perching and sitting on the nest. A total of 517 calls were uttered.

In September 1992 a nest of Javan Hawk-eagles was found in the Gede-Pangrango national park and observed by BirdLife staff (van Balen et al., 1994). An eaglet which approached the adult birds in size (originally estimated age of eight weeks but re-estimated by the authors at 9 weeks) was found to be present at the nest. Its plumage was already cinnamon brown and it had a short white-tipped crest. The adult birds never visited the nest in each other's company but one of the birds was always in the

vicinity. The female was seen bringing fresh green limbs into the nest and the young was seen manipulating sticks. At arrival of the adults a begging posture was adopted although the young worked the prey by itself and had no difficulties eating. The young was also seen defaecating while standing at the edge of the nest. Preening, practising its wings and walking on the nest. Nine days later the young was seen 1m from the nest (approximate age 10.5 weeks). No calls were described of the chick.

Although still fragmentary the above observations are the only ones ever made on the post-hatching period of the Javan Hawk-eagle. They may be very valuable for insight in its breeding biology which is an important aspect of the birds' ecological requirements. So, indirectly, these observations contribute to the data needed for the species' conservation.

9.4.4 Observations during the post-fledging period

In April a pair of Javan Hawk-eagles was observed on Gn Slamet and a local warden told us that a third specimen occasionally joined the other two. This third bird was not seen during the next observation days.
When at the 23rd of August the site was visited for the fifth time we saw this bird.

A total of 5.28 observation hours were made of this pair of Javan Hawk-eagles together with their approximately one year old young on Gn Slamet. The youngster was seen nine times (total period 5.10 minutes) when it usually just soared past the observation site and only two times together with its parents while they were making display flights, the young however did not take part in these display flights. Once it was attacked by a Drongo (*Dicrurus* spec.). Its calls were somewhat more monotonous than those of its parents and were described as a high pitched "ee-eeek" (resembling the call of *S. cirrhatus* in the sonagram; fig.11). The young was a little smaller and less robust than its parents and the flight image was quite different; the wingspan seemed relatively smaller and the overall colour was much lighter than the adult birds. The underside of its body was cinnamon brown, and from below a large white triangle was seen on its wings (see description of juveniles in chapter 3.2.1).

9.5 THE BREEDING SEASON

The egg of the Pangrango breeding pair was laid around the 29th of March and the incubation period has been observed to be 47 (+/- 1) days. We observed a copulation on the 22nd of April.

On the 18th of May we saw two juvenile Javan Hawk-eagles, one only about one week older than the other, offered for sale near Palabuhan Ratu. These birds appeared slightly older than the chick in the Pangrango nest, which was observed up to 6 weeks of age. Also an account of subsequent observations of these and other Javan Hawk-eagles, we estimated that these birds were ten and eleven weeks old when we found them at a dealer's.

The 16th of July we first saw a newly obtained juvenile Javan Hawk-eagle in Taman Safari which was obtained on the 28th of June. Upon arrival this bird was still

covered with downy feathers. We estimated the age of this bird to be nine weeks and concluded that it was *ca.* 6.5 weeks old when it came into the zoo.

The juvenile of the Gn Slamet breeding pair was in its second year plumage and was observed with the two adult birds by one of the Perhutani staff members in April. We observed this bird also on several occasions, the last time in late August.

Copulation has only been reported twice: once by van Balen (*in litt.*) on the 13th of February [1994] and once during our study on the same couple on Gn Pangrango on the 22nd of April. According to Bartels (1931) the mating season on Gn Patuha is in July and August. An egg has been collected in April [18-04-1927] by H. Bartels and described by Hellebrekers and Hoogerwerf (1967). The egg of the Pangrango breeding pair was laid on the 28th of March. Breeding has been reported in May and June, West Java (Hoogerwerf, 1949c); in May [1919] on Gn Pangrango (Bartels 1924); in September [1992] on Gn Gede near Cibodas (van Balen et al, in press) and from March untill June [1994] on Gn Pangrango. In the second half of September a newly fledged young was shot by Bartels (1924) at Gn Pangrango and hopping on a branch near the nest has been observed in the same month by van Balen et al. (in press). From the described plumage and behaviour we estimated the age of the latter bird at about ten weeks and a half.

As we are only beginning to understand the breeding behaviour of the Javan Hawk-eagle and a full breeding season has never been observed, we compare data gathered on other members of the same genus to get an insight in the time of fledging.

The young of a Changeable Hawk-eagle was seen in the branches over the nest for the first time at an age of 10 weeks. Also at ten weeks it was hopping in the vicinity of the nest and at 11.5 weeks it fledged (Naoroji, 1985). Also the Mountain Hawk-eagle is known to have a nestling period of 11.5 weeks (Yamazaki, 1990). Madrid et al. (1991) reported Ornate Hawk-eagles to perch on limbs near the nest at an age of ten weeks; fledging was observed at ten and more than 13 weeks. The first movements of another Ornate Hawk-eagle outside the nest was observed at an age of 10 weeks; fledging occurred after 12.5 weeks (Klein et al., 1988).

Combining the above data with those of van Balen et al. (1994) and our own observations we conclude that fledging of the Javan Hawk-eagle is at *ca.* 12 weeks. These findings, the incubation period of 47 days and the fledging period of 12 weeks, reveal that the eggs resulting in the two Palabuan Ratu birds were laid in respectively the second and the third week of January. The egg resulting in the newly obtained Javan Hawk-eagle in Taman Safari, Cisarua, observed on the 26th of June 1994, was probably laid in the last week of March. This chick might thus have been the same as the one which had disappeared after the 26th of June 1994 from the Pangrango nest.
The egg of the Cibodas pair (Gn Gede) was laid in the third week of May 1992.
In general fledging occured between the first week of March and the beginning of October.

		Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Gn Pangrango	egg laying			X									
1994, Sözer &	incubation			X	XXXX	XX							
Nijman	post-hatching					XX	XXXX						
Taman Safari	egg laying			x									
Young	incubation			x	xxxx	xx							
16-07-1994	post-hatching					xx	xxxx	xxx					
Gn Gede 1992,	egg laying						x						
B. van Balen	incubation						xxxx	xxx					
	post-hatching							x	xxxx	xxxx	x		
Pelabuhan R.,	egg laying	x											
Young 1,	incubation	xx	xxxx	x									
18-05-1994	post-hatching			xxx	xxxx	xxx							
Pelabuhan R.,	egg laying	x											
Young 2,	incubation	xxx	xxxx										
18-05-1994	post-hatching			xxxx	xxxx	xxx							
Hellebrekers &	egg laying				x								
Hoogerwerf,	incubation				xxxx	xxx							
1967	post-hatching					x	xxxx	xxxx	xxx				
Hoogerwerf,	egg laying					x							
1949 c	incubation					xxxx	xxxx						
	post-hatching						x	xxxx	xxxx	xxx			
Bartels 1924	egg laying					x							
	incubation					xxxx							
	post-hatching					x	xxxx	xxxx	xxx				
Bartels 1924	egg laying					x							
	incubation					xxxx	xxx						
	post-hatching						x	xxxx	xxxx	xxx			
BREEDING	SEASON	xxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	xxxx	x		

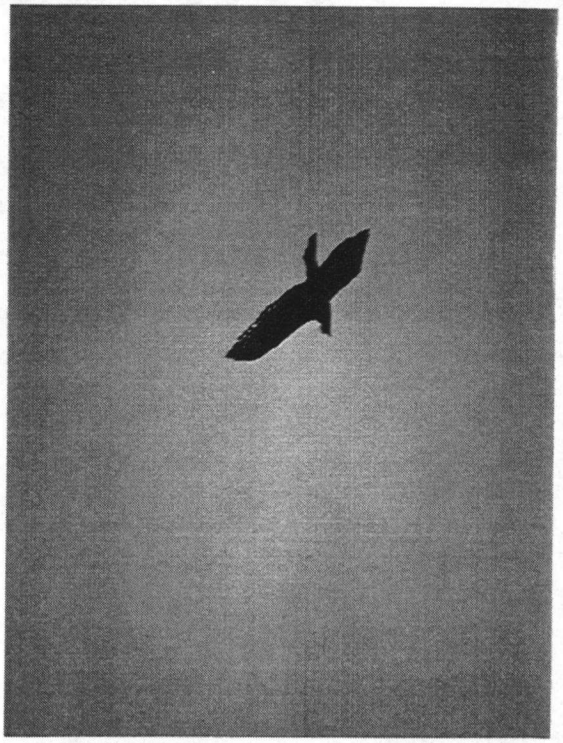
Fig.16: Months in which the different stadia of breeding have been recorded and the resulting breeding season; x = exact data, x = calculated from the exact data.

Although the localities where the juvenile birds from Pelabuhan Ratu and Taman Safari were caught are not known it is very likely that they were obtained from West Java. The rest of our data are all from West Java and thus we can conclude that in this

PLATE V FLIGHT IMAGES OF JAVAN HAWK-EAGLES

Page bottom left: Javan Hawk-eagle in flight, 24-8-'94 Gn Slamet. Page top left: Javan Hawk-eagle soaring, 24-8-'94 Gn Slamet. Page bottom right: Javan Hawk-eagle in flight 22-4-'94 Gn Pangrango. Page top right: Javan Hawk-eagle soaring, 24-8-'94 Gn Slamet (photos: V. Nijman).

PLATE V



part of the island the breeding season starts early January and continues until the beginning of October. The period in which breeding has not been reported is the second week of October until the first week of January. An explanation for this non-breeding period can be simply that there is still a gap in the knowledge in this period, or that the birds do not breed in this period because it is the wettest period of the rainy season.

Javan Hawk-eagles probably have a prolonged post-fledging period and the juvenile may stay up to 1.5 years in the vicinity of its parents. Bartels (1931) states that the young keeps begging for food even if they have been fledged for a long time. The juvenile of the Gn Slamet breeding pair was seen in the vicinity of its parents in the period April until the end of August. Other Hawk-eagles also have a prolonged post fledging period and up to one year after fledging the juveniles can are observed near their parents (c.f. *S. ornatus*: Klein et al., 1988; Madrid et al., 1991, *S. nipalensis*: Brown and Amadon, 1968).

In tropical Hawk-eagles breeding is believed to occur only once every two to three years (c.f.. *S. ornatus*:, Klein et al., 1988; *S. ornatus*, Madrid et al., 1991). In May 1919 one of the Bartelses regularly observed two, probably Javan, Hawk-eagles near the vicinity of a huge clump of moss vegetation high up in an emergent tree where they were thought to breed. In December 1920 a first year juvenile Javan Hawk-eagle (see Meyburg et al., 1989), which was already heard for a long time, was shot in the vicinity of the same nest tree. September 1921 breeding was observed in the same nest tree and the newly fledged young was shot two weeks later. In 1922 and 1923 the two adult Javan Hawk-eagles were still regularly seen in the surroundings of the nest but breeding was not observed (Bartels, 1924). These observations and the prolonged post fledging period make us believe that the Javan Hawk-eagle breeds maximally every two years.

9.6 INTERSPECIFIC BEHAVIOUR

On the 30th of March at 11.35 hrs we saw a group of Grizzled Leaf Monkeys (*Presbytis comata comata*) at thirty metres from the nest while the female was incubating. The monkeys themselves were not calling but as they were jumping from tree to tree they caused a lot of branch movement and noise. We did not notice a change in behaviour of the bird.

The valley was also frequently visited by two Black Eagles, one of which was missing some primaries. Sometime we saw them soaring very high above the valley, sometimes very low above the canopy. No change in behaviour of the female was noticed during these visits. However when the male was coming in, the female started vocalising, stretching her neck and usually seemed very alerted. She was not sitting quietly anymore even though the male was soaring at very high altitude and was not yet seen by the observers. This shows that the incubating female must certainly have been fully aware of the near-by Black Eagles.

On another occasion, however, the female was alerted by one of the observers chopping wood to build an observatory shelter. Every time the chopping started the female turned her head in the direction from which the sound came and stretched her neck.

9.6.1 Aggressive behaviour

Javan Hawk-eagles were frequently observed being attacked by drongos (*Dicruridae*). We have observed single drongo's attacking both single Javan Hawk-eagles as well as a pair. Pairs of Black Drongo's (*Dicrures macrocercus*) was seen mobbing a single Javan Hawk-eagles. On Gn Slamet an Ashy Drongo (*D. leucophaeus*) was observed attacking a male Javan Hawk-eagle in flight. Also other species such as Woolly-necked Storks (*Ciconia episcopus)* showed aggressive behaviour towards Javan Hawk-eagles (for detailed records see: Nijman & Sözer, in press b).

Aggressive behaviour of a Javan Hawk-eagle was observed towards another species; a Javan Hawk-eagle was continuously following a Crested Serpent-eagle (*Spilornis cheela*) until the latter flew off (T. Sibuea, pers. comm.).

9.6.2 Interspecific competition

On the island of Java two sympatric members of the genus *Spizaetus* occur: the Javan Hawk-eagle and the Changeable Hawk-eagle *S. cirrhatus*. Their coexistence in partially the same habitat poses an interesting problem in the light of the competitive exclusion principle, according to which no two species with similar ecological requirements can live side by side. Related species have to be segregated by range, by habits or by feeding methods. Here we present some features of the morphology, feeding behaviour and habitat preferences in order to show the amount of segregation between the two species.

We observed Changeable Hawk-eagles several times in primary forests as well as in cultivated land. On Gn Gede three birds were observed soaring above the Safari Park near Cisarua where they were attracted by the calls of their captive conspecifics. The area is surrounded with dense forest where also Javan Hawk-eagles were present. South of the village of Salem near Pegunungan Pembarisan, Central Java, we observed two Changeable Hawk-eagles; one of them flew off from a pine tree near the road and later two of them were soaring above rice paddies and pine plantations. Two others, a dark and a light phased specimen, were performing display flights along a ridge near a village on the foot of Gn Segara. Also on Gn Wilis, East Java, in a densely forested area, two individuals of the dark morph were performing display flights and they were followed by a third. In the same area a Javan Hawk-eagle was present. These observations show that the two species occur alongside each other in many areas, though Javan Hawk-eagles were mainly observed in the primary forests.

The two species as well as the sexes within the species differ in size: the females being larger than the males and *cirrhatus* being larger than *bartelsi*. The wing length of the male *cirrhatus*: measures 405-430mm; the female 448-462mm; male *bartelsi* 358mm; female 371-372mm (Brown and Amadon, 1968) and total length 70cm for *cirrhatus* and 60-70cm for *bartelsi* . This results in four different groups which might show differences in habitat selection, choice of prey and mode of hunting (see e.g. for *Accipiter gentilis* and *A. nisus*, Opdam, 1975).

