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Spatial and temporal variation in migrant raptors on Java, Indonesia

Vincent Nijman

Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, PO Box 94766,
1090 GT Amsterdam, The Netherlands. Email: nijman@science.uva.nl

Abstract. The migration of northern migrant raptors was studied at three sites in the western half of the island of Java, Indonesia during the northern autumns of 1998 and 1999. During 58 days of observation 4716 migrants were observed, 3087 of which could be identified to species level. The migrants comprised six species, i.e. Chinese Sparrowhawk, *Accipiter soloensis* (2570 birds identified), Japanese Sparrowhawk, *A. gularis* (245 birds), Oriental Honey-buzzard, *Pernis ptilorhyncus* (269 birds), Common Buzzard, *Buteo buteo* (1 bird), Booted Eagle, *Hieraaetus pennatus* (1 bird), and Marsh Harrier, *Circus aeruginosus* (1 bird). Both Chinese Sparrowhawks and Japanese Sparrowhawks were frequently observed in large flocks, whereas Oriental Honey Buzzards were more frequently seen singly or in pairs. Between sites, intra-annual variation in proportions of the three most common species identified remained constant over the two-year study period, whereas within one site (Puncak Pass) the proportion of Oriental Honey Buzzards varied from 6 to 10% between years. Migration starts in the third week of September and passage rates (the number of birds passing per hour during 09.01–12.00 hours) of the raptors peaked at the end of October and showed little spatial variation. Migration was observed until the second week of November but it probably continues until mid- or late November. The findings confirm the existence of a large east-south-eastern passage over Java similar to that over the Thai–Malay Peninsula and Bali. Populations migrating through Java originate from northern Asia and most likely have passed over the Thai–Malay Peninsula and Sumatra before reaching Java. An unknown proportion continues on to Bali and/or the Lesser Sunda Islands, but little is known about their final wintering grounds.

Introduction

The island of Java, Indonesia, harbours 18 resident species of birds of prey, the populations of three of which are augmented by congeners from the mainland during the northern winter (viz. Osprey, *Pandion haliaetus*, Oriental Honey Buzzard, *Pernis ptilorhyncus*, and Peregrine Falcon, *Falco peregrinus*). Additionally, seven species have been recorded as migrants, i.e. five during the northern winter, one (Australian Kestrel, *Falco cenchroides*) as an irregular visitor from Australia, and one (Short-toed Eagle, *Circaetus gallicus*) that has been recorded regularly at the easternmost part of Java. Individuals of the latter most probably originate from the resident population in the Lesser Sunda Islands (van Balen and Compost 1989). Of the five northern migrants, four migrate further east to Bali (Grey-faced Buzzard, *Butastur indicus*, and Common Buzzard, *Buteo buteo*) and the Lesser Sunda Islands (Chinese Sparrowhawk, *Accipiter soloensis*, and Japanese Sparrowhawk, *A. gularis*) (Ash 1993; MacKinnon *et al.* 1998) whereas the fifth, Black Baza, *Aviceda leuphotes*, rarely reaches West Java (van Balen 1984).

In the last decade there has been a steady increase in the number of studies of Javan raptors. Most of these are centred on the endangered, endemic Javan Hawk-eagle, *Spizaetus bartelsi*, especially after its proclamation as Indonesia's

national bird in 1993 (van Balen 1998; Nijman *et al.* 2000). Comparatively few studies have been conducted on migratory species, and the area south of the equator remains part of the Asian–Australasian bird-migration system least studied (cf. Lane and Parish 1991; Zalles and Bildstein 2000). Zalles and Bildstein (2000: p. 33) commented, ‘with the exception of the Middle East, information regarding the movements of raptors in the [Asian-Pacific] region remains decidedly imprecise. Indeed, country specific information is lacking for at least half of all migratory raptors in six countries in the region [including Indonesia]’. Ash's (1984, 1993) study, during which thousands of migrant raptors were observed making a land-fall on Bali, clearly indicated that Java is an important passage site for raptors.

During September 1998–January 1999 and September–October 1999, systematic observations on migrating raptors were made as part of a long-term (1994 onwards) raptor study. Few quantitative data are available on the numbers of raptors migrating through the Indo-Malayan region or on temporal changes in their abundance (Wells 1999; Zalles and Bildstein 2000). The study therefore set out to collect quantitative data on northern migrant raptors and to document the temporal and spatial variation in numbers and species composition on Java.

Methods

The study was conducted near the village of Linggo [7°06'S, 109°35'E], in the north-western foothills of the Dieng mountains, central Java (22 September–31 October 1998, 20 December 1998–6 January 1999, 24–26 September and 9–22 October 1999) and near the Puncak Pass [6°35'S, 106°58'E], west Java (19–21 September, 30 September–3 October and 24 October–3 November 1999). Additionally, observations were made on 6 and 9 November 1999 near Bakauheni [5°50'S, 105°43'E] and Merak [5°55'S, 105°59'E], on either side of the Sunda Strait between Java and Sumatra (Fig. 1). Up to several weeks prior to the study proper, resident forest raptors were studied in Linggo (1998) and the Puncak Pass (1999); systematic data collection on migrant raptors started when the first migrant raptor was observed. In all, raptor migration was studied on 58 days; during the remaining days observations were made on an *ad hoc* basis.

The surroundings of Linggo consisted of hilly terrain at 300–1310 m above sea level, covered with a mixture of old secondary forest, wet rice fields and shrub land. The Puncak Pass (c. 1100–1400 m above sea level) was dominated by tea gardens, with small patches of natural forest on some of ridges or valleys. Observation points were selected on ridges, hill tops, along forest edges and, in Linggo, on a watch-tower. Observations were made at all hours of the day, but since both study sites are characterised by large amounts of rain (Linggo c. 6000–7000 mm annually, Puncak Pass c. 2000–3000 mm; RePPPProT 1990), conditions were unfavourable during parts of the day, especially during the afternoon. Most observations were made between 08.00 and 12.00 hours; the sky was methodically scanned using clouds and distant landmarks as a frame of reference for distance focusing (Bildstein and Zalles 1995). Special attention was paid to aggregations of resident raptors and storks as these tend to indicate good flight conditions that may be conducive to migration. In comparing temporal and spatial variation in species composition unpublished data was used from A. Long and S. van Balen (in Nijman 2001), who studied raptor migration in the Puncak Pass in October 1996 using similar methodologies at the same observation point (S. van Balen, personal communication) as in the present study. For each week the passage rates (the number of individuals passing per hour) during 09.01–12.00 hours for the three most common species were calculated, both for Linggo and the Puncak Pass. Significantly more groups of raptors are observed during this time than during other parts of the day (Nijman 2001). Means are reported plus or minus one standard error of the mean (s.e.m.). For statistical analyses non-parametric statistics were used

(Siegel 1956), and significance is assumed when $P < 0.05$ in a two-tailed test.

Results

During the study, six species of northern migrants were recorded: Chinese Sparrowhawk, Japanese Sparrowhawk, Oriental Honey Buzzard, Common Buzzard, Booted Eagle, *Hieraaetus pennatus*, and Marsh Harrier, *Circus aeruginosus*. Generally, at all three localities, migration was in an easterly direction. In total, some 4770 individuals were counted, i.e. 3665 near Linggo, 1024 near the Puncak Pass, and 93 in the Sunda Strait. Most individuals were accipiters ($n = 4444$), of which two-thirds could be identified to species level. The Chinese Sparrowhawk was about ten times as common as the Japanese Sparrowhawk. Some 6% of the migrants were Oriental Honey Buzzards (Table 1). Of the three remaining species only a single individual of each was recorded. The results from the Puncak Pass in 1996 were similar to the count made in the present study, i.e. 1472 Chinese Sparrowhawks, 36 Japanese Sparrowhawks, 735 unidentified Sparrowhawks, and 260 Oriental Honey Buzzards (S. van Balen and A. Long, in Nijman 2001).

No significant differences were apparent in the numbers of birds identified at the Sunda Strait, Linggo (1998 and 1999) and Puncak Pass (1996 and 1999) (Kruskal–Wallis one-way ANOVA, $H = 5.93$, d.f. = 4, $P > 0.1$); pairwise comparisons within sites between years showed no significant difference either (Puncak Pass 1996 v. 1999, Mann–Whitney U , $n_1 = 3$, $n_2 = 3$, $P > 0.2$; Linggo 1998 v. 1999, Mann–Whitney U , $n_1 = 3$, $n_2 = 3$, $P > 0.1$). Excluding the Sunda Strait (many accipiters may have been missed as they are less easily spotted above open sea than were the larger Oriental Honey Buzzards), the number of all accipiters compared with Oriental Honey Buzzards differs between sites and between years ($\chi^2 = 74.7$, d.f. = 3, $P < 0.001$).