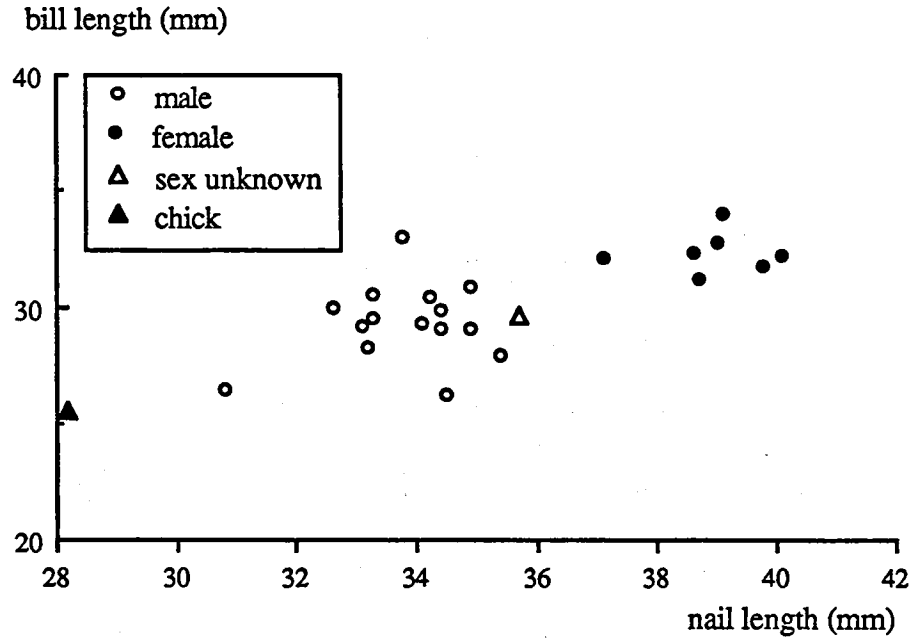


Fig. 17: Sexual dimorphism in Javan Hawk-eagles expressed in bill-nail length differences. Measurements taken in Museum Zoologi Bogoriense and Leiden Museum of Natural History.

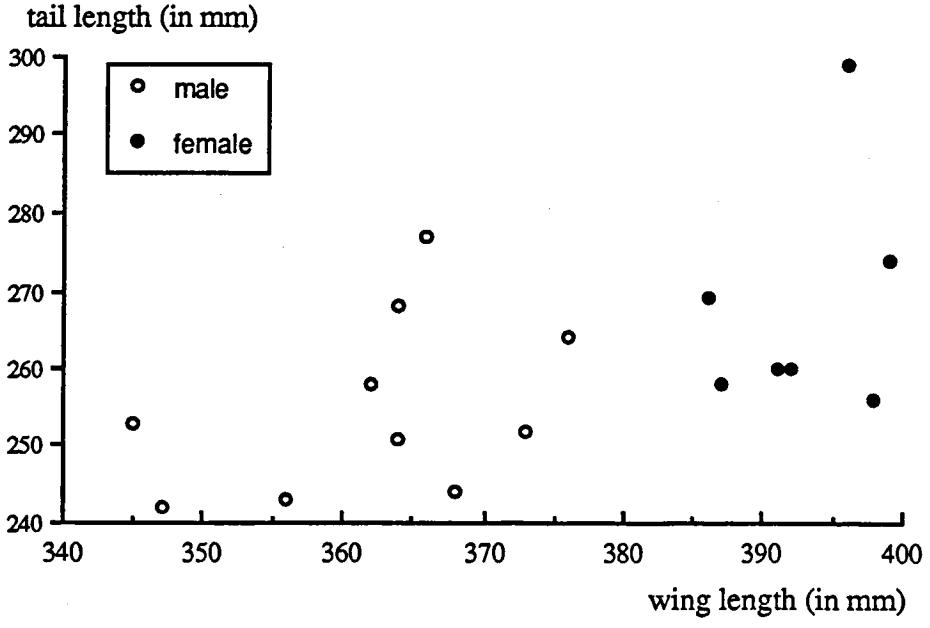


Fig. 18: Sexual dimorphism in Javan Hawk-eagles expressed in tail-wing length differences. Measurements taken in Leiden Museum of Natural History.

S. cirrhatus has a far greater geographical range and has been studied in more detail than *S. bartelsi* . Variable habitat preferences in different parts of its range have been reported (e.g. Bartels, 1924). The Sumatran and Javan races are known to inhabit the dense rainforests but also commonly frequent the open country and cultivated land as e.g. rice paddies (Brown & Amadon, 1968). The species can be found in cultivated land as long as some patches of natural forest or plantation forest is present in the surroundings (Bartels, 1924). They can frequently be seen in the vicinity of villages. It is known to breed in forest edges (Kuroda, 1936) and even in cultivated land (Bartels, 1924). *S. bartelsi* is more a bird of the primary forest and only juveniles are known to disperse far beyond their preferred habitat. The nest has only been reported in the best preserved forest areas.

Changeable Hawk-eagles usually feed on birds (Hoogerwerf, 1949b), mainly on gamebirds and poultry, and occasionally on squirrels, rats, lizards and snakes (Bartels, 1931). Javan Hawk-eagles hunt in the dense forest (Bartels, 1931; M. Linsley, pers. comm. and own obs.) in contrast to the Changeable Hawk-eagle which is known to hunt above clearings (MacKinnon & Phillipps, 1993), cultivated land and even near human settlements.

We have seen that Javan Hawk-eagles and Changeable Hawk-eagles are segregated at least partially by habitat requirements where the first inhabits and hunts not only in primary forest, but also in production forests and cultivated land and the latter is generally confined to the undisturbed forests. The diet of the Javan Hawk-eagle is poorly known but mammals and reptiles probably form the main part of it while the Changeable Hawk-eagle's diet at least partially consists of birds.

PART D: CONSERVATION

10 Status and threats

10.1 JAVAN HAWK-EAGLE AS INDICATOR SPECIES

The tropical rainforest can still be considered among the least known major environments. It is not only amongst the world richest ecosystems in total number of plants and animals but is also the richest area of any specialised genera and species exclusive to it (Walter, 1985).

At the present rate of forest decrease, most of the forest raptors such as the Javan Hawk-eagle, will be extinct before becoming well known. With this study we tried to gather the basic knowledge, necessary for any management of its habitat and populations. Now more is known about the distribution of the species, its density and population numbers, even though only rough estimates, its habitat requirements and breeding biology, it is possible to come to a better funded protection of the species and its habitat.

First of all the protection and management of this endemic bird is important in its own right, but secondly it can also take the role as a flagship species because of their large home ranges which encompass larger populations of most other species under which several less impressive and less known but equally endangered ones. Furthermore the Javan Hawk-eagle can be used as a flagship species, and its presence in any location can be used for the justification for the conservation of the rainforest ecosystem. The national bird in particular is very suitable for arousing public interest and support.

Because Javan Hawk-eagles are probably more susceptible to forest destruction than all other Javan forest raptors (Thiollay & Meyburg, 1988), the monitoring of this species can teach us much about the changes in the forest ecosystem and can thus be used as an bio-indicator for this fragile environment. Especially in the tropics raptors can and are already being used as sensitive bioindicators of environmental change, particular in terms of habitat quality and pollution, and to help monitor the forest degradation. Currently several conservation programmes in tropical countries encompass global management plans including forest conservation, development of ecotourism, economic incentives for sustainable forest use by local people, research conducted by local students and training of rangers. Examples of these projects are the Maya project (Burnham et al., 1994) in Latin America, the Philippine Eagle project (Salvador, 1994) and the Madagascar Fish-eagle project (Watson and Lewis, 1994). Also knowledge on the distribution and density of diurnal raptors in rainforest is used in the design of national parks (Thiollay, 1989). The establishment of an integrated protected area system on Java can benefit from the data gathered during our study of the Javan Hawk-eagle.

Their biological role as top predators may be critical for the balance and functioning of the ecosystem. The narrow relationships between prey and predators may contribute to the occurrence of high species diversity. In spite of the difficulties in studying large predators the last years it became evident that they hold the key to the stability of the ecosystem and to the maintenance of the extraordinary diversity of plants and animal in

it, a function that extends far beyond the demographic impact on its immediate victims (Terborgh, 1988).

As a result of its large size, its specialisation, its occurrence in low densities, limited distribution and the very low reproductive rate, the Javan Hawk-eagle is among the most extinction prone species. Considering these biological constraints and the rapid destruction of evergreen forest, large areas should be set aside for the long-term survival of the species. For the maintenance of species strictly associated with the primary forest large tracks of undisturbed forests have to be preserved (Thiollay, 1994), and whatever their size, these should be connected with other similar areas by scattered smaller patches of forest to allow faunal exchanges.

10.2 STATUS

The Javan Hawk-eagle has a limited distribution. It was considered to be dependent on the montane forests of West Java and has never been described as being abundant. Kuroda (1936) in his birds of the island Java treats the bird as being very rare. Also Hoogerwerf (1949b) and Brown & Amadon (1968) describe the bird as rare. The species is included in the list of most endangered raptors of the world (Meyburg, 1986), van Balen (1994) lists it as only one of two species to be endangered in the Sondaic and Wallacean regions of Indonesia , and Collar et al., (1994) include the species as 'endangered' (Mace and Lande category) in the checklist of threatened birdspecies.

10.2.1 Status in the wild

As the gap in distribution is proved to be due to lack of knowledge, and as the species appears to occur along the entire length of Java, it is now possible to determine the overall status of the Javan Hawk-eagle more accurately than was done by Meyburg et al. (1989) or van Balen & Meyburg (1994).

The larger populations of Javan Hawk-eagles survive in the western and eastern provinces where the larger reserves and national parks can be found. Most of the pairs of Javan Hawk-eagle in West Java have their residence inside (formally) adequately protected areas such as nature reserves and national parks.

PLATE VI THREATS TO THE JAVAN HAWK-EAGLE

Page bottom left: Confiscation of one of the two juvenile Javan Hawk-eagles at Bojong Galing, Pelabuhan Ratu, West Java. 18-5-'94 (photo: V. Nijman).

Page top left: Adult Javan Hawk-eagle above cultivated land, southern slope of Gn Slamet, Central Java 24-8-'94. (photo: V. Nijman).

Page bottom right: Pest control in tobacco plantations on Gn Sundoro, Central Java, 1-7-'94 (photo: V. Nijman).

Page top right: Collecting of fire wood on the eastern slope of Gn Prahu, Central Java 26-8-'94 (photo: V. Nijman).

PLATE VI

This is also, although to a lesser extent, the case in the eastern province (see table 3). However in Central Java only two of the remaining forest patches; Nusa Kambangan-Segara Anakan, on a peninsula in the south, and Gn Celering, north of Gn Muria in the north, include more than 1000ha and are also preserved as a nature reserve. All the 18 to 25 pairs of Javan Hawk-eagles present in this part of the island live outside sufficiently protected areas and thus are extremely vulnerable (see also Sözer & Nijman, in press).Not only juvenile Javan Hawk-eagles tend to wander outside their preferred habitat but also occasionally the adults do and can be seen outside the protected areas. Territories of breeding pairs may partially be located outside the reserve boundaries. It should be borne in mind that even Javan Hawk-eagles are not totally safe within the boundaries of the national parks and reserves. Encroachment within the boundaries of protected forests is only illegal when the boundaries are sufficiently clear and this is not always the case. Several reserves are understaffed and thus cannot be adequately protected so people with all kinds of intentions can enter the reserves unnoticed. These difficulties in management are major obstacles in ensuring the survival of the Javan Hawk-eagle and put its survival in jeopardy.

Although a recent population estimate gives a higher number of pairs of Javan Hawk-eagles than previously thought, the species must not be considered to be less rare or less endangered. With almost all the available habitat occupied and only 81 to 108 pairs left, the species still can be considered amongst the most endangered raptors of the world.

10.2.2 Status in captivity

At this moment six Javan Hawk-eagles are present in zoos in Indonesia. There are no data on Javan Hawk-eagles outside of Indonesia. There are also a number of birds in private ownership, exact data however are not yet available to us.

Table 5: Javan Hawk-eagles in captivity

bird	location	age	obtained	from	additional notes
1	TMI	subadult	1991	?	died August 1994
2	TMI	adult	1994	?	died August 1994
3	TMI	juvenile	08-1994	?	data unconfirmed
4	TSF	adult	02-1994	private owner Jakarta	escaped May 1994
5	TSF	juvenile	05-1994	confiscation P. Ratu	
6	TSF	juvenile	05-1994	confiscation P. Ratu	
7	TSF	juvenile	06-1994	private owner Jakarta	
8	TSF	subadult	06-1994	private owner Jakarta	
9	SBY	adult	01-1994	confiscation Madiun	died January 1994
10	TSF	adult	11-1994	?	B. van Balen (pers.
11	TSF	adult	11-1994	?	comm. 15-12-1994)

TMI = Taman Mini Indonesia Indah, TSF = Taman Safari Indonesia, SBY = Kebun Binatang Surabaya.

10.3 BIOLOGICAL CONSTRAINTS

As stated before, the Javan Hawk-eagle is considered to be a rare species. Like other *Spizaetus* species the Javan Hawk-eagle becomes sexually mature after three to four years (c.f. *S. cirrhatus*: Brown & Amadon, 1968; *S. bartelsi*: own obs.) and is believed to breed only once every two to three years (c.f. *S. ornatus*: Klein et al., 1988 and Madrid et al., 1991). Because only one single egg is laid (Hellebrekers & Hoogerwerf, 1967) less than 50 young are produced each year, assuming that there are approximately 81 to 108 breeding pairs. Just as other *Spizaetus* species (c.f. *S africanus*, Brown et al., 1982; *S ornatus* Lyon et al., 1985, Klein et al., 1988) the species has a prolonged post-fledging period for up to one and a half year. The Javan Hawk-eagle has a very low reproductive rate and the dependence of the juveniles on the parents for a long time makes the species a very vulnerable one. The low rate of fecundity severely limits the Javan Hawk-eagle to recover from even modest disturbance such as a weak hunting pressure.

10.4 THREATS

For an endangered species as the Javan Hawk-eagle it is important to understand the threats it is subjected to in order to make some recommendations which could positively influence its survival. This is all the more important as the effects of different threats are accumulative.

10.4.1 Habitat destruction

The main threat is habitat destruction. This includes not only the total destruction of forest and its replacement by forest plantations, pasture, or other forms of cultivation, but also the degradation of the forest. The continuous fragmentation of primary forests and the intensification of land use in the areas between the remaining forest patches result in isolation of the populations trapped in the forest remnants. As Wind (1994) states, gaps between populations may soon become too wide due to further habitat loss and fragmentation which will result in inbreeding depression. The reduction and the fragmentation of the forests result in populations too small and too widely separated to persist in the long term (Thiollay, 1985a). According to Thiollay & Meyburg (1988), of all the Javan forest raptors, the Javan Hawk-eagle is probably the most susceptible to forest destruction. To prevent the extinction of the Javan Hawk-eagle it is necessary to preserve large areas of primary forest as reserves or national parks. Nevertheless large areas of primary forest on Java are increasingly rare and every year opportunities to create such reserves are lost for ever.

Another immediate threat is encroachment along the edges of the forested areas. As the infrastructure is being improved the accessibility is increasing and the Javan Hawk-eagle and man are getting more and more in conflict. This usually turns out to be unfavourable for the first mentioned.

The large scale negative effects of the use of pesticides on the populations of raptors in Europe and North America in the '60 and '70 have taught us to be very cautious with organo-chlorides and other pollutants. The large amount of pesticides that are used for instance in Javan tea plantations and the pollution of the water in these areas are reason

for concern for the existance of all kinds of birds of prey. We have no data whether or not their is an increase in the use of pesticides on Java nor do we have data on any negative effects of the use of pesticides on Javanese raptors, but it remains clear that the use of these toxic chemicals can have a very negative effect on the populations of species already endangered.

10.4.2 Hunting and capture

The greater accessibility may also increase hunting activities. The increasing use of airguns is worrying. While studying Javan Hawk-eagles near the Gn Gede-Pangrango National Park during the first three months of this study no fewer than seven people carrying powerful air rifles for hunting birds were seen entering the area. Javan Hawk-eagles are rather easy to hunt, and to catch one is not too difficult for experienced bird trappers (H. Bartels, pers. comm.). Immature birds tend to wander out of their natural habitat and thus may also be seen near villages and plantations; this makes them even more vulnerable for capture and hunting. E. g. Van Balen (1991) reports that several juvenile birds were seen above tea and coffee plantations; a juvenile bird was shot above a tennis lawn (specimen in Museum Zoologi Bogoriense, collected by E. Kerkhoven; note: "*Op het tennisveld geschoten.*"); another bird was caught underneath a village house (Sody, 1920) and in April 1994 a juvenile bird was seen near the village of Sukaresmi on Gn Halu, south of Bandung (T. Sibuea, pers. comm.).