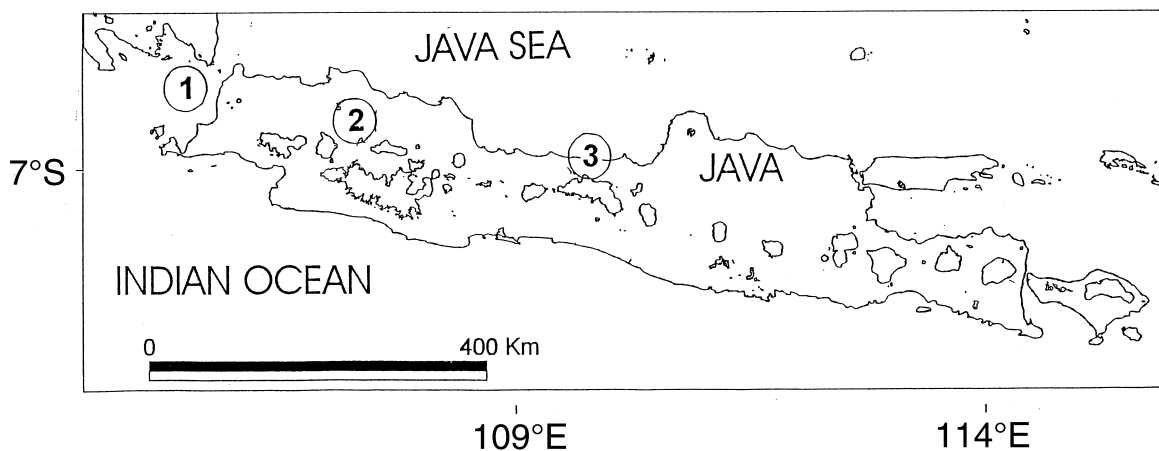


Fig. 1. The island of Java, Indonesia, with the three study sites. The drawn line indicates land above 1000 m above sea level. Key: 1 = Sunda Strait; 2 = Puncak Pass; 3 = Linggo.

Table 1. Numbers, proportion and group sizes of three northern migrant raptors at three study sites in Java, Indonesia
Group sizes are of single-species flocks only (i.e. excluding mixed flocks); data shown are mean \pm s.e.m. (no. of flocks observed), and maximum flock size

Site ^A and year	Chinese Sparrowhawk <i>Accipiter soloensis</i>		Japanese Sparrowhawk <i>Accipiter gularis</i>		Unidentified sparrowhawk <i>Accipiter</i> spp.	Oriental Honey Buzzard <i>Pernis ptilorhynchus</i>	
	No. observed	Group size	No. observed	Group size		No. observed	Group size
1. Sunda Strait, 1999	3 (3%)	1.5 \pm 0.5 (2) 2	7 (8%)	1.2 \pm 0.2 (6) 2	45 (48%)	38 (41%)	4.3 \pm 1.1 (8) 9
2. Puncak, 1999	553 (54%)	8.3 \pm 2.9 (55) 130	24 (2%)	4.4 \pm 1.4 (9) 13	389 (38%)	58 (6%)	2.0 \pm 0.3 (10) 4
3. Linggo, 1998	565 (64%)	8.1 \pm 3.2 (45) 129	16 (2%)	3.2 \pm 1.3 (5) 8	256 (29%)	47 (5%)	2.7 \pm 0.9 (6) 7
3. Linggo, 1999	1449 (53%)	11.1 \pm 3.2 (58) 144	198 (7%)	7.6 \pm 2.9 (9) 27	939 (35%)	126 (5%)	4.8 \pm 2.3 (10) 25
Total, 1998–99	2570 (54%)	9.2 \pm 1.7 (161) 144	245 (5%)	4.5 \pm 1.1 (29) 27	1629 (35%)	269 (6%)	3.6 \pm 0.8 (35) 25

^ANumbers refer to Fig. 1.

Inter-annual differences are non-significant ($\chi^2 = 0.11$, d.f. = 1, $P > 0.5$) for Linggo, but significant for the Puncak Pass ($\chi^2 = 62.6$, d.f. = 1, $P < 0.001$); in 1996 more than 10% of the migrants observed were Oriental Honey Buzzards, whereas in 1999 this species comprised less than 6%.