The trade in birds of prey is a profitable business and although all species of diurnal birds of prey are protected by the Indonesian law since 1970, they are offered for sale at nine out of the ten bird market we have visited. Although the rarity of the Javan Hawk-eagle makes it less offered for sale than other raptor species, quite a number of Javan Hawk-eagles were seen at bird markets the last years (B. van Balen, pers. comm.). Although no quantified data are available, we fear that trade in the Javan Hawk-eagle, which has become more familiar and has become a national symbol, might increase. Experience with the Bali Starling (*Leucopsar rothschildi*), which has become the Bali province mascotte, has taught us that these praise worthy initiatives should be supported by adequate law enforcement and awareness programmes.

10.4.3 Bird fanciers, birdparks and zoos

Zoos and safari parks, just as bird fanciers, see birds of prey, and preferably the rarer ones, as status symbols and important assets for their collections. It is beyond doubt that zoos and birdparks play an important role in education as well as in conservation of many animal species, but if all 17 zoos that keep birds in Indonesia were to have a couple of Javan Hawk-eagles in their collection, 34 Javan Hawk-eagles would have to be caught from the wild if the sexes of the birds are positively known; if not, even more birds have to be removed out of the wild.

For the preservation of the species in the wild it is in our opinion totally irrelevant whether or not the species is able to breed in captivity. One has to accept that Javan Hawk-eagles only have any value as part of the Javan rainforest. For the conservation of the species zoos and birdparks have a tiny though important role: the promotion of conservation through education and awareness programmes and teaching the local people why to appreciate the values of their unique biodiversity.

10.5 CAPTIVE BREEDING

"Captive breeding can be a useful supplement to in situ conservation for some easy-to-breed species and a source of animals for stocking other zoological gardens. The value of zoo efforts to captive breed endangered species for reintroductions to the wild is more doubtful. For many, indeed most, endangered animal species captive breeding programmes may not be realistic of the expense, limited space, difficulties in encouraging animals to breed in captivity and even greater difficulties in reintroducing captive-bred young to the wild."
(Bappenas; Ministry of National Development Planning and National Development Planning Agency, 1993.).

Captive breeding or ex-situ conservation usually refers to breeding endangered wild animals in captivity with the main purpose of protecting such animals from extinction. Opposite to ex-situ conservation there is in-situ conservation which refers to protection of habitats and the endangered animals with them. Examples of this kind of conservation are national parks and nature reserves.

A third kind of conservation is kryo-preservation which is the storing of deep-frozen animal material as sperm and eggs, embryos or genetic material as DNA. We will not go further into this third method of conservation as it is not of relevance for the Javan Hawk-eagle and has all along more a character of science fiction. A fourth possibility is leaving nature be and face extinction of some endangered animals, as it is and has always been one of many aspects of evolution. However, not to take any action and let extinction run rampant through the biodiversity, waiting whether evolution is able to restore the losses after man has gone extinct himself, is an option we, in this case, do not support.

In the case of the Javan Hawk-eagle, efforts have to be made for its survival. Deforestation and destruction of its natural habitat are the main threats to this endemic species, although the last few years the bird was occasionally seen at birdmarkets and ten new specimen were brought to zoos in the year 1994, five of which died. No information is available on the presence of Javan Hawk-eagles in zoos outside of Indonesia.

The optimal habitat for this species, which is the scarce primary rainforest on the island of Java, is almost completely occupied. Basic knowledge about its exact distribution, behaviour in the wild, food, breeding habits, demography and genetics is still fragmentary.

10.5.1 IUCN rules

Ex-situ conservation is a conservation tool for species that are rare, endangered and have low population sizes. It can be applied in order to preserve animals in captivity that face extinction and have no natural habitat anymore. Ex situ conservation can also be applied to species that have become rare because of human influence or environmental disasters. These species might be bred in zoos in order to establish a captive population that may later on boost the natural population. Restocking or repopulation of such species may be valuable for conservation if their natural habitat still exists. According to the IUCN (1987b) a captive breeding programme for repopulation can be applied if the following conditions are met:

- the species or population has radically decreased in numbers
- the species faces extinction
- inbreeding will occur in a short period of time
- natural recovery is not likely

Before any programme can be started the cause of decrease has to be taken away and thorough research on the possible effects of the future repopulation on the ecological system has to be done

The main IUCN requirements (1987a) for establishing a captive bird population suitable for restocking the wild population are: first, the founder birds need to be from the same subspecies as the population that needs restocking, preferably even from the same area in order to breed birds that match the wild birds in genotype. Second, the captive stock needs to be self-perpetuating and produce appreciable numbers of young. Third, the offspring has to be successfully established in the wild. Therefore contact with humans has to be avoided in order to reduce the chance of imprinting on humans, and the birds have to be behaviourally adapted to their natural habitat and wild relatives

10.5.2 Difficulties with captive breeding

With a small founder population, effects of genetic and demographic stochasticity (May, 1989) may cause problems that might result in extinction. These effects are inversely correlated with population size.

The IUCN policy statement on captive breeding (1987a) declares that captive populations need to be founded and managed according to sound scientific principles in order to secure the survival of species through stable, self-sustaining captive populations. In order to establish such a captive population, however, one needs to have a very large founder population to prevent inbreeding in the long term. In order to preserve 99% of the genetic variation in one hundred generations of any species one needs roughly 500 individuals as a founder population. Even though this number can hardly ever be met, it it thought to be clear that the founder population needs to be as large as possible. Removal of birds from the wild for breeding purposes may endanger the vulnerable wild population even more. Illegal removals, whether or not actively encouraged by zoos, might be stimulated by a captive-breeding programme. If the zoos involved do not accept these birds they will be sold to private bird collectors and thus refrained from any breeding.

Natural selection is replaced by artificial selection in captive breeding programmes because of the subjective selection of breeding 'pairs' and the absence of predators and competitors. This might result in maladaptive genes, decrease of brain volume and reduction of viability and fecundity.

Maladaptive behaviour may inhibit adjustment to future habitat as well as to wild mates. It is very important for captive-bred birds to learn hunting skills, choice of prey, selection of a territory, selection of a nest tree, communication and intraspecific behaviour. No information on what skills are instinctive known and what is to be learned from the parents is available. Some of this knowledge can be taught by captive companions or even by humans, although getting used to or imprinted on humans is not preferable. Habitat and nest tree selection are more difficult to teach in captivity.

Infection of the wild population with diseases that occur much easier in captivity is one of the other difficulties; impact of infection of the wild population might be disastrous.

10.5.3 Is captive breeding an option?

Several zoos in Indonesia want to breed the Javan Hawk-eagle in captivity although proper facilities are lacking and insufficient knowledge about the status, behaviour in the wild or even about identification of the species is available; for example: very recently a captive breeding programme was planned with a Blyth's Hawk-eagle (*Spizaetus alboniger*) as a member of the founder population.

With an approximate number of only 81 to 108 breeding pairs in the wild the establishment of a founder population large enough to sustain itself is a problem. As the Javan Hawk-eagle is a very slow reproducer, with a maximum of 0.5 youngs per couple per year the question remains whether Javan Hawk-eagles can be bred in captivity in acceptable numbers for restocking purposes. Furthermore this bird has never been bred in captivity.

Maladaptive behaviour is likely to occur in the Javan Hawk-eagle because unlike many other birds of prey, the single young is believed to stay in the neighbourhood of its parents for up to one and a half years. Birds that are dependent on their parents for a longer period of time are obviously more susceptible to acquire maladaptive behaviour under artificial circumstances.

We conclude there is absolutely no justification for removal of Javan Hawk-eagles out of their natural habitat to keep them in captivity for a restocking breeding programme. Javan Hawk-eagles will be able to survive in low numbers as long as there is sufficient exchange between populations. In addition, the carrying capacity for the Javan Hawk-eagle is probably reached and no empty habitat for restocking the existing population is available. Furthermore, the situation in which captive breeding may be applied as described by the IUCN (1987b) is not reached and the requirements cannot be fulfilled. Basic knowledge about genetics, behaviour and habitat requirements is insufficient.

The present captive stock of Javan Hawk-eagles is very small (6 individuals in December 1994) which means that wild birds would have to be caught for establishing a sound founder population.

10.5.4 Conclusion

Taking the problems mentioned above and high costs involved in captive breeding programmes into account, efforts can be more usefully used on a cheaper and better alternative: in-situ conservation. If the established national parks and nature reserves in West and East Java would be supplemented with protection of the remaining forest patches in Central Java, the threat of extinction for the Javan Hawk-eagle would be reduced.

The conservation of habitat would not only be beneficial for the Javan Hawk-eagle but also for many other species. At the same time all problems that might occur in captive breeding would be avoided.

As people would like to know what the Javan Hawk-eagle looks like, it is justifiable for zoos to keep some confiscated young birds in their collection. Possible breeding success of these birds would at least decrease the demand for wild birds from the zoo involved.

11 Recommendations for conservation

Much of the status of the Javan Hawk-eagle has still to be revealed. However some recommendations for conservation are made:

11.1 HABITAT PROTECTION

As the little remaining rainforest in Central Java is still under threat of destruction it is of the greatest importance to know more about the distribution and population size in this province. The Central Javan populations of Javan Hawk-eagles may form the genetic link between the remaining subpopulations in the eastern and the western part of the island; therefore it is essential to create one or preferably more 'safe havens'. Although most people are more easily convinced of the need to preserve a particular species, here the Javan Hawk-eagle, than the need to preserve an ecosystem, it cannot be stressed enough that the Javan Hawk-eagle is a inextricable component of the whole Javan rainforest ecosystem and that it cannot be seen as an isolated case. Thus in order to preserve the Javan Hawk-eagle one must preserve the system it inhabits. In particular the larger forest patches, which besides the Javan Hawk-eagle also supports populations of other endangered endemics such as the Javan Gibbon and the Javan Leaf Monkey, are of primary importance for conservation. Already in 1982 large parts of the most valuable forests in Central Java have been proposed as nature reserves or game reserves (MacKinnon et al., 1982) but subsequently no action has been taken. The gazettement and management of these proposed protected areas are necessary for the long-term survival of several endangered species. As not only the Javan Hawk-eagle but several other endangered species are susceptible to disturbance e.g. in the form of hunting, the newly formed reserves should have buffer zones to minimise the impact of human disturbance. The four most valuable areas for the survival of the Javan Hawk-eagle are listed below.

11.1.1 Dieng mountains

The mountains on the north and north-east side of the Dieng plateau between Gn Besar (1579m) in the west and Gn Prahu (2565m) in the east are still covered with a continuous block of rainforest of *ca.* 27,500ha. Due to steep and densely forested slopes the mountain massif is poorly accessible and the forest prevents the area from floods and landslides .

The area is poorly known but it is thought to be of prime importance for the survival of several endangered endemics including Javan Hawk-eagles, Javan Gibbons and Grizzled Leaf Monkeys. The Dieng mountains as a whole have a range of natural forests from lowland to montane and although the area is somewhat disturbed, it is an excellent example of Central Java's forest ecosystem. As parts of the area are presently being cleared for the extension of rubber (*Hevea brasiliensis*) plantations, immediate action should be taken.

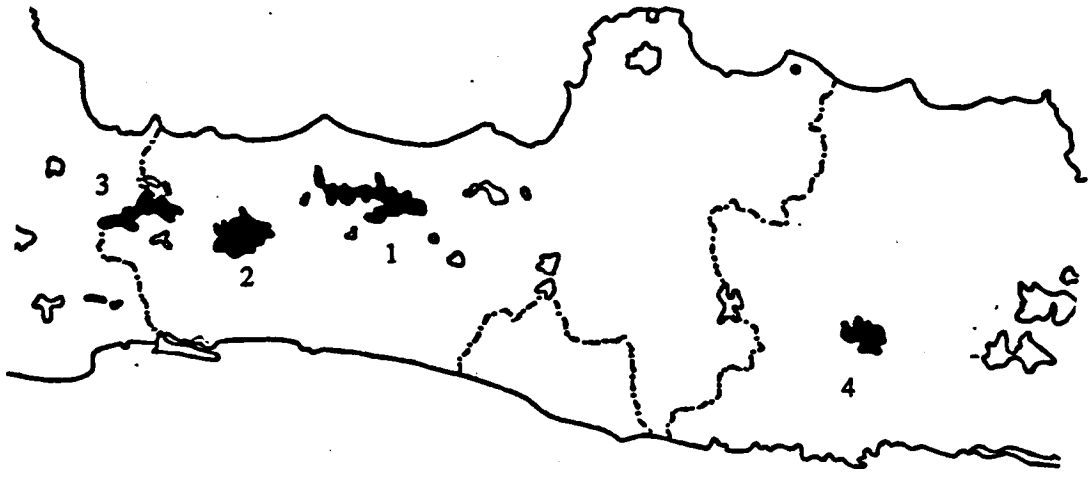


Fig. 19. Map of the central part of Java showing the recommended areas for conservation of the Javan Hawk-eagle.

11.1.2 Gn Slamet

This well known volcano (3418m) is Java's second tallest mountain and is a very distinctive feature in the Central Javan landscape. The mountain is paid great respect by local people as it is believed to be sacred. Because the southern slopes of Gn Slamet are one of the wettest areas in the world with an annual rainfall of more than 8000mm, the area will be subjected to landslides and torrents if the remaining forest is not adequately protected.

Especially on the southern and eastern slopes the forest is still intact and descends into the lowland zone. Gn Slamet is one of the few areas in Central Java that supports larger populations of Javan Hawk-eagles, Javan Gibbon and the Grizzled Leaf Monkey and the gazettement of the proposed 15,000ha nature reserve would be very positive for the long-term survival of these unique species.

11.1.3 Pegunungan Pembarisan and Gn Segara

The lowland and hill rainforests of Gn Segara and Pegunungan Pembarisan are one of the few forests remaining on non-volcanic soils in Java. The area has been long time recognised as one of the most valuable forests in Central Java because of the presence of rare endemic flora and fauna. These include typical Javan animals such as Barking Deer and Javan Leafmonkey. The first observations of Javan Hawk-eagles and the presence of Javan Gibbon on Gn Segara makes the area even more valuable. The proposed *ca.* 13,000ha nature reserve Pegunungan Pembarisan should be extended to the north-east so that Gn Segara is also included and the gazettement of this extended proposed reserve should be undertaken before the pine plantations are further extended.

11.1.4 Gn Wilis-Liman

The twin volcanoes Wilis and Liman are covered with an extensive block of rainforest from hill to montane with an approximate size of 45,000ha. The Gn Wilis-Liman complex is very valuable as it represents a rather undisturbed mountain ecosystem: the upper slopes are covered with *Casuarina* forests and on the lower slopes the forest descends into the lowland zone. Situated on the western part of East Java it forms a link between the populations in this province and the population in Central Java. Because of its large size it may support one of the few larger populations of Javan Hawk-eagles in the middle part of the island and if adequately protected it will be very valuable for the survival of many unique forms of Javan wildlife.

11.2 Law enforcement

Law enforcement is a very helpful tool for conservation; regular monitoring of bird markets and bird sellers by local PHPA officers, and appropriate enforcement of law is needed to discourage further capture and trade. If this includes confiscation of birds we suggest consideration is given to release adult birds back to the wild in the area they were caught immediately after the necessary medical examination. Juvenile birds, which have not yet learned to survive in the wild, should be brought to zoos for exhibition and education purposes.

11.2.1 Bird markets

Birdmarkets are a major threat to many endangered bird species. Especially on Java where the songbird near the house is one of the five symbols of stages in a well balanced Javan life (Kortschak, 1991), the demand for wild birds is high. Amongst the birds on markets which occur in almost every city, occasionally Javan Hawk-eagles can be found. These are even sometimes offered for sale to zoos (own obs.). The public should be made aware that it is forbidden to keep certain bird species while others are allowed. In order to control the trade these markets should be more regularly visited by the Police or PHPA staff and illegal possession of protected birds should be discouraged by confiscations and penalties. Zoos should refuse protected birds offered to them by bird traders. Dealers should be traced and prosecuted.

11.2.2 Zoos

Because no Javan Hawk-eagles were ever bred in captivity, all birds that are kept in zoos originate from the wild population. During interviews with zoos it became clear that three Javan Hawk-eagles were obtained from confiscations by PHPA, three were "given by private owners" and data on five other birds are not traceable. Anyway all these birds directly or indirectly derive from trade which means that they originated from the wild population. As long as there are no rules for zoos about the numbers of protected birds and as long as there is no control of their origin, zoos form an indirect threat to the wild population of Javan Hawk-eagles. Records of zoos need to be established and these records need to be checked. The birds should be brought under a captive breeding scheme with a formally appointed studbook keeper.

11.2.3 Private owners

Recently a number of Javan Hawk-eagles was found with private owners (van Balen, in litt.) and registered. A part of these birds which have obviously been purchased in birdmarkets or captured by the owners could be released (in case of mature and wild birds) and the other part (juvenile and tame birds) could well be brought to zoos in order to satisfy their demand. Furthermore the public should be made aware of the fact that it is forbidden to keep certain species and thereafter every illegal possession should be discouraged by confiscation and punishment.

11.3 RESEARCH AND SURVEYS

Further research on the Javan Hawk-eagle is necessary because one cannot protect the unknown. To get a better insight in the status of the species, an extension of the existing dataset is the first necessity.

11.3.1 More accurate population size estimate and monitoring

Further surveying in Java is still a major priority. As the little remaining rainforest is still under threat of destruction it is of the greatest importance to know more about the distribution and population size in each province. The most promising and interesting areas that need to be surveyed include (listed from west to east): the surroundings of Gn Tangkuban Prahu (2084m), including Gn Burangrang (2064m) and Gn Bukit Tunggul (2209), the mountains south of Bandung e.g. Gn Limbung (1813m), the peninsula Nusa Kambangan, Gn Merbabu (3142m), the northern and western slopes of Gn Lawu (3265m), Gn Tengger (2770m), Gn Semeru (3676m) and the Yang plateau with summit Gn Argopuro (3088m).

Areas that have already been surveyed should be combed out for the setting of exact subpopulation sizes which could be used for more accurate estimate of the total population size of Javan Hawk-eagles. For a more accurate population estimate and for information about recruitment rates, also a study of demography is needed.

If research is intensified consideration should be given to the fact that once the exact distribution of a population, and the exact locations of nest sites is better known, it is not only known to those with 'good' intentions but also to those with 'bad' intentions.

11.3.2 Exchange between subpopulations, dispersal

In order to get a better insight in the bird's ability to occupy new territories and in the amount of genetic exchange between subpopulations, dispersal behaviour of juvenile and adult birds needs to be studied. Radio tracking is a cheap method though difficult for species which inhabit inaccessible terrain and that travel over large distances in a short period of time. An easier alternative is satellite tracking (e.g. Meyburg, 1994) but this can only be applied if financial resources are sufficiently available.

11.3.3 Habitat requirements and altitudinal distribution

For a focused conservation, protection of the most suitable habitats is required; further studies on the habitat requirements and altitudinal preferences of the different age classes are therefore recommended. Even before more is known about the Javan Hawk-eagle's habitat requirements, the last remnants of virgin forest left on Java should be protected. It is not wise to wait untill the habitat preferences are studied in more detail before the knowledge derived from this study is used in the planning of an adequate reserve system. As the deforestation continues there might be no area with natural forest left to be declared a reserve. More insight in the effects of disturbance to the population densities of Javan Hawk-eagles is needed and to what extent the species is able to survive in disturbed or secondary forests.

11.3.4 Lacking basic ecological data

Involvement of local biologists and students, and expatriate students would enhance transfer of skills and information, which can be of great importance for the efficiency of the research. Until now the Javan Hawk-eagle is still one of the least known raptors. Still much basic knowledge is lacking, this includes: diet, territory size, relation between the sexes during the non-breeding period, the daily cycle, the yearly cycle, competition etc. etc. Anyway, in order to protect the species as adequately as possible its is necessary that more is known about its biology.

During our study we were occasionally joined by Indonesian biology students, Indonesian ornithologists and people who showed interest in our research, and this turned out to be beneficial to both parties.

PART E: GENERAL DISCUSSION

12.1 BEHAVIOURAL ECOLOGY

As we have the impression that only a few people are able to recognise the Javan Hawk-eagle under field conditions, we consider it necessary to try to give an accurate field description. It is of prime importance that the species is sufficiently recognised, even if only the most fanatic birdwatchers or naturalists will be able to observe the species long enough to contribute significantly to the knowledge we have today. In order to protect the species one has to be able to recognise it.

Until now descriptions in standard works on raptors are rather poor or even wrong, e.g. Kuroda (1936) shows a juvenile Rufous-bellied Eagle (*Hieraaetus kienerii*) in stead of a Javan Hawk-eagle. The illustrations in Hoogerwerf (1949a, b) depict all juveniles or immatures. A juvenile and an adult in Brown & Amadon (1968) do not show several important characteristics and no flight images are given. In the painting in Burton (1989) the head and chest are too dark and the crest is much too short. Field guides on birds of Java also give an incomplete description of the bird. The fieldguide of the birds of Java and Bali by MacKinnon (1990, translated in Indonesian, and thus much used) gives an image which resembles a bird in its juvenile plumage and is a copy of Hoogerwerf's illustration. The picture in MacKinnon & Phillipps (1993) is far better but also does not show a full-grown adult. The flight image of the adult bird resembles the flight image of the juvenile and an almost totally white juvenile was never seen by us.

Most of the specimens stored in the museums are juvenile or immature birds and this may account for the inaccuracy of the depictions (see plate I).

From the study on habitat requirements it became evident that the Javan Hawk-eagle is dependent on the lush evergreen lowland to montane rainforest. The incidental records outside the primary forest into degraded forests do not indicate that the species can survive in this type of habitat. When no pristine forest is present the species cannot exist in the area. Nesting has only been recorded in the the best preserved forest areas although sometimes in the vicinity of disturbed parts. According to Newton (1979) raptors are among the few groups of birds whose numbers and nest success are clearly limited by the availability of the nesting sites and with the dependence on colossal trees for building their nest the Javan Hawk-eagle is a typical example. The depletion of forest from these trees, as they are all valuable timber trees, is of serious concern for the Javan Hawk-eagle.

To what respect the Javan Hawk-eagle is dependent on the lush tropical rainforests and to what extent it is able to survive in disturbed habitats is not clear. Habitat requirements of its nearest congeners -*S. nanus*, *S. alboniger*, *S. lanceolatus* and *S. philippensis*- are even less known than those of the Javan Hawk-eagle. All four are reported to be dependent on evergreen dense forest, but no information on their ability to live outside these forest is available. Our observations on the Javan Hawk-eagle and the resulting conclusions and recommendations could equally held true for the other members in the region, if not now than in the near future.

The observations made during the breeding season contributed to the insight we have on the reproductive biology of the Javan Hawk-eagle but once again made evident that much is to be learned. Incubation is mainly done by the female and during this period she can be found in the near proximity of the nest. During this period the prey is brought in by the male and he usually visits the nest only when the female is absent. In the post-hatching period the hunting tasks are also done by the female. Juvenile Javan Hawk-eagles are dependent on their parents for a long period of time and this prolonged post-fledging period of up to one and a half year prevents the parents to breed every year. The findings gathered during the breeding season are partly confirm data gathered in previous studies on other members of the genus *Spizaetus* (e.g. *S. ornatus*: Madrid et al., 1991; Klein et al., 1988; Lyon & Kuhningk, 1985, *S. cirrhatus*: Bartels, 1924, Naoroji,1985). From the available data it could be concluded that the breeding starts in the first half of the year, between January and May and fledging lasts until October.

Although still fragmentary the observations during the breeding period of the Javan Hawk-eagle may be very valuable for insight in its reproductive biology; its needs and limitations. The observed incubation period of 47 (± 1) days falls within the range of other *Spizaetus* members. The notes from Hans Bartels (see also Rozendaal, 1981 and Meyburg et al., 1989) and Max Bartels Jr. (1924) and the 16 hours of observations during three successive days and one additional one by van Balen et al. (in press) are the only other sources of information on the breeding behaviour of this species. This is one of the more important aspects of the birds' ecological requirements and thus part of the data needed for its conservation.

We are aware that our study of the behavioural ecology has its limitations. Only a few birds could be observed in only a few areas over a relative short period of time. This has resulted in few data, too few for detailed statistical analyses. Almost no comparisons could be made between birds observed in different areas or at different periods of their life, so the data gathered in different areas at different times are all used as additions to a single general picture. By gathering as much literature as possible we tried to extend our data set. Recently only little has been written about the Javan Hawk-eagle's behaviour, so we often had to consult literature from the first half of this century, much of them in Dutch or German. On the other hand ours is the most comprehensive study on the behaviour on the Javan Hawk-eagle done sofar. During the research we concentrated entirely on Javan Hawk-eagles and we had more than 114 contact hours with Javan Hawk-eagles in the wild in different parts of Java.

The Javan Hawk-eagle is confined to the wettest vegetation types and it is therefore not surprising that it is mostly found in those areas with the least pronounced dry periods. In West Java virtually all Javan Hawk-eagles are present in areas with 30 or more rainy days in the driest consecutive 4 months. East Java has a far more pronounced dry season but here also some areas with higher rainfall and wet vegetation types can be found, notably at the south-south-east sides of the volcanoes. Javan Hawk-eagles in this part of the island are found to be more present in these wet areas than in the drier areas, but occasionally the species is seen in drier areas.

12.2 DISTRIBUTION

The Javan Hawk-eagle was thought to have a disjunct distribution with a 520km wide gap between the easternmost record in West Java and the westernmost one in East Java. This gap originated as a result of the lack of sufficient biological research conducted in the central part of the island. By surveying almost all the larger forest areas in Central Java this gap in knowledge is closed for the Javan Hawk-eagle. The species can still be found all over the island but in very few, relatively small forest patches. Ornithologically, Central Java is probably the island's least studied province. Several bird species are thought to be restricted to either the western or the eastern province or to show a disjunct distribution with no records from the central part. An increase in ornithological research in the this part of the island will show whether this assumption holds. The endemic Chestnut-breasted Partridge (*Arborophila javanica*) was, just as the Javan Hawk-eagle, previously not recorded from Central Java but we found it present throughout this province. Brown-throated Barbet (*Megalaima corvina*) was thought to be restricted to West Java (MacKinnon & Phillipps, 1993) but we found it to be present as far to the east as on Gn Prahu (Nijman & Sözer, in press c).
The more interesting new records come from several areas: Ujung Kulon as the forest in this area is rather safe and in spite of the high search intensity in the past, the species was never found to be present here before; Gn Segara, in the western part of Central Java, as it is a biologically diverse area adjoining the *ca.* 13,000ha proposed nature reserve Pegunungan Pembarisan; Gn Slamet as it probably contains one of the larger populations of Javan Hawk-eagles in Central Java and as 15,000ha have been proposed as a nature reserve; the Dieng mountains, in this little known area Javan Hawk-eagles were present in the western- and easternmost parts and are thought to be present all over this *ca.* 25,000ha large forest; and Gn Wilis-Liman, in the western part of East Java, as it is one of the largest forest areas in the central part of the island.

Although the Javan Hawk-eagle was previously thought to be exclusively confined to the mountain forests, the last years it became evident that this is certainly not true. The finding of Javan Hawk-eagles at lower altitudes in Ujung Kulon, Gn Segara and near Gn Besar and the sightings of van Balen (1991) in Lebakhardjo and Alas Purwo confirmed our suspicions that the species could occur in the lowland forest. The presence of the Javan Hawk-eagle in the lowland rainforests -one of the two Endemic Bird Areas on Java with 6 species confined to it (Bibby et al., 1992)- makes this ecosystem even more valuable than it was thought to be.

12.3 POPULATION SIZE

The new population estimate is done by the extrapolation of the density of Javan Hawk-eagles expressed in numbers of pairs and forest areas inhabited. This is a common method and has previously been used to calculate densities of other species which are difficult to study, e.g. primates (*Hylobates moloch*: Kappeler, 1984; MacKinnon, 1987).

Previous population estimates by Meyburg et al. (1989) and van Balen & Meyburg (1994) used the same method and are both based on the same assumptions we used.

In spite of the various assumptions which had to be made and the lack of recent detailed vegetation maps we think that the new population estimate is the most accurate currently possible and that it once again has become clear that the long-term survival of the Javan Hawk-eagle is still in jeopardy. Now that almost all the potentially suitable areas on Java have been surveyed, its distribution is known and it must be stated that the future of the Javan Hawk-eagle does not seem hopeful Although a fairly high proportion is present within the boundaries of the national parks and nature reserves in the western and eastern provinces, all the Javan Hawk-eagles present in Central Java are outside the two protected areas and this is at least reason for concern.

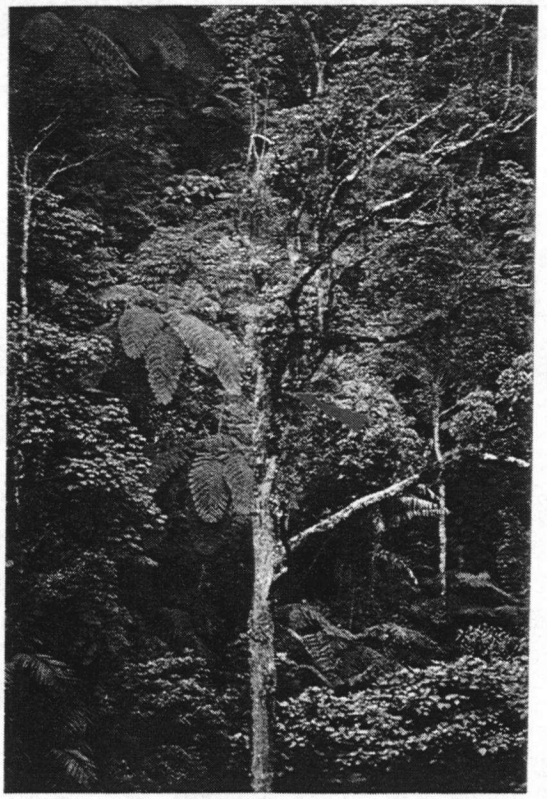
The best known reserves and national parks are particularly known because of only one unique animal that is restricted to it. Ujung Kulon is probably Indonesia's most famous national park as it is the last stronghold of the Javan Rhino, Meru Betiri was founded to secure the last Javan Tigers, Baluran is known for its Bantengs and Komodo national park has become a national park for it is the only place where the Komodo Dragon can be found.