Although more raptors were observed at Linggo in 1999 than in 1998, passage rates did not differ for any of the three common species (Mann–Whitney U , all $P > 0.05$). Therefore, data from both years were pooled to provide an overview of the numbers of migrants involved (Fig. 2). Passage rates in the fifth week (18–24 October) were higher for accipiters (both species plus all accipiters combined) in Linggo than at the Puncak Pass, but due to the relatively large number of hours without raptor passage, the difference was not significant (Mann–Whitney U , all $P > 0.05$). In the sixth week (25–31 October) the reverse was observed, when the combined passage rates for all accipiters at the Puncak Pass were higher than at Linggo (Mann–Whitney U , $n_1 = 9$, $n_2 = 11$, $P < 0.05$).

In general, during the first week of migration (20–26 September), only single individuals passed by, whereas in the second and third week (27 September–10 October), on average, fewer than 10 raptors passed by per hour. In the fourth and fifth weeks (11–24 October) passage rates were higher, but in the last two weeks (25 October–4 November) numbers dropped again to an average of fewer than 10 birds per hour, although occasionally passage rates of over 100 birds per hour were recorded.

Chinese Sparrowhawks were by far the most commonly encountered migrant and were observed during 26 September–31 October (Linggo), 21 September–3 November (Puncak Pass) and 6–9 November (Sunda Strait). Passage rates were highest during 18–24 October, with 36.4 ± 23.2 individuals per hour (Linggo) and during 25–31 October, with 38.7 ± 18.3 individuals per hour (Puncak Pass). Japanese Sparrowhawks were encountered less often and were observed during 26 September–31 October (Linggo), 2 October–3 November (Puncak Pass) and 6–9 November (Sunda Strait). More often than Chinese

Sparrowhawks, Japanese Sparrowhawks were observed as solitary individuals, i.e. some 42%; however, occasionally flocks of more than 5 individuals were observed. Passage rates peaked during 18–24 October, with 9.4 ± 7.3 and

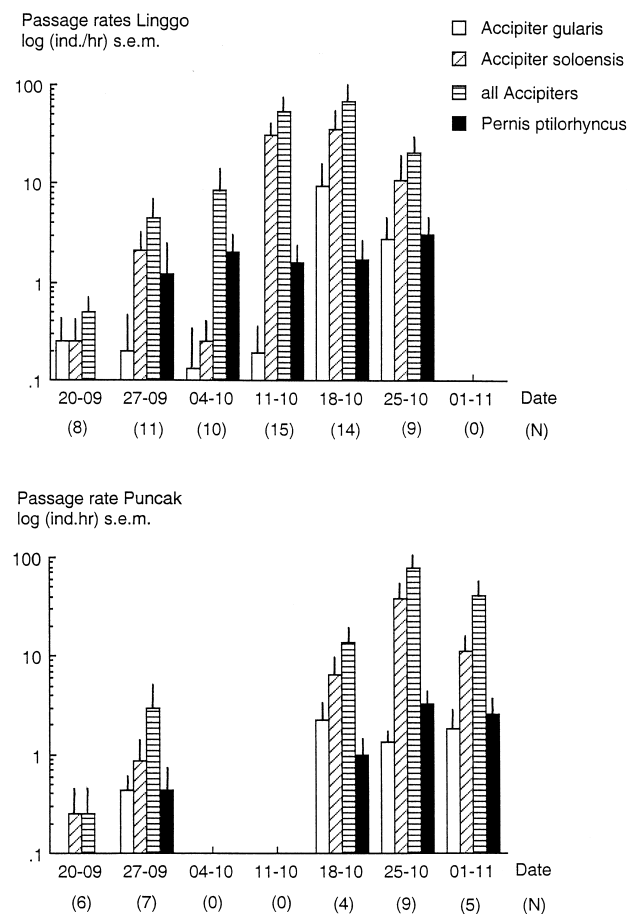


Fig. 2. Passage rates (number of individuals passing per hour between 09.01–12.00 hours) plus one standard error of the mean, of three species of northern migrant raptor between 20 September and 4 November at two sites on Java, Indonesia. Sample size (N) is number of observation hours.

2.3 ± 1.4 individuals per hour, for Linggo and the Puncak Pass, respectively. Oriental Honey Buzzards passed during 28 September–27 October (Linggo), 3 October–3 November (Puncak Pass) and 6–9 November (Sunda Strait). At the latter site it was the most common raptor identified, possibly as it was more easily spotted above open sea than were the smaller accipiters. The species was mostly observed as singles or in pairs, or, less frequently, small groups (<5 birds). Oriental Honey Buzzards were frequently observed among flocks of accipiters. Passage rates were highest during 25–31 October, with 3.1 ± 1.8 and 3.3 ± 1.3 individuals per hour, for Linggo and the Puncak Pass, respectively. Oriental Honey Buzzards did not show a clear peak in numbers, in contrast to the two accipiters.