Because the Javan Hawk-eagle was declared a national symbol, the next step should be actively ensuring its long-term survival. The only way of doing this is probably the safeguarding of its habitat. Thus in order for Indonesia to save its national bird, the government should protect its environment: the rainforests. It would be a good thing to create a national park for the national bird, and as no national park or even a large nature reserve is present in Central Java but some larger populations of the Javan Hawk-eagle can be found in this province, it should ideally be done in this part of the island. By the establishment of a national park for the Javan Hawk-eagle far more plant and animal species will be able to survive into the near future. In addition to world-wide famous archaeological monuments like the Borobodur and the Prambanan temples, which are visited by millions of people every year, this province has also areas which could become famous as last refugees for the Javan Hawk-eagle. West Java has got Ujung Kulon, Halimun and Gede-Pangrango and East Java has Bromo-Tengger, Baluran and Meru Betiri: Central Java can have the Dieng mountains, Slamet and Pembarisan. As nature has become scarce in Java, the last remnants should be saved, for the Javanese people have the right to experience their unique rainforest ecosystem. By creating a national park with all kinds of typical Javan animal species this can be fulfilled.

PLATE VII MISCELLANEOUS

Page top left: First collected specimen of the Javan Hawk-eagle by Kuhn and van Hasselt in 1820 (1823?), National Museum of Natural History, Leiden, The Netherlands (photo: V. Nijman). Page bottom left: A Rasamala tree *Altingia excelsa* with an arrow indicating a nest of Javan Hawk-eagles in a trifurcation of the main trunk, western slope Gn Pangrango, West Java 30-3-'94 (photo: V. Nijman). Page bottom right: Head study of a 12 week old juvenile Javan Hawk-eagle at a birdseller's in Bojong Galing, West Java, 18-5-'94 (photo: V. Nijman). Page top right: Head study of a 26 week old juvenile Javan Hawk-eagle at Taman Safari Cisarua, West Java, 22-8-'94 (photo: R. Sözer).

PLATE VII



Although the shy and inconspicuous behaviour of the Javan Hawk-eagle will prevent most people without proffesional guiding to have contact with it, this does not imply that people do not feel the need to support a reserve for the species. The bare fact that a very rare species is present makes the area attractive; for instance many visitors of Meru Betiri national park want to see a glimpse of the last Javan Tigers and the fact that this species already has become extinct probably a decade ago does not seem to have any effect, the same is true for Ujung Kulon national park: huge numbers of tourists are eager to see one of the few remaining Javan Rhino's and only very few actually do.

12.4 CONSERVATION

The Javan Hawk-eagle is a rare and vulnerable species. For the long-term survival of this National symbol, protection of its habitat is a top priority. In order to stop the further decline of the population, poaching and illegal capture of Javan Hawk-eagles have to be discouraged by adequate law-enforcement. Birds in private ownership should be placed in zoos for education and exhibition purposes, and possibly for captive propagation.

It may be assumed that the amount of suitable relatively undisturbed lowland and hill rainforests is just large enough to maintain a natural population of Javan Hawk-eagles. In order to support a sufficiently large number of Javan Hawk-eagles, all destructive influences in the last remaining forests known to inhabit the species should be banned.

Although not all the potential forest has been surveyed for the presence of Javan Hawk-eagles no large suitable forest blocks which do not support Javan Hawk-eagles are known to be present. All activities aiming at an increase of the Javan Hawk-eagles in an ex-situ programme are therefore superfluous and can even be dangerous. Unlike for strictly sedentary species that are unable to disperse, the translocation of Javan Hawk-eagles to potentially suitable areas is not thought to be desirable.

Finally we conclude that the most important recommendation for adequate protection of the Javan Hawk-eagle is habitat protection. Actions for the survival of the species should concentrate entirely on the survival of the remaining natural forests and not on saving individual birds. A start should be made with the establishment and adequate management of several larger reserves in the mountainous regions of Central Java.

Summary

In the period December 1993 - January 1995 research on the behavioural ecology, distribution and conservation of the Javan Hawk-eagle *Spizaetus bartelsi* was carried out by R. Sözer and V. Nijman, under supervision of BirdLife International / PHPA - Indonesia Programme. This research was part of the requirements for graduation in the study of Biology at the University of Amsterdam (UVA).
During the seven-month of fieldwork many new data were collected on these subjects and recommendations for the conservation of the Javan Hawk-eagle were formulated.

The main research aims were: 1) a study of the home range, habitat requirements and behaviour of the Javan Hawk-eagle, and 2) a study of the distribution of the hawk-eagle with special reference to the central part of Java. This area was as yet unknown to hold populations of the species. Some background information on the biodiversity of Java, its geology and climate, natural vegetation and characteristic mountain birds, is presented. An overview of all *Spizaetus* species, their taxonomy and systematics is given. Furthermore, accurate descriptions of *S. bartelsi* for positive identification in the field as well as in museum collections are made. Sonagrams of the species' call are presented.

A total of 16 areas was surveyed; *S. bartelsi* was found in nine areas, six of these being new localities for the species. Taking these new localities into account, the population size was estimated, resulting in an increase from 52-61 to 81-108 pairs.

Most Javan Hawk-eagles were observed in primary forest and the ruggedness of the terrain was a common feature of all localities. The visable homerange was 12km^2 but realistic estimates gave homerange sizes between 33km^2 [Gn Slamet] and 155km^2 [Alas Purwo N.P.], varying with suitability of the habitat. During 114 contact hours with a breeding pair, and a pair together with their second year young, many new data were gathered on the behaviour and ecology of the species, e.g. the breeding period was determined at 47 +/- 1 days, the breeding season was calculated and copulation observed. Courtship displays, nest tree and nest maintenance are described. Sexual dimorphism was quantified by measuring 23 museum specimens.

Even though the new population estimate is more positive than earlier estimates, the fact remains that less than 10% of Java is covered with natural forest, not all of which is suitable habitat for the Javan Hawk-eagle. The combination of this lack of habitat and the its low reproductive rate (36 - 45 young per year for the entire population) make the species one of the world's most endangered raptors. In addition, the species is not suitable for captive propagation, but nevertheless 10 specimens arrived in zoos in 1994 of which three died during the same year. Available habitat is the limiting factor for the wild population and destruction of its natural environment is the eagle's main threat.

Four areas are recommended as priority areas for conservation of *S. bartelsi* habitat; in order of significance: 1) The Dieng Mountains, 2) Gn Slamet, 3) Pegunungan Pembarisan and Gn Segara, 4) Gn Wilis-Liman. Further recommendations for the conservation of the Javan Hawk-eagle include: more effective law enforcement, confiscation of illegally kept specimens, prosecution of violators, restriction of numbers legally held in captivity, monitoring of birdmarkets, further conservation research.

In conclusion, the Javan Hawk-eagle, the national symbol of Indonesia [Garuda], and symbol of all rare species, need not become extinct if its natural habitat is effectively preserved and other threats eliminated.

Samenvatting

In de periode December 1993-Januari 1995 is er door R Sözer en V. Nijman onderzoek gedaan naar gedragsoecologie, verspreiding en behoud van de Javaanse Kuifarend *Spizaetus bartelsi*, onder supervisie van BirdLife/PHPA-Indonesia Programme. Dit onderzoek maakte deel uit van de afstudeer-eisen van de studie Biologie aan de Universiteit van Amsterdam (UVA). Gedurende zeven maanden veldwerk zijn nieuwe gegevens verzameld en aanbevelingen ter bescherming van de Javaanse Kuifarend geformuleerd.

De voornaamste onderzoeks doelen waren: 1) studie naar de homerange, habitateisen en gedrag van de Javaanse Kuifarend en 2) onderzoek naar de verspreiding van de soort, met nadruk op centraal Java. Van dit gebied was tot nu toe niet bekend dat er populaties van de soort voorkwamen. Achtergrond informatie over Java's biodiversiteit, geologie en klimaat, natuurlijke vegetatie, alsmede karakteristieke bergvogels is gepresenteerd. Een overzicht van alle *Spizaetus* soorten, hun taxonomie en systematiek is gegeven. Ook zijn er nauwkeurige beschrijvingen gemaakt van *S. bartelsi* voor de herkenning van de soort in het veld en in museum collecties. Sonagrammen van de roep van de soort worden gegeven.

In totaal zijn er 16 gebieden onderzocht; *S. bartelsi* is in negen gebieden aangetroffen, zes ervan zijn niewe vindplaatsen voor de soort. Deze nieuwe gebieden in aanmerking nemende is er een nieuwe populatie schatting gemaakt, resulterend in een toename van 52-61 naar 81-108 paren.

De meeste waarnemingen van de Kuifarenden komen uit het primaire bos, een algemene eigenschap van alle waarnemingen is echter het ruige bergachtige karakter van het gebied. De zichtbare homerange was 12km^2, maar realistische schattinge komen uit op een grootte van 33km^2 [Gn Slamet] tot 155km^2 [Alas Purwo N.P.], afhankelijk van de geschiktheid van het gebied. Gedurende 114 contacturen met een broedpaar en een paartje met hun tweedejaars jong, zijn er nieuwe gegevens verzameld over het gedrag en de oecologie van de soort, zo is de broedduur vastgesteld op 47 +/- 1 dag, het broedseizoen is berekend en copulatie is waargenomen. Baltsvluchten, nestboom en nestonderhoud zijn beschreven. Sexuele dimorphie is gequantificeerd door metingen aan 23 museum exemplaren.

Hoewel de nieuwe populatieschatting positiever is dan eerdere, blijft het een feit dat minder dan 10% van Java nog met natuurlijk bos is bedekt, waarvan niet alles geschikt habitat is voor de kuifarend. De combinatie van gebrek aan habitat en zijn lage reproductiesnelheid (36-45 jongen/jaar voor de totale populatie) maakt de soort één van 's werelds meest bedreigde roofvogels. Bovendien zijn er in 1994 tien exemplaren in dierentuinen terechtgekomen, hoewel het fokken van deze soort in gevangenschap niet mogelijk is; drie ervan overleden datzelfde jaar. De limiterende factor voor de wilde populatie is beschikbaar habitat en de grootste bedreiging voor de soort is dan ook vernietiging van zijn natuurlijke milieu.

Voor de bescherming van *S. bartelsi* 's habitat zijn de vier voornaamste gebieden aanbevolen, teweten: 1) het Dieng gebergte, 2) Gn Slamet, 3) Pegunungan Pembarisan en Gn Segara, 4) Gn Wilis-Liman. Verdere aanbevelingen betreffen: effectievere wetshandhaving, inbeslagname van illegaal gehouden exemplaren, vervolging van overtreders, beperking van het aantal legaal in gevangenshap te houden exemplaren, controle van vogelmarkten, verder onderzoek.

Ten slotte is de conclusie dat de Javaanse Kuifarend, nationaal symbool van Indonesië [Garuda], en symbool van alle zeldzame vogels, behouden kan blijven, mits het natuurlijke habitat effectief beschermd wordt en de andere bedreigingen geëlimineerd worden.

Epilogue

Although the previous paper is a students' fieldwork-report, we hope it will have other uses than merely the function of final requirement for our 'Doctorandus' title. We hope it can contribute to the extention of the knowledge that is needed the protect this, or even other species, that are still poorly known. Either directly, by means of conservation actions, or indirectly, by using our data or methods which might make fieldwork less time-consuming for other scientists.

We would be very satisfied if only one of our recommendations to protect this species is followed up by the Indonesian government or conservation agencies; than we can say our fieldwork would really have been useful for nature conservation.

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Appendix

I: List of birds recorded during this study

Uj = Ujung Kulon, Gp = Gn Gede and Gn Pangrango, Se = Gn Segara, Sla = Gn Slamet, Bes = Gn Besar, Pra = Gn Prahu and Dieng plateau, Su = Gn Sumbing, Gn Sundoro, Gn Butak and Gn Bismo, Mer = Gn Merapi, Mur = Gn Muria, La = Gn Lawu, Wil = Gn Wilis-Liman.

	Uj	GP	Se	Sla	Bes	Pra	Su	Mer	Mur	Law	Wil
Bubulcus ibis	√										
Cattle Egret											
Ciconia episcopus					√						
Woolly-necked Stork											
*Leptoptilos javanicus**	√										
Lesser Ajudant											
Haliaeetus leucogaster	√										
White-bellied Sea-eagle											
Spilornis cheela		√	√	√	√	√					
Crested Serpent-eagle											
Accipiter virgatus						√					
Besra											
Ictinaetus malayensis		√	√	√	√	√	√	√	√		√
Black Eagle											
Spizaetus cirrhatus		√	√								√
Changeable Hawk-eagle											
Spizaetus bartelsi	√	√	√	√	√	√		√			√
Javan Hawk-eagle											
Falco Moluccensis				√		√	√				
Spotted Kestrel											
Coturnix chinensis		√		√							
Blue-breasted Quail											
Arborophila javanica		√	√	√	√	√					√
Chestnut-bellied Patridge											
Gallus gallus		√	√							√	√
Red Junglefowl											
Gallus varius	√	√	√	√	√	√					
Green Junglefowl											
Turnix suscitator				√		√					
Barred Button-quail											
Gallinula chloropus						√					
Common Moorhen											
Gallinago gallinago		√									
Common Snipe											

	Uj	GP	Se	Sla	Bes	Pra	Su	Mer	Mur	Law	Wil
Treron griseicauda								√			√
Grey-cheeked Green Pigeon											
Ptilinopus porphyreus						√					
Pink-headed Fruit-dove											
Macropygia unchall				√							
Barred Cuckoo-dove											
Macropygia emiliana		√		√	√						
Ruddy Cuckoo-dove											
Macropygia ruficeps		√									
Little Cuckoo-dove											
Streptopelia chinensis	√	√	√	√	√	√	√	√	√	√	√
Spotted Dove											
Geopelia striata				√							
Zebra Dove											
Loriculus pusillus		√		√	√						
Yellow-throated Hanging-parrot											
Cacomantis merulinus					√						
Plaintive Cuckoo											
Cacomantis sepulcralis				√	√	√					
Rusty-breasted Cuckoo											
Zanclostomus javanicus		√									
Red-billed Malkoa											
Rhamphococcyx curvirostris		√		√							
Chestnut-breasted Malkoa											
Centropus bengalensis		√		√		√					
Lesser Coucal											
Collocalia esculenta				√	√	√					
Glossy Swiftlet											
Apus affinis	√	√	√	√	√	√	√	√	√	√	√
Little Swift											
Cypsiurus balasiensis		√									
Asian Palm-swift											
Harpactes reinwardtii		√									
Blue-tailed Trogon											
Halcyon cyanoventris		√		√	√	√			√		
Javan Kingfisher											
Halcyon chloris		√		√	√	√			√		
Collared Kingfisher											
Rhyticeros undulatus				√	√						√
Wreathed Hornbill											
Buceros rhinoceros	√										
Rhinoceros Hornbill											

	Uj	GP	Se	Sla	Bes	Pra	Su	Mer	Mur	Law	Wil
Megalaima lineata Lineated Barbet						√					
Megalaima corvina Brown-throated Barbet		√	√	√	√	√					
Megalaima javensis Black-banded Barbet		√		√	√	√					
Megalaima armillaris Orange-fronted Barbet	√	√		√		√					
Megalaima australis Blue-eared Barbet		√			√						
Megalaima haemacephala Coppersmith Barbet				√							
Dendrocopus macei Fulvous-breasted Woodpecker				√		√					
Pitta guajana Banded Pitta			√								
Hirundo tahitica Pacific Swallow					√	√					
Coracina larvata Sunda Cuckoo-shrike		√		√							
Pericrocotus miniatus Sunda Minivet		√		√		√					
Pericrocotus flammeus Scarlet Minivet				√	√						
Hemipus hirundinaceus Black-winged Hemipus			√	√							
Pycnonotus zeylandicus Straw-headed Bulbul						√					
Pycnonotus aurigaster Scooty-headed Bulbul	√	√	√	√	√	√	√	√	√	√	√
Pycnonotus bimaculatus Orange-spotted Bulbul		√		√		√		√			√
Pycnonotus goiavier Yellow-vented Bulbul					√	√					
Pycnonotus plumosus Olive-winged Bulbul						√					
Criniger bres Grey-cheeked Bulbul				√		√					
Aegithina tiphia Common Iora						√			√		
Chloropsis sonnerati Greater Green Leafbird		√		√					√		

	Uj	GP	Se	Sla	Bes	Pra	Su	Mer	Mur	Law	Wil
Lanius schach		√	√	√	√	√	√	√	√	√	√
Long-tailed Shrike											
Brachypteryx leucophrys		√									
Lesser Shortwing											
Brachypteryx montana		√									
White-browed Shortwing											
Copsychus saularis			√								
Oriental Magpie-robin											
Enicurus velatus				√							
Lesser Forktail											
Enicurus leschenaulti				√	√						
White-crowned Forktail											
Myophonus glaucinus		√							√		
Sunda Whisteling-thrush											
Myophonus caeruleus				√		√					
Blue Whisteling-thrush											
Zootera citrina			√								
Orange-headed Trush											
Pomatostomus montanus									√		
Chestnut backed Scimitar-babbler											
Pellorneum capistratum				√	√	√					
Black-capped Babbler											
Pnoepygia pusilla		√									
Pygmy Wren-babbler											
Stachyris grammiceps		√		√							
White-breasted Babbler											
Stachyrus melanothorax						√					
Crescent-chested Babbler											
Crocias albonotatus		√									
Spotted Crocias											
Garrulax rufifrons		√									
Rufous-fronted Laughing-thrush											
Alcippe brunneicauda		√									
Javan Fulvetta											
Tesia superciliaris		√		√							
Javan Tesia											
Prinia polychroa					√						
Brown Prinia											
Prinia familiaris				√	√	√					
Bar-winged Prinia											
Orthotomus sutorius									√		
Common Tailorbird											
Orthotomus sepium					√	√					
Olive-backed Tailorbird											

	Uj	GP	Se	Sla	Bes	Pra	Su	Mer	Mur	Law	Wil
Phylloscopus trivirgatus Mountain Leaf-warbler		√				√					
Eumyias indigo Indigo Flycatcher				√		√					
Ficedula hyperythra Snowy-browed Flycatcher						√					
Ficedula westermanni Little Pied Flycatcher		√		√							
Cyornis banyumas Hill Blue Flycatcher			√								
Rhipidura phoenicura Rufous-tailed Fantail		√				√					
Rhipidura javanica Pied Fantail		√			√			√			
Parus major Great Tit		√		√	√	√			√		
Dicaeum maugei Red-chested Flowerpecker		√		√							
Dicaeum trochileum Scarlet-headed Flowerpecker		√		√	√	√					
Nectarinia jugularis Olive-backed Sunbird		√		√	√	√					
Aetophygia mysticalis Violet-tailed Sunbird		√	√	√							
Arachnothera longirostra Little Spiderhunter		√		√	√	√					
Zosterops palpebrosus Oriental White-eye		√	√	√	√	√	√	√	√	√	√
Zosterops montanus Mountain White-eye		√									
Lophozosterops javanicus Grey-throathed Darkeye		√		√		√					
Serinus estherae Sunda Serin		√	√	√		√				√	√
Erythrura hyperythra Tawny-breasted Parrot-finch		√									
Lonchura leucogastroides Javan Munia	√	√		√	√	√			√		
Lonchura punctulata Scaly-breasted Munia				√	√						
Lonchura maja White-headed Munia		√		√							

	Uj	GP	Se	Sla	Bes	Pra	Su	Mer	Mur	Law	Wil
Passer montanus	√	√	√	√	√	√	√	√	√	√	√
Tree-sparrow											
Acridotherus javanica				√			√				
White-vented Myna											
Oriolus chinensis		√		√		√					
Black-naped Oriole											
Dicrurus macrocercus			√		√	√					
Black Drongo											
Dicrurus leucophaeus			√		√						
Ashy Drongo											
Dicrurus hottentottus						√					
Hair-crested Drongo											
Dicrurus paradiseus			√								
Greater Racket-tailed Drongo											
Cissa thalassina			√								
Short-tailed Green Magpie											
Crypsirina temia											√
Racquet-tailed Treepie											
Corvus enca				√							
Slender-billed Crow											
Corvus macrorhynchos				√	√	√	√				
Large-billed Crow											

Appendix II

Measurements of museum specimens of Spizaetus bartelsi taken in National Museum of Natural History (RMNH), Leiden, The Netherlands and Museum Zoologi Bogoriense (MZB), Bogor, Indonesia.

Plate II, no.	collection no. * Bartels coll.	date of collection	sex	crest	wing	tail	tarsus	toe	nail front	nail back	bill length	bill depth	estimated age (years)
1	MZB 5536	13-5-1928	m	96						34.9	29.0	20	1
2	MZB 17347	1908	?	113						35.7	29.6	20	3
3	MZB 17349	22-6-1933	m	100						34.9	30.9	20	2
4	MZB 17348	13-4-1931	m	95						33.8	33.0	20.5	2
5	MZB 17350	11-8-1940	m	89						34.2	30.4	20	2
6	MZB 5331	27-6-1922	m	99						33.3	30.5	20	6 (full adult)
7	RMNH*	?	?	36	232	±80	122	28.8	19.1	28.2	25.5	19.2	chick
8	RMNH* 12209	6-10-1921	m	86	347	242	119	28.8	20.9	30.8	26.4	19.1	3
9	RMNH* 12051	19-12-1920	m		364	268	126	32.2	22.8	33.2	28.2	20.6	1
10	RMNH* 14663	28-6-1928	m	85	362	258	133	28.0	24.1	33.3	29.5	20.9	1
11	RMNH* 10810	10-10-1917	f	75	386	269	126	43.0	25.0	38.7	31.2	27.7	3
12	RMNH*	26-4-1937	f	121	396	299	174	31.8	26.2	40.1	32.2	23.4	4
13	RMNH* 14277	8-10-1925	m	97	373	252	133	32.2	24.0	34.4	29.0	21.0	3
14	RMNH* 6824	8-10-1909	m	90	368	244	112	33.9	23.3	33.1	29.1	19.7	3
15	RMNH* 14660	31-5-1928	f	96	387	258	116	321	25.1	38.6	30.5	22.3	4
16	RMNH* 14657	17-5-1928	f	84	391	260	122	31.0	25.7	39.1	34.0	23.4	5
17	RMNH* 13438	17-5-1923	m	70	398	256	189	33.5	26.3	29.8	31.8	22.7	5
18	RMNH* 14579	30-5-1927	m	80	364	251	123	23.1	23.0	34.1	29.3	21.7	5
19	RMNH* 14694	23-1-1929	f	87	392	260	130	33.7	25.0	39.0	32.8	22.7	5
20	RMNH* 4790	30-4-1907	m	91	356	243	118	29.2	23.5	34.5	26.2	21	6 (full adult)
21	RMNH* 12490	13-4-1922	m	92	366	277	121	29.1	23.9	35.4	27.9	20.4	6 (full adult)
22	RMNH*	13-10-1938	m	120	376	264	124	30.5	23.6	34.4	29.8	19.3	6 (full adult)
23	RMNH* 14574	18-4-1927	f	96	399	274	105	29.6	23.2	37.1	32.1	23.3	6 (full adult)
24	RMNH	1820-1823	m	86	345	25.3	102	32.4	32.6	22.3	29.9	24.0	1

Appendix III

Publications resulting from the project

Maps and photographs are omitted, lay-out, spelling and final text may have been changed in final publication.

KUKILA: IN PRESS

AGGRESSIVE BEHAVIOUR DISPLAYED TOWARDS THE JAVAN HAWK-EAGLE.

By
Vincent Nijman and Resit Sözer
(First draft received 15 December 1994)

Summary

Aggressive behaviour displayed towards the Javan Hawk-eagle *Spizaetus bartelsi* is described. Most of the attacks were performed by drongos but attacks by Woolly-necked Stork *Ciconia episcopus* and towards Crested Serpent-eagle *Spilornis cheela* are presented.

Ringkasan

Dalam tulisan ini dipertelakan tingkah laku agresif yang ditujukan kepada Elang Jawa. Serangan yang dilakukan oleh jenis burung lain terhadap Elang Jawa kebanyakan dilakukan oleh jenis burung dari keluarga *Dicruridae*, dicatat pula serangan yang dilakukan oleh Sandang Lawe, sementara itu terdapat satu laporan serangan yang dilakukan oleh Elang Jawa terhadap Elang Ular.

Introduction

The Javan Hawk-eagle *Spizaetus bartelsi* Stresemann 1924, is endemic to the island of Java and is restricted to the lowland and montane forests. It is known to occur not only the western and eastern part of the island (MacKinnon and Phillipps, 1993) but also in Central Java (Sözer and Nijman, in press). The species is one of the world's least known raptors (van Balen et al., 1994) although recently more information is becoming available. The Javan Hawk-eagle is classified as endangered according to the IUCN threat criteria (Collar et al., 1994) because of its small population of probably less than 200 birds [van Balen and Meyburg (1994) estimate 52-61 pairs], the continuing habitat destruction and fragmentation, and trade.

During research on the Javan Hawk-eagle during the period March-August 1994, the authors frequently observed it being attacked by other species. As very little is known about the behaviour of this species, observations of aggressive behaviour are presented here as they provide some insight into interspecific relations. Most but not all of the attacks were performed by drongos.

Drongo's and Javan Hawk-eagles

Most of the observations of drongo's mobbing Javan Hawk-eagles are made on one breeding pair of the latter that inhabitated several valleys on the western slope of Gn Pangrango, near the border of the Gede-Pangrango National Park, West Java.

On 25 March the female of this pair was attacted while soaring by two Black Drongos (*Dicrurus macrocercus*). The attacks were performed from above, and ceased when the eagle retired to settle in a tree.

On 22 April, both the male and female eagle were attacked by two drongos, while the female was chasing the male for food, and later that day the male was attacked from below by a Black Drongo while it was flying along a ridge. While under attack, the male gave a hard call: 'Glie-eck'.
On 8 May a Javan Hawk-eagle was attacked by two crow-like birds, but the distance was to far and the light conditions inadequate for identification. The attack consisted of frequent mobbing by both birds from all directions while the eagle was soaring above a ridge. In order to get rid of its aggressors the eagle repeatedly let itself fall down 10 to 15 m during which time it turned on its back for defense. During these attacks the eagle gave several calls consisting of a three-syllabled: 'ee-ee-eeew'.
On 11 May, the male Hawk-eagle was attacked in flight by an Ashy Drongo (*Dicrurus leucophaeus*), the attack lasting for 25 seconds.
Finally on 15 May the female was attacked by two Black Drongos at *ca.* 200 m from the nest tree. While flying towards this tree, one of the Drongos mobbed her 13 times, every time from above. Each time, the eagle dropped a few meters but kept on flying. During each attack it uttered a hars 'ee-eeew'.

A bold attack of a drongo towards a flying eagle was observed on 24 August on the southern slope of Gn Slamet, Central Java. The attack lasted for several seconds but no change in behaviour was noted in the eagle.

Drongos are well known for their aggressive behaviour and they are known to attack hawks and cuckoos (MacKinnon and Phillipps 1993), hornbills and even frogmouths (Nash and Nash 1985a, 1985b). All the attacks on Javan Hawk-eagles were performed while the latter were flying or soaring. However we also observed a Black Eagle *Ictinaetus malayensis* being frequently attacked by a drongo while the eagle was perched in a tree.

Javan Hawk-eagles and other raptors
In March 1994 T. Sibuea (pers. comm.) observed a juvenile Javan Hawk-eagle continuously following a Crested Serpent-eagle *Spilornis cheela* until the latter flew off. During our study we have quite often seen Javan Hawk-eagles in close assembly with other raptors, for instance during thermal soaring. We have also observed Black Eagles and Javan Hawk-eagles soaring very close together without any aggressive behaviour between them

Storks and Javan Hawk-eagles
On 27 August on the foot of Gn Besar, Central Java (109°37' E, 7°05' S) we were very surprised to see a Javan Hawk-eagle being attacked by a Woolly-necked Stork *Ciconia episcopus.*
Two Woolly-necked Storks were seen above a small valley at an altitude of *ca.* 600 m, close to relatively undisturbed lowland forest. During that morning these two birds always stayed close together and were seen regularly.
At 11.02 h they were seen again, at a distance of several kilometres, and were joined by a third bird. The three birds were flying from the south to the north-east in a straight line, but after 30 seconds the two storks veered to the west while the third bird continued its course. Shortly after this, the third bird was identified as a mature Javan

Hawk-eagle. While this eagle was passing over the observers, the storks had returned and one of them attacked the eagle while the other followed a few metres behind. During the attack the eagle kept its wings close to its body and stooped down into the forest canopy, after which it was lost to sight. The storks were then also lost to sight behind a small hill.

In conclusion the following behavioural patterns were recorded in Javan Hawk-eagles in response to attacks by other birds:

1. Whilst flying or soaring, the eagle will lose height, at the same time turning on its back to defend itself, and calling.
2. The eagle maintains its flight in a straight line but responds to each attack by a drop in height, and calling.
3. The eagle gains speed by stooping with the wings close to the body.
4. The eagle appears to ignore the attack, with almost no change noted in flight pattern or behaviour, although the bird may be vocalising.

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THE JAVAN HAWK-EAGLE: NEW INFORMATION ON ITS DISTRIBUTION IN CENTRAL JAVA AND NOTES ON ITS THREATS.

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ABSTRACT

A study on the Javan hawk-eagle (*Spizaetus bartelsi*) is presently being carried out in Central Java. This continuing study allows some data to be presented. The species was found to be present on localities were the species was formerly not known: Mt Slamet and Mt Merapi. Status and threats of which habitat loss is considered to be to most severe one, are discussed. In order to preserve the species the gazzetement of one or more protected areas in Central Java is recommended.

Key words: Javan hawk-eagle, *Spizaetus bartelsi*, Java, conservation, status.

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INTRODUCTION

The Javan hawk-eagle (*Spizaetus bartelsi*), locally known as *Elang Jawa*, was declared Indonesia's national bird and a symbol of rare species by President Soeharto (10 January 1993) on account of its resemblance with *Burung Garuda*, Indonesia's mythological bird, and because of its rarity and uniqueness.

As its name implies the Javan hawk-eagle is restricted to the island of Java. It is confined to the lowland and montane forests and mainly occurs in the best preserved forest areas. Although recently some surveys and observations have been made (e.g. Meyburg et al., 1989, van Balen, 1991, van Balen and Meyburg, 1994, Nijman & Sözer, in press), the species is still considered as one of the world's least known raptors (van Balen et al., 1994). The general biological knowledge we have today is derived largely from historical notes (e.g. Bartels, 1924; Hoogerwerf, 1949), from bird skins in musea and to a lesser extent from recent anecdotal records.

Although more research is needed about the distribution and population status, the total population was estimated by van Balen & Meyburg (1994) between 51 and 62 pairs. By virtue of this low number, the continuing habitat destruction and indications of a recent increase in domestic trade resulted in the species being classed as endangered in according to the current IUCN threat categories (Collar et al., 1994).