On the morning of 26 October 1998, near Linggo, a single Common Buzzard was observed. The buzzard was attacked by a resident Crested Serpent-eagle, *Spilornis cheela*, after the buzzard counter-attacked three times from above. On 22 October 1999, a single pale-morph Booted Eagle was seen soaring over an area of shrub-land near Linggo, adjacent to tall forest. On 11 October 1999 from the watchtower near Linggo, a Marsh Harrier was observed gliding in an easterly direction. All three species flew in from a westerly direction and flew off in an easterly or south-easterly direction, following the alignment of the Dieng mountains.

Discussion

The present study indicates that there is a large easterly passage of migrant raptors over Java, including species rarely recorded for the island. Just as in the Thai–Malay peninsula (Wells 1990, 1999) and Bali (Ash 1984, 1993), the main species involved are Chinese Sparrowhawks, Japanese Sparrowhawks and Oriental Honey Buzzards, although the proportions at which the species are recorded differ greatly between the sites (Nijman 2001). On Java, within sites, inter-annual variation is small, as is variation between sites. Both accipiters were frequently observed in small to moderately large flocks, contradicting Kerlinger (1989) who, while reviewing the flocking behaviour of migratory raptors, noted that of the 18 complete migrants only the Chinese Sparrowhawk was not known to form flocks. Likewise, the Japanese sparrowhawk was considered to be a non-flocking species (Kerlinger 1989). Common Buzzards, Booted Eagles and Marsh Harriers are rarely observed on Java (MacKinnon *et al.* 1998), and the observation of these species demonstrates that much is yet to be learned about the zoogeography of raptor migration in Indonesia.

The migrating raptors observed consisted of birds originating from eastern Asia. They must have passed over Indo-China, the Thai–Malay peninsula and Sumatra before reaching the Sunda Strait, the Puncak Pass or the Dieng mountains. An unknown proportion migrates further to Bali and/or the Lesser Sunda Islands, but their final destination remains largely unknown (Coates and Bishop 1997). None of

the south-east Asian migratory raptors reaches mainland Australia or mainland New Guinea (Beehler *et al.* 1986; Lane and Parish 1991; Marchant and Higgins 1993) although there is a resident population of (Eastern) Marsh Harrier, *Circus aeruginosus spilonotus*, on New Guinea (Beehler *et al.* 1986).

In Java migration starts at the end of September. The numbers of accipiters seem to peak during the second and third week of October when up to several hundred birds were passing per hour. Honey Buzzards showed less of a peak. Data from the Sunda Strait and observations at the Puncak Pass (A. A. Supriatna, personal communication) indicate that migration continues into the second half of November and possibly even later. In the Thai–Malay peninsula (Medway and Wells 1976; Wells 1990, 1999), Japanese Sparrowhawks are generally observed migrating southwards from the second week of September to the end of December, with a peak from the end of September to the end of October. Chinese Sparrowhawks are observed in smaller numbers, but the peak occurs at roughly the same time. Passage rates of accipiters may reach >1200 birds per hour. For Bali, Ash (1993) recorded passage rates of 313 and 60 birds per hour for Japanese Sparrowhawks and Chinese Sparrowhawks, respectively. The greatest numbers of accipiters were observed between 13 and 25 October for Chinese Sparrowhawks and 10 and 20 October for Japanese Sparrowhawks. This suggests a time-lag of approximately one week between Java and Bali. This might be due to birds arriving at Bali from a northern direction (Nijman 2001), which probably did not overflow western Java. Oriental Honey Buzzards in the Thai–Malay peninsula are observed in great numbers throughout October and November (Wells 1999). Passage rates have been as high as 540 birds per hour (Wells 1990), i.e. up to two orders of magnitude higher than recorded during the present study. On Bali, numbers of Oriental Honey Buzzards seemed to peak from the third week of October to the first week of November, with the passage of 77 birds per hour (Ash 1993).

Little is known about the return migration of raptors on Java. Passage has been observed at the end of February and early March in the surroundings of Bogor [6°35'S, 106°48'E], west Java (E. Meijaard, personal communication; R. Grimmett, personal communication) and in early April over Sangiang Island in the Sunda Strait [5°56'S, 105°50'E] (Milton and Marhadi 1985). Few observations have been made on return migration possibly because, as in the Thai–Malay peninsula (Medway and Wells 1976), it is more attenuated and less conspicuous than the northern autumn passage (cf. Zalles and Bildstein 2000).

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