The species' distribution is known to encompass West and East Java province. Meyburg et al. (1989) conducted an extensive survey but did not cover the central Javan province. The only previous record from this province originates from the southern slopes of Mt Slamet were Seitre & Seitre (1990) found a juvenile Javan hawk-eagle to be present.
Central Java (including D. I. Yogyakarta) forms a climatic a transition zone between the everwet tropical rainforests of western Java and the deciduous monsoon forests of the eastern part. Although most of Java's remaining natural forest (less than 10% land coverage) can be found in the eastern and western part of Java (MacKinnon et al., 1982), some patches of primary forest still exist in the mountainious regions of Central Java. This province has the highest human population density in Indonesia and the lowest percentage of remaining natural forest with only 3.3% of the total area (MacKinnon et al., 1982). Ornithologically this province forms a wide gap between the better known areas of West and East Java (see Nijman & Sözer, in press a). Only two of the few remaining forest patches viz. Nusa Kambangan-Segara Anakan and Mt Celering, include more than 1000 ha and are preserved as a nature reserve. The remaining patches could turn out to be vital for the longterm-survival of the Javan hawk-eagle because they may provide a stepping stone between the two remaining subpopulations.

As part of an ongoing study on the behaviour and biological requirements of the Javan hawk-eagle we surveyed several seemingly suitable forest areas in the central part of the island. For a better protection of the Javan hawk-eagle it was thought necessary to obtain a better insight in its present distribution. The results presented here were gathered in the period March-September 1994. The new data allow us to present some new facts concerning the status and threats to the species in this region.

STUDY SITES AND SURVEY METHODS

a. Study sites:

The main study sites were located on the western slope of Mt Pangrango [106°55'E, 6°41S], West Java and the southern slope of Mt Slamet [109°15'E, 7°15'S], Central Java. Survey areas in Central Java included, in an west to east sequence: Mt Slamet; the forests on the twin volcanoes Sumbing [110°04'E, 7°22'S] and Sundoro [110°00'E, 7°17S] and adjoining Mt Bismo [109°55'E, 7°14S] and Mt Butak [109°58'E, 7°15'S]; and Mt Merapi [110°26'E, 7°32'S].
Mt Slamet is a well-known volcano on the western part of Central Java. Large part of this mountain are still covered with natural forest. Of the forest above 1000 m, 150 km^2 are proposed as a nature reserve (MacKinnon, 1982), but especially on the southern and eastern slopes the forest descents below 700 m. We surveyed the southern slopes between 700 and 1000 m and the northwestern slopes between 1200 and 2200m.
In the middle part of island larger tracks of natural forest were thought to remain on Mt Sumbing (*c.* 100 km^2 on this mountain is proposed as a nature reserve, MacKinnon, 1982), Mt Sundoro and the smaller, adjoining Mt Bismo and Mt Butak. A short survey has been carried out on the south-eastern slopes of Mt Sundoro by B. van Balen in

1990, during which no Javan hawk-eagles were seen, but a more profound survey in the area was recommended (van Balen and Meyburg, 1994).
Mt Merapi is situated north of Yogyakarta. Especially the southern slopes of this very active volcano are covered with dense montane rainforest, while the western slopes are covered with the outflow of lava. Together with its twin volcano Merbabu, Merapi is proposed as a 150 km^2 recreation forest (MacKinnon et al., 1982). We surveyed the forest on the southern slopes of Mt Merapi and those on two smaller mountains on Merapi's slopes, Mt Turgo and Mt Plawangan, between *c.* 900 and the forestline at *c.* 2300 m.

b. Survey methods:
Observations from viewpoints over the canopy, on hill sides as well as surveying in the forest and identification by call were the main techniques for establishing the presence of the Javan hawk-eagle. When an area was judged to be potentialy suitable for large rainforest raptors we stayed at least two days in the area, when not we left.
We acquired more information on the distribution and status of birds by interviewing local people living near the forests and by consulting ornithologists familiar with the Javan hawk-eagle. Additional information was gathered by visiting birdmarkets and zoos.

RESULTS AND DISCUSSION

a. Distribution in Central Java
In the period April to August we visited Mt Slamet on several occassions. A pair of Javan hawk-eagles together with their second year young inhabited the the southern slopes and were observed between 650 and 970 m. On several occasions the two adult birds made display flights above a small ridge close to the forest canopy. At the end of June we surveyed the northwestern slopes near the village of Pekangdangan and we observed adult Javan hawk-eagles on different occassions between 1310 and 2200m.
In July Mt Sundoro, Mt Bismo, Mt Butak and the eastern, northern, and western parts of Mt Sumbing were visited. The area mainly consisted of cultivated land with tea plantations up to 2200 m. The water was polluted by pesticides and the only forest left were small patches of production forest, mainly consisting of *Pinus* spec. No Javan hawk-eagles were seen nor heard and it seems very unlikely that the area could support even a small population of this species.
During a survey on the southern slopes of Mt Merapi in June it became clear that the Javan hawk-eagle is also present on this mountain; from the top of Mt Turgo (*c.* 1300m), a small mountain situated north-west of the village of Kaliurang, the characteristic call of the Javan hawk-eagle was heard coming from the forest on the northern slope. A few days later, from a top of Mt Plawangan situated north-east of Kaliurang the call was heard again. This time an adult Javan hawk-eagle was flying very steadily over the canopy. After half a minute the bird disappeared into the canopy.

Prior to our survey the Javan hawk-eagle the only record of a Javan hawk-eagle in this province was that of a juvenile on the southern slopes of Mt Slamet (Seitre and Seitre, 1990). As juvenile birds are known to disperse beyond their original habitat there was no certainty about the existence of a population on Mt Slamet. The presence of adult

Javan Hawk-eagles on several localities on Mt Slamet shows that this mountain could be one of the strongholds for the Javan hawk-eagle in Central Java.
The south slope of Mt Merapi is covered with dense montane rainforest and although the area north of Kaliurang is relatively more disturbed due to it being used as a recreation forest, the area as a whole seems to be a suitable habitat for the Javan hawk-eagle.
With a conservative estimate of the home range size of a pair of Javan hawk-eagles, of 30-40 km^2 (*c.f.* van Balen and Meyburg, 1994; for assumptions see Sözer and Nijman, 1995), 5-6 pairs might be present on Mt Slamet, while Mt Merapi may harbour only one pair. If Javan hawk-eagles are also present on Merapi's twin volcano Merbabu the area as a whole may harbour 3-4 pairs.
In total these mountains may harbour almost 10% of the total population.

b. Threats to the Javan hawk-eagle
The four major threats to the Javan hawk-eagle, being its biological constraints, habitat loss, hunting and the illegal trade in birds of prey, are considered below.

As all other large birds of prey the Javan hawk-eagle has some intrinsic biological constraints such as the need of large territory sizes and therefore low population densities and prey availability. Like other *Spizaetus* species the Javan hawk-eagle may become sexually mature after three to four years (e.g. *S. cirrhatus*: Brown & Amadon, 1968; *S. bartelsi*: own obs.) and is believed to breed only once every two to three years (e.g. *S. ornatus*: Klein et al., 1988 and Madrid et al., 1991). Because only one single egg is laid (Hellebrekers and Hoogerwerf, 1967), and assuming that there are approximately 60 breeding pairs (van Balen and Meyburg, 1994), less than 30 young are produced each year. The low fecundity severly limits the Javan hawk-eagle to recover from even modest disturbances.

Besides these biological constraints there is a number of external factors that cause reason for concern. The main threat is still habitat loss. This includes deforestation and forest degradation. Fragmentation of primary forest and intensification of land use in the areas between the remaining forest patches results in an increase in isolation. As Wind (1994) states, gaps between populations may soon become too wide due to further habitat loss and fragmentation resulting in an increase of inbreeding depression. According to Thiollay and Meyburg (1988), of all the Javan forest raptors, the Javan hawk-eagle is probably the most susceptible to forest destruction.
Another immediate threat is encroachment along the edges of the forested areas. As the infrastructure is being improved the accessibility to remote areas is increasing and the Javan hawk-eagle and humans are coming into conflict more and more. This greater accessibility may also increase hunting activities. Javan hawk-eagles are rather easy to hunt, and to catch one is not too difficult for experienced bird trappers (H. Bartels, pers. comm.). Immature birds tend to wander out of their natural habitat and thus may also be seen near villages and plantations. Van Balen (1991) reports that several juvenile birds were seen above tea and coffee plantations and one was shot above a tennis lawn; another was caught underneath a village house (Sody, 1920). In April 1994 a juvenile bird was seen near the village of Sukaresmi on the northern slope of Mt Halu, south of

Bandung (T. Sibuea, pers. comm.). The presence of juvenile birds near human settlements makes them even more vulnerable for capture and hunting.
The increasing use of airguns is another major cause of concern. While studying Javan hawk-eagles near the Mt Gede-Pangrango National Park in the period April-June the authors have seen not less than seven people carring powerful air rifles for hunting birds.

The trade in birds of prey is a profitable business and although all species of diurnal birds of prey have been protected by the Indonesian law since 1970, raptors were offered for sale at nine of the ten bird markets we visited. Quite a number of Javan hawk-eagles were seen at bird markets the last years (B. van Balen, pers. comm.). Although no quantified data are available, we fear that domestic trade in the Javan hawk-eagle which has become more familiar partially as the national symbol, might increase. Experience with the Bali Starling (*Leucopsar rothschildi*), which has become the Bali province mascotte, has taught that these praise worthy initiatives should be supported by adequate law enforcement and awareness programmes.

c. Recommendations for conservation
Much of the status of the Javan hawk-eagle has still to be revealed. However some recommendations for preservation can be made:

1. As the little remaining rainforest in Central Java is still under threat of destruction, it is of the greatest importance to know more about the distribution and population size in this province. The Central Javan populations of Javan hawk-eagles are not only valuable in their own right but may also form the genetic link between the remaining subpopulations in the eastern and the western part of the island. Therefore it is essential to create one or preferably more 'safe havens'. Large forest patches like that on Mt Slamet, on which already 15,000 ha has been proposed as a nature reserve (MacKinnon et al., 1982), and which supports populations of other threatened Javan endemics such as the Javan gibbon (*Hylobates moloch*) and the Javan leaf monkey (*Presbytis comata fredericae*) are preferred for conservation purposes. The gazettement and management of such proposed protected areas would be very positive for the longterm survival of both the Javan hawk-eagle as other equally endangered species.

2. Law enforcement is a very helpful tool for conservation; regular monitoring of bird markets and bird sellers by local PHPA (Forest Protection and Nature Conservation) officers, and appropriate enforcement of the law is needed. If this includes confiscation of birds we suggest consideration is given to release adult birds back into the wild in the area they were caught immediately after the necessary medical examinations. Juvenile birds, which have not yet learned to survive in the wild, should be brought to zoos for exhibition and education purposes.

3. Further study on the Javan hawk-eagle is necessary because one cannot protect the unknown. To get a better insight in the status of the species, an extension of our dataset is welcome. We hereby elucidate some topics for further research:
- For a more accurate population estimate, information about recruitment and study of demography is needed.

- In order to get a better insight into the bird's ability to occupy new territories, and the amount of genetic exchange between subpopulations, dispersal behaviour of juvenile and adult birds need to be studied.
- For protection of the most suitable habitats, further studies on the habitat requirements and altitudinal preferences of the different age classes are recommended.

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RECENT OBSERVATIONS OF THE GRIZZLED LEAF MONKEY (*Presbytis comata*) AND AN EXTENSION OF THE RANGE OF THE JAVAN GIBBON (*Hylobates moloch*) IN CENTRAL JAVA.

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Key words: Grizzled leaf monkey, *Presbytis comata*, Javan gibbon, *Hylobates moloch*, Java.

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The western part of the island of Java, Indonesia, is the home of two endemic primate species: the Grizzled leaf monkey (*Presbytis comata*) and the Javan gibbon (*Hylobates moloch*). During ornithological research in March-September 1994, we observed both species on the western slopes of Gn Pangrango (106°51' E, 6°41' S), West Java (Gn is the abbreviation of *Gunung*, meaning mountain). During survey work in Central Java, we noted the presence of Grizzled leaf monkeys on Gn Prahu. Javan gibbons were observed in several locations throughout Central Java. Localities where observations have been made are presented in fig. 1.

The Grizzled leaf monkey or Surili has lost up to 96% of its original habitat. The total population remaining has been calculated at 8040 individuals (MacKinnon, 1987). Sody (1930) described the subspecies *fredericae*, based on specimens collected on Gn Slamet, Central Java. Unlike the West Javan Grizzled leaf monkey, which has white underparts, the Central Javan subspecies is entirely black except for some white patches on throat and abdomen (Pocock, 1934). This subspecies has been proposed as a distinct species; *P. fredericae* (D. Brandon-Jones *in* Eudey, 1987). The subspecies is known from only three localities viz. Gn Slamet, the only place where it has recently been observed (own observations and M. Linsley, pers. comm.), the northwestern slopes of mountains north of the Dieng plateau (Bartels, 1937) and Gn Lawu, for which a skin in the collection of the National Museum of Natural History at Leiden, The Netherlands, is the only evidence.

On the 5 July, on the summit of Gn Prahu (109°55' E, 7°20') - one of Bartels' Dieng mountains - at an altitude of 2565 m we observed two Grizzled leaf monkeys on the northeastern slopes. One was foraging and sun bathing in a large tree at *c.* 50 m distance. We observed the animal for about 30 minutes and a detailed description was made. In contrast to other Grizzled leaf monkeys which we had seen on the western part of Java, this animal had a large triangular shaped white patch on the chest. The lower abdomen and inner parts of the legs were white and the remainder of the underparts were black. The face was light coloured. Although this description is slightly different from those given by Sody (1930) and Pocock (1934), these individuals were presumed

to be members of the Central Javan subspecies because of the pronounced morphological difference with the West Javan form. A visit to the Leiden Museum confirmed our finding. The altitude at which the observations were made shows that the subspecies' altitudinal range appears to be considerable larger than formerly known. The rediscovery of the species at this locality provides hope for the long term survival of the subspecies and justifies a survey on its presence at other localities in Central Java. During our survey on Gn Lawu we did not find Grizzled leaf monkeys.

The Javan or Silvery Gibbon is the rarest and most endangered species of gibbon. Although most of the larger populations are found in the western province, some presumably small populations still survive in the central province. Sody (1949) described the Central Javan populations of the Javan gibbon as a separate subspecies; *Hylobates moloch pongoalsoni*. During a survey in 1978, only few gibbons were found on Gn Slamet (Kappeler, 1984). The only larger population of Javan gibbons in Central Java survived in a small forest block of 1000 ha on Gn Lawét (109°30' E, 7°15' S) (Kappeler 1984). This population was thought to be the most eastern population of the species.

Foraging Javan gibbons were observed at very close range on the southern slopes of Gn Slamet (109°13' E, 7°19' S), and we frequently heard the vocalisations of the species in the same area.

In the early morning of 22 July, we heard gibbons calling on the southeastern slopes of Gn Segara (108°48' E, 7°07' S) at an altitude of *c.* 600 m. Gn Segara is situated north-east of Gn Pojok (108°40'E, 7°10'S). Kappeler (1984) reported that this mountain did not harbour Javan gibbons, even though he did not actually survey the area. The forest on Gn Segara seemed quite undisturbed and may be very valuable as it is one of the few remaining lowland forests on non-volcanic soils in Java.

An even more interesting observation was made on 27 August. While at the foot of Gn Besar (109°37' E, 7°05' S), at an altitude of 620 m we saw one gibbon and heard gibbons caling. The calls came from two different directions, so at least two animals inhabited the area. According to a local rattan collector, a group of six gibbons was regularly seen in this area.

In the early morning of 25 September, in the same area, the vocalisations of gibbons were heard coming from the same locality as on the earlier occasion. Later that day, a gibbon was heard at close range but this time while situated on a ridge at an altitude of *c.* 750 m and *c.* 5 km south of the previous location. To our knowledge this is the first observation of Javan gibbons at this location and also the most eastern record ever. The forest in this area is still in suitable condition and only small patches are moderately disturbed. This forest extends to the eastern slopes of Gn Prahu and probably consists of more than 25,000 ha (after Collins et al., 1991), part of which is a proposed game reserve (MacKinnon et al., 1984). On Gn Prahu neither we nor Kappeler (1984) did find gibbons, and we agree with this author that there is not much suitable habitat on this mountain below the species' upper limit of 1600 m. We did, however, find natural forest descending below 1500 m on the eastern slopes, which contradicts Kappeler's (1984) statement that no forest is found below 2100 m.

The gibbons of Gn Besar are separated from their congeners on Gn Slamet by 45 km of unsuitable habitat and thus form an isolated population. The forest on Gn Besar

starts at an altitude of *c.* 300 m and according to local officers of the Forest Protection and Nature Conservation Department the lowland and lower montane forest total 10,000 ha. Just north of the area there is a new extension of rubber plantations. According to local villagers, only half a year ago this area was still covered with natural forest. Apart from Javan gibbon the area supports several interesting species e.g. Javan Hawk-eagle (*Spizaetus bartelsi*), Woolly-necked Stork (*Ciconia episcopus*) and Wreathed Hornbill (*Aceros undulatus*).

Research to confirm the suitability of these areas for the continued survival of the Javan gibbon and Grizzled leaf monkey is urgently needed. Even now, it is clear that protection of the areas discussed above is of prime importance, otherwise these species may be lost forever on this part of the island.

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O.B.C. BULLETIN: IN PRESS

Nest building of the Pink-headed Fruit-dove *Ptilinopus porphyreus* (Temminck) 1823, observed.

On 26 August 1994 at 8.30 hrs, during a survey on the eastern slopes of Mount Prahu (109°55'E, 7°10'S), 10 km west of the village of Tretep in Central Java, Indonesia, the authors, together with A. P. Setiadi and I. Setiawan, observed a pair of Pink-headed Fruit-doves *Ptilinopus porphyreus*. The birds were first seen while flying through the forest and landing in a tree. The tree was situated on a slope at an altitude of 1715 m a.s.l. From the ridge one could view the tree's canopy. The forest along the trail was moderately disturbed due to woodcutting but the adjoining valleys were still covered with primary and undisturbed secondary montane forest.

While staying on the ridge, both birds could be observed from only a few metres distance. In the male, head, neck, nape and upper breast were pinkish-purple bordered by a white and a black band which was rather contrasting with the greyish-green underparts and dark green upperparts. The female was somewhat duller coloured and its breast band was less bright. The birds were perched very close to each other and when one flew to another branch, the other almost immediately followed. After *c.* 10 minutes the male flew off in southern direction into the adjacent valley while the female remained perched in the tree. After about five minutes the male flew along the trail passing us with high speed and perched in a tree a few meters from the previous one, but on the other side of the trail. When the well camouflaged fruit-dove was seen hopping in this tree we noted that the bird carried a twig in its bill. This twig, between 15-20 cm in size, was brought to a construction which appeared to be the beginning of a nest. The nest was situated near the tip on a horizontally forked branch in the lower canopy of one of the larger trees in the area, *c.* 3 m above the ground and consisted of an untidy construction of dry twigs.

During the next 45 minutes the male was observed flying into the valley and bringing twigs to the nest for seven times. When returning to the nest, the male first landed in the lower canopy of a tree lower on the slope. It then hopped from one branch to a higher one and upon reaching the higher canopy it flew to the next tree somewhat higher on the slope. When it reached the nest the twig was quickly put in to it and the male left the site, in search for another twig. The female was not seen participating in the nestbuilding.

About 90 minutes after the site was left the authors returned to make some more observations. This time only the male was seen and it seemed as if the nest was almost finished while the bird stayed in the vicinity of the nest. After 10 minutes we left the site.

The Pink-headed Fruit-dove occurs on the islands of Sumatra, Java and Bali. It is found in the forested mountain areas between 1400 and 2200 m [6],but has also been reported at lower altitudes [5]. Pink-headed Fruit-doves are mostly seen in pairs and have been reported to feed together with other bird species like barbets *Megalaima* spp.[4] This bird is nowhere common and although it is present throughout Java, it is seldom seen. It is described as shy and inconspicious in its behaviour [6]. Little is known about this bird and its breeding biology [3]. The first observations of a nest where made by van Balen &

Marhadi [1] who noted breeding in the beginning of October and the presence of chicks in the same nest in November. They reported that the birds were quiet and little active, and could be approached up to a few metres. Crome [2] studied the Purple-crowned Fruit-dove *P. superbus* and reported this species to be extremely nervous during nest building. This does not agree with our observations on Pink-headed Fruit-dove and that species seems to be less shy than its congener. We could approach the male up to three metres without it taking off. During the observations we were sitting very close to the nest tree but the male kept on bringing nesting material and building its nest.

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BIRD CONSERVATION INTERNATIONAL: IN PRESS

New information on the distribution of Chestnut-bellied Partridge *Arborophila javanica* in the central parts of Java

VINCENT NIJMAN and RESIT SÖZER

Summary

Chestnut-bellied Partridge *Arborophila javanica* is confined to the hill and mountain forests of Java. Until recently, its range was thought to be restricted to the western and eastern part of the island. Surveys performed in March-September 1994 in the central part of the island showed it to be present there as well. The species was found in six remnant forest patches where it was not known to occur. Data on habitat preferences and altitudinal distribution are given.

Ringkasan

Puyuh-gonggong Jawa *Arborophila javanica* hanya dapat dijumpai di hutan-hutan pegunungan di Pulau Jawa. Dahulu jenis ini diperkirakan hanya tersebar di bagian Barat dan Timur pulau ini saja. Sebuah survey yang dilakukan pada bulan Maret-September 1994 di bagian tengah pulau menunjukan keberadaan jenis ini. Jenis ini dijumpai di enam lokasi yang merupakan sisa-sisa hutan. Data mengenai habitat dan distribusi berdasarkan ketinggian dipertelakan dalam tulisan ini.

Introduction

The Greater Sunda Islands are the domain of ten species of partridge, including four single island endemics. One of the latter is the Chestnut-bellied Partridge *Arborophila javanica*, endemic to the island of Java, Indonesia. The species is considered to be rather common within its limited range (Holmes 1989). It is confined to the hill and montane forests and has been recorded at altitudes from 300 to 3000 m (van Balen 1992). The species is not considered to be globally threatened but is considered 'vulnerable' in the Mace-Lande categorisation (del Hoyo et al. 1994). Based on differences in head pattern three 'subspecies' have been named: nominate *javanica* in the western part, *bartelsi* on Mt Ciremai on the eastern part of West Java (Siebers 1929), and *lawuana* on Mt Lawu on the border between Central and East Java (Bartels 1937). In easternmost part of East Java it is replaced by the Grey-breasted Partridge *A. orientalis*. The latter species is also present throughout Sumatra (van Marle and Voous, 1988).

Surveys by van Balen (1992) showed that the Chestnut-bellied Partridge is still widespread in the western and eastern part of the island. To the best of our knowledge there are no records between the easternmost locality in West (Mt Ciremai) and the westernmost locality in East Java (Mt Semeru-Tengger) other than those from Mt Lawu.

In this paper information is provided on the distribution of the species in the central part of the island and data on altitudinal distribution and habitat preference are presented.

Methods

During ornithological fieldwork in March-September 1994, of which the endemic Javan Hawk-eagle *Spizaetus bartelsi* was the main study object, we became familiar with the vocalisations of Chestnut-bellied Partridge on Mt Pangrango and Mt Gede in West Java. A part of our study was to clarify the distribution of the Javan Hawk-eagle in the central parts of Java and during these surveys we noted the presence of Chestnut-bellied Partridge and other endemics. Chestnut-bellied Partridge is rather secretive and difficult to observe, but when one is familiar with the call it is easily detected. The vocalisation of Chestnut-bellied Partridge is characteristic although the Grey-breasted Partridge, from the easternmost part of East Java, has been reported to have a similar call (van Balen 1992). All but one of the observations were made by ear. In several of the areas visited we found scrapes in the litter on the forest bottom, but although these were probably made by Chestnut-bellied Partridge, we did not consider them as confirmed records. Additional information was gathered by interviewing local people living near the forest and by visiting local birdmarkets.

Almost all the larger tracts of forest between Mt Ciremai in West Java and Mt Tengger-Semeru in East Java were visited. Altogether these comprise more than 1200 km^2, which is over 90% of the remaining natural forest in this part of Java. The areas in which we found Chestnut-bellied Partridge are discussed below in a west to east sequence.

Results

Mt Segara

This mountain is situated in the eastern part of Central Java, near the border with West Java, and less than 50 km south-east of Mt Ciremai, the type locality of *bartelsi.* The forests on this mountain are continuous with those of the proposed nature reserve Pembarisan to the northeast (see map 19.2 in Collins et al. 1989). Together the forests in these area total *c.* 22,500 ha. On 21 and 22 July we heard calls coming from the dense forest at altitudes between 600-700 m.

In the village of Salem, south of Mt Segara, we saw several Chestnut-bellied Partridges kept by a private owner. They were said to be caught in the forest nearby.

Mt Slamet

On the southern slopes of this mountain the Chestnut-bellied Partridge was heard calling, and scratch marks were seen on a ridge at 950 m altitude. On 23 July we observed a party of six Chestnut-bellied Partridges in an undisturbed patch of montane forest on the northwestern slopes, at an altitude of 1730 m. On Mt Slamet *c.* 200 km^2 of forest remains.

Mt Besar
During a short visit, on 26 August, to the moderately disturbed lowland forest on the northern foot hills of Mt Besar, we frequently heard Chestnut-bellied Partridges calling from the interior of the forest. The forest in this area descends below *c.* 250 m; the calling was heard at altitudes between 600 and 650 m.

Mt Prahu
Chestnut-bellied Partridges were recorded on the southern and eastern slopes of this mountain, all above 1600 m. On 5 July we heard the calls of the species while we were at the summit of the mountain at an altitude of 2565 m. The forests on Mt Prahu are continuous with those on Mt Besar and comprise *c.* 275 km^2.

Mt Wilis-Liman
The twin volcanoes Wilis and Liman are covered with an extensive block of rainforest (*c.* 450 km^2) ranging from hill to montane and are situated between Mt Lawu and the Mt Tengger-Semeru complex in East Java. We visited the southeastern slopes of Mt Wilis on 13 and 14 August and Chestnut-bellied Partridge was recorded at altitudes between between 700 and 1200 m. There is a slight possibility that our records from these mountains refer to Grey-breasted Partridge. However, present knowledge of the distribution of these species suggests that our records concerned Chestnut-bellied Partridge.

During a short survey on Mt Sundoro (3135 m; 110°00'E, 7°17'S) we found that there was no suitable forest left for the species and Chestnut-bellied Partridge was not heard in this area. On Mt Merapi (2911 m; 110°26'E, 7°32'S) and Mt Muria (1620 m; 110°52'E, 6°37'S) rather large areas are still covered with forest but we did not find Chestnut-bellied Partridge in these mountains either. We also paid a visit to the forests between 1000 and 2500 m on Mt Lawu (111°10' E, 7°40'S) and although the species is reported from this mountain we did not observe it.

Discussion

Most of our observations were made within undisturbed forest areas. As lowland and hill forests have become very rare on Java, only a small number of records originate from these areas. However we observed the species at all altitudes from 600 m to almost 2600 m.

Our observations reveal a more or less continuous distribution throughout the island. The three 'subspecies' show considerable individual variation in the morphological characters on which there separation was based. In view of the new information on distribution it would be interesting to know whether intraspecific variation is geographically disjunct - as suggested by Siebers (1929) and Bartels (1937) - or of a clinal nature, in which case recognition of different subspecies would not be warranted. As no specimens are available from the central parts of Java, this question must remain open for the moment.

The Chestnut-bellied Partridge is more widespread than previously thought, as became apparent after an increase in ornithological activities during the last decade (van

Balen, 1992). Ornithologically, Central Java is probably the island's least studied province. Several bird species are thought to be restricted to either the western or the eastern province or to show a disjunct distribution with no records from the central part. Further ornithological research in this part of the island will have to clarify whether this assumption holds. For instance, the Brown-throated Barbet *Megalaima corvina* was thought to be confined to the montane rainforests of West Java (MacKinnon and Phillipps 1993), but we found it to be present not only on Mt Gede-Pangrango but also on Mt Segara, Mt Slamet, Mt Besar and Mt Prahu, the latter locality being 125 km east of the West Javan border. The same accounts for the Javan Tesia *Tesia superciliaris*, said to be endemic to West Java and recorded east to Mt Ciremai (MacKinnon and Phillipps 1993). We found this species to be present on Mt Slamet. Furthermore, the Sunda Serin *Serinus estherae* and the Javan Hawk-eagle are species known to have a disjunct distribution (MacKinnon and Phillipps, 1993). We found both species on several localities in the cental part of Java (Sözer and Nijman 1995).

Less than 10% of Java's natural forest now remains and especially the lowland and hill rainforests are shrinking every year. With an ever increasing human population and infrastructural developments, pressure on the montane forest also becomes more and more severe. The Chestnut-bellied Partridge is highly prized for its meat and as the mountains become more accessable, hunting pressure may become a serious threat (van Balen 1992). The species is not included in BirdLife's checklist of threatened bird species (Collar et al. 1994). During conversations with local people it became clear that they appreciate the species both as a cage bird and as food. At almost every bird market visited during our stay in Java, Chestnut-bellied Partridges were offered for sale.

The present study shows that the Chestnut-bellied Partridge is still to be found in almost all the major forest areas from Mt Halimun (Holmes 1989, van Balen 1992) in the west[1] to Mt Tengger-Semeru in the east. Although the species is not considered to be threatened at present, it would be essential for its long term survival to preserve the forest areas in the central part of the island, where no large areas currently have an adequate protection status. This would prevent populations to become isolated in different small subpopulations. Many other species would equally benefit from such conservation actions. Specific recommendations for the conservation of forest areas in Central Java are made in a species conservation action plan for the Javan Hawk-eagle, presently being prepared by BirdLife International Indonesia Programme, Bogor.

[1] Note: The species may even be found further to the west as van Balen (1992) reports an unconfirmed record by D.A. Holmes from Mt Karang.

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ERRATA

Fig. 11: Distribution of the Javan Hawk-eagle. Solid lines indicate borders of forest areas.
● = present, o = not found during this study, or known from historical data only.
1. Ujung Kulon, 2. Gn Halimun, 3. Gn Salak, 4. Gn Pangrango, 5. Gn Gede, 6. Gn Tankuban Perahu, 7. Gn Halu, 8. Gn Patuha, 9. Gn Papandayan, 10. Gn Segara, 11. Karananyar, 12. Gn Slamet, 13. Gn Besar, 14. Gn Prahu, 15. Gn Bismo, 16. Gn Butak, 17. Gn Sundoro, 18. Gn Sumbing, 19. Gn Ungaran, 20. Gn Merbabu, 21. Gn Merapi, 22. Gn Muria, 23. Gn Lawu, 24. Gn Liman-Wilis, 25. Gn Kawi-Arjuno, 26. Lebakharjo, 27. Gn Tengger-Bromo, 28. Yang highlands, 29. Meru Betiri, 30. Kalibaru, 31. Ijen highlands, 32. Baluran, 33. Alas Purwo.